Don Pedro Project Relicensing

W&AR-05
Salmonid Population Information Synthesis

Consultation Workshops Log

Workshop Description	No.	Meeting Date
Salmonid Population Information Synthesis	1	04/10/2012
Salmonid Population Information Synthesis	2	06/26/2012

April 10, 2012 Workshop No. 1 Documents:

DATE	FROM	TO	SUBJECT
02/07/2012	Rose Staples, HDR	Relicensing Participants	Proposed Workshops/Meetings Schedule for 2012
04/02/2012	Rose Staples, HDR	Relicensing Participants	Agenda and Advanced Materials
04/06/2012	Rose Staples, HDR	Relicensing Participants	Logistics
04/10/2012	Rose Staples, HDR	Relicensing Participants	Logistics
04/20/2012	Rose Staples, HDR	Relicensing Participants	Draft Meeting Notes for 30-Day Review and Comment (copy attached to 06/15/2012 filing of the Final Meeting Notes with FERC)
05/07/2012	Zachary Jackson, USFWS	Rose Staples, HDR	List of Additional Information Sources (copy attached to 06/15/2012 filing of the Final Meeting Notes with FERC)
05/16/2012	Jeffrey Single, CDFW	Districts	Comments on Draft Meeting Notes (copy attached to 06/15/2012 filing of the Final Meeting Notes with FERC)
05/18/2012	Conservation Groups	Districts	Comments on Draft Meeting Notes (copy attached to 06/15/2012 filing of the Final Meeting Notes with FERC)
06/15/2012	Rose Staples, HDR	Relicensing Participants	Final Meeting Notes filed with FERC, including Comments from Relicensing Participants and Districts' Response to Comments

June 26, 2012 Workshop No. 2 Documents:

DATE	FROM	TO	SUBJECT
02/07/2012	Rose Staples, HDR	Relicensing Participants	Proposed Workshops/Meetings Schedule for 2012
03/05/2012	Rose Staples, HDR	Relicensing Participants	Confirmation of Workshop Dates/Consultation Workshop Process Draft
06/15/2012	Rose Staples, HDR	Relicensing Participants	Agenda and Advanced Materials
06/15/2012	Rose Staples, HDR	Relicensing Participants	Recent Website Postings
06/25/2012	Rose Staples, HDR	Relicensing Participants	Logistics
07/11/2012	John Devine, HDR	Annie Manji, CDFW	Response to Inquiry Regarding Meeting Notes
07/25/2012	Rose Staples, HDR	Relicensing Participants	Draft Meeting Notes for 30-Day Review and Comment (copy attached to 11/15/2012 filing of the Final Meeting Notes with FERC)
08/24/2012	Daniel Welsh, USFWS	Districts	Comments on Draft Meeting Notes (copy attached to 11/15/2012 filing of the Final Meeting Notes with FERC)
08/24/2012	Patrick Koepele, TRT and Chris Shutes, CSPA	Districts	Comments on Draft Meeting Notes (copy attached to 11/15/2012 filing of the Final Meeting Notes with FERC)
08/31/2012	Jeffrey Single, CDFW	FERC/Districts	Comments on Draft Meeting Notes (copy attached to 11/15/2012 filing of the Final Meeting Notes with FERC)
08/31/2012	Peter Barnes, SWRCB	Rose Staples, HDR and John Devine, HDR	Comments on Draft Meeting Notes (copy attached to 11/15/2012 filing of the Final Meeting Notes with FERC)
11/15/2012	John Devine, HDR	FERC	Final Meeting Notes filed with FERC, including Comments received from Relicensing Participants and Districts’ Response to Comments

Consultation Workshop No. 1

April 10, 2012

From: Staples, Rose
Sent: Tuesday, February 07, 2012 8:15 PM
To: Alves, Jim - City of Modesto; Anderson, Craig - USFWS; Asay, Lynette - N-R; Aud, John - SCERD; Barnes, James - BLM; Barnes, Peter - SWRCB; Beuttler, John - CSPA; Blake, Martin; Bond, Jack - City of Modesto; Boucher, Allison - TRC; Boucher, Dave - Allison - TRC; Bowes, Stephen - NPS; Bowman, Art - CWRMP; Brenneman, Beth - BLM; Brewer, Doug - TetraTech; Brochini, Anthony - SSMN; Brochini, Tony - NPS; Buckley, John - CSERC; Buckley, Mark; Burley, Silvia-CVMT; Burt, Charles - CalPoly; Cadagan, Jerry; Carlin, Michael - SFPUC; Catlett, Kelly - FOR; Charles, Cindy - GWWF; Cismowski, Gail - SWRCB; Costa, Jan - Chicken Ranch; Cowan, Jeffrey; Cox, Stanley Rob - TBMWI; Cranston, Peggy - BLM; Cremeen, Rebecca - CSERC; Day, Kevin - TBMI; Day, P - MF; Denean - BVR; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne - OHP; Dowd, Maggie-SNF; Drekmeier, Peter - TRT; Edmondson, Steve - NOAA; Eicher, James - BLM; Fety, Lauren - BLM; Findley, Timothy - Hanson Bridgett; Freeman, Beau - CalPoly; Fuller, Reba - TMTC; Furman, Donn W - SFPUC; Ganteinbein, Julie - Water-Power Law Grp; Giglio, Deborah - USFWS; Gorman, Elaine - YSC; Grader, Zeke; Gutierrez, Monica - NOAA-NMFS; Hackamack, Robert; Hastreiter, James L - FERC; Hatch, Jenny - CT; Hayat, Zahra - MF; Hayden, Ann; Hellam, Anita - HH; Heyne, Tim - CDFG; Holden, James ; Holm, Lisa; Horn, Jeff - BLM; Horn, Tini; Hudelson, Bill - StanislausFoodProducts; Hughes, Noah; Hughes, Robert - CDFG; Hume, Noah - Stillwater; Jackman, Jerry ; Jackson, Zac - USFWS; Jennings, William - CSPA; Jensen, Art - BAWSCA; Jensen, Laura - TNC; Johannis, Mary; Johnson, Brian - CalTrout; Justin; Keating, Janice; Kempton, Kathryn - NOAA-MNFS; Kinney, Teresa; Koepele, Patrick - TRT; Kordella, Lesley - FERC; Lein, Joseph; Levin, Ellen - SFPUC; Lewis-Reggie-PRCI; Linkard, David - TRT /RH; Looker, Mark - LCC; Loy, Carin; Lwenya, Roselynn, BVR; Lyons, Bill - MR; Madden, Dan; Manji, Annie; Marko, Paul ; Marshall, Mike - RHH; Martin, Michael - MFFC; Martin, Ramon - USFWS; Mathiesen, Lloyd - CRRMW; McDaniel, Dan -CDWA; McDevitt, Ray - BAWSCA; McDonnell, Marty - SMRT; McLain, Jeffrey - NOAA-NMFS; Means, Julie - CDFG; Mills, John - TUD; Morningstar Pope, Rhonda - BVR; Motola, Mary - PRCI; O'Brien, Jennifer - CDFG; Orvis, Tom - SCFB; Ott, Bob; Ott, Chris; Paul, Duane - Cardno; Pavich, Steve-Cardno; Pinhey, Nick - City of Modesto; Pool, Richard; Porter, Ruth - RHH; Powell, Melissa - CRRMW; Puccini, Stephen - CDFG; Raeder, Jessie - TRT; Ramirez, Tim - SFPUC; Rea, Maria - NOAA-NMFS; Reed, Rhonda - NOAA-NMFS; Richardson, Kevin - USACE; Ridenour, Jim; Robbins, Royal; Romano, David O - N-R; Roos-Collins, Richard - Water-Power Law Grp for NHI; Roseman, Jesse; Rothert, Steve - AR; Sander, Max - TNC; Sandkulla, Nicole - BAWSCA; Saunders, Jenan; Schutte, Allison - HB; Sears, William - SFPUC; Shakal, Sarah - Humboldt State; Shipley, Robert; Shumway, Vern - SNF; Shutes, Chris - CSPA; Sill, Todd; Slay, Ronn - CNRF/AIC; Smith, Jim - MPM; Staples, Rose; Steindorf, Dave - AW; Steiner, Dan; Stone, Vicki -TBMI; Stork, Ron - FOR; Stratton, Susan - CA SHPO; Taylor, Mary Jane - CDFG; Terpstra, Thomas; TeVelde, George A ; Thompson, Larry - NOAA-MNFS; Vasquez, Sandy ; Verkuil, Colette - TRT/MF; Vierra, Chris; Villalabos, Ruben; Walters, Eric - MF; Wantuck, Rick - NOAA-NMFS; Welch, Steve - ARTA; Wesselman, Eric - TRT; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas - RHH; Wilcox, Scott - Stillwater; Williamson, Harry (NPS); Willy, Alison - FWS; Wilson, Bryan - MF; Winchell, Frank - FERC; Wood, Dave - FR; Wooster, John -NOAA; Workman, Michelle - USFWS; Yoshiyama, Ron; Zipser, Wayne - SCFB
Subject: Don Pedro Project Relicensing Water & Aquatic Study Plans Workshop/Meeting Schedule for 2012

In accordance with FERC's Study Plan Determination and the Districts' Water & Aquatic (W&AR) study plans to be underway in 2012, we have developed schedule dates for the various workshops contained within the study plans. Please make note of these below:

April 2012

Apr 09 1:00 pm - 5:00 pm PT Don Pedro Project Relicensing - Hydrology Workshop (W&AR-2) (Modesto Irrigation District Offices, Modesto {MID})

Apr 10 8:00 am – 10:00 am PT Don Pedro Project Relicensing - Reservoir Temperature Modeling Data and Methods (MID)

Apr 10 10:15 am - 5:00 pm PT Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5) (MID)

June 2012

Jun 26 9:00 am – 4:00 pm PT Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5) (MID)

September 2012

Sep 18 9:00 am - 4:00 pm PT Don Pedro Project Relicensing - Temperature Model Verification/Calibration Meeting (MID)

November 2012

Nov 15 9:00 am - 4:00 pm PT Don Pedro Project Relicensing - Chinook Population (W&AR-6) and O.mykiss Population (W&AR-10) Modeling Workshop (MID)

In addition, in accordance with FERC's direction regarding the development and implementation of a more explicit consultation program for those studies with workshops, we are proposing to hold a meeting on March 20th at MID (from 1:30 to 4:30 p.m.) to discuss and finalize such a Workshop Consultation Program. An initial proposal will be forwarded by March 5 to all participants.

March 2012

Mar 20 1:30 pm – 4:30 pm PT Don Pedro Project Relicensing - Workshop on Consultation Process (as per Appendix B of FERC's Study Plan Determination) (MID)

We look forward to continuing to work with all relicensing participants in 2012.

ROSE STAPLES
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From: Staples, Rose
Sent: Monday, April 02, 2012 7:27 PM
To: Alves, Jim; Anderson, Craig; Asay, Lynette; Aud, John; Barnes, James; Barnes, Peter; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burley, Silvia; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Cismowski, Gail; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fety, Lauren; Findley, Timothy; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackman, Jerry; Jackson, Zac; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Looker, Mark; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; McLain, Jeffrey; Means, Julie; Mills, John; Morningstar Pope, Rhonda; Motola, Mary; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Steindorf, Dave; Steiner, Dan; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Walters, Eric; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: AGENDAs - Material for Don Pedro Relicensing Workshops-Meetings April 9-11

Today I will be forwarding to you four (4) emails containing the Agendas and materials for the four upcoming Don Pedro Relicensing workshops and meetings scheduled for next week. The Agendas and materials will also be uploaded to the www.donpedro-relicensing.com website in the Announcement section which you can access by clicking on the INTRODUCTION tab.

All meetings will be held at the Modesto Irrigation District Offices. For those not able to attend in person, there will be a call-in number listed on each of the agendas.

Monday, April 9 (10 am – 5 pm): Hydrology Workshop (W&AR-2)

- Agenda
- Don Pedro Unimpaired and Other Flow Data (Version 1) (excel spreadsheet)
- Don Pedro Unimpaired Flow Computation

Tuesday, April 10 (8:30 am – 10:15 am): Reservoir Temperature Modeling Data and Methods Consultation Meeting (W&AR-3)

- **Agenda**
- Reservoir Model Data Table
- Reservoir Model Steps

- Mike 21 & 3 Flow Model FM Scientific Documentation

Tuesday, April 10 (10:30 am – 5:00 pm) Salmonid Information Synthesis Workshop No. 1 (W&AR-5)

- Agenda
- W&AR-5 Process Diagram
- W&AR-5 Glossary
- W&AR-5 Preliminary Reference List

Wednesday, April 11 (9:00 am – Noon): Temperature Criteria Evaluation Consultation Meeting (W&AR-14)

- Agenda
- Reference List

If you are unable to open any of the files attached to the emails—or download the documents from the website, please let me know. Thank you.

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To: 'Alves, Jim'; 'Anderson, Craig'; 'Asay, Lynette'; 'Aud, John'; 'Barnes, James'; 'Barnes, Peter'; 'Blake, Martin'; 'Bond, Jack'; Borovansky, Jenna; 'Boucher, Allison'; 'Bowes, Stephen'; 'Bowman, Art'; 'Brenneman, Beth'; 'Brewer, Doug'; 'Buckley, John'; 'Buckley, Mark'; 'Burley, Silvia'; 'Burt, Charles'; 'Byrd, Tim'; 'Cadagan, Jerry'; 'Carlin, Michael'; 'Charles, Cindy'; 'Cismowski, Gail'; 'Colvin, Tim'; 'Costa, Jan'; 'Cowan, Jeffrey'; 'Cox, Stanley Rob'; 'Cranston, Peggy'; 'Cremeen, Rebecca'; 'Day, Kevin'; 'Day, P'; 'Denean'; 'Derwin, Maryann Moise'; Devine, John; 'Donaldson, Milford Wayne'; 'Dowd, Maggie'; 'Drekmeier, Peter'; 'Edmondson, Steve'; 'Eicher, James'; 'Fety, Lauren'; 'Findley, Timothy'; 'Fuller, Reba'; 'Furman, Donn W'; 'Ganteinbein, Julie'; 'Giglio, Deborah'; 'Gorman, Elaine'; 'Grader, Zeke'; 'Gutierrez, Monica'; 'Hackamack, Robert'; 'Hastreiter, James'; 'Hatch, Jenny'; 'Hayat, Zahra'; 'Hayden, Ann'; 'Hellam, Anita'; 'Heyne, Tim'; 'Holley, Thomas'; 'Holm, Lisa'; 'Horn, Jeff'; 'Horn, Timi'; 'Hudelson, Bill'; 'Hughes, Noah'; 'Hughes, Robert'; 'Hume, Noah'; 'Jackman, Jerry'; 'Jackson, Zac'; 'Jennings, William'; 'Jensen, Art'; 'Jensen, Laura'; 'Johannis, Mary'; 'Johnson, Brian'; 'Justin'; 'Keating, Janice'; 'Kempton, Kathryn'; 'Kinney, Teresa'; 'Koepele, Patrick'; 'Kordella, Lesley'; 'Lein, Joseph'; 'Levin, Ellen'; 'Lewis, Reggie'; 'Linkard, David'; 'Looker, Mark'; 'Lwenya, Roselynn'; 'Lyons, Bill'; 'Madden, Dan'; 'Manji, Annie'; 'Marko, Paul'; 'Marshall, Mike'; 'Martin, Michael'; 'Martin, Ramon'; 'Mathiesen, Lloyd'; 'McDaniel, Dan'; 'McDevitt, Ray'; 'McDonnell, Marty'; 'McLain, Jeffrey'; 'Means, Julie'; 'Mills, John'; 'Morningstar Pope, Rhonda'; 'Motola, Mary'; 'O'Brien, Jennifer'; 'Orvis, Tom'; 'Ott, Bob'; 'Ott, Chris'; 'Paul, Duane'; 'Pavich, Steve'; 'Pinhey, Nick'; 'Pool, Richard'; 'Porter, Ruth'; 'Powell, Melissa'; 'Puccini, Stephen'; 'Raeder, Jessie'; 'Ramirez, Tim'; 'Rea, Maria'; 'Reed, Rhonda'; 'Richardson, Kevin'; 'Ridenour, Jim'; 'Robbins, Royal'; 'Romano, David O'; 'Roos-Collins, Richard'; 'Roseman, Jesse'; 'Rothert, Steve'; 'Sandkulla, Nicole'; 'Saunders, Jenan'; 'Schutte, Allison'; 'Sears, William'; 'Shakal, Sarah'; 'Shipley, Robert'; 'Shumway, Vern'; 'Shutes, Chris'; 'Sill, Todd'; 'Slay, Ron'; 'Smith, Jim'; Staples, Rose; 'Steindorf, Dave'; 'Steiner, Dan'; 'Stone, Vicki'; 'Stork, Ron'; 'Stratton, Susan'; 'Taylor, Mary Jane'; 'Terpstra, Thomas'; 'TeVelde, George'; 'Thompson, Larry'; 'Vasquez, Sandy'; 'Verkuil, Colette'; 'Vierra, Chris'; 'Walters, Eric'; 'Wantuck, Richard'; 'Welch, Steve'; 'Wesselman, Eric'; 'Wheeler, Dan'; 'Wheeler, Dave'; 'Wheeler, Douglas'; 'Wilcox, Scott'; 'Williamson, Harry'; 'Willy, Allison'; 'Wilson, Bryan'; 'Winchell, Frank'; 'Wooster, John'; 'Workman, Michelle'; 'Yoshiyama, Ron'; 'Zipser, Wayne'
Subject: AGENDA-MATERIAL for Don Pedro Relicensing W-AR-5 Synthesis Workshop April 10 at 10:30 a.m.
Attachments: W&AR_5_Process_Diagram.pdf; WAR5_Workshop_AGENDA_120402.pdf; W&AR-5 References.doc; W&AR-5 Glossary_DRAFT.DOC

Please find attached the AGENDA and Material for the Don Pedro W&AR-5 Salmonid Information Synthesis Workshop No. 1 to be held on April 10th from 10:30 am to 5 pm:

1. Agenda
2. Process Diagram
3. Preliminary Reference List
4. Glossary

These documents will also be uploaded to the www.donpedro-relicensing.com website later today.

If you have any problems accessing this information, please let me know. Thank you.

ROSE STAPLES | **HDR Engineering, Inc.**
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Salmonid Information Integration and Synthesis Study (W&AR-5)
Draft Glossary

Terms	Definitions
Adipose fin	A small fleshy fin with no rays, located between the dorsal and caudal fins. Clipping of adipose fins is used to identify hatchery-raised salmonids.
Age	The number of years of life completed, here indicated by an arabic numeral, followed by a plus sign if there is any possibility of ambiguity (e.g., age 1, age 1+).
Age composition	Proportion of individuals of different ages in a stock or in the catches.
Age-class	A group of individuals of a certain species that have the same age.
Alevin	Newly hatched salmon or steelhead that have not completely absorbed their yolk sacs and usually have not yet emerged from the gravel.
Alluvial	Originating from the transport and deposition of sediment by running water.
Anadromous	Fish such as salmon and steelhead trout that migrate up rivers from the sea to spawn in fresh water.
Caudal fin	The tail fin.
Coded-wire tag (CWT)	A small (0.25mm diameter x 1 mm length) wire etched with a distinctive binary code and implanted in the snout of salmon or steelhead, which, when retrieved, allows for the identification of the origin of the fish bearing the tag.
Cohort	Members of a life-stage that were spawned in the same year.
Density-dependent	Factors affecting the population that are dependent on the population size, such as spawning habitat area or juvenile rearing area at higher population sizes.
Density Independence	Factors affecting the population regardless of population size, such as temperature, disease, or stranding.
Delta	An alluvial landform composed of sediment at a river mouth that is shaped by river discharge, sediment load, tidal energy, land subsidence, and sea-level changes. The Sacramento and San Joaquin River Delta is formed at the western edge of the Central Valley by the confluence of these rivers and refers to a complex network of channels

	east of where the rivers enter Suisun Bay (an upper arm of San Francisco Bay).
Escapement	The number of sexually mature adult salmon or steelhead that successfully pass through an ocean fishery to reach the spawning grounds. This amount reflects losses resulting from harvest, and does not reflect natural mortality, typically partitioned between enroute and pre-spawning mortality. Thus, escaped fish do not necessarily spawn successfully.
El Niño	A climactic event that begins as a warming episode in the tropical Pacific zone that can result in large scale intrusions of anomalously warm marine water northward along the Pacific coastline of North America.
Estuary	A region where salt water from the ocean is mixed with fresh water from a river or stream (also see Delta).
Floodplain	The part of a river valley composed of unconsolidated river deposits that periodically floods. Sediment is deposited on the floodplain during floods and through the lateral migration of the river channel across the floodplain.
Fry	Salmonid life stage between the alevin and parr stages.
Homing	The ability of a salmon or steelhead to correctly identify and return to their natal stream, following maturation at sea.
Hydroelectric	Generation of electricity by conversion of the energy of running water into electric power.
Irrigation	To application of water to land by means of pumps, pipes, and ditches in order to help crops grow.
Kelts	A spent or exhausted salmon or steelhead after spawning. All species of Pacific salmon, except some steelhead and sea-run cutthroat, die at this stage.
Life history	The events that make up the life cycle of an animal including migration, spawning, incubation, and rearing. There is typically a diversity of life history patterns both within and between populations. Life history can refer to one such pattern, or collectively refer to a stylized description of the 'typical' life history of a population.
Life-stage	Temporal stages (or intervals) of a fish’s life that have distinct anatomical, physiological, and/or functional characteristics that contribute to potential differences in use of the environment.

Macroinvertebrate	Invertebrates visible to the naked eye, such as insect larvae and crayfish.
Osmoregulation	Refers to the physical changes that take place in salmonids as their gills and kidneys adjust from fresh water to salt water as they enter the ocean, and from salt water to fresh water upon their return.
Parr	Life stage of salmon or steelhead between the fry and smolt stages. At this stage, juvenile fish have distinctive vertical parr marks and are actively feeding in fresh water.
Predator	An animal which feeds on other living animals.
Production	Output from a stock-production model at a particular life-step.
Recruitment	Addition of new fish to a defined life history stage by growth from among smaller size categories. Often used in context of management, where the stage is the point where individuals become vulnerable to fishing gear.
Redd	A nest of fish eggs consisting of gravel, typically formed by digging motion performed by an adult female salmon or steelhead trout.
Riffle	A shallow gravel area of a stream that is characterized by increased velocities and gradients, and is the predominant stream area used by salmonids for spawning.
Riparian	Referring to the transition area between aquatic and terrestrial ecosystems. The riparian zone includes the channel migration zone and the vegetation directly adjacent to the water body that influence channel habitat through alteration of microclimate or input of LWD.
River mile	A statute mile measured along the center line of a river. River mile measurements start at the stream mouth (RM 0.0).
Riverine	Referring to the entire river network, including tributaries, side channels, sloughs, intermittent streams, etc.
Smolt	Salmonid life stage between the parr and adult stages. At this stage, juvenile salmon and steelhead undergo physical changes and migrate to the ocean.
Smoltification	Refers to the changes that take place in salmonids as they prepare to enter the ocean. These changes include the development of the silver color of adults and a tolerance for salt water.

Spawn	The act of producing a new generation of fish. The female digs a redd in the river bottom and deposits her eggs into it. The male then covers the eggs with milt to fertilize them.
Spawning grounds	Areas where fish spawn.
Straying	A natural phenomena of adult spawners not returning to their natal stream, but entering and spawning in some other stream.
Stock	Input value required by the stock-production models. It is the first required value entered into the population dynamics model spreadsheets; for example, stock would be the number of fry, for a fry-to-juvenile step.
Wild	Salmon or steelhead produced by natural spawning in fish habitat from parents that were spawned and reared in fish habitat.
Woody debris	Logs, branches, or sticks that fall or hang into rivers. This debris gives salmonids places to hide and provides food for insects and plants which these fish feed upon.
Yolk sac	A small sac connected to alevin which provides them with protein, sugar, minerals, and vitamins. Alevin live on the yolk sac for a month or so before emerging from the gravel and beginning to hunt food for themselves.

Preliminary Reference List
Updated March 27, 2012

Brown, L. R., and T. Ford. 2002. Effects of flow on the fish communities of a regulated California river: implications for managing native fishes. River Research and Applications 18: 331–342.

Brown R. L. (editor). 2001. Contributions to the Biology of Central Valley Salmonids. Fish Bulletin 179. Volumes 1 and 2. California Department of Fish and Game. Sacramento, CA.

CALFED Bay Delta Program. 2000. Ecosystem restoration program plan, strategic plan for ecosystem restoration. Final Programmatic EIS/EIR Technical Appendix. http://calfed.ca.gov/Programs/EcosystemRestoration/EcosystemVol3RestorationPlan.shtml

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CRRF (California Rivers Restoration Fund). 2004. Adult O. mykiss habitat in the lower Tuolumne River. Prepared for the Tuolumne River Technical Advisory Committee, Modesto, California.

Dauble, D., D. Hankin, J. J. Pizzimenti, P. Smith. 2010. The Vernalis Adaptive Management Program (VAMP): Report of the 2010 Review Panel. Prepared for the Delta Science Program.

Ford, T., and S. Kirihara. 2010. Tuolumne River *Oncorhynchus mykiss* monitoring report. Prepared by Turlock Irrigation District/Modesto Irrigation District, California and Stillwater Sciences, Berkeley, California for Federal Energy Regulatory Commission, Washington, D.C.

Ford, T. and L. R. Brown. 2001. Distribution and abundance of Chinook salmon and resident fishes of the Lower Tuolumne River, California. Contributions to the Biology of Central Valley Salmonids. Fish Bulletin 179: 2.

Fry, D. H. 1961. King salmon spawning stocks of California Central Valley, 1940-1959. Calif. Fish and Game, 47(1):55-71.

Fry, D. H. and A. Petrovich, Jr. 1970. King salmon, *Oncorhynchus tshawytscha*, spawning stocks of the California Central Valley, 1953-1969. Calif. Dept. Fish and Game, Anad. Fish. Admin. Rep. No. 70-11, 21p.

Fuller, A. N., and M. Simpson. 2005. Presence, relative abundance, and distribution of fishes at Grayson River Ranch. Draft Report. Submitted to East Stanislaus Resource Conservation District by S. P. Cramer & Associates, Gresham, Oregon.

Hallock, R. J., R. F. Elwell, and D. H. Fry, Jr. 1970. Migrations of adult king salmon *Oncorhynchus tshawytscha* in the San Joaquin Delta as demonstrated by the use of sonic tags. State of California, The Resources Agency, Department of Fish and Game. Fish Bulletin 151.

McBain & Trush. 2000. Habitat restoration plan for the lower Tuolumne River corridor. Final Report. Prepared for the Tuolumne River Technical Advisory Committee with assistance from U.S. Fish and Wildlife Service Anadromous Fish Restoration Program.

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Appendix 1: Population model documentation. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 2: Stock recruitment analysis of the population dynamics of San Joaquin River system Chinook salmon. Prepared by EA Engineering, Science and Technology. February 1992

Appendix 3: Tuolumne River salmon spawning surveys 1971-1988. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 4: Instream flow data processing Tuolumne River, California. Prepared by Robert E. Meyer Consultants, Inc. August 1984

Appendix 5: Analysis of 1981 lower Tuolumne River IFIM data. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 6: Lower Tuolumne River spawning gravel availability and superimposition report. Prepared by EA Engineering, Science and Technology. February 1992

Appendix 7: Lower Tuolumne River Chinook salmon redd excavation report. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 8: Lower Tuolumne River spawning gravel studies report. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 9: Spawning gravel cleaning methodologies. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 10: 1987 juvenile Chinook salmon mark-recapture study. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 11: An evaluation of the effect of gravel ripping on redd distribution in the Lower Tuolumne River. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 12: Data results: Seining of juvenile Chinook salmon in the Tuolumne, San Joaquin and Stanislaus Rivers, 1986-1989. Prepared by EA Engineering, Science and Technology. August 1991

Appendix 13: Preliminary juvenile salmon study: Report on sampling of Chinook salmon fry and smolts by fyke net and seine in the Lower Tuolumne River 1973-1986. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 14: Tuolumne River fluctuation flow study report. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 15: Tuolumne River fluctuation flow study plan: Draft. Prepared by EA Engineering, Science and Technology. February 1992

Appendix 16: Aquatic invertebrate studies report. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 17: Preliminary Tuolumne River water temperature report. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 18: Lower Tuolumne River instream temperature model documentation: Description and calibration. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 19: Modeled effects of La Grange releases on instream temperatures in the Lower Tuolumne River. Prepared by EA Engineering, Science and Technology. September 1991

Appendix 20: Juvenile salmon pilot temperature observation experiments. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 21: Possible effects of high water temperature on migrating Chinook salmon (Oncorhynchus tshawytscha) smolts in the San Joaquin River System. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 22: Lower Tuolumne River predation study report. Prepared by EA Engineering, Science and Technology. February 1992

Appendix 23: Effects of turbidity on bass predation efficiency. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 24: Effects of introduced species of fish in the San Joaquin River system. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 25: Preliminary summary smolt survival index study. Prepared by Loudermilk, Fjelstad, Neillands, Wingett, Della Valle, Presher and Traylor, California Department of Fish and Game. July 1987

Appendix 26: Export mortality fraction submodel. Prepared by EA Engineering, Science and Technology. February 1992

Appendix 27: Tuolumne River summer flow study report 1988-1990. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 28: Tuolumne River summer flow invertebrate study. Prepared by EA Engineering, Science and Technology. November 1991

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Report 2002-4: Large CWT smolt survival analysis (1987, 1990, 1994-2001). Prepared by Noah Hume and Peter Baker, Stillwater Ecosystem, Watershed & Riverine Sciences, Berkeley, CA and Tuolumne River Technical Advisory Committee. March 2003

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Report 2004-7: Large CWT smolt survival analysis update. Prepared by Stillwater Ecosystem, Watershed & Riverine Sciences Berkeley, CA and Tuolumne River Technical Advisory Committee. March 2005

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Report 2006-8: Special run pool 9 and 7/11 reach: Post-project monitoring synthesis report. Prepared by Jennifer Vick, McBain and Trush, Arcata, CA and A.J. Keith, Stillwater Ecosystem, Watershed & Riverine Sciences, Berkeley, CA. March 2007
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Report 2009-2: Spawning survey summary update. Prepared by Tim Ford, Turlock and Modesto Irrigation Districts and Steve Kirihara, Stillwater Sciences, Berkeley, CA. March 2010

Report 2009-3: 2009 seine report and summary update. Prepared by Prepared by Tim Ford, Turlock and Modesto Irrigation Districts and Steve Kirihara, Stillwater Sciences, Berkeley, CA. June 2009

Report 2009-4: 2009 rotary screw trap report. Prepared by Michele L. Palmer and Chrissy L. Sonke, FISHBIO Environmental, LLC, Oakdale, CA. February 2010

Report 2009-5: 2009 snorkel report and summary update. Prepared by Tim Ford, Turlock and Modesto Irrigation Districts and Steve Kirihara, Stillwater Sciences, Berkeley, CA. March 2010

Report 2009-6: Review of 2009 summer flow operation. Prepared by Tim Ford, Turlock and Modesto Irrigation Districts and Steve Kirihara, Stillwater Sciences, Berkeley, CA. March 2010

Report 2009-7: Aquatic invertebrate monitoring and summary update. Prepared by Stillwater Sciences, Berkeley, CA. March 2010.

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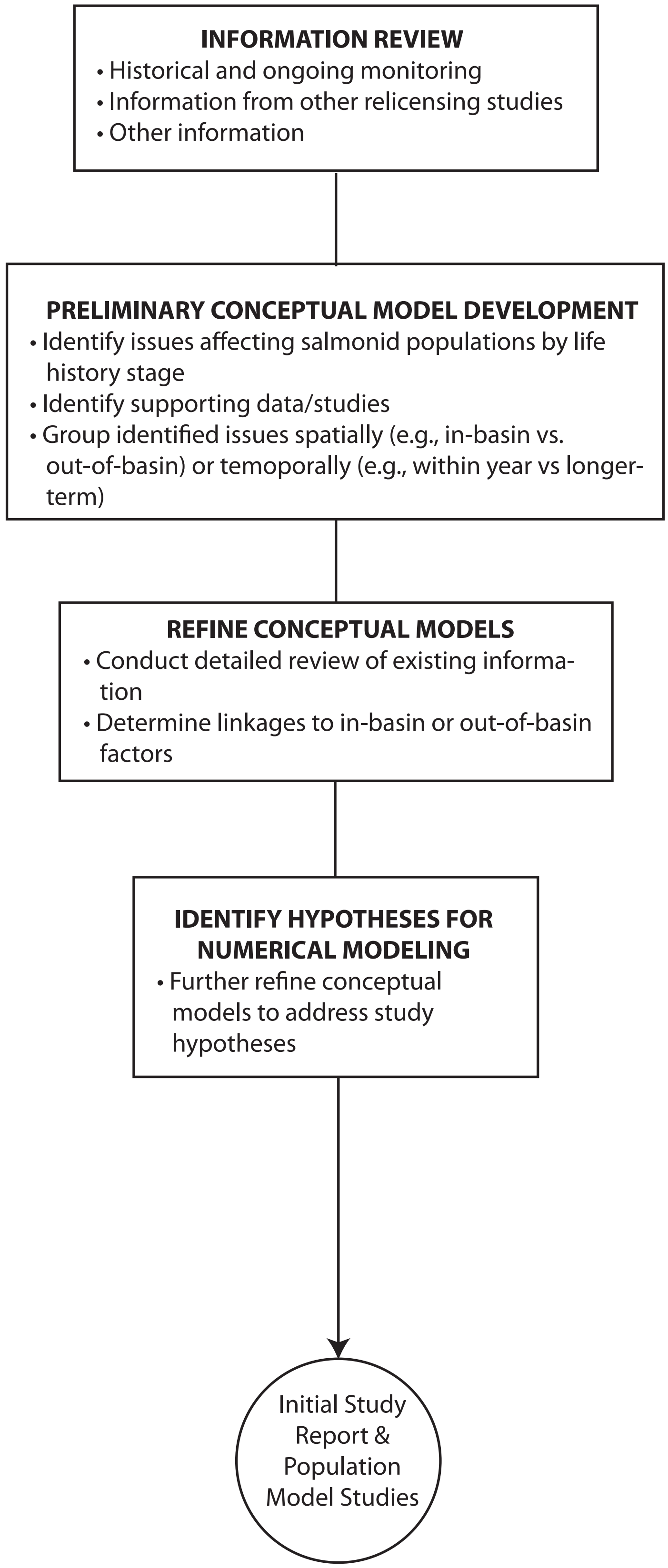
Salmonid Information Synthesis Study Process



Salmonid Information Synthesis Workshop No. 1
Don Pedro Relicensing Study W&AR-5
April 10, 2012 – 10:30 a.m. to 5:00 p.m. - MID Offices

Conference Line Call-In Number 866-994-6437; Conference Code 5424697994

AGENDA

10:30 a.m. – 11:00 a.m.	**Introductions and Background** 1. Purpose of Meeting 2. Overview of Study Plan and FERC Determination 3. Relationship to other studies 4. ILCM Workshop Process Recommendations
11:00 a.m. – 12:30 p.m.	**Overview of Don Pedro Fisheries Programs** 1. Article 39 Study Program 2. 1986 Amended Fish Study Agreement 3. 1992 Article 39 Twenty-Year Fish Study Report 4. 2005 10-Year Summary Report under 1996 FERC Order 5. Ongoing Fisheries Monitoring
12:30 p.m. – 1:00 p.m.	**Lunch**
1:00 p.m. – 4:00 p.m.	**Discussion of Issues Affecting Tuolumne River Salmonids** 1. Supplements to January 2012 References 2. Relicensing Participants assessment of major issues affecting salmonid populations by species and life stage 3. Identify preliminary Conceptual Models
4:30 p.m. – 5:00 p.m.	**Next Steps and Closure**

From: Staples, Rose
Sent: Friday, April 06, 2012 6:48 PM
To: 'Alves, Jim'; 'Anderson, Craig'; 'Asay, Lynette'; 'Aud, John'; 'Barnes, James'; 'Barnes, Peter'; 'Blake, Martin'; 'Bond, Jack'; Borovansky, Jenna; 'Boucher, Allison'; 'Bowes, Stephen'; 'Bowman, Art'; 'Brenneman, Beth'; 'Brewer, Doug'; 'Buckley, John'; 'Buckley, Mark'; 'Burt, Charles'; 'Byrd, Tim'; 'Cadagan, Jerry'; 'Carlin, Michael'; 'Charles, Cindy'; 'Cismowski, Gail'; 'Colvin, Tim'; 'Costa, Jan'; 'Cowan, Jeffrey'; 'Cox, Stanley Rob'; 'Cranston, Peggy'; 'Cremeen, Rebecca'; 'Day, Kevin'; 'Day, P'; 'Denean'; 'Derwin, Maryann Moise'; Devine, John; 'Donaldson, Milford Wayne'; 'Dowd, Maggie'; 'Drekmeier, Peter'; 'Edmondson, Steve'; 'Eicher, James'; 'Ferrari, Chandra'; 'Fety, Lauren'; 'Findley, Timothy'; 'Fuller, Reba'; 'Furman, Donn W'; 'Ganteinbein, Julie'; 'Giglio, Deborah'; 'Gorman, Elaine'; 'Grader, Zeke'; 'Gutierrez, Monica'; 'Hackamack, Robert'; 'Hastreiter, James'; 'Hatch, Jenny'; 'Hayat, Zahra'; 'Hayden, Ann'; 'Hellam, Anita'; 'Heyne, Tim'; 'Holley, Thomas'; 'Holm, Lisa'; 'Horn, Jeff'; 'Horn, Timi'; 'Hudelson, Bill'; 'Hughes, Noah'; 'Hughes, Robert'; 'Hume, Noah'; 'Jackman, Jerry'; 'Jackson, Zac'; 'Jennings, William'; 'Jensen, Art'; 'Jensen, Laura'; 'Johannis, Mary'; 'Johnson, Brian'; 'Justin'; 'Keating, Janice'; 'Kempton, Kathryn'; 'Kinney, Teresa'; 'Koepele, Patrick'; 'Kordella, Lesley'; 'Lein, Joseph'; 'Levin, Ellen'; 'Lewis, Reggie'; 'Linkard, David'; 'Looker, Mark'; 'Lwenya, Roselynn'; 'Lyons, Bill'; 'Madden, Dan'; 'Manji, Annie'; 'Marko, Paul'; 'Marshall, Mike'; 'Martin, Michael'; 'Martin, Ramon'; 'Mathiesen, Lloyd'; 'McDaniel, Dan'; 'McDevitt, Ray'; 'McDonnell, Marty'; 'McLain, Jeffrey'; 'Means, Julie'; 'Mills, John'; 'Morningstar Pope, Rhonda'; 'Motola, Mary'; 'O'Brien, Jennifer'; 'Orvis, Tom'; 'Ott, Bob'; 'Ott, Chris'; 'Paul, Duane'; 'Pavich, Steve'; 'Pinhey, Nick'; 'Pool, Richard'; 'Porter, Ruth'; 'Powell, Melissa'; 'Puccini, Stephen'; 'Raeder, Jessie'; 'Ramirez, Tim'; 'Rea, Maria'; 'Reed, Rhonda'; 'Richardson, Kevin'; 'Ridenour, Jim'; 'Robbins, Royal'; 'Romano, David O'; 'Roos-Collins, Richard'; 'Roseman, Jesse'; 'Rothert, Steve'; 'Sandkulla, Nicole'; 'Saunders, Jenan'; 'Schutte, Allison'; 'Sears, William'; 'Shakal, Sarah'; 'Shipley, Robert'; 'Shumway, Vern'; 'Shutes, Chris'; 'Sill, Todd'; 'Slay, Ron'; 'Smith, Jim'; Staples, Rose; 'Steindorf, Dave'; 'Steiner, Dan'; 'Stone, Vicki'; 'Stork, Ron'; 'Stratton, Susan'; 'Taylor, Mary Jane'; 'Terpstra, Thomas'; 'TeVelde, George'; 'Thompson, Larry'; 'Vasquez, Sandy'; 'Verkuil, Colette'; 'Vierra, Chris'; 'Walters, Eric'; 'Wantuck, Richard'; 'Welch, Steve'; 'Wesselman, Eric'; 'Wheeler, Dan'; 'Wheeler, Dave'; 'Wheeler, Douglas'; 'Wilcox, Scott'; 'Williamson, Harry'; 'Willy, Allison'; 'Wilson, Bryan'; 'Winchell, Frank'; 'Wooster, John'; 'Workman, Michelle'; 'Yoshiyama, Ron'; 'Zipser, Wayne'
Subject: LIVE MEETING LINK IF NOT ATTENDING DON PEDRO WORKSHOPS / MEETINGS IN PERSON

If you are unable to attend the upcoming Don Pedro workshops and meetings in person, you will be able to call in (see "AUDIO INFORMATION" below) and you can also use your computer to LIVE MEETING (see individual workshop/meeting links below). If you have not used LIVE MEETING before, please be sure, well before the meeting time, to click on "FIRST ONLINE MEETING" link below. Thank you.

AUDIO INFORMATION
Use call-in number: **866-994-6437**, Conference Code **5424697994**

ON-LINE MEETING INFORMATION
(On-Line Meetings will be open approximately half hour prior to the meeting start time to allow for any technical issues to be resolved. If you have not used On-Line Meeting in the past, please allow a few extra minutes for your first log-on.)

Monday, April 9 (10 am – 5 pm): Hydrology Workshop (W&AR-2)

[Join online meeting](https://meet.hdrinc.com/jenna.borovansky/DG5FH7C1)
https://meet.hdrinc.com/jenna.borovansky/DG5FH7C1

First online meeting?

Tuesday, April 10 (8:30 – 10:15am): Reservoir Temperature Modeling Data and Methods Consultation Meeting (W&AR-3)

Join online meeting
https://meet.hdrinc.com/jenna.borovansky/QC5C5HN1

First online meeting?

Tuesday, April 10 (10:30am – 5:00pm) Salmonid Information Synthesis Workshop (W&AR-5)

Join online meeting
https://meet.hdrinc.com/jenna.borovansky/37NNBCDP

First online meeting?

Wednesday, April 11 (9:00 am – Noon): Temperature Criteria Evaluation Consultation Meeting (W&AR-14)

Join online meeting
https://meet.hdrinc.com/jenna.borovansky/MHVKDJYZ

First online meeting?

ROSE STAPLES
CAP-OM

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From: Staples, Rose
Sent: Tuesday, April 10, 2012 10:51 AM
To: Alves, Jim; Anderson, Craig; Asay, Lynette; Aud, John; Barnes, James; Barnes, Peter; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Cismowski, Gail; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackman, Jerry; Jackson, Zac; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Looker, Mark; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; McLain, Jeffrey; Means, Julie; Mills, John; Morningstar Pope, Rhonda; Motola, Mary; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Steindorf, Dave; Steiner, Dan; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Walters, Eric; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Use Links Below for Don Pedro Apr 10 - Apr 11 Meetings-Workshop

Importance: High

For today's meeting / workshop and tomorrow's meeting, we will be using the "live meeting" links previously announced last week—and I have copied them below for your ease of use. If you are unable to connect, please send me an email or call me at 207-239-3857! Thank you.

AUDIO INFORMATION
Use call-in number: **866-994-6437**, Conference Code **5424697994**

ON-LINE MEETING INFORMATION
(On-Line Meetings will be open approximately half hour prior to the meeting start time to allow for any technical issues to be resolved. If you have not used On-Line Meeting in the past, please allow a few extra minutes for your first log-on.)

Tuesday, April 10 (8:30 – 10:15am): Reservoir Temperature Modeling Data and

Methods Consultation Meeting (W&AR-3)

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Join online meeting
https://meet.hdrinc.com/jenna.borovansky/QC5C5HN1

First online meeting?

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Tuesday, April 10 (10:30am – 5:00pm) Salmonid Information Synthesis Workshop (W&AR-5)

....

Join online meeting
https://meet.hdrinc.com/jenna.borovansky/37NNBCDP

First online meeting?

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Wednesday, April 11 (9:00 am – Noon): Temperature Criteria Evaluation Consultation Meeting (W&AR-14)

....

Join online meeting
https://meet.hdrinc.com/jenna.borovansky/MHVKDJYZ

First online meeting?

ROSE STAPLES
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From: Staples, Rose
Sent: Friday, April 20, 2012 9:53 PM
To: Alves, Jim; Anderson, Craig; Asay, Lynette; Aud, John; Barnes, James; Barnes, Peter; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Cismowski, Gail; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackman, Jerry; Jackson, Zac; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Lara, Marco; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Looker, Mark; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; McLain, Jeffrey; Means, Julie; Mills, John; Morningstar Pope, Rhonda; Motola, Mary; Murphy, Gretchen; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Steindorf, Dave; Steiner, Dan; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Walters, Eric; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro W-AR-5 Meeting Notes for 30-day Review

On April 10, 2012, the Districts held a relicensing participant meeting as proposed in the Salmonid Populations Information Integration and Synthesis Study (W&AR-5) Study Plan. Materials for the meeting were distributed one week prior to the meeting for participant review.

During the meeting, the Districts requested that relicensing participants provide any additional references they would like considered in the W&AR-5 information synthesis by May 10, 2012. The proposed list of references is included as an attachment to the meeting notes and was distributed prior to the meeting.

In accordance with Appendix B of FERC's December 22, 2011 Study Plan Determination, the Districts developed a draft workshop consultation process. Consistent with this process, the Districts have uploaded to the relicensing website www.donpedro-relicensing.com (in the Introduction/Announcements section) the draft meeting notes from the W&AR-5 Workshop for a 30-day review period. Please provide comments to me at rose.staples@hdrinc.com no later than May 21, 2012.

Following the 30-day comment period, the Districts will file with FERC a revised version of the workshop notes, copies of comments received, and a discussion of how the Relicensing Participant comments and recommendations have been considered by the Districts, as well as the rationale for the Districts not adopting any Relicensing Participant recommendations, if applicable.

Thank you.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

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June 15, 2012
E-Filed

Don Pedro Project
FERC No. 2299-075

Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
888 First Street, NE
Washington, DC 20426

RE: Filing on behalf of Turlock Irrigation District and Modesto Irrigation District's Don Pedro Project - FERC Project No. 2299
Final Meeting Notes and Relicensing Participants Comments on the April 10, 2012 Salmonid Information Synthesis Workshop No. 1

As part of the ongoing ILP Relicensing Studies for the Don Pedro Project (FERC Project No. 2299-075), the Districts held a relicensing participant meeting (Workshop No. 1) on April 10, 2012 as proposed in the Salmonid Populations Information Integration and Synthesis Study Plan (W&AR-5) and approved by FERC in its December 22, 2011 Study Plan Determination.

The workshop was held to summarize and update existing salmonid information originally provided to relicensing participants on January 17, 2012 and to provide an opportunity for relicensing participants to propose additional literature and data sources for use in this Salmonid Populations Information Integration and Synthesis Study ("Synthesis Study"). Materials for the meeting were distributed one week prior to the meeting for participants review and Draft Meeting notes were provided on April 20, 2012 for review and comment. During the 30-day review period, comments were received by the California Department of Fish and Game ("CDFG"), Conservation Groups[1], and the U.S. Fish and Wildlife Service ("USFWS"). In accordance with Appendix B of FERC's December 22, 2011 Study Plan Determination, this letter provides Draft and Final meeting notes, as well as relicensing participants comments as attachments A through E below:

Attachment A: Final Meeting Notes – W&AR-5 Salmonid Information Synthesis Workshop No. 1,
Attachment B: Draft Meeting Notes and Workshop Materials – W&AR-5 Salmonid Information Synthesis Workshop No. 1
Attachment C: California Dept. of Fish and Game comments regarding the April 10, 2012 Salmonid Information Synthesis Workshop

[1] American Rivers, American Whitewater, California Sportfishing Protection Alliance, California Trout, Inc., Central Sierra Environmental Resource Center, Environmental Defense Fund, Friends of the River, Golden West Women Flyfishers, Northern California Council Federation of Fly Fishers, Merced Fly Fishing Club, Pacific Coast Federation of Fishermen's Associations, Trout Unlimited, Tuolumne River Trust, and Water 4 Fish

Attachment D:	Conservation Groups Comments regarding the April 10, 2012 Salmonid Information Synthesis Workshop
Attachment E:	U.S. Fish and Wildlife Service comments regarding the April 10, 2012 Salmonid Information Synthesis Workshop

Comments by California Department of Fish and Game

In their letter of May 16, 2012 (Attachment C), CDFG provided five comments on factors contributing to the "current decline of anadromous fish populations on the Tuolumne River." The comments provided below, excerpted from direct testimonies of Mr. Timothy Heyne and Dr. Andrew Gordus (Attachment C, Exhibits DFG-2 and DFG-4, respectively), were previously submitted in support of the September 2009 Administrative Law Judge (ALJ) proceeding on interim conditions pending relicensing.[2]

CDFG comments excerpted from ALJ testimony of Timothy Heyne (See Attachment C, Exhibit DFG-2 for complete text):

- "[c]urrent flow releases to the lower Tuolumne River required under Article 37 of the Project license are insufficient to conserve fall-run Chinook salmon and steelhead" (DFG-2, page 2).
- "The single most important impact of Project operations affecting anadromous fish populations is the manipulation of flows in the Tuolumne River" (DFG- 2, page 4).
- "Providing more flow to the river at specific times of the year will improve habitat and water temperature for fall-run Chinook and steelhead" (DFG-2, page 7).
- Inadequate spring flows "have been identified repeatedly as the principle limiting factor on fall-run Chinook salmon populations in the Tuolumne River" (DFG-2, page 14).

CDFG comments excerpted from ALJ testimony of Andrew Gordus (See Attachment C, Exhibit DFG-4 for complete text):

- "Elevated water temperatures contribute to the ongoing decline [of] fall-run Chinook salmon in the Tuolumne River by: (1) inducing adult mortality as adults migrate into the San Joaquin River and adjacent tributaries to spawn (i.e. pre-spawn mortality); (2) reducing egg viability for eggs deposited in stream gravels; (3) increasing stress levels, thereby reducing survival of juveniles within the tributary nursery habitats; and (4)

[2] Turlock Irrigation District and Modesto Irrigation District, Order on Rehearing, Amending License, Denying Late Intervention, Denying Petition, and Directing Appointment of a Presiding Judge for a Proceeding on Interim Conditions, 128 FERC ¶ 61,035 (2009) (July 2009 Order).

> reducing salmon smolt out-migration survival as smolts leave the nursery habitats within the tributaries to migrate down the San Joaquin River to Vernalis and through the south Delta" (DFG-4, page 12).

The Districts do not agree with the characterizations regarding "declining" salmonid populations and point to recent April 19, 2012 FERC Order Clarifying Proceeding on Interim Conditions (139 FERC ¶ 61,045), which stated that the recent decline of the Tuolumne River fall-run Chinook salmon could not be attributed to the Article 37 flow regime, and that more information was needed to determine flow requirements for steelhead as to whether higher flows may result in higher steelhead production. Despite these and other limitations, the comments above will be considered in evaluating the relative importance of contributing factors to various life history outcomes of Tuolumne River salmonids as well as which of the factors to include in subsequent salmonid production models as part of the interrelated Tuolumne River Chinook Salmon Population Model (W&AR-6) and the *O. mykiss* Population (W&AR-10) studies.

In addition to the comments above, CDFG also provided eighteen citations to reports and analyses (Attachment C) that were largely provided as part of the 2009 ALJ proceeding as well as the 2008 biennial review of water quality information in support of the California Central Valley Regional Water Quality Control Board's Integrated Report pursuant to Sections 303(d), 305(b), and 314 of the Clean Water Act. The citations may be grouped into broad topical areas addressing limiting factors affecting Tuolumne River salmonids, fry and juvenile Chinook salmon survival, salmon population modeling, floodplain habitat use studies, as well as attainment of various regional water temperature standards. Although comparisons of historical water temperature data with various water temperature standards is the subject of a separate Temperature Criteria Assessment for Chinook Salmon and *O. mykiss* Study (W&AR-14), all of the referenced information provided by CDFG will be reviewed for primary data sources for use in this Synthesis Study.

Comments by Conservation Groups

In their letter of May 18, 2012 (Attachment D), Conservation groups submitted comments regarding the 2012 workshop schedule presented in the March 20, 2012 Consultation Process for Workshops remaining in 2012 (See Attachment B, sub-Attachment 3). Conservation Groups commented that the initial population modeling workshops for studies W&AR-6 and W&AR-10, currently scheduled for November 15, 2012, were not consistent with the preliminary schedules presented in the approved individual study plans. Conservation Groups encouraged the Districts to conduct an initial workshop for studies W&AR-6 and W&AR-10 prior to the planned November 15 workshop.

In planning the work to be conducted by the Districts for 2012 after receipt of FERC's Study Plan Determination in December 2011, it became apparent that the two-month time period between Workshop No. 1 and Workshop No. 2 for W&AR-6 and -10 was insufficient to allow integration of the Workshop Consultation Process required by the FERC Determination. The subsequent study dispute notices and study disputes filed by three agencies also required significant additional attention from the same study plan teams involved in the Workshops. For these reasons, the Districts made the decision to keep the W&AR-5 Workshops on the original schedule, but to provide additional time preparing for and between Workshops No. 1 and No. 2 for W&AR-6 and -10. The schedule for the final report for these two studies remains unchanged.

In addition to the comments above, Conservation Groups submitted nine citations to reports and analyses (Attachment D), including citations to direct testimony used in the 2009 ALJ Proceedings as well as materials submitted as part of the 2008 biennial review of water quality information in support of the California Central Valley Regional Water Quality Control Board's Integrated Report pursuant to Sections 303(d), 305(b) and 314 of the Clean Water Act. In addition to the recommended substitution of the 2009 peer-reviewed literature version of the Zimmerman et al 2008 data report on *O. mykiss* anadromy, the supplied citations include the USFWS (2008) overbank flow analyses, the USFWS (2008) Draft Limiting Factor analysis for Tuolumne River salmonids, as well as several documents related to attainment of water temperature standards by CDFG. Although evaluation of historical water temperature data with respect to various water temperature standards is the subject of a separate Temperature Criteria Assessment for Chinook Salmon and *O. mykiss* (W&AR-14), all of the referenced information provided by Conservation Groups will be reviewed for primary data sources for use in this Synthesis Study.

<u>Comments by U.S. Fish and Wildlife Service</u>

In an e-mail of May 7, 2012 (Attachment E), USFWS provided six citations to reports on factors affecting Tuolumne River and Central Valley salmonids, hyperlinks to annual data reports on Tuolumne River rotary screw trap monitoring, as well as hyperlinks to Mossdale trawl data on the lower San Joaquin River. All of the referenced information provided by USFWS will be reviewed for primary data sources for use in this Synthesis Study.

Sincerely,

John Devine

John Devine, P.E.
Project Manager

Attachment A
Final Meeting Notes
W&AR-5 Salmonid Information Synthesis Workshop No. 1

Don Pedro Project Relicensing
W&AR-5 Salmonid Information Synthesis Workshop No. 1
Final Meeting Notes

Tuesday, April 10, 2012

Attendees

Peter Barnes - State Water Resources Control Board (SWRCB), *by phone*	Bill Johnston - MID
Jenna Borovansky - HDR	Patrick Koepele - Tuolumne River Trust (TRT)
Steve Boyd - Turlock Irrigation District (TID)	Ellen Levin - CCSF, *by phone*
Allison Boucher - Friends of the Tuolumne (FOT), *by phone*	Carin Loy - HDR
John Devine – HDR	Mike Maher - SWRCB
Greg Dias - Modesto Irrigation District (MID)	Annie Manji - California Department of Fish and Game (CDFG), *morning only*
Karl English - LGL Limited	Bob Nees - TID
Donn Furman - City and County of San Francisco (CCSF)	Tim O'Laughlin - MID, *by phone*
Art Godwin – TID	Dale Stanton - CDFG, *morning only*
Bethany Hackenjos – Stillwater	Joy Warren - MID
Noah Hume – Stillwater	Scott Wilcox - Stillwater
Zach Jackson - U.S. Fish and Wildlife Service (FWS)	Ron Yoshiyama - CCSF

Introductions and Background – 10:30 AM to 11:00 AM

1. John Devine made introductions, described the workshop consultation process developed in response to the FERC Study Determination, and emphasized the overall purpose of the meeting was to:

    - reach agreement on information to used in the synthesis study, and
    - provide an opportunity for relicensing participants to propose additional literature and data sources for use in this synthesis study.

2. Noah Hume provided an overview of the W&AR-5 study plan, described the relationship to other salmonid studies (i.e., population model development under studies W&AR-6 and W&AR-10), and discussed recommendations adopted from the FERC Study Determination.

- Study Plan Overview and Relationship to Other Studies - *See November 22, 2011 Revised Study Plan, Study Process Diagram (Attachment 1), and meeting overview slides (Attachment 2).*

- Recommendations adopted from FERC Study Determination:

    i. Address association between flows, water temperature, habitat conditions, predation, and response of in-river salmonid life-stages – *To be addressed by this W&AR-5 synthesis, as well as development of associated population models in studies W&AR-6 and W&AR-10.*

    ii. Establish an efficient structure for consultation – *See consultation process described as part of the March 20, 2012 Consultation Workshop held at MID offices (Attachment 3).*

    iii. Adopt guidelines similar to the June 2011 Salmonid Integrated Life Cycle Model (ILCM) Workshop - *See meeting overview slides (Attachment 2)*

    iv. Describe how interested participants and Turlock Irrigation District and Modesto Irrigation District (collectively, the Districts) would achieve consensus on issues – *See consultation process described as part of the March 20, 2012 Consultation Workshop (Attachment 3).*

    v. Make information available to participants (on electronic media) for review – *See workshop materials e-mailed to Relicensing Participants (RP) by Rose Staples (HDR) on April 2, 2012 (Attachment 4).*

    vi. Allow additional workshops as necessary – *As discussed in the March 20, 2012 Consultation Workshop, the need for additional workshops will be determined as issues arise within the scheduled workshops.*

3. Noah Hume discussed the W&AR-5 Study reference list (Attachment 4), which updates the preliminary reference list originally distributed on January 17, 2012. Only 4-5 new citations were included in the reference list and up-to-date literature compilations were made available to meeting attendees on CD-ROM (Revision 2 dated April 2012). In addition, criteria for assessing relevancy of existing data and reports for inclusion in the W&AR-5 study were presented and discussed (Attachment 5).

Overview of Don Pedro Fish Study Programs – 11:00 AM to 12:00 PM

1. Noah Hume presented an overview of fish monitoring and studies required under various FERC Orders from 1971 to the present, including additional fish monitoring and studies by the Districts, fish resource agencies, Tuolumne River Technical Advisory Committee

(TRTAC), and various habitat restoration project monitoring by CALFED and local non-governmental organizations – *See monitoring summary (Attachment 6).*

2. Allison Boucher highlighted a change in sampling designs in the annual snorkel surveys in the early 2000s that may have resulted in higher relative abundance than in the period 1982–2000. Noah Hume agreed and suggested these data, termed “reference count” surveys, were to be used to establish presence/absence and river-wide distribution in various years, and only the 2008–2011 population estimate surveys would be used to assess abundance. [Not discussed at the meeting, Ford and Brown (2001) provide a summary of changes in methods and gear types in various historical salmonid monitoring efforts.]

3. Donn Furman asked whether or not it would be helpful to look at the status of other fish species to determine overall health of the river. Noah Hume referred to the citation list item Brown and Ford (2002), which examined changes in native and nonnative fish species distribution in various years and water year types.

4. At the conclusion of the presentation, John Devine solicited additional reference materials not included in the list distributed to RPs. Patrick Koepele suggested the Districts should review the reference materials provided by Conservation Groups during the development of the Pre-Application Document (PAD) in 2010.

Action Item: The Districts will review references submitted by Conservation Groups during development of the PAD for consideration in the W&AR-5 information synthesis.

Action Item: Relicensing Participants will review the existing reference list and suggest any additional references for inclusion in the W&AR-5 information synthesis within 30 days (May 10, 2012).

Lunch Break – 12:00 PM to 1:00PM

Discussion of Issues Affecting Tuolumne River Salmonids – 1:00 PM to 2:30 PM

1. RPs were asked to identify specific issues affecting various life stages of Tuolumne River salmonids and any supporting information that could be provided. Because no issues affecting salmonids were raised during this meeting, Noah Hume suggested organization of an informal discussion by life stage to facilitate Relicensing Participant input on additional data sources or concerns.

2. Noah Hume suggested that the W&AR-5 report would be generally organized by life stage. Based on this, he led a broad discussion of various potential issues identified in historical monitoring documents, primarily discussing Chinook salmon:

   - Upstream Migration – Potential issues are primarily related to historical water quality concerns in the Sacramento San-Joaquin Delta (Delta), specifically low dissolved oxygen (DO) at the Stockton Deepwater Ship Channel (DWSC), as well as more recent concerns regarding water temperature raised in recent SWRCB 303(d) listings.

     - Noah Hume suggested that the Hallock et al. (1970) study was the only historical document examining water quality barriers to migration with only anecdotal information related to either pre-spawn mortality of up-migrating fish or reduced viability following egg deposition.

     - Art Godwin described current Total Maximum Daily Load (TMDL) efforts to control nutrients in the Delta (Denitrification at the Stockton Wastewater Treatment Plan) and DO (temporary barriers [i.e., the DO bubbler]).

     - Karl English asked if there were any other mechanisms in place. Noah Hume suggested that Vernalis flows in excess of 2,000 cubic feet per second (cfs) were shown to be effective in dispersing algae and low DO at the Stockton DWSC, and speculated that this may underlie decisions related to the application of fall attraction flows.

   - Spawning – Potential issues are well documented as they relate to spawning gravel availability and gravel quality.

     - Noah Hume discussed changes in redd distribution since the 1997 floods, apparent losses in spawning gravels, changes in redd superimposition, and the results of various redd trapping and survival-to-emergence studies. There are no data to indicate water temperature is affecting egg survival.

     - Karl English suggests that flows are not changing gravel quality until a flood event. Noah Hume says current estimates were that 3,000 to 4,000 cfs would be required to mobilize the gravels in the spawning reach.

     - Donn Furman asked about the relative contributions of the Tuolumne, Stanislaus, and Merced rivers to the overall spawning populations. Noah Hume responded that the Tuolumne River had historically contributed greater numbers, with these numbers falling in recent years, perhaps due to greater relative contributions of hatchery fish from the Merced River Fish Facility. Zack Jackson cautioned that current runs were lower than historical returns. Tim O'Laughlin stated that the current runs are dominated by hatchery returns in all tributaries, citing the results of the "2012 Constant Fractional Marking Report" released by CDFG.

- Fry Production – Potential issues are well documented as they relate to gravel predation, with potential issues related to food availability.

  - Noah Hume stated that extensive seine data, recent rotary screw trap (RST) data, and predation studies have been conducted. Some invertebrate and feeding studies have been conducted, but comprehensive benthic macroinvertebrate data are limited to summer sampling periods. Karl English suggested that the RST data would provide the basis for calibration/validation of the population models.

- Smolt Production – Like fry and juveniles, potential issues relate to gravel predation and water temperature during outmigration.

  - Noah Hume stated that extensive, recent RST monitoring is available, as well as several predation and smolt survival studies. Karl English asked how predation would be incorporated. Noah Hume responded that this would likely be as a flow-based regression, either based upon the historical coded-wire tag evaluation by the TRTAC, or information from the ongoing predation study (W&AR-7).

  - Noah Hume pointed to the extensive amounts of pool habitat resulting from historical mining that underlies the predation issue. John Devine asked whether any channel realignment had been considered in the past. Allison Boucher described the re-working of the floodplain near La Grange as part of the construction of the Don Pedro Project and partially funded under the Davis-Grunsky Act, authorized in 1960 as part of the Burns-Porter Act.

  - Karl English suggested a potential relationship between hatchery fish recoveries in RST data and the relative proportion of "Jacks" in the spawner population.

Next Steps and Closure – 2:30 PM to 2:45 PM

1. John Devine summarized Action Items from the meeting. He noted that it will be most helpful if RPs provide any additional references within the next 30 days as the study will move toward developing preliminary conceptual models for the upcoming workshop in June.

2. Action Items:

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    - Districts will provide draft meeting notes. RPs to provide any comments or corrections to these study notes within 30 days of distribution.

3. Next Workshop: June 26, 2012 at MID Offices.

Attachment B

Draft Meeting Notes and Workshop Materials

W&AR-5 Salmonid Information Synthesis Workshop No. 1

Don Pedro Project Relicensing
W&AR-5 Salmonid Information Synthesis Workshop No. 1
Draft Meeting Notes – For Relicensing Participant Review

Tuesday, April 10, 2012

Attendees

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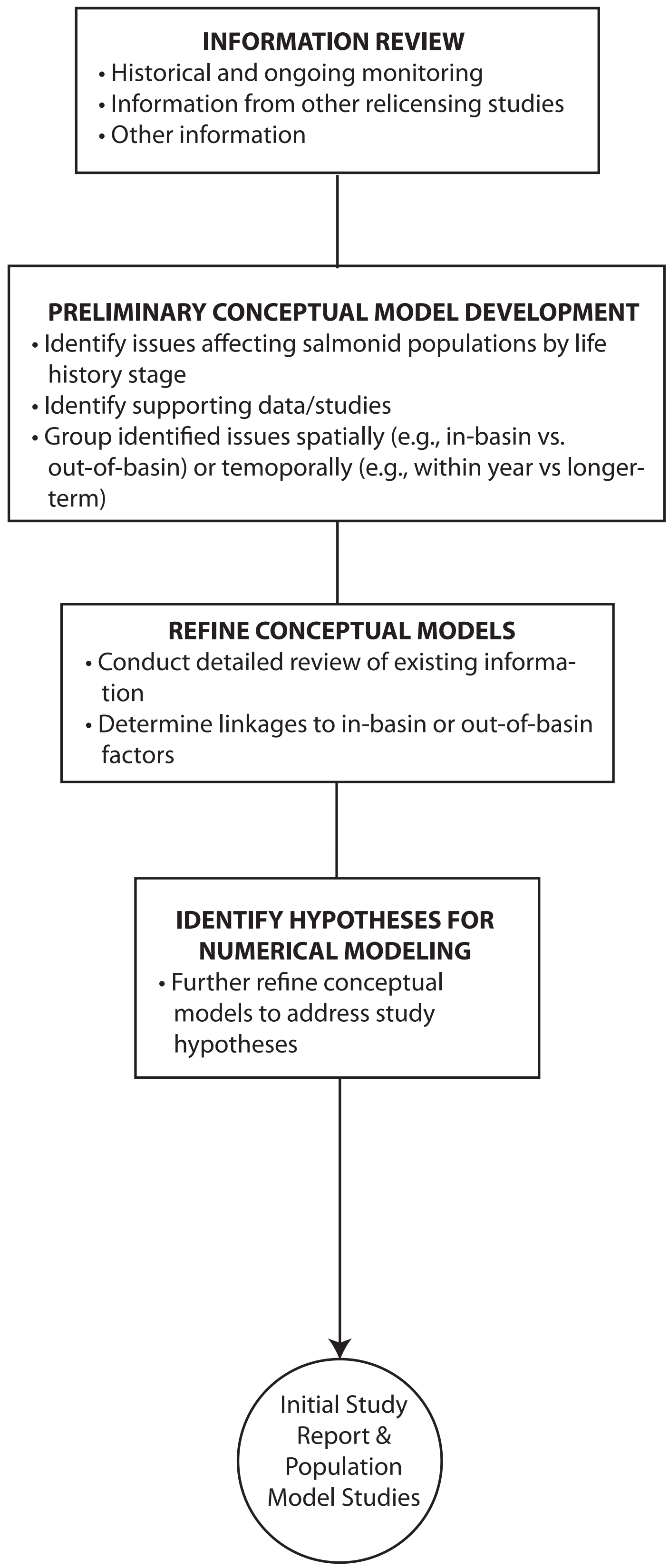
    - Districts will provide draft meeting notes. RPs to provide any comments or corrections to these study notes within 30 days of distribution.

3. Next Workshop: June 26, 2012 at MID Offices.

Attachment 1
W&AR -5 Study Process Diagram

Salmonid Information Synthesis Study Process



Attachment 2
April 10, 2012 Meeting Overview

Agenda/Overview

Introductions and Background

1. Purpose of Meeting
2. Overview of Study Plan and FERC Determination
3. Relationship to other studies
4. ILCM Workshop Process Recommendations

Don Pedro Fish Study Programs

1. Article 39 Study Program
2. 1986 Amended Fish Study Agreement
3. 1991 Article 39 Twenty-Year Fish Study Report
4. 2005 10-Year Summary Report
5. Monitoring under 2008 and 2009 Orders

Discussion of Issues Affecting Tuolumne River Salmonids

Next Steps and Closure

Introduction

Workshop No. 1 Purpose

Study Plan Overview and Relationships to other Studies

- Information Review (Study Plan Step 1)
- Conceptual Model Development (Study Plan Step 2)
- Hypotheses for Numerical Modeling (*W&AR-6 and -10 population modeling*) (Study Plan Step 2)

FERC Study Determination

ILCM Workshop Process Recommendations

Introduction

FERC Study Determination Recommendations

1. Address association between flows, water temperature, habitat conditions, predation, and response of in-river salmonid life-stages
2. Establish an efficient structure for consultation (March 20, 2012 Consultation Workshop)
3. Adopt guidelines similar to the June 2011 Salmonid Integrated Life Cycle Model Workshop (See next)
4. Describe how interested participants and the Districts would achieve consensus on issues (See Consultation Workshop process)
5. Make available sufficient information (on electronic media) for review.
6. Allow additional workshops as necessary.

Introduction

ILCM Workshop* Process Recommendations

- Standardized glossary of terms
- Tailor presentations/documentation to audience
- Peer review panel to provide feedback and advice (*Not formally adopted*)
- Develop any model as series of iterative steps from the questions to the formulation of the new model
- Transparency of available data used in calibration and validation
- Parallel data synthesis effort

* Rose, K., J. Anderson, M. McClure and G. Ruggerone. 2011. Salmonid Integrated Life Cycle Models Workshop. Report of the Independent Workshop Panel. Prepared for the Delta Stewardship Council.

Attachment 3

March 20, 2012 Consultation Workshop Process Materials

DRAFT
WORKSHOP CONSULTATION PROCESS
ON INTERIM STUDY PLAN DECISIONS

As part of certain studies to be undertaken in the Don Pedro Project relicensing, the Districts had proposed a series of workshops to share and discuss relevant data with Relicensing Participants (RPs). FERC has recommended that the Workshop Consultation process be formalized. In accordance with Appendix B of FERC's December 22, 2011 Study Plan Determination, the draft workshop consultation process outlined below has been developed to provide guidance for the decision-making process involved within the following study plans:

- W&AR-2 (Project Operations Model): Hydrology Workshop
- W&AR-5 (Salmonid Population Information Synthesis): Literature/Data Review Workshop and Conceptual Model Review Workshop
- W&AR-6 (Chinook Population Model): Conceptual Model Review Workshop and Modeling Approach Workshop
- W&AR-10 (*O.Mykiss* Population Model): Conceptual Model Review Workshop and Modeling Approach Workshop
- W&AR-14 (Temperature Criteria Assessment): Water Temperature Evaluation Criteria Workshop

The purpose of the eight workshops is to provide opportunity for RPs and the Districts to discuss relevant data sources, methods of data use and development, and modeling parameters at key points in the execution of these study plans. The goal of the workshops is for RPs and the Districts to reach agreement where possible after thorough discussion of data, methods and parameters. Consensus on decisions dealing with data acceptability, or study approaches or methods can only be achieved by the active and consistent in-person attendance and participation of interested Relicensing Participants. Additional workshops beyond those already specified above may be held as agreed to between the RPs and the Districts.

FERC has also directed the Districts to formalize the workshop process to define how interim decisions on model inputs and parameters will be made. To promote clear communication and informed participation, the Districts will make a good-faith effort to provide two (2) weeks before each workshop, in electronic format, information and presentation materials to be discussed at the workshops. For studies that involve resource modeling, presentation materials will be tailored to the audience at a level that assumes familiarity with the resource issues being addressed. To promote a common understanding of terms, a glossary of definitions will be prepared prior to each initial workshop, updated and expanded upon periodically, and included in the final study report. Prior to the initial workshops, the Districts will also prepare a logic diagram of the study steps from data selection through model development and numerical procedures to model scenario evaluation. This study "process diagram" will aid in promoting a common understanding of the step-wise approach being used in model development.

Following each workshop, draft meeting notes of the consultation workshop will be distributed to participants within approximately eight (8) working days. The notes will identify areas where participants reached agreement on data, methods and/or parameters, areas where there is disagreement among participants, and action items for any future meetings. Following a 30-day comment period, the Districts will file with FERC a revised version of the consultation workshop notes describing areas of agreement, areas where agreement was not reached, copies of comments received, a discussion of how the Relicensing Participant comments and recommendations have been considered by the Districts, as well as the rationale for the Districts not adopting any Relicensing Participants recommendations.

The proposed schedule for workshops is included below. All meetings will be held at MID offices in Modesto.

March 2012
Mar 20 - 1:30 pm – 4:30 pm
Don Pedro Project Relicensing - Workshop on Consultation Process (as per Appendix B of FERC's Study Plan Determination)

April 2012
Apr 09 - 1:00 pm - 5:00 pm
Don Pedro Project Relicensing - Hydrology Workshop (W&AR-2)

Apr 10* - 10:30 am - 5:00 pm Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5)

Apr 11 - 9 am – 12:00 pm Don Pedro Project Relicensing – Temperature Criteria Workshop (W&AR-14)

June 2012
Jun 26 - 9:00 am - 4:00 pm Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5)

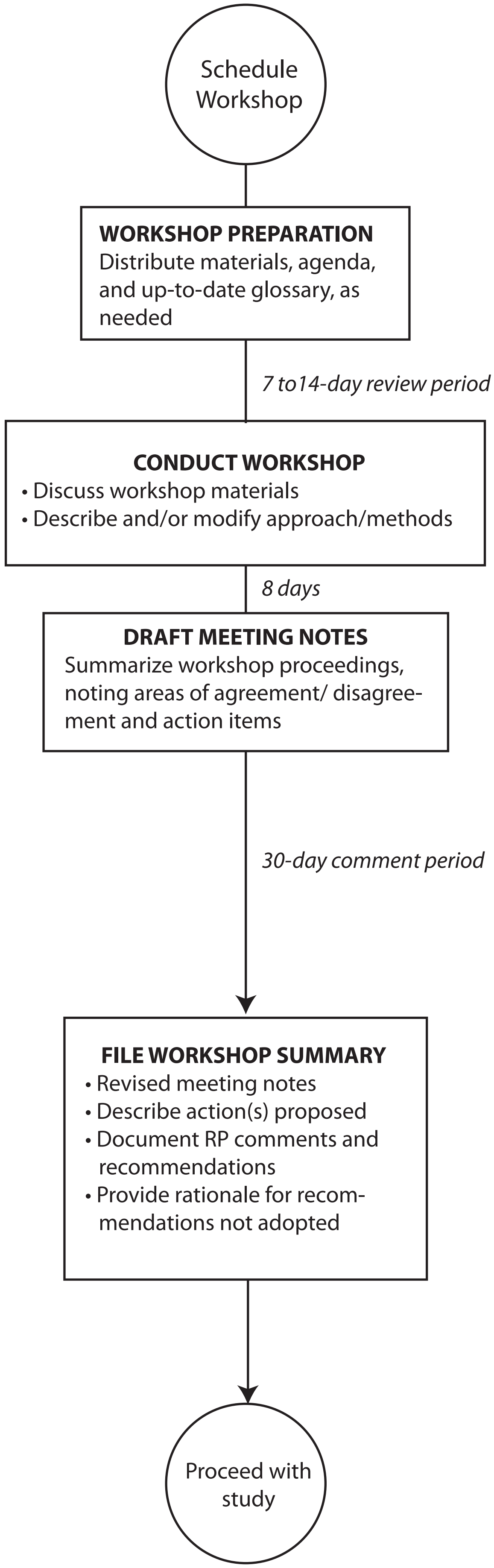
November 2012
Nov 15 - 9:00 am - 4:00 pm Don Pedro Project Relicensing - Chinook Population (W&AR-6) and O.mykiss Population (W&AR-10) Modeling Workshop

2013 (Dates to be determined)

March 2013 (preliminary) - 9 am to 4 pm Don Pedro Project Relicensing - 2nd Workshop Chinook Population (W&AR-6) and O.mykiss Population (W&AR-10) Modeling

***NOTE:** From 8:30 am to 10:15 am, the Districts will conduct an introduction to the MIKE3 reservoir temperature model for use in W&AR-3. The goal is to introduce the model platform, computation methods, model development, and data sources. This is not considered a formal workshop. The Districts are also planning to conduct a discussion and presentation of the reservoir temperature model validation results at a Relicensing Participant Meeting on September 18, 2012 from 9 am to 4 pm at MID. Please add this meeting to your calendars.

Workshop Consultation Process Diagram



Attachment 4
Workshop Materials Transmitted by e-mail on April 2, 2012

Salmonid Information Synthesis Workshop No. 1
Don Pedro Relicensing Study W&AR-5
April 10, 2012 – 10:30 a.m. to 5:00 p.m. - MID Offices

Conference Line Call-In Number 866-994-6437; Conference Code 5424697994

AGENDA

10:30 a.m. – 11:00 a.m.	**Introductions and Background**	
	1.	**Purpose of Meeting**
	2.	**Overview of Study Plan and FERC Determination**
	3.	**Relationship to other studies**
	4.	**ILCM Workshop Process Recommendations**
11:00 a.m. – 12:30 p.m.	**Overview of Don Pedro Fisheries Programs**	
	1.	**Article 39 Study Program**
	2.	**1986 Amended Fish Study Agreement**
	3.	**1992 Article 39 Twenty-Year Fish Study Report**
	4.	**2005 10-Year Summary Report under 1996 FERC Order**
	5.	**Ongoing Fisheries Monitoring**
12:30 p.m. – 1:00 p.m.	**Lunch**	
1:00 p.m. – 4:00 p.m.	**Discussion of Issues Affecting Tuolumne River Salmonids**	
	1.	**Supplements to January 2012 References**
	2.	**Relicensing Participants assessment of major issues affecting salmonid populations by species and life stage**
	3.	**Identify preliminary Conceptual Models**
4:30 p.m. – 5:00 p.m.	**Next Steps and Closure**	

Preliminary Reference List
Updated March 27, 2012

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Appendix 4: Instream flow data processing Tuolumne River, California. Prepared by Robert E. Meyer Consultants, Inc. August 1984

Appendix 5: Analysis of 1981 lower Tuolumne River IFIM data. Prepared by EA Engineering, Science and Technology. November 1991

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Appendix 18: Lower Tuolumne River instream temperature model documentation: Description and calibration. Prepared by EA Engineering, Science and Technology. November 1991

Appendix 19: Modeled effects of La Grange releases on instream temperatures in the Lower Tuolumne River. Prepared by EA Engineering, Science and Technology. September 1991

Appendix 20: Juvenile salmon pilot temperature observation experiments. Prepared by EA Engineering, Science and Technology. November 1991

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Appendix 25: Preliminary summary smolt survival index study. Prepared by Loudermilk, Fjelstad, Neillands, Wingett, Della Valle, Presher and Traylor, California Department of Fish and Game. July 1987

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General Criteria for assessing relevancy of existing data and reports for inclusion in the W&AR-5 Salmonid Information Integration and Synthesis Study

From the W&AR-5 Study Plan

"Information from previously conducted monitoring of Chinook salmon populations in the lower Tuolumne River will be supplemented with compilations of other relevant biologic, hydrologic, physical habitat, and water quality data information."

"The highest priority will be given to data and reports specific to the lower Tuolumne River, then to data and reports related to the San Joaquin and its major tributaries. Information from broader sources may be used to address specific data or information gaps identified as part of this process."

"A preliminary list of existing information included in the PAD will be provided to Relicensing Participants for review and …. will be updated in advance of a workshop (Section 6.0), with an opportunity for Relicensing Participants to provide additional relevant information following the workshop."

From the Preliminary Workshop 1 Materials transmittal of January 17, 2012

"These references provide information on factors affecting salmonid populations in the lower Tuolumne River. General salmonid life history references, as well as Tuolumne River specific information are included. The Districts would like to emphasize that the attached reference set is intended as an initial background survey of available information and some, or portions of some, of these references may not ultimately be required to be included in the final study report. In the course of this study, the reference list will be revised and/or supplemented as required in advance of the initial or subsequent workshops. Also, additional data resources will be reviewed and incorporated, if needed."

From the above, the semi-formal criteria for inclusion in the study are:

1. Literature should provide data or present findings using basin-specific data regarding issues affecting Tuolumne River salmonids.
2. Information from broader sources will be included if they address information needs not met from Tuolumne River specific information.
3. While not excluding documents that have not been peer-reviewed, peer-reviewed publications will be given priority over non-peer-reviewed publications.
4. Draft publications will be given a low priority and require a thorough examination of any analyses supporting a Draft report's conclusions.
5. Reports developed in response to various FERC Orders are considered acceptable for the purposes of characterizing factors affecting in-river life stages.

Attachment 5
Criteria for assessing relevancy of existing data and reports for inclusion in the W&AR-5 Study

General Criteria for assessing relevancy of existing data and reports for inclusion in the W&AR-5 Salmonid Information Integration and Synthesis Study

From the W&AR-5 Study Plan

"Information from previously conducted monitoring of Chinook salmon populations in the lower Tuolumne River will be supplemented with compilations of other relevant biologic, hydrologic, physical habitat, and water quality data information."

"The highest priority will be given to data and reports specific to the lower Tuolumne River, then to data and reports related to the San Joaquin and its major tributaries. Information from broader sources may be used to address specific data or information gaps identified as part of this process."

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4. Draft publications will be given a low priority and require a thorough examination of any analyses supporting a Draft report's conclusions.
5. Reports developed in response to various FERC Orders are considered acceptable for the purposes of characterizing factors affecting in-river life stages.

Attachment 6
Historical Salmonid Monitoring Summary

Don Pedro Fish Study Programs

1972	Cooperative Article 39 fish study program (TID/MID/CDFG)
1986	Amended Article 39 studies, added Article 58 monitoring (TID/MID/CDFG/USFWS)
1991	Article 39 20 Year Study Report
1996	Amended Article 58 (1995 FSA: TID/MID/CDFG/USFWS/CSPA/FOT/TRE/TRPT/BAWUA)
2005	10-Year Summary Report
2008	FERC accepts 2005 10-Year Summary Report, additional Article 58 monitoring/*O. mykiss* studies
2009	Rehearing and ALJ Process/WT and IFIM studies

Don Pedro Fish Study Programs

Article 39 Fish Study Program (1971-1986)

- Annual spawning surveys, redd counts, sex composition
- Habitat transect surveys, air photos, temperature monitoring (3 normal and 3 dry year releases)
- Gravel condition, plant encroachment, BMI productivity (every 3 years)
- Flow fluctuation effects on redd dewatering and egg loss (5 times)
- Outmigrant timing (2 yrs normal flow, 2 yrs dry flow, 2 yrs flushing flow)

Don Pedro Fish Study Programs

1986 Amended Article 39 Fish Studies (1987-1996)

- IFIM Studies (Depth, Velocity, Substrate) for spawning, fry, and juvenile life stages
- Temperature monitoring
- Flow fluctuation effects on juvenile salmon and BMI
- Outmigrant timing (2 yrs normal flow, 2 yrs dry flow, 2 yrs flushing flow)
- Paired release smolt-survival studies (6 years)
- Spawning surveys, live and redd counts/distribution, sex composition, length-frequency distribution, spawning population estimate
- Juvenile salmon study (seining) in conjunction with CWT releases

Don Pedro Fish Study Programs

1996 Article 58 Monitoring (1997-2004)

- Spawning Surveys (No., size distribution, scale/otolith sampling)
- Quality and Condition of Spawning Habitat (gravel quality, survival to emergence)
- Relative Fry Density/Female Spawners (seine and spawner data)
- Fry Distribution and Survival (flow fluctuation)
- Juvenile Distribution and Temperature Relationships (seining)
- Smolt Survival (additional CWT studies)

Don Pedro Fish Study Programs

Monitoring Under 2008 and 2009 FERC Orders

- *O. mykiss* population estimates (2008-2011)
- *O. mykiss* tracking (2010-2011)
- *O. mykiss* anadromy (not completed)
- Water temperature modeling (2011)
- IFIM and 2D Floodplain Study (in progress)

Don Pedro Fish Study Programs

Tuolumne River monitoring/study reporting periods

- Spawning Surveys (1971 – present), Weir Counts (2009 – present), and Redd Distribution Studies (1996, 2012)
- Gravel Studies (1987 – 1989, 1991 – 1993, 2000) and BMI monitoring (1989 – 1993, 1996, 2002 – 2009)
- Fyke Net/Seine Surveys (1973 – 2012) and RST Monitoring (1995 – present)
- Fluctuation and Stranding Assessments (1992, 1996 – 2002)
- CWT Smolt Survival (1992, 1996, 1998 – 2007) and Predation Studies (1992, 2006, 2012)
- *O. mykiss* riverwide distribution (1986 – 2011), population (2008-2011), and tracking (2010 - 2011)
- Water Temperature Monitoring (1987 – present) and modeling (1992 [1978 – 1988 data]; 2011 [1999 – 2008 data]; 2012 [1999 – 2011 data])
- IFIM (1981, 1992, 1995, 2012)

Other Studies

Tuolumne and San Joaquin River basin Chinook salmon Population Models (1992, 1996)

Resident Fish Community Assessments (1988 - 1994, 2001) show 38 species in 15 families, including 14 native spp. in 7 families

Tuolumne River Restoration Plan (2001)

Tuolumne River Coarse Sediment Management Plan (2004)

Fine Sediment Studies (Gasburg and Dominici Cr. Sources, 1992-1993 gravel cleaning analysis, survival-to-emergence)

TRTAC and other Restoration Project Monitoring (various)

Others

Attachment C
California Dept. of Fish and Game comments regarding the April 10, 2012 Salmonid Information Synthesis Workshop

State of California -The Natural Resources Agency
DEPARTMENT OF FISH AND GAME
Central Region
1234 East Shaw Avenue
Fresno, California 93710
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EDMUND G. BROWN JR., Governor
CHARLTON H. BONHAM, Director

May 16, 2012

Robert Nees
Turlock Irrigation District
Post Office Box 949
Turlock, California 95381

Greg Dias
Modesto Irrigation District
Post Office Box 4060
Modesto, California 95352

Subject: Turlock and Modesto Irrigation District's April 10, 2012 Salmonid Information Synthesis Workshop Don Pedro Hydroelectric Project (FERC Project No. 2299-075) Tuolumne River, California

Dear Messrs. Nees and Dias:

Representatives from the California Department of Fish and Game (Department) attended the morning session of the subject workshop hosted by the Turlock and Modesto Irrigation Districts (Districts) as part of Water and Aquatic Resources Study Plan (W&AR-5) Salmonid Information Synthesis, for the Don Pedro Hydroelectric Project, Federal Energy Regulatory Commission (FERC) Project No. 2299-075 (Project). The Department has also reviewed the associated draft meeting notes prepared and distributed by the Districts. The Department provides the following comments in response to the salmonid information synthesis workshop and draft meeting notes.

Workshop and Draft Meeting Note Comments

The Department acknowledges the Tuolumne River watershed has been the subject of multiple fish studies and monitoring programs for well over 20 years. To synthesize this body of work into a single report identifying key hypotheses and areas of uncertainty, as well as assigning relative importance to limiting factors, will be a major undertaking. Such an effort will require many choices and will ultimately be shaped by the perceptions of the author(s). Different parties will likely have different opinions as to what data are "most appropriate" to be carried forward into subsequent analyses. Given the variety of Relicensing Participants interested in this Project, the objective of achieving consensus on conclusions about the "in-river factors thought to be of greatest importance to salmonid population levels in the basin" may be overly optimistic.

As context, we refer to FERC's appointment of an Administrative Law Judge (ALJ) in 2009 to conduct an expedited, non-adversarial fact finding proceeding to evaluate possible interim measures to benefit the Tuolumne River salmonid populations and develop a more complete factual record. As part of the ALJ proceeding, the Department provided testimony that synthesized existing data and provided key hypotheses concerning in-river factors thought to be of greatest importance to the Tuolumne's salmonid populations. Other parties to the ALJ proceeding, namely the Districts, the City and County of San Francisco (CCSF), the Bay Area Water Users Association (BAWUA), fellow Resource Agencies and Conservation Groups, also filed testimony. On November 20, 2009, the ALJ issued her final report. The Districts, CCSF and BAWUA all filed comments in support of the judge's report while the Resource Agencies and Conservation Groups jointly filed comments in opposition to the judge's report.

As the April 19, 2012 Commission Order[1] notes: ". . . the testimony confirms that conflicting evidence exists on each topic" with parties disagreeing as to what "certain evidence was more probative than other evidence" (paragraph 57, page 16). The Order also notes the ALJ proceeding ultimately ended without agreement among the parties as to whether or not there was even a need for interim measures (paragraph 32, page 10). It is unclear to the Department how this current study plan effort involving essentially the same parties with access to the same information will now achieve consensus on what are the most appropriate elements of the existing data and literature.

However, given FERC's determination that this study should go forth, some key hypotheses and conclusions prepared by the Department are reiterated here. Based on Department experience within the watershed, we conclude the Project's manipulation of flows (particularly spring flows), and the Project's role in elevating water temperatures are two fundamental limiting factors contributing to the current decline of anadromous fish populations on the Tuolumne River. The following statements, taken from the Direct Testimony of two Department representatives before the ALJ, are provided in a format intended to complement the broad issues and life stage organization of the

[1] Turlock Irrigation District and Modesto Irrigation District, Order Clarifying Proceeding On Interim Conditions, 139 FERC ¶ 61,045 (2012).

W&AR-5 draft meeting notes. Copies of the complete testimonies which synthesize field data and ecological concepts from a variety of sources are attached for reference.

Excerpts from the Direct Testimony of Mr. Timothy Heyne, Senior Environmental Scientist with the Department's anadromous fishes program in the San Joaquin River, (Department's Exhibit 2 for Project No. 2299, filed on September 14, 2009 with FERC's Secretary):

- "[c]urrent flow releases to the lower Tuolumne River required under Article 37 of the Project license are insufficient to conserve fall-run Chinook salmon and steelhead" (page 2).
- "The single most important impact of Project operations affecting anadromous fish populations is the manipulation of flows in the Tuolumne River" (page 4).
- "Providing more flow to the river at specific times of the year will improve habitat and water temperature for fall-run Chinook and steelhead" (page 7).
- Inadequate spring flows "have been identified repeatedly as the principle limiting factor on fall-run Chinook salmon populations in the Tuolumne River" (page 14).

Excerpt from the Direct Testimony of Dr. Andrew Gordus, Water Quality Biologist with the Department's Central Region (Department's Exhibit 4 for Project No. 2299, also filed with FERC's Secretary on September 14, 2009):

- "Elevated water temperatures contribute to the ongoing decline [of] fall-run Chinook salmon in the Tuolumne River by: 1) inducing adult mortality as adults migrate into the San Joaquin River and adjacent tributaries to spawn (i.e,. pre-spawn mortality); 2) reducing egg viability for eggs deposited in stream gravels; 3) increasing stress levels, thereby reducing survival of juveniles within the tributary nursery habitats; and 4) reducing salmon smolt out-migration survival as smolts leave the nursery habitats within the tributaries to migrate down the San Joaquin River to Vernalis and through the south Delta" (page 12).

References Not Included in the W&AR-5 Study Plan or Workshop Materials

In support of the preceding statements, Mr. Heyne and Dr. Gordus provided numerous references in their respective testimonies. Some of the sources they cited are contained in the references of the W&AR-5 study plan or the workshop materials, but some are not. Below is a list of the subject references we did not find listed in the study plan or workshop materials. Again, these references were filed on September 14, 2009 by the Department as Exhibits in the docket for Project No. 2299 and are available in their entirety on FERC's website.

California Department of Fish and Game. 1987. The Status of San Joaquin Drainage Chinook Salmon Stocks, Habitat Conditions and Natural Production Factors.

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Marston, Dean D. 2005. FINAL DRAFT 11-28-05 San Joaquin River Fall-run Chinook Salmon Population Model. San Joaquin Valley Southern Sierra Region November 2005.

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Myrick, C. and J. Cech Jr. 2001. Temperature Effects on Chinook Salmon and Steelhead: A Review Focusing on California's Central Valley Populations. Bay Delta Modeling Forum Technical Publication 01-1.

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Newman, K. 2008. An Evaluation of Four Sacramento-San Joaquin River Delta Juvenile Salmon Survival Studies. Report to the CalFed Science Program (Project Number SCI-06-G06-299).

Rich, A. A. 2007. Impacts of water temperature on fall-run Chinook salmon (Oncororhynchus tshawytsca) and steelhead (O. mykiss) in the San Joaquin River system. A. Rich and Associates. Fisheries and Ecological Consultants. San Anselmo, California 94960.

Sommer, T. R., M. L. Nobriga, W. C. Harrell, W. Batham, and W. J. Kimmerer. 2001. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:325-333.

United States Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. 49 pp.

Yoshiyama, R.M., E. R. Gerstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California.

Conclusion

Thank you for the opportunity to provide comments on the salmonid information synthesis workshop for the subject study. If you have questions regarding these comments, please contact Annie Manji, Staff Environmental Scientist, at (530) 225-2315, or Dean Marston, Environmental Program Manager, at (559) 243-4014

Sincerely,

Andrew G. Gordus, Ph.D.

for Jeffrey R. Single, Ph.D.
Regional Manager
Central Region

Attachments

cc: Kimberly D. Bose, Secretary
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John J. Devine
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EXHIBIT NO. DFG-2

BEFORE THE U.S. FEDERAL ENERGY REGULATORY COMMISSION

OFFICE OF ADMINISTRATIVE LAW JUDGES

Turlock Irrigation District and Modesto Irrigation District New Don Pedro Project FERC Projects Nos. 2299-065 and 2299-053	))))))	DIRECT TESTIMONY OF TIMOTHY HEYNE ON BEHALF THE CALIFORNIA DEPARTMENT OF FISH AND GAME

DIRECT TESTIMONY OF TIMOTHY HEYNE

ON BEHALF OF CALIFORNIA DEPARTMENT OF FISH AND GAME

My name is Timothy Heyne. My address is California Department of Fish and Game, 1234 East Shaw Avenue, Fresno, California 93710. I have been employed by the California Department of Fish and Game (DFG) for nearly 20 years. Currently, I am a Senior Environmental Scientist responsible for supervising staff assigned to DFG's anadromous fishes program in the San Joaquin River. All of my work experience with DFG has been in the southern portion of California's Central Valley.

I hold a Bachelor of Science degree in environmental science and a Master of Science degree in biology from California State University at Fresno. I have planned, lead or participated in scientific evaluations of salmonid life history and factors limiting their abundance, the toxicity of trace elements to San Joaquin River fishes, juvenile life history of striped bass in the San Joaquin River-Sacramento Delta (Delta) and its tributaries, reservoir fishes biology in the Central Valley, and a variety of other aquatic biology evaluations.

My testimony relates to the following issues that Presiding Administrative Law Judge Charlotte J. Hardnett identified in her August 13, 2009, Order on Scope and Proceedings and Setting Due Dates in the above-referenced proceeding: 1) the effects of the operation of the Don Pedro Project (Project) on the fishery resources for the near term pending relicensing; and 2) the views of the parties regarding proposals for interim protective measures and any reasonable alternatives that may be considered necessary or desirable to address those effects, including possible changes in project facilities or operations.

I explain, with regard to the effects of the Project on fishery resources, that: 1) California Central Valley fall-run Chinook salmon and California Central Valley steelhead occur in the Tuolumne River, a part of the Central Valley; 2) fall-run Chinook salmon and steelhead in the lower Tuolumne River are in serious decline; and 3) current flow releases to the lower Tuolumne River required under Article 37 of the Project license are insufficient to conserve fall-run Chinook salmon and steelhead. This last fact frames the majority of my testimony because DFG considers the insufficient flow releases from the Project to be the dominant factor limiting populations of fall-run Chinook salmon and steelhead in the Tuolumne River.

In regard to measures that would protect these fish species on an interim basis, increasing flows in the lower Tuolumne River would benefit fall-run Chinook salmon and steelhead. The interim measures proposed by the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (FWS) in this proceeding (Exhibit No. DFG-1 (National Marine Fisheries Service and U.S. Fish and Wildlife Service Interim Measure Elements) would increase flows in the lower Tuolumne River. Because that would represent an improvement over existing conditions, DFG supports the measures NMFS and FWS have proposed on an interim basis for the purpose of this proceeding. However, as NMFS and FWS emphasize, the interim measures represent *minimum* flows in an effort to prevent the continuing decline of fall-run Chinook salmon and steelhead in the short-term. Different measures will be required to meet DFG's longer-term objective to recover these and other fish species to sustainable population levels. The recommendations DFG makes in the relicensing proceeding for the Project, and in any other proceeding that relates to the lower Tuolumne River, including those before the State Water Resources Control Board, will be based on that longer-term objective.

Fall-run Chinook salmon and steelhead occur in the Tuolumne River, a part of the Central Valley. Over several decades, the numbers of both fall-run Chinook salmon and steelhead found in the Tuolumne River have dramatically declined, as reflected by the fact that steelhead is listed as a threatened species under the Endangered Species Act (ESA) and fall-run Chinook salmon in the Central Valley is categorized as a federal species of concern. Identifying factors that contribute to these declines has been an important objective for DFG and other fish management agencies.

Extensive research has been conducted into the complex interactions of abundance and distribution for the various life stages of anadromous salmonids and the multiple factors affecting those that are found in the Tuolumne River. This research includes long-term monitoring of young and adult fish including population sizes, health, and distribution. In addition to fish monitoring, data have been collected to monitor indicators of habitat quality, with streamflow, sediment, and water temperature being identified as some of the most critical. Studies have also been performed to understand how streamflow and sediment conditions affect the geomorphic processes that maintain and shape fish habitat on the Tuolumne River. As a result of these efforts, DFG asserts that Project operations are partly responsible for the Tuolumne River fall-run Chinook salmon and steelhead population declines. The single most significant impact of Project operations affecting the anadromous fish populations is the manipulation of flows in the Tuolumne River. The following sections identify some of the fundamental information in support of this conclusion and other related facts.

Figure 1. View of California's Central Valley Showing the Various Rivers Within the Central Valley and the Two Primary Sub-Basins: Sacramento (Northern) and San Joaquin (Southern)

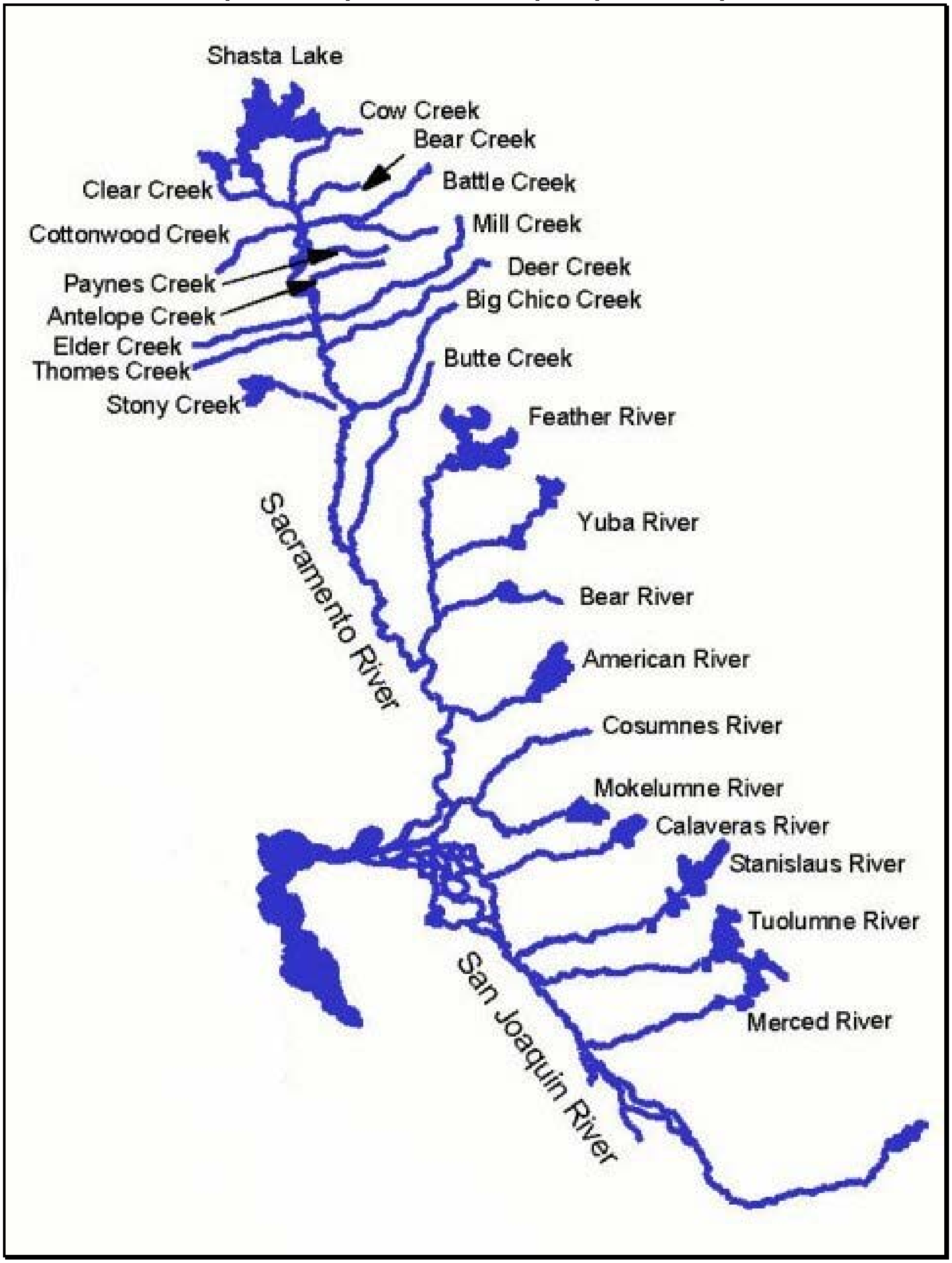
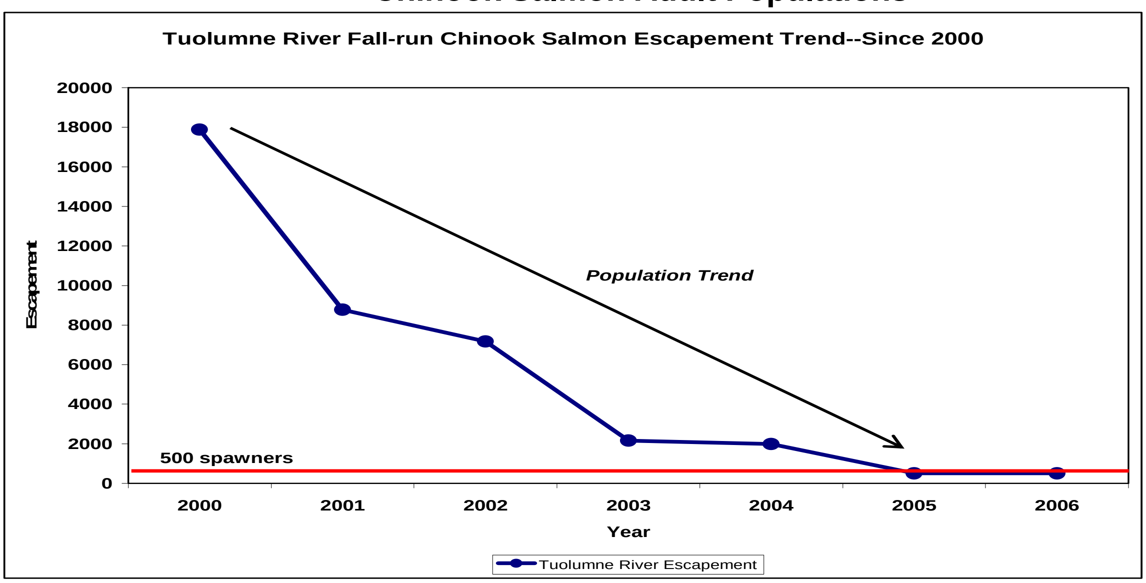


Figure 2 illustrates that over the last decade the numbers of fall-run Chinook salmon found in the Tuolumne River have dramatically declined. Current fall-run Chinook salmon adult escapement abundance for the Tuolumne River is only one quarter to one third of targeted population goals and fall-run Chinook salmon are considered to be in poor condition. Steelhead still exist in the lower Tuolumne River (Exhibit No. DFG-26 Zimmerman et al., 2008), but have reached such low numbers as to barely be detected by monitoring, as evidenced by licensee's annual reports to the Commission.

Figure 2. Tuolumne River Annual Salmon Escapement Trend 2000 to 2006, Showing the Recent Downward Trend for Tuolumne River Fall-Run Chinook Salmon Adult Populations



Salmon escapement refers to the number of adult salmon escaping ocean harvest and returning to fresh water to spawn. Since a peak escapement in the year 2000 (over 17,000 spawners), escapement of fall-run Chinook salmon in the Tuolumne River has dropped sharply to less than 500 spawners for both the 2005 and 2006 escapement years. This recent crash in escapement population occurred well before a decline in ocean conditions during 2005 and occurred concurrently with a substantial decline in Project spring time flow releases during the 1999 to 2004 time period.

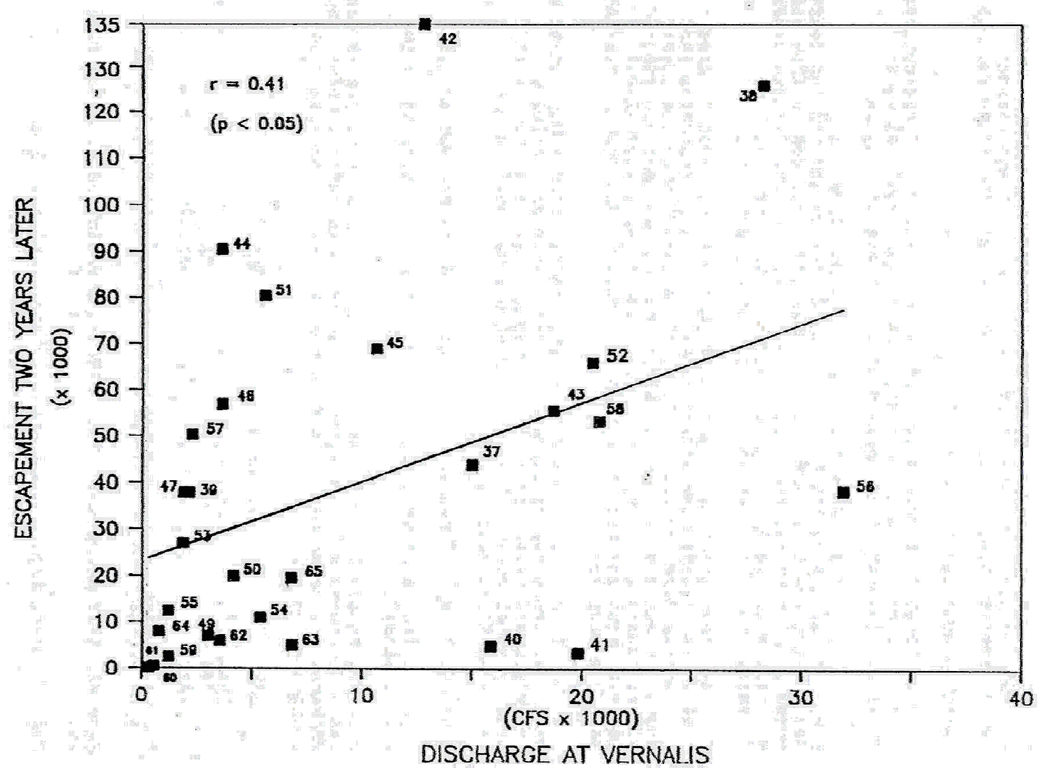
The portion of the Tuolumne watershed that currently can be used by these fish for migration, spawning, incubation, and rearing is limited by several impassable dams, including the Project's 585-foot high Don Pedro Dam. Currently, anadromous fish are blocked from accessing over 50 percent of their historic range on the Tuolumne River by these dams (Exhibit No. DFG-25 Yoshiyama et al., 2001).

The Project substantially contributes to impaired flow in the lower Tuolumne River. In addition to reducing instream flows overall, the Project changes the times of year when flows peak. Where unimpaired flow levels were once highest (on average) in the spring (during juvenile out-migration), the Project now releases the highest flows in the winter (during egg incubation and fry emergence).

Neither past nor present instream flow schedules implemented by the Project have resulted in the restoration of fall-run Chinook salmon or steelhead in the Tuolumne River or kept these fish populations from experiencing an ever-worsening decline. Interim actions to assist in recovery of fall-run Chinook and steelhead are warranted. Providing more flow to the river at specific times of the year will improve habitat and water temperatures for fall-run salmon Chinook and steelhead.

These declines in population have been occurring at least since the original licensing of the Project. DFG began trying to identify the causes of the declines beginning in the early 1970s through the 1980s, culminating in a submittal of an assessment to the State Water Resources Control Board on the relationship of fall-run Chinook salmon population numbers to spring streamflows (Exhibit No. DFG-6 California Department of Fish and Game, 1987). Figure 3 is from that report.

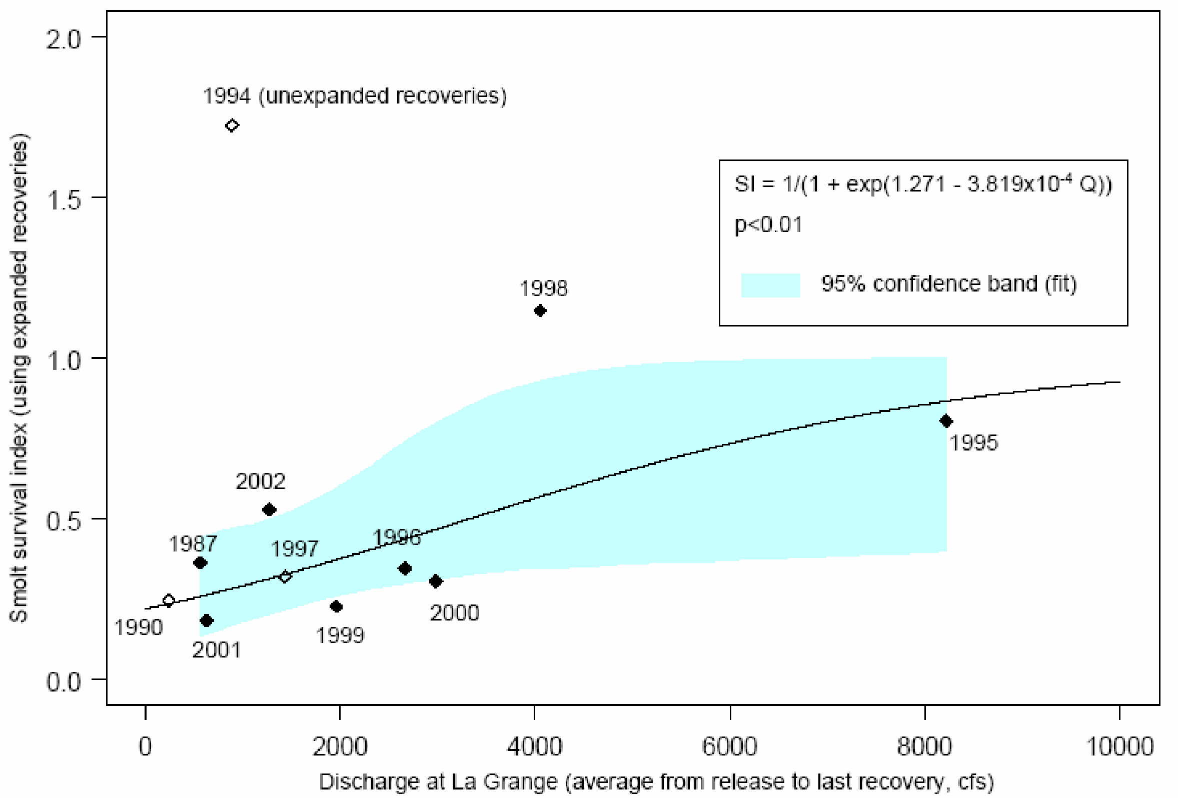
Figure 3. Number of Adult Chinook Returning Compared to Spring Flows in Their 1st Year (CDFG, 1987)



Annual spawning surveys for fall-run Chinook salmon have been performed for more than 55 years. Analysis of these data by the 1980s showed a relationship between spring flows and the number of adults returning several years later as a result of those flows. This relationship indicated that the numbers of salmon returning to the river to spawn were much increased when spring streamflows in the first year the fish's life were high (Figure 3).

The Project licensees asserted that there were other factors affecting the number of salmon returning to spawn. In response, DFG agreed to pursue additional evaluations, particularly assessments that focused on specific sections of the river system so that flows needs could be identified on a reach-by-reach basis. Beginning in the 1980s, DFG in cooperation with the licensees began performing a tagging program for hatchery juvenile fall-run Chinook salmon that strategically planted the fish throughout the San Joaquin River basin (including the Tuolumne River) in order to assess survival in all sections of the river system at a variety of flows. After a number of years of study and a joint evaluation by all parties, including the licensees, on the Tuolumne River, a report was produced that the licensees filed in their 2004 report to the Commission that documented a relationship indicating increased flow in the spring resulted in increased numbers of smolts surviving out of the Tuolumne River (Figure 4).

Figure 4. Tuolumne River Smolt Survival Relationship



Figures 3 and 4 illustrate the benefits increased spring time flows can provide for the fall-run Chinook salmon population. However, the spring stream flow levels provided by the Project are grossly deficient (in terms of flow magnitude, flow duration, and elevated flow frequency) and do not produce an adequate supply of smolts to conserve the fall-run Chinook salmon population. The artificially low flows cause the juveniles to stop migrating and also cause excessive warming of water as flow level recedes. Low flows during the spring out-migration also impact smolts moving through the Delta where predation and water quality are significant sources of mortality. The losses of smolts associated with current Project releases in the spring are a significant impact on the fishery and have been correlated with fewer adults returning to spawn.   Given the current Project flow releases into the lower Tuolumne River, currently there are simply not enough juveniles getting out of the basin to sustain the population.

Additional data supporting the conclusion that current spring flows are insufficient come from analyses of smolts collected in rotary screw traps, seines, and trawls in the lower Tuolumne and Delta. These smolt production evaluations have been performed since the early 1980s, with the rotary screw trap estimates beginning in mid 1990s. Observed trends in smolt number, size, and river mile have been correlated with spring flow conditions as well as water temperature. Data from all of these long term evaluations demonstrate that fish production is heavily dependent on river flows. To maximize smolt production, spring flows must be elevated during the smolt out-migration season, which, as demonstrated by the licensees' juvenile monitoring, occurs from about mid-March to mid-June. Elevated flows (defined as increased flow magnitude, flow duration, and flow level frequency) during this spring time would maximize smolt survival and reduce water temperature, both of which would substantially enhance likelihood of smolt survival out of the Tuolumne River.

The licensees raised a concern on the smolt survival evaluations about the use of hatchery fish. Due to the concerns regarding how well hatchery fish represent wild fish and a desire to understand the migration and abundance of wild fall-run Chinook salmon smolts, DFG had already begun (1995) a program of using a capture device called a rotary screwtrap at the mouth of the Tuolumne to document the numbers of fish leaving the Tuolumne River. This program, too, was operated in conjunction with the licensees. The result of screw trapping is an estimate of the number of juvenile fall-run Chinook salmon leaving the river each year. These estimated number of outmigrants are presented in the table below (Table1) with the estimated number of eggs that produced those outmigrants. The egg estimates are produced by DFG each year after they perform adult spawning surveys. When you divide the outmigrants by the eggs produced and then multiply by 5,000 you have an estimate of the number of outmigrants that make it out of the river per average female. By comparing the "high" production years and low production years to streamflow it is clear that streamflow has a large impact on production, affecting the number of outmigrants/female making out of the river.

Table 1. Evaluation of Production of Outmigrant Juveniles per Spawning Female Compared Spring Flows in the Tuolumne River.

Outmigration Year	Potential Eggs	RST Outmigrants	% Leaving River	Outmigrants / Avg. Female	Spring Flow Apr-Jun
1998	21,520,864.77	1,615,673	7.507%	375	3931
1999	22,640,987.17	1,073,669	4.742%	237	1381
2000	18,842,659.42	132,017	0.701%	35	1029
2001	68,954,846.59	111,644	0.162%	8	467
2002	30,833,259.73	14,540	0.047%	2	388
2003	23,220,487.01	7,261	0.031%	2	453
2004	7,939,399.75	13,134	0.165%	8	503
2005	5,227,439.49	74,471	1.425%	71	4426
2006	2,813,709.71	178,034	6.327%	316	6703
2007	1,802,677.00	937	0.052%	3	338
2008	543,200.66	3,283	0.604%	30	448

I submit that after three major and substantially independent evaluation programs, all reaching the same conclusion, it is time to act on the information available. Current spring flows are inadequate and need to increase to keep the fall-run Chinook salmon populations from declining to zero (extinction). This is not to say that spring flows are the only area that needs improvement, but it is the best studied and the studies provide a consistent answer. Even a consultant hired by the Federal Energy Regulatory Commission (Commission) in the 1980s to work on modeling the actions needed to improving the Tuolumne River fall-run Chinook salmon populations identified increased spring flows as the number one priority to improve fall-run Chinook salmon populations (Exhibit No. DFG-12 Jaeger et al., 1997).

Based on the long-term evaluation data, the likely mechanisms for higher flows enhancing smolt out-migration include: 1) improved water quality (e.g., water temperature, contaminants, and dissolved oxygen) in the lower river and Delta which reduces mortality causal factors (e.g., disease and starvation); 2) out-migration transit time is reduced through the lower Tuolumne River and Delta; 3) predation, by native Sacramento pikeminnow and introduced black bass and striped bass, is reduced as water temperature declines, water velocity increases, and turbidity increases; and 4) entrainment and impingement in the lower river and Delta is reduced. The following references detail the relationships between low spring flow, elevated temperature and smolt production and survival: Exhibit No. DFG-10 (Fuller and Sonke, 2006); Exhibit No. 12 (Jager et al. 1997); Exhibit No. DFG-14 (Marston et al., 2008); Exhibit No. DFG-17 (Mesick, C., et al., 2008); Exhibit No. DFG-16 (Mesick, C., 2008); Exhibit No. DFG-18 (Myrick, C. and J. Cech Jr., 2001); Exhibit No. DFG-20 (Newman, K., 2008); and Exhibit No. DFG-23 (Turlock Irrigation District and Modesto Irrigation District, 2005).

The discussion above has focused on the spring flows because these have been identified repeatedly as the principle limiting factor on fall-run Chinook salmon populations in the Tuolumne River. However, other time periods have significant flow issues including winter, summer and early fall. In summer, low flows can be shown to have a negative impact on the number of steelhead in the river using the seine data developed by the licensees. This area will be addressed by several other witnesses in this proceeding.

Winter flows are also an issue for fall-run Chinook salmon fry and while there is not a great deal of information available some literature indicates that this is a critical issue for juvenile fall-run Chinook salmon as well. The Project's winter (or salmon fry rearing) flow releases are inadequate to inundate or maintain floodplain habitat, thereby limiting fry rearing habitat, food, and therefore survival. The amount of fry habitat that is wetted under current operations is very limited, serving as a bottleneck and contributing to the overall decline in fall-run Chinook salmon and steelhead populations. Additionally under the current flow schedule, channel forming flows (referred to as geomorphic flows) are very limited. This results in the deterioration of the in-river habitats and floodplain habitats. Currently the U.S. Fish and Wildlife Service is proposing a study program for floodplain wetting that DFG supports in principle.

If the Project were to provide higher flows beginning in February and extending into late-May, a higher percentage of juveniles would survive as a result of: 1) increased rearing habitat quantity and quality as floodplain habitat increases; 2) increased food availability from inundated floodplains; 3) improved water quality (including water temperature, contaminants, and dissolved oxygen) which reduces mortality from other stressors (e.g., disease, contaminates, and starvation); and 4) reduced predation by Sacramento pikeminnow, black bass and striped bass. The following references detail the relationship between floodplain inundation, geomorphic flows and fry density: Exhibit No. DFG-13 (Jeffres, C.A., J.J. Opperman, and P.B. Moyle, 2008); Exhibit No. DFG-17 (Mesick, C., et al., 2008); and Exhibit No. DFG-22 (Sommer, T. R., M. L. Nobriga, W. C. Harrell, W. Batham, and W. J. Kimmerer, 2001).

The Project currently has requirements to release fall pulse flows. The pulse flows are intended to attract adults into the Tuolumne and keep water temperatures cool to promote successful spawning by the returning adults. These fall pulse flows typically occur the last two weeks of October and vary in volume, based on water year type. In some years, very little fall attraction flow water is released, providing little to no improvement. The minimum flow schedule for the Project does not require any fall pulse flow in 4 of the 10 water year types and relatively minor pulse flows in Intermediate Dry-Below Normal and Median Below Normal water year types such that 6 out of 10 years has little to no fall pulse flows. These flows are insufficient to support adult migration, by consistently reducing the straying of adults, or preventing high water temperatures and low dissolved oxygen.

Analysis of coded wire tags recovered in both the Sacramento and San Joaquin watersheds supports the conclusion that higher fall flows are needed to reduce straying rates. Water temperature monitoring in the mainstem San Joaquin and Tuolumne has demonstrated the release of fall pulse flows can significantly lower water temperatures. The following references detail the relationships between low fall flow releases and adult Chinook straying rates and elevated water temperatures: Exhibit No. DFG-8 (Central Valley Regional Water Quality Control Board, 2009a); Exhibit No. DFG-9 (Central Valley Regional Water Quality Control Board, 2009b); Exhibit No. DFG-15 (Marston, D., 2007); Exhibit No. DFG-14 (Marston et al., 2008); and Exhibit No. DFG-17 (Mesick, C., et al., 2008).

Higher fall migration pulse flow releases from the Project, especially in drier water years, are warranted. Providing additional fall pulse flows is the first step towards increasing fall-run Chinook salmon production in the Tuolumne River. If adult migration into the Tuolumne can be maximized by sufficient fall attraction flows, fry production will substantially increase.

In conclusion there is a strong connection between elevated spring flow level and: 1) fall-run Chinook salmon smolt habitat quality; 2) smolt out-migration abundance; and 3) future year adult fall-run Chinook salmon production. Having the Project release substantially improved spring flows (across years) would have compounding benefit effects downstream of the Tuolumne River in that more smolts would likely survive the entrance into and their migration through the South Delta. More Tuolumne River origin juvenile (smolt) salmon arriving at Jersey Point will increase the likelihood that adult production would increase as well. Additionally the current scientific information on Central Valley salmonids indicates that increases in winter and early spring flows would improve fall-run Chinook salmon populations and increases in summer flows would increase steelhead populations as well as over-summer fall-run Chinook salmon juveniles.

Because fall-run Chinook salmon in the lower Tuolumne River is at an elevated risk of extinction it is imperative that the stream flows in the Tuolumne

River are substantially improved now to maximize lower Tuolumne River fall-run Chinook salmon smolt, thence adult, production. Producing substantially larger numbers of escaping salmon is needed immediately to restore (build) and sustain (establish) a healthy adult salmon population level that can reduce the likelihood of extinction and put the lower Tuolumne River fall-run Chinook salmon population on a path to dramatically improve public trust in-river and ocean fishery harvest.

<u>References Cited in My Testimony</u>

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Exhibit No. DFG-8: Central Valley Regional Water Quality Control Board. 2009a. Draft 2008 California 303(d)/305(b) Integrated Report-Supporting Information for Regional Board 5-Central Valley Region. Staff Report to the California Central Valley Regional Water Quality Control Board Documenting Evidence to List Water Temperature as Impaired in the Tuolumne River. (excluding appendices)

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Exhibit No. DFG-14: Marston, D., T. Heyne, A. Hubbard, W. Getz, L. Rachowicz, M. Daugherty, A. Dotan, I. Mlaker and R. Starfield. 2008. California Department of Fish and Game San Joaquin River Fall-run Chinook Salmon Population Model Peer Review: Response to Peer Review Comments Initial Response. California Department of Fish and Game Report to the California State Water Resources Control Board.

Exhibit No. DFG-15: Marston, Dean D. 2005. FINAL DRAFT 11-28-05 San Joaquin River Fall-run Chinook Salmon Population Model. San Joaquin Valley Southern Sierra Region. California Department of Fish and Game. Fresno CA.

Exhibit No. DFG-16: Mesick, C. 2008. The Moderate to High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Tuolumne River due to Insufficient Instream Flow Releases. USFWS Report.

Exhibit No. DFG-17: Mesick, C., et al. 2008. Limiting Factor Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River.

Exhibit No. DFG-18: Myrick, C. and J. Cech Jr. 2001. Temperature Effects on Chinook Salmon and Steelhead: A Review Focusing on California's Central Valley Populations. Bay Delta Modeling Forum Technical Publication 01-1.

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Exhibit No. DFG-22: Sommer, T. R., M. L. Nobriga, W. C. Harrel, W. Batham, and W. J. Kimmerer. 2001. Floodplain rearing of juvenile Chinook salmon: evidence of enhanced growth and survival. Canadian Journal of Fisheries and Aquatic Sciences 58:325-333.

Exhibit No. DFG-23: Turlock Irrigation District and Modesto Irrigation District. 2005. 2005 Ten Year Summary Report pursuant to Paragraph (G) of the 1996 FERC Order issued July 31, 1996. Report on the Don Pedro Project (FERC Project No. 2299-024) prepared for the Federal Energy Regulatory Commission. April 1, 2005.

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Exhibit No. DFG-26: Zimmerman, C. E., G.W. Edwards and K. Perry. 2008. Maternal Origin and Migratory History of *Oncorhynchus mykiss* captured in rivers of the Central Valley, California. Final Report Prepared for California Department of Fish and Game under Contract P0385300

BEFORE THE U.S. FEDERAL ENERGY REGULATORY COMMISSION

OFFICE OF ADMINISTRATIVE LAW JUDGES

Turlock Irrigation District and Modesto Irrigation District New Don Pedro Project FERC Projects Nos. 2299-065 and 2299-053	))))))	DIRECT TESTIMONY OF TIMOTHY HEYNE ON BEHALF THE CALIFORNIA DEPARTMENT OF FISH AND GAME

DECLARATION CERTIFYING DIRECT WRITTEN TESTIMONY OF TIMOTHY HEYNE

Pursuant to 28 U.S.C. §1746, I declare under penalty of perjury that the foregoing is true and correct. Executed on this 10th day of September, 2009

Timothy Heyne

EXHIBIT NO. DFG-4

BEFORE THE U.S. FEDERAL ENERGY REGULATORY COMMISSION

OFFICE OF ADMINISTRATIVE LAW JUDGES

Turlock Irrigation District and	)	DIRECT TESTIMONY OF
Modesto Irrigation District	)	ANDREW G. GORDUS ON BEHALF OF
New Don Pedro Project	)	THE CALIFORNIA DEPARTMENT OF
Project Nos. 2299-065	)	FISH AND GAME
and 2299-053	)	

DIRECT TESTIMONY OF ANDREW G. GORDUS, Ph. D.

ON BEHALF OF THE CALIFORNIA DEPARTMENT OF FISH AND GAME

My name is Andrew G. Gordus. My address is California Department of Fish and Game, 1234 East Shaw Avenue, Fresno, California 93710. My occupation is a Water Quality Biologist. For the past nine years, I have been employed by the California Department of Fish and Game (DFG), Central Region. I hold a Bachelor of Science degree in Wildlife Management and Master of Science degree in Natural Resources with a Wildlife Management emphasis from Humboldt State University, and a Ph. D. from the University of California at Davis in Comparative Pathology. My specialties are waterfowl and wetland habitat management, wildlife diseases (i.e., pathology) and toxicology, ecotoxicology, water quality, and most recently food safety in relation to wildlife bacterial contamination (*E. coli* O157:H7 and *Salmonella*) of leafy green vegetables from wildlife.

My testimony relates to the following issues that Presiding Administrative Law Judge Charlotte J. Hardnett identified in her August 13, 2009, Order on Scope and Proceedings and Setting Due Dates in the above-referenced proceeding: 1) the effects of the operation of the Don Pedro Project (Project) on the fishery resources for the near term pending relicensing; and 2) the views of the parties regarding proposals for interim protective measures and any reasonable alternatives that may be considered necessary or desirable to address those effects, including possible changes in project facilities or operations. In regard to the effects of the Project on fishery resources, California Central Valley fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and California Central Valley steelhead (*O. mykiss*) in the lower Tuolumne River are in decline (Exhibit No. DFG-2 (Direct Testimony of Tim Heyne)) and elevated water temperatures in the lower Tuolumne River during critical life stages of these species are a significant factor in that decline. In regard to measures that would protect these fish species on an interim basis, increasing flows in the lower Tuolumne River would benefit fall-run Chinook salmon and steelhead by reducing water temperatures to levels suitable to these fish species at all life stages. The interim measures proposed by the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (FWS) in this proceeding (Exhibit No. DFG-1 (National Marine Fisheries Service and U.S. Fish and Wildlife Service Interim Measure Elements) would increase flows in the lower Tuolumne River that would reduce water temperatures. Because that would represent an improvement over existing conditions, DFG supports the measures NMFS and FWS have proposed on an interim basis for the purpose of this proceeding. However, as NMFS and FWS emphasize, the interim measures represent *minimum* flows in an effort to prevent the continuing decline of fall-run Chinook salmon and steelhead in the short-term. Different measures will be required to meet DFG's longer-term objective to recover these and other fish species to sustainable population levels. The recommendations DFG makes in the relicensing proceeding for the Project, and in any other proceeding that relates to the lower Tuolumne River, including those before the State Water Resources Control Board, will be based on that longer-term objective.

In February 2007, DFG responded to the Central Valley Regional Water Quality Control Board's (CVRWQCB) "Public Solicitation of Water Quality Data and Information for 2008

Integrated Report – List of Impaired Waters and Surface Water Quality Assessment," which CVRWQCB prepared pursuant to Sections 303(d) and 305(b) in the Clean Water Act. In summary, DFG asserted that elevated water temperatures in the San Joaquin, Stanislaus, Tuolumne, and Merced Rivers are contributing to the decline of salmon and steelhead in those rivers and provided temperature data, an analysis of those data, and other information in the form of a report to support our conclusion, in summary, that water temperatures in these rivers are too warm for anadromous fish during all of their life stages. The CVRWQCB completed its own analysis and reached the same conclusion. In doing so, the CVRWQCB used the same temperature data DFG used in its analysis, but used a different methodology to analyze those data. The Central Valley Regional Water Quality Control Board (CVRWQCB) approved the listing of the Tuolumne River as water temperature impaired (Exhibit No. DFG-8, CVRWQCB 2009a, Exhibit No. DFG-9, CVRWQCB 2009b).

Table 1 below summarizes the information supporting my testimony that the Tuolumne River does not meet (cool) temperature water quality standards to protect anadromous fish beneficial uses. It represents a summary of the total number of weeks of water temperature impairment for anadromous fish using the Tuolumne River from 1998 through 2006.

Table 1. Summary of Water Temperature Impairment for Anadromous Fish in Tuolumne River: 1998-2006

Life Stage	Season	Number of Weeks	Criteria °C (°F)	Number of weeks above threshold/Total weeks (%)
Chinook Adult Migration	Sep 1 – Oct 31	8	18 (64.4)	53/72 (73.6)
Chinook Spawning	Oct 1 - Dec 15	11	13 (55.4)	63/99 (63.6)
Chinook Smoltification	Mar 15 – Jun 15	14	15 (59.0)	74/126 (58.7)
Steelhead Summer Rearing	Jun 15 – Sep 15	14	18 (64.4)	65/126 (51.6)

As mentioned above, water temperatures in the lower Tuolumne River are to warm for fall-run Chinook salmon and steelhead during all of their life stages. DFG reached this conclusion by comparing the temperature criteria recommended by the U.S. Environmental Protection Agency's Region 10 (EPA) to protect salmon and trout (Exhibit No. DFG-24, EPA 2003). Those criteria are listed in Tables 1 and 2. DFG relied on these criteria because the EPA completed a very thorough literature review for water temperatures to protect cold water fish species (trout and salmon), referencing 41 sources that included five issue papers. The issue papers, in turn, referenced approximately 700 citations. As a result, EPA's recommendations are grounded in a broad spectrum of the scientific literature across North America for developing chronic protective temperature criteria for anadromous fish populations across multiple generations. This is consistent with the emphasis by DFG on the reproduction and recruitment success of an entire population across each generation, as compared to the survival of a group of individuals across a short time period under high temperature conditions, recognizing the evolution and importance of the multi-year class life history strategy of salmon and steelhead. For the purpose of determining when temperatures exceeded the temperature criteria, temperature data were collected in the field from 1998 to 2006 at specific river mile points using the data reporting metrics normally utilized by the EPA (i.e., seven-day average of daily maximum temperatures).

The temperature water quality criteria necessary to protect cold water salmonid fisheries beneficial uses for the Tuolumne River are presented in Tables 2 through 4, herein. Table 2 presents a summary overview of life stage seasons, water temperature criteria, and available river habitat measured by river miles from the confluence of the San Joaquin River (i.e., the mouth) to the La Grange Dam for the Tuolumne River. The river mile points for the locations where the temperature data were collected (except at the confluence) in the Tuolumne River are listed in Table 3. (For reference, the Tuolumne River confluence at the San Joaquin River is 85 miles from the confluence of the San Joaquin River at the Sacramento River.) Table 4 identifies the temperature threshold levels as identified by the EPA (2003) (Exhibit No. DFG-24).

Table 2. Summary of Tuolumne River Seasons, Available River Habitat, and Temperature Thresholds

River	Location	Season	Life Phase (Beneficial Use)	Threshold (°C)	Available River Habitat (Miles)
Tuolumne	Mouth	9/1 - 10/31	Adult/Egg	18	52
	Waterford	10/1 - 12/15	Egg	13	24
	Mouth	3/15 - 6/15	Smolt	15	52
	Turlock State Recreation Area	6/15 – 9/15	Steelhead Summer Rearing	18	10

Table 3. Tuolumne River Mile Points From the Confluence of the San Joaquin River to La Grange Dam

Site Name	River Mile
La Grange Dam	52
Basso Bridge	47
Turlock State Recreation Area	42
Waterford	32
Fox Grove	26
Shiloh	4
San Joaquin River Confluence	0

Table 4. EPA Temperature Thresholds for Pacific Migratory Salmonids and Life Stages

Salmonid Life History Phase Terminology	EPA-Based Recommended Temperature Thresholds to Protect Salmon and Trout[1]
Adult migration	<64°F (<18°C) for salmon and trout migration
	<68°F (<20°C) for salmon and trout migration - generally in the lower part of river basins that likely reach this temperature naturally, if there are cold-water refugia available [but no evidence of such refugia are available for the Tuolumne River]
Incubation	<55°F (<13°C) for salmon and trout spawning, egg incubation, and fry emergence
Juvenile rearing (early year)	<61°F (<16°C) for salmon "core" juvenile rearing - generally in the mid- to upper part of river basins
Smoltification	<59°F (<15°C) for salmon smoltification
	<57°F (<14°C) for steelhead smoltification (for composite criteria steelhead conditions are applied)
Juvenile rearing (late year)	<64°F (<18°C) for juvenile salmon and steelhead migration plus non-Core Juvenile Rearing - generally in the lower part of river basins

[1]Criteria are based on the 7-day average of the daily maximum values. The EPA identified temperature unit is seven-day average of the daily maximum water temperature .

Adult Chinook salmon migration season

Adult fall-run Chinook salmon migrate upstream through the San Joaquin and Tuolumne Rivers from approximately September 1st through October 31st. The overall mean maximum weekly temperature for the Tuolumne River was above the maximum threshold (18°C) for most weeks across all years (Exhibit No. DFG-7, Table 1). The area of impaired water temperature of the river during this same period ranged from two to 49 miles (4% to 94%) of the river's length (Exhibit No. DFG-7, Table 1). In most years, the last one to two weeks of the primary migration season had suitable (i.e., cool) water temperatures for the adult salmon. Adults continue to migrate through December; however if spawning/egg incubation temperatures are met (13°C), by default, adult migration temperatures (18°C) will be met. Exhibit No. DFG-19, Figure 1 provides a visual summary of the percent of habitat-impaired areas within the entire 52-mile reach downstream from La Grange Dam. The figure shows the extreme length of impairment across weeks for all years including above normal and wet water years.

Spawning/Egg Incubation Season

The Chinook salmon spawning/egg incubation season in the Tuolumne River occurs from approximately October 1st through December 15th. The overall mean maximum weekly temperatures across years were above the maximum threshold (13°C) for weeks 40 through 46 for the Tuolumne River (Exhibit No. DFG-7, Table 2). The area of impaired river miles ranged from one to 24 (4% to 100%) miles of available spawning habitat on the Tuolumne River. The period of time water temperatures are too warm for this life stage is approximately two-thirds of the spawning season and includes up to 100 percent of the available habitat in any given year. Exhibit No. DFG-19, Figure 2 provides a visual summary of the percent of habitat impaired areas within the 24-mile reach down stream from La Grange Dam. Except for the last three to four weeks in the season (i.e., December, weeks 47 to 50), length of impairment across years including above normal and wet water years is extreme.

Smoltification

The Chinook salmon smoltification period in the Tuolumne River occurs from approximately March 15th through June 15th. The overall *mean* maximum water temperature across all years is above the maximum threshold (15°C) for 11 of the 14 weeks on the Tuolumne River (Exhibit No. DFG-7, Table 3). Overall impaired habitat is approximately 7 to 52 (13% to 100%) miles of the river's length during below normal and dry water (precipitation) years and most notably during weeks 20 through 24 (Exhibit No. DFG-7, Table 3). Thus, during May and

June (the last one-third of the season), the water temperature during this life-stage season is above the threshold for smoltification/smolt survival for the Tuolumne River. Exhibit No. DFG-19, Figure 3 provides a visual summary of the percent of habitat-impaired areas within the entire 52-mile reach down stream from the La Grange Dam. The differences of impairment across weeks between the wet years (1998, 2005, 2006) are extreme compared to the dry years (2001, 2002, 2004).

Smolt Outmigration Season

Chinook salmon smolt outmigrate occurs from approximately March 15th through June 15th. Habitat temperature requirements for smolt migration are similar to what is required for successful smoltification and discussed above. Similar to the conditions described above, the second half of the migration season has water temperatures above this threshold (Exhibit No. DFG-7, Table 3) with impairment occurring over one-third of the available outmigration habitat. This downstream warm temperature creates a barrier preventing smolts from outmigrating to the San Joaquin River and to the Delta Region.

Specific information about thermal requirements necessary to maximize smolt out-migration habitat quality is presented in Figures 1 and 2 below. The figures demonstrate that increased spring flows are strongly associated with reduced water temperatures and that as spring flows increase, water temperatures substantially decrease. This supports DFG position that reducing spring water temperatures is necessary to maximize smolt out-migration habitat quality, which is a precursor to maximizing smolt out-migration abundance.

Figure 1. Comparison of Tuolumne River Water Temperature With Instream Flow Levels

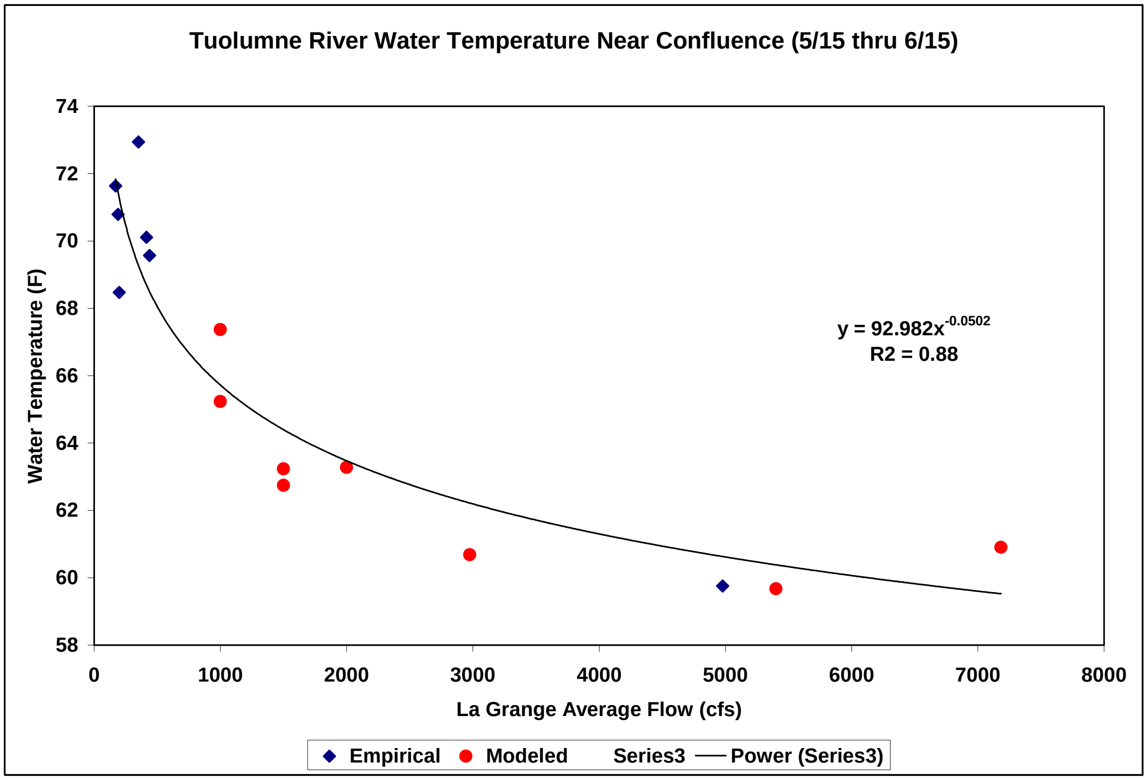

Figure 1 data points include historical flow and water temperature response results for years 1999 through 2006 (e.g., time frame is May 15 to June 15). May 15 is the approximate date the water districts begin to decrease flows, yet approximately 30 percent of the smolts are still present in the river. The data points are either empirical (real field data), shown as blue diamonds, or modeled, shown as red circles, per the San Joaquin River Basin HEC5Q Water Temperature Model Developed for the CalFed Ecosystem Restoration Program. Each empirical data point represents the 32 day average (May 15 to June 15) of daily maximum water temperatures. For the modeled data, the data point represents temperatures at 1800 hours (on a daily basis) which corresponds to the daily maximum water temperature. The non-linear (power) (i.e., curved line instead of a straight “linear” line) is derived from the combined empirical and modeled generated data sets. The smoltification water temperature criterion is 15°C (59°F).

Figure 2. Spring Tuolumne River Water Temperature as Function of Flow Level.

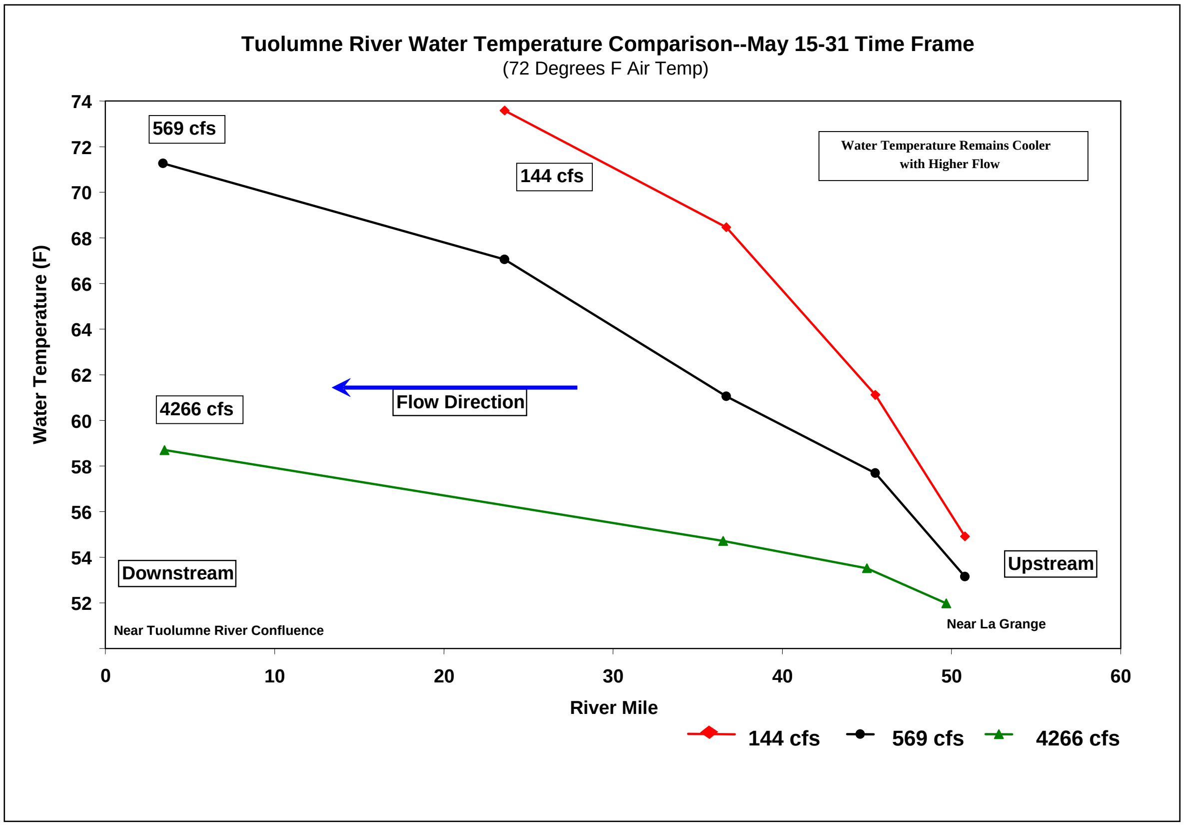

Figure 2 shows the relationship between La Grange Dam water release volumes and water temperatures. There is an inverse relationship with increased flow releases resulting in decreasing water temperatures downstream of La Grange Dam. This cooling of the water temperatures is seen from the dam to the mouth of the river during the late spring time period when salmon smolts are migrating out of the Tuolumne River. Both the reduced and elevated flow levels depicted in this figure occurred during similar meteorological conditions (approximately 72°F). In general, elevated flows have the ability to withstand meteorologically induced thermal warming of the water as it moves downstream in the Tuolumne River. The presence of colder water prolongs the smolt outmigration window which increases smolt outmigration survival and abundance.

Steelhead Summer Rearing Season

The steelhead summer rearing season occurs from approximately June 15th through September 15th. For the Tuolumne River, the entire rearing season maximum mean temperatures were above the threshold (18°C) the entire season for three of the nine years analyzed (Exhibit No. DFG-7, Table 4). Temperatures were met during wet years, indicating more flows improved water temperatures during the summer months. During years of impairment, the area of impaired river during this life stage ranged from one to eight miles (10% to 80%) of the Tuolumne River's length that is available for rainbow trout and steelhead (Exhibit No. DFG-7, Table 4). Exhibit No. DFG-19, Figure 4 provides a visual summary of the percent habitat impaired areas within the first 10 miles down stream from the La Grange Dam. The differences of impairment across weeks between the wet years (1998, 2005, and 2006) are extreme compared to the dry years (2001, 2002, 2004).

Summary of Temperature Impacts

My testimony emphasizes chronic temperature protections for the last remaining reach (downstream from the dams), for all life stages, for the last remaining genetic population of Chinook salmon and steelhead in the San Joaquin River Basin. Anadromous fish once could migrate up to higher elevation cooler waters, but today are blocked by dams.

There is an inverse relationship between water temperature and dissolved oxygen in the water. Warm water temperatures can decrease dissolved oxygen in the water and can act as an oxygen barrier to migration (Exhibit No. DFG-11, Hallock et. al. 1970). Increased water temperatures can decrease the availability of dissolved oxygen to the eggs, decrease egg hatchability, and decrease the survival of fry once they emerge from the eggs. On the Tuolumne River, water temperatures are too warm during the last one-third of the season (greater than

15°C), including above normal and wet water years, to support successful smoltification. Warm temperatures can decrease, inhibit, or reverse the physiological function or events of smoltification, as well as decrease available oxygen to the smolt. Similar to adult migrants, warm water temperatures can also act as a movement barrier to migrating smolts moving downstream, decrease physiological function and growth, and decrease dissolved oxygen availability to the fish.

Steelhead require appropriate water temperatures on a year-round basis. DFG evaluated the rearing period because this is considered the most critical life stage/period for steelhead survival. The other time periods overlap with Chinook salmon, which if salmon water temperatures are met, by default, steelhead water temperatures criteria will also be met. Tuolumne River water temperatures were very warm (greater than 18°C) 100 percent of the time for three of the nine-year study period (1998-2006) during this critical life stage.

Elevated water temperatures contribute to the ongoing decline fall-run Chinook salmon in the Tuolumne River by: 1) inducing adult mortality as adults migrate into the San Joaquin River and adjacent tributaries to spawn (i.e., pre-spawn mortality); 2) reducing egg viability for eggs deposited in stream gravels; 3) increasing stress levels, thereby reducing survival of juveniles within the tributary nursery habitats; and 4) reducing salmon smolt out-migration survival as smolts leave the nursery habitats within tributaries to migrate down the San Joaquin River to Vernalis and through the south Delta (Exhibit No. DFG-21, Rich 2007). Each of these factors has the capacity, individually and cumulatively, to lower adult salmon escapement abundance. Escapement is the ability of a fish surviving to reproductive age and migrating back to its spawning grounds. For steelhead and rainbow trout, excessively warm water temperatures have the potential to limit population abundance by restricting juvenile and adult resident over-summer rearing habitat to very short stream reaches due to downstream thermal regimes (i.e., high water temperature areas) (Exhibit No. DFG-17, Mesick et. al. 2008). As a result, too few miles of suitable habitat exist to sustain healthy population levels.

Secondary effects occur as well, especially in predator-rich systems like Central Valley rivers. As thermal optima for salmon/steelhead/rainbow trout are exceeded at temperatures above 64 to 65°F (17.7°C to 18.3°C), major predators like pikeminnow (*Ptychocheilus grandis*) (native to California), striped bass (*Morone saxatilis*) (non-native to California), and black bass (*Micropterus* sp.) (non-native to California) are just entering their thermal optima (Exhibit No. DFG-18, Myrick and Cech 2001). As cold water fish become stressed at temperatures above 64°F, salmon and trout become more vulnerable to predation.

Fish are exothermic (e.g., physiologically controlled by ambient water temperature levels). As such, water temperature controls everything about a fish's life, such as physiological function (oxygen/carbon dioxide exchange, blood chemistry/pH, organ function, heart rate, egg and sperm viability), basic survival, food consumption, rearing location preference, ability to successfully spawn, spawning location preference, growth rates, stress factors, immune function, disease resistance, and predator avoidance (Exhibit No. DFG-18, Myrick and Cech 2001). Water temperature is as important to fish as air quality is to humans.

As such, the EPA's temperature criteria presented above is a chronic threshold to protect a population of anadromous fish across multiple generations. In addition, this is an average, meaning a range of values, not constant values, were used to calculate the criteria values. Using daily temperatures that are elevated across seven days indicates the fish are *not* being briefly exposed across time. As such, the daily water temperature range is narrow (on the higher temperature scale) in the Tuolumne River, thus the fish are not briefly exposed to elevated temperatures, but are chronically exposed to warm temperatures across both a temporal (time) and spatial (space) continuum. In addition, the temperature monitoring results do not indicate that fish have the luxury of a brief exposure to optimal cool temperatures (i.e., cool temperature refugia) during a 24-hour period in the San Joaquin Valley Basin river systems. These fish require extended cool water exposure over the length of the river system to successfully complete its complex life cycle. Without changes in the flow regime and water temperatures, anadromous fish populations will continue to decline and remain potentially at risk of extinction (Exhibit No. DFG-16, Mesick 2008).

References

Exhibit No. DFG-8. Central Valley Regional Water Quality Control Board (CVRWQCB). 2009a. Draft 2008 California 303(d)/305(b) Integrated Report-Supporting Information for Regional Board 5-Central Valley Region. Staff Report to the California Central Valley Regional Water Quality Control Board Documenting Evidence to List Water Temperature as Impaired in the Tuolumne River. (excluding appendices).

Exhibit No. DFG-9. Central Valley Regional Water Quality Control Board (CVRWQCB). 2009b. Clean Water Act Section 305(b) and 303(d) Integrated Report for the Central Valley Region-May 2009 Draft Final Report, Appendix A. Staff Report to CVRWQB Regarding Proposed Additions to and Deletions from the 303(d) list for the Central Valley Region. http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/impaired_waters_list/303d_list.shtml (On web page see Appendix A, *Proposed changes to the 303(d) list*).

Exhibit No. DFG-11: Hallock, R.J., R.F. Elwell, and D.H. Fry, Jr . 1970. Migrations of adult king salmon *Oncorhynchus tshawytscha* in the San Joaquin Delta as demonstrated by the use of sonic tags. State of California, The Resources Agency, Department of Fish and Game. Fish Bulletin 151.

Exhibit No. DFG-16: Mesick, C. 2008. The Moderate to High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Tuolumne River due to Insufficient Instream Flow Releases U.S. Fish and Wildlife Service, Stockton Fishery Resource Office, Stockton, California.

Exhibit No. DFG-17. Mesick, C., J. McLain, D. Marston, and T. Heyne. 2008. Limiting factor analyses & recommended studies for fall-run Chinook salmon and rainbow trout in the Tuolumne River. Anadromous Fish Restoration Program, U.S. Fish and Wildlife Service, Office of the National Marine Fisheries Service. Sacramento, California, and California Department of Fish and Game, Fresno, California.

Exhibit No. DFG-18. Myrick, C.A., and J.J. Cech, Jr. 2001. Temperature effects on Chinook salmon and steelhead: a review focusing on California's Central Valley populations. Bay-Delta Modeling Forum Technical Publication 01-1

Exhibit No. DFG-21. Rich, A.A. 2007. Impacts of water temperature on fall-run Chinook salmon *(Oncorhynchus tshawytscha) and* steelhead *(O. mykiss*) in the San Joaquin River system. A. Rich and Associates. Fisheries and Ecological Consultants. San Anselmo, California 94960.

Exhibit No. DFG-24. United States Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. 49 pp.

Pursuant to 28 U.S.C. §1746, I declare under penalty of perjury that the foregoing is true and correct. Executed on this 11th day of September, 2009.

Andrew G. Gordus, Ph.D.

Andrew G. Gordus, Ph. D.

Attachment D
Conservation Groups comments regarding the
April 10, 2012 Salmonid Information Synthesis Workshop

May 18, 2012

Robert Nees
Turlock Irrigation District
PO Box 949
Turlock, CA 95381

Greg Dias
Modesto Irrigation District
PO Box 4060
Modesto, CA 95352

RE: Don Pedro Project (FERC Project P-2299) Comments Regarding W&AR-5: Salmonid Population Information Synthesis

Dear Mr. Devine,

American Rivers, American Whitewater, California Sportfishing Protection Alliance, California Trout, Inc., Central Sierra Environmental Resource Center, Environmental Defense Fund, Friends of the River, Golden West Women Flyfishers, Northern California Council Federation of Fly Fishers, Merced Fly Fishing Club, Pacific Coast Federation of Fishermen's Associations, Trout Unlimited, Tuolumne River Trust, and Water 4 Fish (collectively, "Conservation Groups") submit these comments regarding study W&AR-5: Salmonid Population Information Synthesis.

<u>Background</u>
On April 10, 2012, the Turlock Irrigation District and Modesto Irrigation District (collectively the Districts) conducted a workshop to reach agreement on information to be used in the synthesis study, and to provide an opportunity for relicensing participants to propose additional literature and data sources for use in this synthesis study. This workshop was conducted in accordance with the Salmonid Population Information Integration and Synthesis Study Plan as contained in the Revised Study Plan for the Don Pedro Project (Project) prepared by the Districts, and approved by the Federal Energy Regulatory Commission (FERC) in its December 22, 2011 Study Plan Determination (SPD). Section 7.0, Schedule, of the study plan contained a task to conduct a Literature and Data Review Workshop to present, discuss, and review the information and data that will be used in W&AR-6 and W&AR-10 studies.

Comments

Conservation Groups participated in the April 10, 2012 workshop and have reviewed the meeting notes and other related materials and have the following comments regarding the information presented during the April 10, 2012 workshop.

Conservation Groups believe that the information and dataset would be significantly enhanced with the addition of the following literature and data:

1. Instead of Zimmerman, et. al. 2008, please use the following peer-reviewed version of this study: Zimmerman CE, Edwards GW, Perry K. 2009, Maternal origin and migratory history of steelhead and rainbow trout captured in rivers of the Central Valley, California, Trans Amer Fish Society 138: 280-291.
2. U. S. Fish and Wildlife Service. 2008. Flow-overbank Inundation Relationship for Potential Fall-Run Chinook Salmon and Steelhead/Rainbow Trout Juvenile Outmigration Habitat in the Tuolumne River. 15 p.
3. Rich, A.A. 2007. Impacts of water temperature on fall-run Chinook salmon (Oncorhynchus tshawytscha) and steelhead (O. mykiss) in the San Joaquin River system. A. Rich and Associates. Fisheries and Ecological Consultants. San Anselmo, CA. Prepared for the California Department of Fish and Game as expert opinion and testimony to the California Regional Water Quality Control Board, Central Valley Region. Sacramento, CA.
4. Mesick, C., McLain, J., Marston, D and T. Heyne. 2008. Limiting Factor Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River. US Fish and Wildlife, National Marine Fisheries Service, California Department of Fish and Game.
5. Gordus, A. 2009. Direct testimony of Andrew G. Gordus, Ph. D. on behalf of the California Department of Fish and Game. Before the U.S. Federal Energy Regulatory Commission Office of Administrative Law Judges.
6. Gordus, A. 2009. Exhibit number 7 to direct testimony of Andrew G. Gordus, Ph.D. on behalf of the California Department of Fish and Game. Before the U.S. Federal Energy Regulatory Commission Office of Administrative Law Judges.
7. Gordus, A. 2009. Exhibit number 19 to direct testimony of Andrew G. Gordus, Ph.D. on behalf of the California Department of Fish and Game. Before the U.S. Federal Energy Regulatory Commission Office of Administrative Law Judges.
8. Myrick, C.A., and J. J. Cech. Bay-Delta Modeling Forum Technical Publication 01-1: Temperature Effects on Chinook Salmon and Steelhead: A Review Focusing on California's Central Valley Populations. Published electronically by the Bay-Delta Modeling Forum.
9. Temperature Water Quality Standards for the Protection of Anadromous Fish in the Stanislaus River, Merced River, Stanislaus River (sic), Tuolumne River and the San Joaquin River, Feb 28, 2007 Report. Department of Fish and Game, Region 4, Fresno. Report to Regional Water Quality Control Board by W.E. Loudermilk.

As described in the meeting schedule presented in the Consultation Workshop Process Meeting on March 20, 2012, the Districts currently propose to conduct a second W&AR-5 workshop on June 26, 2012, and the first workshops for W&AR-6 and W&AR-10 on November 15. This schedule is not consistent with the schedules presented in the approved individual study plans for W&AR-6 and W&AR-10. We encourage the Districts to conduct a first workshop for W&AR-6 and W&AR-10 prior to the

November workshop to discuss modeling alternatives and come to a consensus on the modeling approach that will best work for this study.

Additionally, we encourage the Districts to work with relicensing participants to collectively identify dates for all the workshops that will allow the greatest participation possible, giving special consideration to the resource agencies. The workshops that the districts conducted in early April coincided with a number of other high-profile meetings, including other relicensing proceedings and State Water Board hearings that required the attention of many Don Pedro relicensing participants. As such, participation was not as great as it might have otherwise been.

Finally, the Conservation Groups would like to express our support the comments and recommendations by the California Department of Fish and Game (DFG) in a letter dated May 16, 2012. We request that the Districts respond to these specific requests in their filing with FERC on revised meeting notes.

The Conservation Groups appreciate the Districts' consideration of our comments. If there are any questions, they can be directed to Patrick Koepele, Tuolumne River Trust, 209-588-8636 or patrick@tuolumne.org.

Sincerely,

Tuolumne River Trust

Eric Wesselman
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CALIFORNIA SPORTFISHING PROTECTION ALLIANCE
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Cindy Charles
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Board Member, Northern California Council Federation of Flyfishers
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FEDERATION OF FLY FISHERS
FF
CATCH AND RELEASE

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American Rivers
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530-478-0206

Attachment E
U.S. Fish and Wildlife Service comments regarding the April 10, 2012 Salmonid Information Synthesis Workshop

From: Zachary_Jackson@fws.gov [mailto:Zachary_Jackson@fws.gov]
Sent: Monday, May 07, 2012 5:56 PM
To: Staples, Rose
Cc: Ramon_Martin@fws.gov; Deborah_Giglio@fws.gov
Subject: Re: Don Pedro W-AR-5 Meeting Notes for 30-day Review

Hi Rose,

Here is a list of information sources that should be included:

Lindley, S.T., R.S. Schick, E. Mora, P.B. Adams, J.J. Anderson, S. Greene, C. Hanson, B.P. May, D.R. McEwan, R.B. MacFarlane, C. Swanson, and J.G. Williams. 2007. Framework for assessing viability of threatened and endangered salmon and steelhead in the Sacramento- San Joaquin Basin. *San Francisco Estuary and Watershed Science* Volume 5, Issue 1 [February 2007], article 4.

Mesick, C.F. 2009. The High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Tuolumne River due to Insufficient Instream Flow Releases. Report prepared for the U.S. Fish and Wildlife Service, Sacramento, CA.

Anadromous Fish Restoration Program, U.S. Fish and Wildlife Service, Sacramento Office of the National Marine Fisheries Service, and Fresno Office of the California Department of Fish and Game. 2008. *DRAFT* Limiting Factor Analyses & Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River. Report submitted to the Tuolumne River Technical Advisory Committee and FERC in 2007. A revised draft was distributed to the TRTAC in 2008.

Stillwater Sciences and McBain and Trush. 2006. Lower Tuolumne River Predation Assessment. Final Report. Prepared for The Tuolumne River Technical Advisory Committee, Turlock and Modesto Irrigation Districts, USFWS Anadromous Fish Restoration Program and California Bay-Delta Authority. June 2006.

Nichols, K and J.S. Foott. 2002. Health Monitoring of Hatchery and Natural Fall-run Chinook Salmon Juveniles in the San Joaquin River and Tributaries, April – June 2001. Report produced by the U.S. Fish & Wildlife Service, California- Nevada Fish Health Center, Anderson, CA. November 2002.

Tuolumne River Rotary Screw Trap Reports: can be accessed at http://www.tuolumnerivertac.com/documents.htm

San Joaquin River Group Authority Annual Technical Reports include Mossdale trawl information (Chapter 6) and can be accessed at http://www.sjrg.org/technicalreport/default.htm

Regards,

Zac Jackson
Anadromous Fish Restoration Program/
San Joaquin River Restoration Program
US Fish and Wildlife Service
4001 N. Wilson Way
Stockton, CA 95205

Consultation Workshop No. 2

June 26, 2012

From: Staples, Rose
Sent: Tuesday, February 07, 2012 8:15 PM
To: Alves, Jim - City of Modesto; Anderson, Craig - USFWS; Asay, Lynette - N-R; Aud, John - SCERD; Barnes, James - BLM; Barnes, Peter - SWRCB; Beuttler, John - CSPA; Blake, Martin; Bond, Jack - City of Modesto; Boucher, Allison - TRC; Boucher, Dave - Allison - TRC; Bowes, Stephen - NPS; Bowman, Art - CWRMP; Brenneman, Beth - BLM; Brewer, Doug - TetraTech; Brochini, Anthony - SSMN; Brochini, Tony - NPS; Buckley, John - CSERC; Buckley, Mark; Burley, Silvia-CVMT; Burt, Charles - CalPoly; Cadagan, Jerry; Carlin, Michael - SFPUC; Catlett, Kelly - FOR; Charles, Cindy - GWWF; Cismowski, Gail - SWRCB; Costa, Jan - Chicken Ranch; Cowan, Jeffrey; Cox, Stanley Rob - TBMWI; Cranston, Peggy - BLM; Cremeen, Rebecca - CSERC; Day, Kevin - TBMI; Day, P - MF; Denean - BVR; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne - OHP; Dowd, Maggie-SNF; Drekmeier, Peter - TRT; Edmondson, Steve - NOAA; Eicher, James - BLM; Fety, Lauren - BLM; Findley, Timothy - Hanson Bridgett; Freeman, Beau - CalPoly; Fuller, Reba - TMTC; Furman, Donn W - SFPUC; Ganteinbein, Julie - Water-Power Law Grp; Giglio, Deborah - USFWS; Gorman, Elaine - YSC; Grader, Zeke; Gutierrez, Monica - NOAA-NMFS; Hackamack, Robert; Hastreiter, James L - FERC; Hatch, Jenny - CT; Hayat, Zahra - MF; Hayden, Ann; Hellam, Anita - HH; Heyne, Tim - CDFG; Holden, James ; Holm, Lisa; Horn, Jeff - BLM; Horn, Tini; Hudelson, Bill - StanislausFoodProducts; Hughes, Noah; Hughes, Robert - CDFG; Hume, Noah - Stillwater; Jackman, Jerry ; Jackson, Zac - USFWS; Jennings, William - CSPA; Jensen, Art - BAWSCA; Jensen, Laura - TNC; Johannis, Mary; Johnson, Brian - CalTrout; Justin; Keating, Janice; Kempton, Kathryn - NOAA-MNFS; Kinney, Teresa; Koepele, Patrick - TRT; Kordella, Lesley - FERC; Lein, Joseph; Levin, Ellen - SFPUC; Lewis-Reggie-PRCI; Linkard, David - TRT /RH; Looker, Mark - LCC; Loy, Carin; Lwenya, Roselynn, BVR; Lyons, Bill - MR; Madden, Dan; Manji, Annie; Marko, Paul ; Marshall, Mike - RHH; Martin, Michael - MFFC; Martin, Ramon - USFWS; Mathiesen, Lloyd - CRRMW; McDaniel, Dan -CDWA; McDevitt, Ray - BAWSCA; McDonnell, Marty - SMRT; McLain, Jeffrey - NOAA-NMFS; Means, Julie - CDFG; Mills, John - TUD; Morningstar Pope, Rhonda - BVR; Motola, Mary - PRCI; O'Brien, Jennifer - CDFG; Orvis, Tom - SCFB; Ott, Bob; Ott, Chris; Paul, Duane - Cardno; Pavich, Steve-Cardno; Pinhey, Nick - City of Modesto; Pool, Richard; Porter, Ruth - RHH; Powell, Melissa - CRRMW; Puccini, Stephen - CDFG; Raeder, Jessie - TRT; Ramirez, Tim - SFPUC; Rea, Maria - NOAA-NMFS; Reed, Rhonda - NOAA-NMFS; Richardson, Kevin - USACE; Ridenour, Jim; Robbins, Royal; Romano, David O - N-R; Roos-Collins, Richard - Water-Power Law Grp for NHI; Roseman, Jesse; Rothert, Steve - AR; Sander, Max - TNC; Sandkulla, Nicole - BAWSCA; Saunders, Jenan; Schutte, Allison - HB; Sears, William - SFPUC; Shakal, Sarah - Humboldt State; Shipley, Robert; Shumway, Vern - SNF; Shutes, Chris - CSPA; Sill, Todd; Slay, Ronn - CNRF/AIC; Smith, Jim - MPM; Staples, Rose; Steindorf, Dave - AW; Steiner, Dan; Stone, Vicki -TBMI; Stork, Ron - FOR; Stratton, Susan - CA SHPO; Taylor, Mary Jane - CDFG; Terpstra, Thomas; TeVelde, George A ; Thompson, Larry - NOAA-MNFS; Vasquez, Sandy ; Verkuil, Colette - TRT/MF; Vierra, Chris; Villalabos, Ruben; Walters, Eric - MF; Wantuck, Rick - NOAA-NMFS; Welch, Steve - ARTA; Wesselman, Eric - TRT; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas - RHH; Wilcox, Scott - Stillwater; Williamson, Harry (NPS); Willy, Alison - FWS; Wilson, Bryan - MF; Winchell, Frank - FERC; Wood, Dave - FR; Wooster, John -NOAA; Workman, Michelle - USFWS; Yoshiyama, Ron; Zipser, Wayne - SCFB
Subject: Don Pedro Project Relicensing Water & Aquatic Study Plans Workshop/Meeting Schedule for 2012

In accordance with FERC's Study Plan Determination and the Districts' Water & Aquatic (W&AR) study plans to be underway in 2012, we have developed schedule dates for the various workshops contained within the study plans. Please make note of these below:

April 2012

Apr 09 1:00 pm - 5:00 pm PT Don Pedro Project Relicensing - Hydrology Workshop (W&AR-2) (Modesto Irrigation District Offices, Modesto {MID})

Apr 10 8:00 am – 10:00 am PT Don Pedro Project Relicensing - Reservoir Temperature Modeling Data and Methods (MID)

Apr 10 10:15 am - 5:00 pm PT Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5) (MID)

June 2012

Jun 26 9:00 am – 4:00 pm PT Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5) (MID)

September 2012

Sep 18 9:00 am - 4:00 pm PT Don Pedro Project Relicensing - Temperature Model Verification/Calibration Meeting (MID)

November 2012

Nov 15 9:00 am - 4:00 pm PT Don Pedro Project Relicensing - Chinook Population (W&AR-6) and O.mykiss Population (W&AR-10) Modeling Workshop (MID)

In addition, in accordance with FERC's direction regarding the development and implementation of a more explicit consultation program for those studies with workshops, we are proposing to hold a meeting on March 20th at MID (from 1:30 to 4:30 p.m.) to discuss and finalize such a Workshop Consultation Program. An initial proposal will be forwarded by March 5 to all participants.

March 2012

Mar 20 1:30 pm – 4:30 pm PT Don Pedro Project Relicensing - Workshop on Consultation Process (as per Appendix B of FERC's Study Plan Determination) (MID)

We look forward to continuing to work with all relicensing participants in 2012.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

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From: Staples, Rose
Sent: Monday, March 05, 2012 3:38 PM
To: Alves, Jim - City of Modesto; Anderson, Craig - USFWS; Asay, Lynette - N-R; Aud, John - SCERD; Barnes, James - BLM; Barnes, Peter - SWRCB; Beuttler, John - CSPA; Blake, Martin; Bond, Jack - City of Modesto; Boucher, Allison - TRC; Boucher, Dave - Allison - TRC; Bowes, Stephen - NPS; Bowman, Art - CWRMP; Brenneman, Beth - BLM; Brewer, Doug - TetraTech; Brochini, Anthony - SSMN; Brochini, Tony - NPS; Buckley, John - CSERC; Buckley, Mark; Burley, Silvia-CVMT; Burt, Charles - CalPoly; Cadagan, Jerry; Carlin, Michael - SFPUC; Catlett, Kelly - FOR; Charles, Cindy - GWWF; Cismowski, Gail - SWRCB; Costa, Jan - Chicken Ranch; Cowan, Jeffrey; Cox, Stanley Rob - TBMWI; Cranston, Peggy - BLM; Cremeen, Rebecca - CSERC; Day, Kevin - TBMI; Day, P - MF; Denean - BVR; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne - OHP; Dowd, Maggie-SNF; Drekmeier, Peter - TRT; Edmondson, Steve - NOAA; Eicher, James - BLM; Fety, Lauren - BLM; Findley, Timothy - Hanson Bridgett; Freeman, Beau - CalPoly; Fuller, Reba - TMTC; Furman, Donn W - SFPUC; Ganteinbein, Julie - Water-Power Law Grp; Giglio, Deborah - USFWS; Gorman, Elaine - YSC; Grader, Zeke; Gutierrez, Monica - NOAA-NMFS; Hackamack, Robert; Hastreiter, James L - FERC; Hatch, Jenny - CT; Hayat, Zahra - MF; Hayden, Ann; Hellam, Anita - HH; Heyne, Tim - CDFG; Holden, James ; Holm, Lisa; Horn, Jeff - BLM; Horn, Tini; Hudelson, Bill - StanislausFoodProducts; Hughes, Noah; Hughes, Robert - CDFG; Hume, Noah - Stillwater; Jackman, Jerry ; Jackson, Zac - USFWS; Jennings, William - CSPA; Jensen, Art - BAWSCA; Jensen, Laura - TNC; Johannis, Mary; Johnson, Brian - CalTrout; Justin; Keating, Janice; Kempton, Kathryn - NOAA-MNFS; Kinney, Teresa; Koepele, Patrick - TRT; Kordella, Lesley - FERC; Lein, Joseph; Levin, Ellen - SFPUC; Lewis-Reggie-PRCI; Linkard, David - TRT /RH; Looker, Mark - LCC; Loy, Carin; Lwenya, Roselynn, BVR; Lyons, Bill - MR; Madden, Dan; Manji, Annie; Marko, Paul ; Marshall, Mike - RHH; Martin, Michael - MFFC; Martin, Ramon - USFWS; Mathiesen, Lloyd - CRRMW; McDaniel, Dan -CDWA; McDevitt, Ray - BAWSCA; McDonnell, Marty - SMRT; McLain, Jeffrey - NOAA-NMFS; Means, Julie - CDFG; Mills, John - TUD; Morningstar Pope, Rhonda - BVR; Motola, Mary - PRCI; O'Brien, Jennifer - CDFG; Orvis, Tom - SCFB; Ott, Bob; Ott, Chris; Paul, Duane - Cardno; Pavich, Steve-Cardno; Pinhey, Nick - City of Modesto; Pool, Richard; Porter, Ruth - RHH; Powell, Melissa - CRRMW; Puccini, Stephen - CDFG; Raeder, Jessie - TRT; Ramirez, Tim - SFPUC; Rea, Maria - NOAA-NMFS; Reed, Rhonda - NOAA-NMFS; Richardson, Kevin - USACE; Ridenour, Jim; Robbins, Royal; Romano, David O - N-R; Roos-Collins, Richard - Water-Power Law Grp for NHI; Roseman, Jesse; Rothert, Steve - AR; Sander, Max - TNC; Sandkulla, Nicole - BAWSCA; Saunders, Jenan; Schutte, Allison - HB; Sears, William - SFPUC; Shakal, Sarah - Humboldt State; Shipley, Robert; Shumway, Vern - SNF; Shutes, Chris - CSPA; Sill, Todd; Slay, Ronn - CNRF/AIC; Smith, Jim - MPM; Staples, Rose; Steindorf, Dave - AW; Steiner, Dan; Stone, Vicki -TBMI; Stork, Ron - FOR; Stratton, Susan - CA SHPO; Taylor, Mary Jane - CDFG; Terpstra, Thomas; TeVelde, George A ; Thompson, Larry - NOAA-MNFS; Vasquez, Sandy ; Verkuil, Colette - TRT/MF; Vierra, Chris; Villalabos, Ruben; Walters, Eric - MF; Wantuck, Rick - NOAA-NMFS; Welch, Steve - ARTA; Wesselman, Eric - TRT; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas - RHH; Wilcox, Scott - Stillwater; Williamson, Harry (NPS); Willy, Alison - FWS; Wilson, Bryan - MF; Winchell, Frank - FERC; Wood, Dave - FR; Wooster, John -NOAA; Workman, Michelle - USFWS; Yoshiyama, Ron; Zipser, Wayne - SCFB
Subject: Reminder Don Pedro March 20 Meeting; Draft Workshop Consultation Process; 2012 Workshop Schedule
Attachments: Don Pedro Draft Workshop Consultation Process_120305.pdf

Reminder of March 2012 Meeting
Mar 20 - 1:30 pm – 4:30 pm - MID Offices
Don Pedro Project Relicensing - Workshop on Consultation Process (as per Appendix B of FERC's Study Plan Determination)

Draft Workshop Consultation Process
Please find attached the Draft Workshop Consultation Process document.

2012 Workshop Schedule
Included in the attached Draft Workshop Consultation Process document.

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DRAFT
WORKSHOP CONSULTATION PROCESS
ON INTERIM STUDY PLAN DECISIONS

As part of certain studies to be undertaken in the Don Pedro Project relicensing, the Districts had proposed a series of workshops to share and discuss relevant data with Relicensing Participants (RPs). FERC has recommended that the Workshop Consultation process be formalized. In accordance with Appendix B of FERC's December 22, 2011 Study Plan Determination, the draft workshop consultation process outlined below has been developed to provide guidance for the decision-making process involved within the following study plans:

- W&AR-2 (Project Operations Model): Hydrology Workshop
- W&AR-5 (Salmonid Population Information Synthesis): Literature/Data Review Workshop and Conceptual Model Review Workshop
- W&AR-6 (Chinook Population Model): Conceptual Model Review Workshop and Modeling Approach Workshop
- W&AR-10 (*O.Mykiss* Population Model): Conceptual Model Review Workshop and Modeling Approach Workshop
- W&AR-14 (Temperature Criteria Assessment): Water Temperature Evaluation Criteria Workshop

The purpose of the eight workshops is to provide opportunity for RPs and the Districts to discuss relevant data sources, methods of data use and development, and modeling parameters at key points in the execution of these study plans. The goal of the workshops is for RPs and the Districts to reach agreement where possible after thorough discussion of data, methods and parameters. Consensus on decisions dealing with data acceptability, or study approaches or methods can only be achieved by the active and consistent in-person attendance and participation of interested Relicensing Participants. Additional workshops beyond those already specified above may be held as agreed to between the RPs and the Districts.

FERC has also directed the Districts to formalize the workshop process to define how interim decisions on model inputs and parameters will be made. To promote clear communication and informed participation, the Districts will make a good-faith effort to provide two (2) weeks before each workshop, in electronic format, information and presentation materials to be discussed at the workshops. For studies that involve resource modeling, presentation materials will be tailored to the audience at a level that assumes familiarity with the resource issues being addressed. To promote a common understanding of terms, a glossary of definitions will be prepared prior to each initial workshop, updated and expanded upon periodically, and included in the final study report. Prior to the initial workshops, the Districts will also prepare a logic diagram of the study steps from data selection through model development and numerical procedures to model scenario evaluation. This study "process diagram" will aid in promoting a common understanding of the step-wise approach being used in model development.

Following each workshop, draft meeting notes of the consultation workshop will be distributed to participants within approximately eight (8) working days. The notes will identify areas where participants reached agreement on data, methods and/or parameters, areas where there is disagreement among participants, and action items for any future meetings. Following a 30-day comment period, the Districts will file with FERC a revised version of the consultation workshop notes describing areas of agreement, areas where agreement was not reached, copies of comments received, a discussion of how the Relicensing Participant comments and recommendations have been considered by the Districts, as well as the rationale for the Districts not adopting any Relicensing Participants recommendations.

The proposed schedule for workshops is included below. All meetings will be held at MID offices in Modesto.

March 2012

Mar 20 - 1:30 pm – 4:30 pm
Don Pedro Project Relicensing - Workshop on Consultation Process (as per Appendix B of FERC's Study Plan Determination)

April 2012

Apr 09 - 1:00 pm - 5:00 pm
Don Pedro Project Relicensing - Hydrology Workshop (W&AR-2)

Apr 10* - 10:30 am - 5:00 pm Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5)

Apr 11 - 9 am – 12:00 pm Don Pedro Project Relicensing – Temperature Criteria Workshop (W&AR-14)

June 2012

Jun 26 - 9:00 am - 4:00 pm Don Pedro Project Relicensing - Salmonid Population Information Workshop (W&AR-5)

November 2012

Nov 15 - 9:00 am - 4:00 pm Don Pedro Project Relicensing - Chinook Population (W&AR-6) and O.mykiss Population (W&AR-10) Modeling Workshop

2013 (Dates to be determined)

March 2013 (preliminary) - 9 am to 4 pm Don Pedro Project Relicensing - 2nd Workshop Chinook Population (W&AR-6) and O.mykiss Population (W&AR-10) Modeling

***NOTE:** From 8:30 am to 10:15 am, the Districts will conduct an introduction to the MIKE3 reservoir temperature model for use in W&AR-3. The goal is to introduce the model platform, computation methods, model development, and data sources. This is not considered a formal workshop. The Districts are also planning to conduct a discussion and presentation of the reservoir temperature model validation results at a Relicensing Participant Meeting on September 18, 2012 from 9 am to 4 pm at MID. Please add this meeting to your calendars.

From: Staples, Rose
Sent: Friday, June 15, 2012 7:53 PM
To: Alves, Jim; Anderson, Craig; Asay, Lynette; Aud, John; Barnes, James; Barnes, Peter; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackman, Jerry; Jackson, Zac; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Lara, Marco; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Looker, Mark; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; McLain, Jeffrey; Mills, John; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Steindorf, Dave; Steiner, Dan; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro W-AR-5 Salmonid Synthesis Information Workshop No 2 Agenda and Other Materials
Attachments: Salmonid models narrative_20120615.pdf; Chinook_Models_20120614.pdf; Steelhead_Models_20120614.pdf; DonPedro_W-AR-5_SalmonidSynthesisInfoWorkshopNo2_June26_Agenda.pdf

Salmonid Information Synthesis Workshop No. 2
Don Pedro Relicensing Study W&AR-5
June 26, 2012 – 9:00 a.m. to 5:00 p.m. - MID Offices, Modesto

Please find attached the AGENDA and materials for the upcoming Salmonid Information Synthesis Workshop No. 2 for the Don Pedro Study Plan W&AR-5, to be held on Tuesday, June 26th, from 9:00 a.m. to 5:00 p.m. at the MID offices in Modesto. There is a lot of material to cover and we expect it will be a busy meeting on the 26th.

If you are not able to participate in person, there will be a conference call-in line available:

> Call-In Number 866-994-6437
> Conference Code 5424697994

The attached material is also being uploaded to the Don Pedro relicensing website at www.donpedro-relicensing.com, both in the INTRODUCTION/Announcement section and also attached to the meeting date in the MEETINGS calendar.

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CAP-OM

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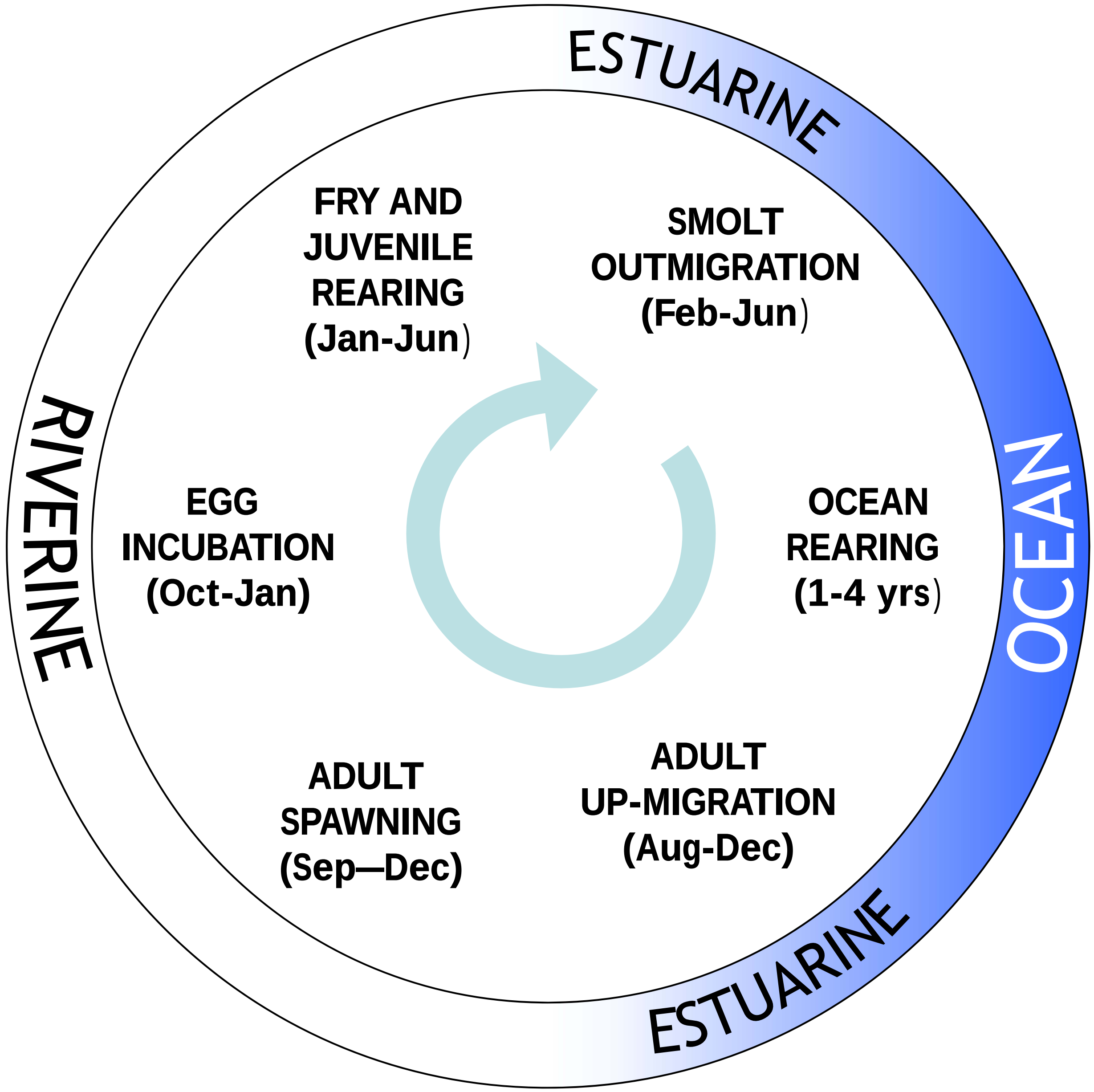
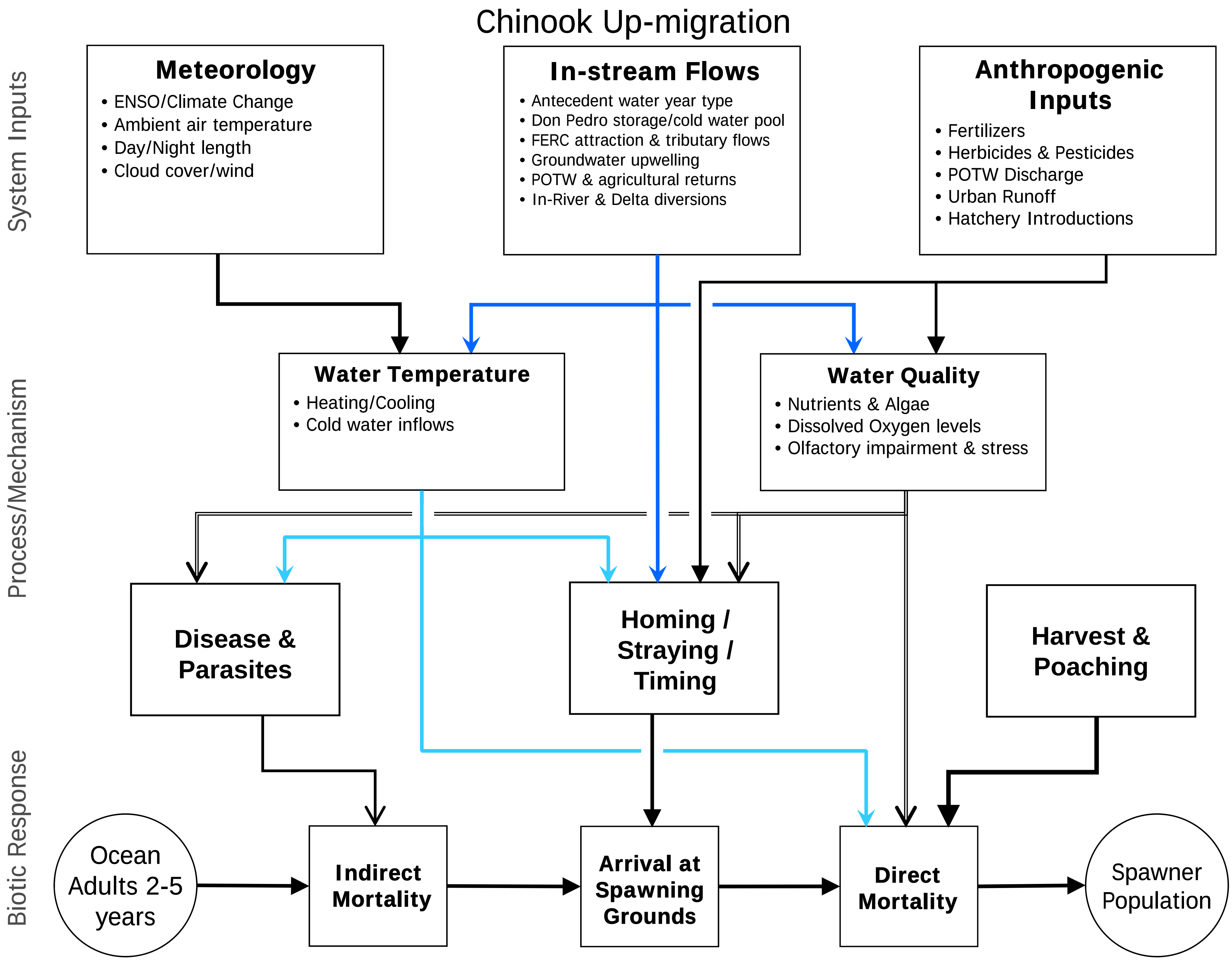
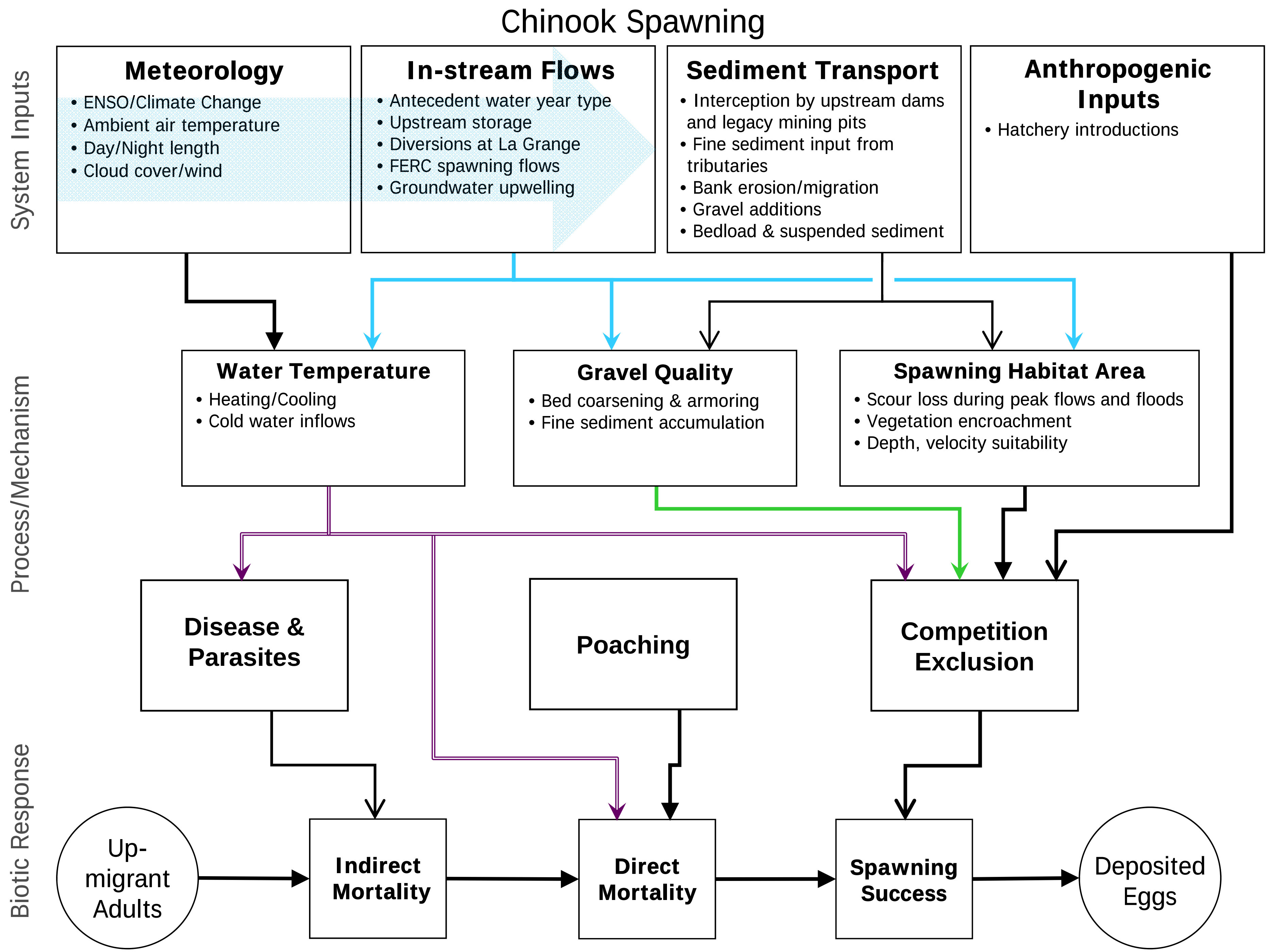
General Chinook salmon Life History Timing for the Tuolumne River

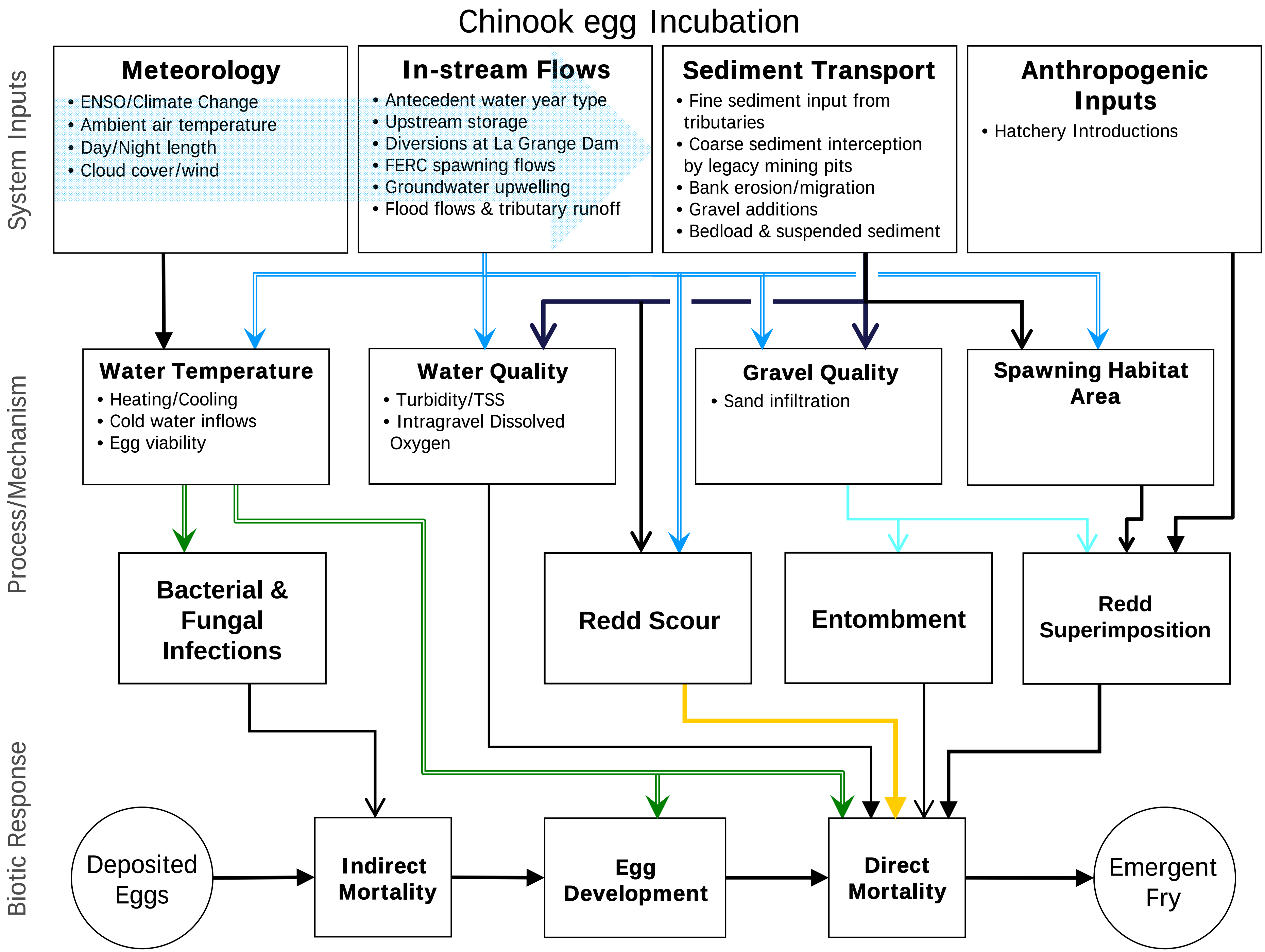


General Chinook salmon Life History Timing for the Tuolumne River

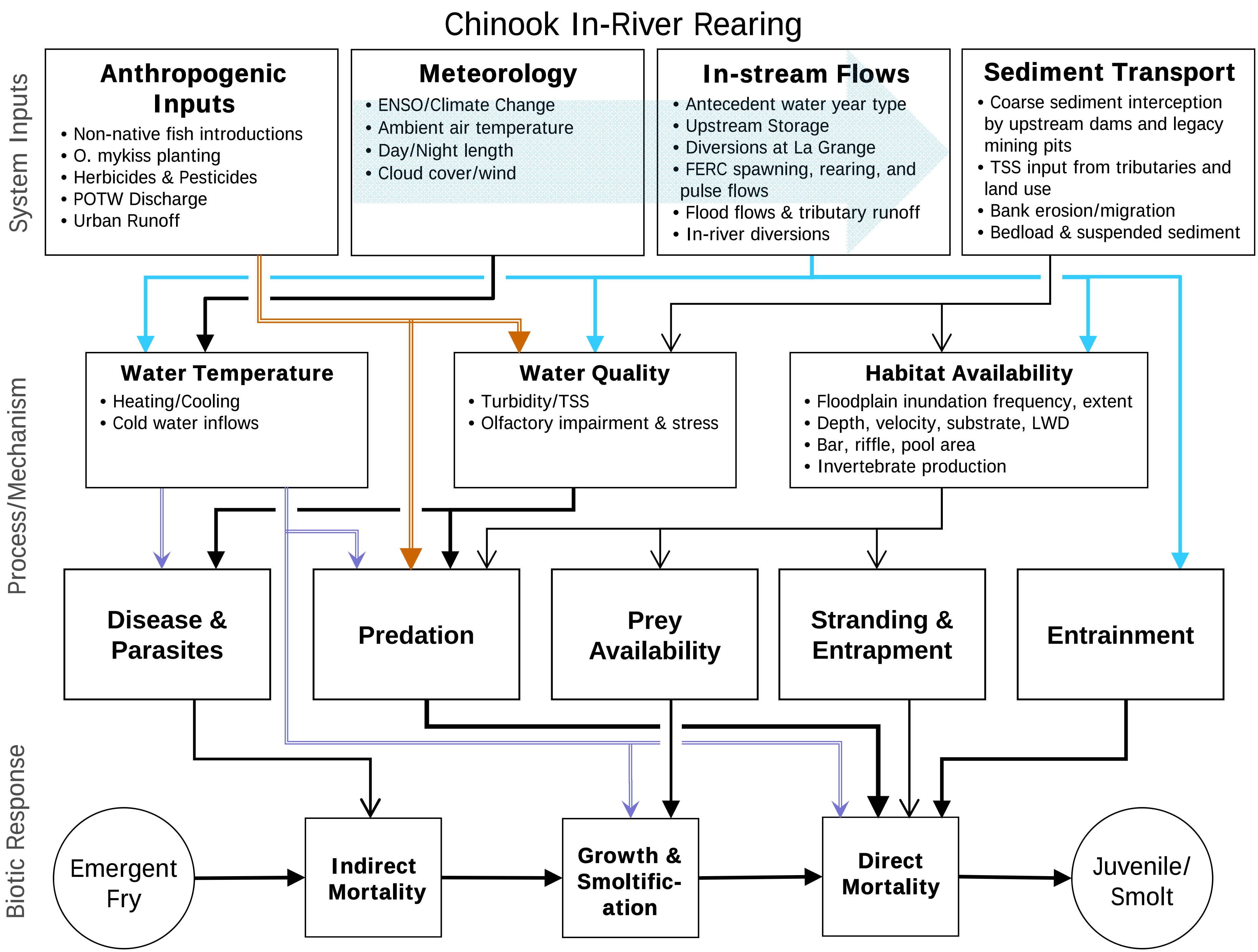
Life Stage	Fall			Winter			Spring			Summer		
	(Sep-Nov)			(Dec-Feb)			(Mar-May)			(Jun-Aug)		
Central Valley Fall-Run Chinook salmon												
Adult upstream migration												
Adult Spawning												
Egg Incubation and Fry Emergence												
In-river Rearing												
Delta Juvenile Rearing												
Smolt Outmigration												


Chinook Up-migration
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Don Pedro storage/cold water pool
• FERC attraction & tributary flows
• Groundwater upwelling
• POTW & agricultural returns
• In-River & Delta diversions
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Harvest & Poaching
Biotic Response
Ocean Adults 2-5 years
Indirect Mortality
Arrival at Spawning Grounds
Direct Mortality
Spawner Population

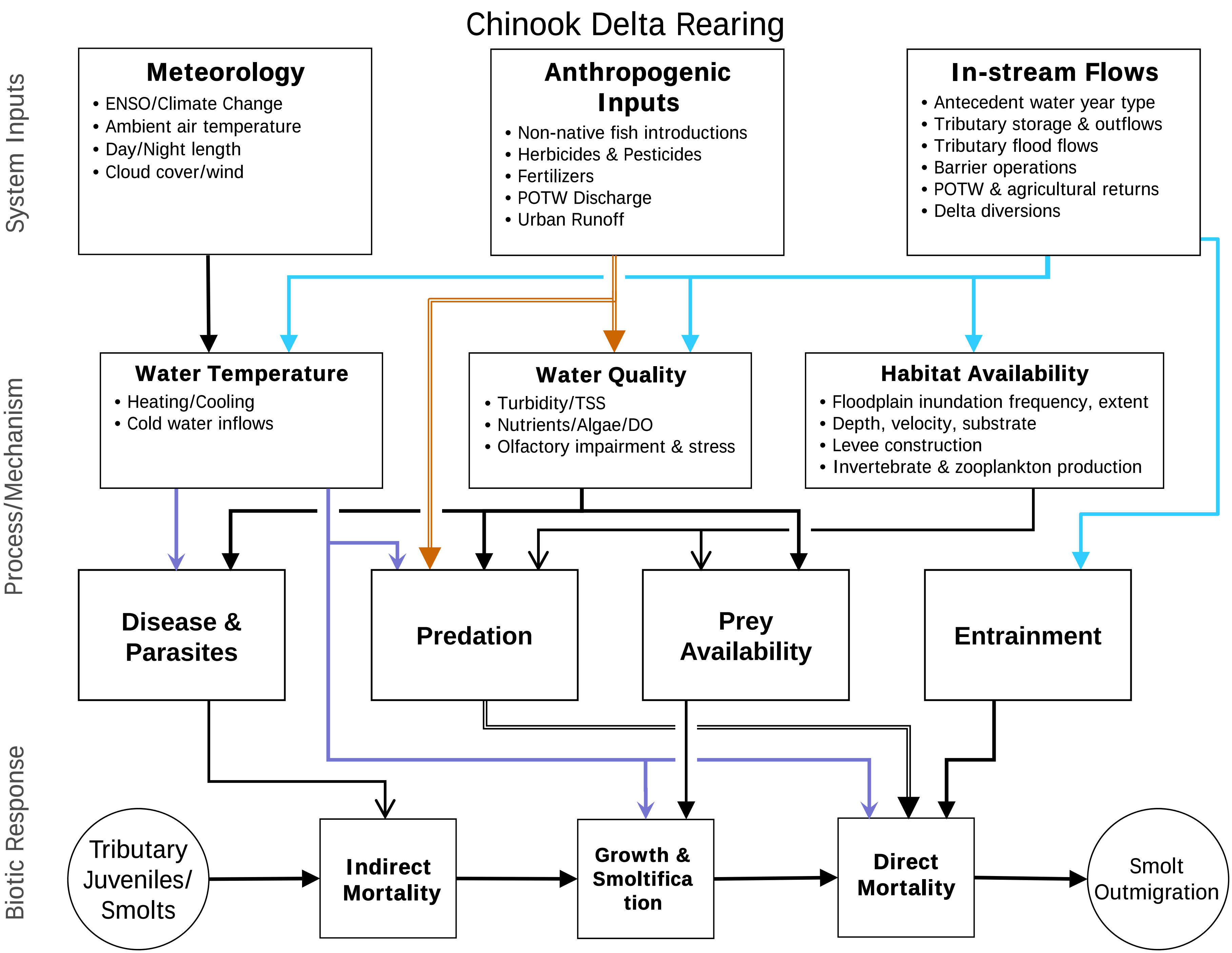

Chinook Spawning
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Poaching
Competition Exclusion
Biotic Response
Up-migrant Adults
Indirect Mortality
Direct Mortality
Spawning Success
Deposited Eggs

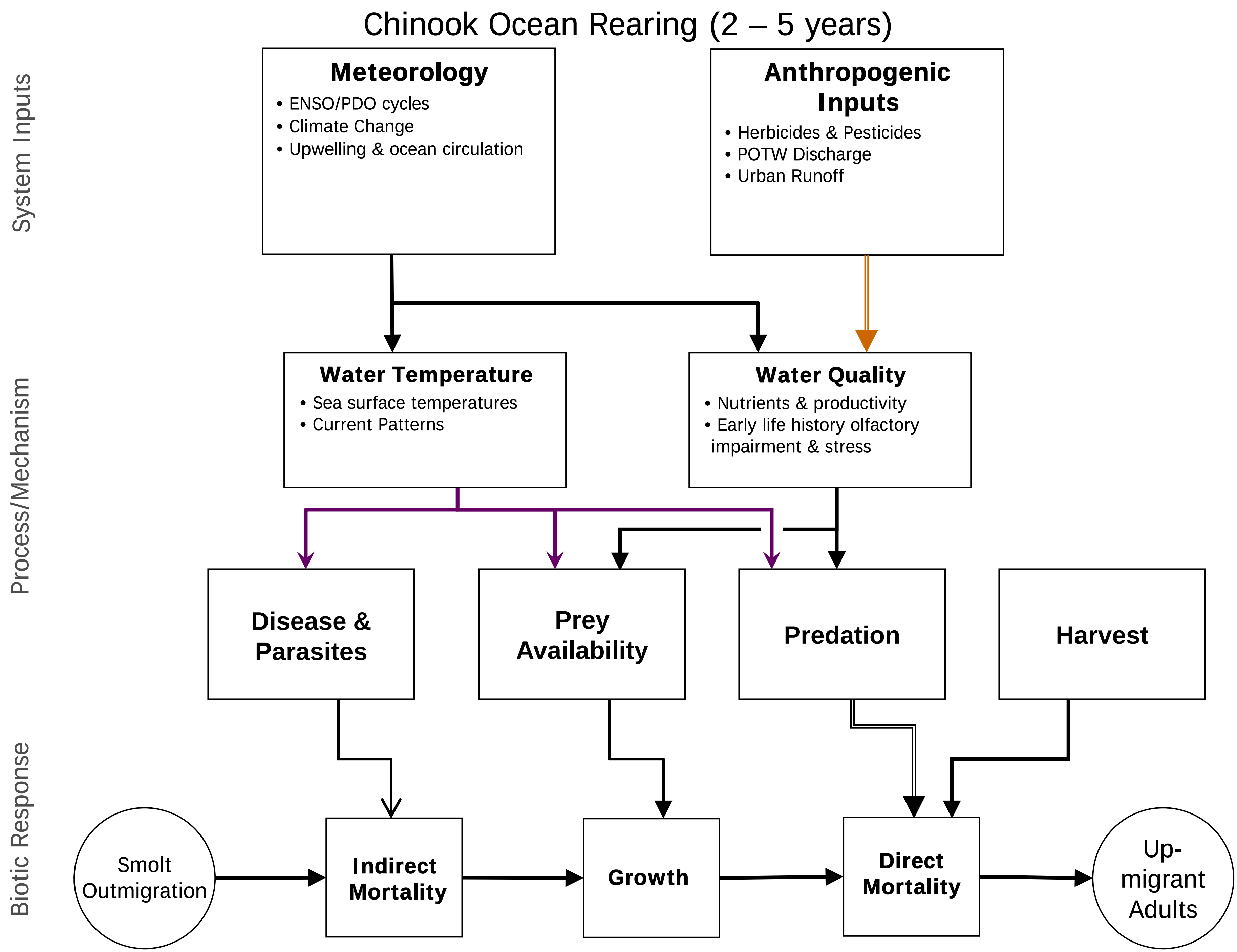


Chinook egg Incubation
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange Dam
• FERC spawning flows
• Groundwater upwelling
• Flood flows & tributary runoff
Sediment Transport
• Fine sediment input from tributaries
• Coarse sediment interception by legacy mining pits
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery Introductions
Water Temperature
• Heating/Cooling
• Cold water inflows
• Egg viability
Water Quality
• Turbidity/TSS
• Intragravel Dissolved Oxygen
Gravel Quality
• Sand infiltration
Spawning Habitat Area
Bacterial & Fungal Infections
Redd Scour
Entombment
Redd Superimposition
Deposited Eggs
Indirect Mortality
Egg Development
Direct Mortality
Emergent Fry



Chinook In-River Rearing
System Inputs
Anthropogenic Inputs
• Non-native fish introductions
• O. mykiss planting
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream Storage
• Diversions at La Grange
• FERC spawning, rearing, and pulse flows
• Flood flows & tributary runoff
• In-river diversions
Sediment Transport
• Coarse sediment interception by upstream dams and legacy mining pits
• TSS input from tributaries and land use
• Bank erosion/migration
• Bedload & suspended sediment
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate, LWD
• Bar, riffle, pool area
• Invertebrate production
Disease & Parasites
Predation
Prey Availability
Stranding & Entrapment
Entrainment
Biotic Response
Emergent Fry
Indirect Mortality
Growth & Smoltific-ation
Direct Mortality
Juvenile/ Smolt


Chinook Delta Rearing
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
Anthropogenic Inputs
• Non-native fish introductions
• Herbicides & Pesticides
• Fertilizers
• POTW Discharge
• Urban Runoff
In-stream Flows
• Antecedent water year type
• Tributary storage & outflows
• Tributary flood flows
• Barrier operations
• POTW & agricultural returns
• Delta diversions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Nutrients/Algae/DO
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate
• Levee construction
• Invertebrate & zooplankton production
Disease & Parasites
Predation
Prey Availability
Entrainment
Biotic Response
Tributary Juveniles/ Smolts
Indirect Mortality
Growth & Smoltification
Direct Mortality
Smolt Outmigration


Chinook Ocean Rearing (2 – 5 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Water Temperature
• Sea surface temperatures
• Current Patterns
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Prey Availability
Predation
Harvest
Smolt Outmigration
Indirect Mortality
Growth
Direct Mortality
Up-migrant Adults

Conceptual Model Narrative
for Tuolumne River Salmonids
Don Pedro Relicensing Study W&AR-5
Workshop No. 2 - June 26, 2012

Purpose of this Document

The purpose of this document is to provide a framework for discussion at the June 26, 2012 Salmonid Information Synthesis Study Workshop No. 2. As outlined in the Study Plan, this narrative has been prepared as a companion to accompanying diagrammatic models regarding processes and mechanisms affecting various life stages of Central Valley Fall run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*O. mykiss*) in the Tuolumne River, Delta, and Pacific Ocean. Recognizing that not all factors affecting Tuolumne River salmonids may be known or well understood, the model diagrams and narrative attempt to identify factors that may potentially affect salmonid life-history progression throughout the species range, separated into mechanisms affecting reproduction, growth, direct and indirect mortality.

This document is separated into three sections describing ecosystem inputs, Chinook salmon life history, and steelhead/*O. mykiss* life history in and downstream of the lower Tuolumne River. To provide context for historical and ongoing ecosystem modifications and variation of habitat conditions across the species range (i.e., Tuolumne River to the Pacific Ocean), primary ecosystem inputs and other factors affecting Tuolumne River salmonids are described without attempting to separate their relative contributions or importance from the "top-down". Instead, the accompanying conceptual models are intended to be used from the "bottom-up" by examining the most proximate processes affecting individual life stages (e.g., predation, prey availability, etc.). Although we have made preliminary assessments regarding whether mechanisms may or may not be affecting a given life stage in some instances, it is intended that their relative importance be discussed with Workshop participants with an opportunity for comment and potential revision of the conceptual models.

As outlined in the Study Plan, following review and potential revision of the broader conceptual models presented here, conceptual models of the relevant density-dependent and density-independent factors affecting each salmonid life-stage in the Tuolumne River will be developed and refined as part of numerical population model development in the interrelated Tuolumne River Chinook Salmon Population Model and the *O. mykiss* Population studies (Studies W&AR-6 and W&AR-10).

Primary ecosystem inputs and other Factors affecting Tuolumne River salmonids

Water Supply and Instream Flows

Upstream Dam Construction – Early dams (Wheaton [ca 1871] and La Grange [1893]) reduced summer base flows but were too small to affect high flows. Later dams (Hetch Hetchy [1923; expanded 1938], Don Pedro [1923; expanded 1971], Cherry Lake [1955] reduced the magnitude and frequency of flood flows and snowmelt runoff to the lower Tuolumne River.

Upstream Diversions by CCSF – Out of basin diversions by CCSF to the San Francisco Bay Area began in 1934. Depending on water year type, upstream diversions by CCSF may exceed 250 TAF per year.

Antecedent Water Year Type and Carryover Storage – In addition to FERC flows, based in part on antecedent precipitation and water year type, the 1995 FERC Settlement Agreement (FSA) provides for carryover of up to 5 TAF from wet water years. To date this provision has not been used.

Flood Control Releases – The Districts are required under ACOE flood control requirements to maintain flood storage space in the Don Pedro Reservoir as well as to limit flows at Modesto below 9,000 cfs.

Diversions at La Grange – Depending upon water year type, the Districts divert on average approximately 900 TAF per year from the river at La Grange Dam for irrigation and M&I uses in the basin.

Minimum FERC Flow Requirements – Depending upon water year type, the current license prescribes annual release and pulse flow volumes, rate changes, and minimum flow requirements measured at La Grange for spawning, rearing, and over-summering of Tuolumne River salmonids.

Accretion Flows – Local rainfall runoff, tributary inflow (primarily from Dry Creek at Modesto), operational outflows from the Districts' canal systems, agricultural drainage return flows, urban runoff, as well as groundwater accretion contribute to the flows of the lower Tuolumne River below La Grange Dam.

Riparian and Delta Diversions – Numerous unscreened riparian diversions exist on the lower Tuolumne River, lower San Joaquin River, and the Delta. There are four larger diversions between the Merced River confluence and the Delta, with screen and bypass facilities only installed recently at the Patterson Irrigation District, West Stanislaus Irrigation District and Banta Carbona Irrigation District.

Delta Exports – The federal Central Valley Project C.W. Bill Jones Pumping Plant (1951) and the California State Water Project Harvey O. Banks Pumping Plant (1968) withdraw large volumes of water from the Old River channel of the San Joaquin River in the south Delta. Average annual diversions (exports) have increased by a factor of two from the years prior to the 1996 FERC Order up to the 2007 court-ordered flow reductions, put in place for the protection of delta smelt entrained by these facilities. Outside of flood periods, Delta exports exceed instream flows at Vernalis at all times of year except during the April 15 to May 15 period when pumping restrictions are imposed on the State and Federal Pumping plants and pulse flows are provided from the San Joaquin River tributaries.

Sediment Supply and Transport

Interception of Upstream Gravels by Dams – Coarse sediment production from the upper watershed is blocked at La Grange Dam and Don Pedro Dam as well as locations farther upstream. Under current conditions, coarse sediment sources to the lower Tuolumne River are limited to bed mobilizing events and bank erosion.

Historical Gravel Mining – Historical gold dredge mining during the early twentieth century excavated in-channel and floodplain sediments and left a legacy of dredger tailing deposits between RM 50.5–38. Beginning in the 1940s, aggregate mines extracted sand and gravel directly from the active river channel, creating a legacy of in-channel mining pits ("special run-pools" [SRPs]) up to 400 feet (120 m) wide and 35 feet (11 m) deep and occupying 32% of the length of the channel in the gravel bedded reach (RM 52–24). Historical dredger tailings upstream of RM 45 were removed as part of the New Don Pedro Dam construction and more recent mining operations have excavated sand and gravel from floodplains and terraces immediately adjacent to the river channel at several locations downstream of Robert's Ferry Bridge (RM 39.5). Floodplain and terrace mining pits are typically separated from the river by narrow un-engineered berms that are susceptible to failure during high flows such as the 1997 flood event.

Loss of Channel Migration – In addition to the large cobble-armored windrows of dredger tailings remaining in the reach from RM 45.4–40.3, historical dredger tailings (RM 50.5–38) served to confine the active river channel, resulting in channel down-cutting and prevention of sediment recruitment from channel migration. Channel migration has been nearly eliminated due to these historical and present day mining operations. In reaches with functionally connected floodplains, flow regulation by upstream dams limits the frequency, duration, and magnitude of high flow events affecting channel migration and floodplain processes.

1997 Flood Impacts – During the 1997 flood, high flows in excess of 60,000 cfs were released over the Don Pedro spillway, resulting in the erosion of approximately 200,000 yd^3 (150,000 m^3) of sediment**.** Much of this sediment was deposited behind La Grange Dam. The remainder was transported downstream and deposited in the river and on the floodplain or was transported downstream to the San Joaquin River and the Delta.

Tributary Fine Sediment Inputs – Tributaries entering the river downstream of La Grange Dam do not contribute coarse sediment to the mainstem channel. A sediment basin installation at Gasburg Creek was completed in 2007, but fine sediments continue to enter the river during runoff events from Peaslee and Dominici creeks. For example, failure of sediment controls following grading operations along Lake Road resulted in extended periods of high turbidity during May 2009.

Gravel Augmentation Projects – To date, gravel augmentation has been limited to two sites near Old La Grange Bridge (RM 50.5) between 1999 and 2001. In addition to predator isolation projects at SRP 9 (RM 25.7), riffle and floodplain reconstruction projects have been completed at Bobcat Flat (RM 43.5) and at 7/11 Materials (RM 37.7), with designs and preliminary permitting completed for additional gravel augmentation projects at upstream locations.

Anthropogenic Inputs

Non-Native Fish Introductions – Predation studies in the Tuolumne River identified 10 non-native and two native fish species that could potentially prey on juvenile Chinook salmon and *O. mykiss*, with the majority of these fish concentrated in slower moving waters found at SRP mining pits.

Hatchery Fish Introductions – Release of marked and unmarked hatchery fish in the San Joaquin basin may result in genetic impacts, reduced naturally spawning population productivity, as well as food and other habitat resource competition in freshwater, estuarine, and ocean environments. Although the proportions of hatchery fish identified in escapement surveys has been historically low, constant fractional marking programs have shown the present day Chinook salmon runs are dominated by hatchery origin fish. Genetic analyses also indicate the majority of Central Valley Steelhead are of common out-of-basin broodstock (Eel River) used at the Nimbus (American River) and other hatcheries, suggesting that hatchery introductions have largely altered the genetic structure of the population. Several studies outside of the San Joaquin River basin have shown lower reproductive success of hatchery fish as compared to wild fish spawning in the same rivers.

Agricultural Development – Historical land clearing as well as levee construction has eliminated access to marsh habitats throughout the Delta. Continued discharge of residual nutrients (N, P) from agricultural fertilizers results in biostimulation of algae, associated DO variations, as well as changes in algal community structure and the Delta food web. In addition to discharges of salts to the San Joaquin River basin, herbicides and pesticides are discharged throughout the Delta. Exposure of common herbicides and pesticides is associated with direct toxicity to planktonic species as well as olfactory impairments in juvenile salmon.

POTW Discharges – Treated municipal wastewater is discharged to Delta waterways from over 300 municipal sources including numerous Publicly Owned Treatment Works

(POTWs). Discharges contain residual nutrients (N, P) associated with biostimulation of algae, DO variations, alterations of the food web, as well as a number of poorly characterized impacts from emerging contaminants associated with endocrine disruption and other effects.

Urban Runoff – In addition to agricultural return flows, urban runoff may contain a range of contaminants from petroleum, heavy metals, trash, to fertilizers (N, P) and pesticides from lawns. Recent studies sampling of urban runoff indicated consistently high levels of pyrethroid pesticides, with effects ranging from invertebrate toxicity to olfactory impairment in salmonid juveniles.

Meteorology

ENSO and PDO Cycles – The Pacific Decadal Oscillation and shorter term El Niño/Southern Oscillation both appear to change ocean productivity through complex processes. The mechanisms of how salmon populations are affected are not well understood, but ocean circulation affects nutrient upwelling and primary and secondary productivity of the marine food web that supports adult rearing of Tuolumne River and other Pacific salmonids.

Climate Change – In addition to future climate change impacts on ENSO and PDO cycles, recent USBR evaluations suggest slight temperature increases will occur in the San Joaquin River basin with variable, but slightly decreasing precipitation by 2050, on the order of 5% below recent averages. Due to early snowmelt and relatively higher winter runoff from warmer conditions, flood control capacity will be reduced, and reductions in basin yield may also result in reduced cold water storage for salmon as well as increased habitat for warm-water adapted invasive species.

Processes and mechanisms affecting Tuolumne River Chinook salmon by life-stage residency

Chinook salmon upmigration

Processes/Mechanisms affecting arrival at Spawning Grounds

Homing/Straying/Timing – Although existing data does not show relationships between homing, straying, or variations in arrival timing with Tuolumne River fall attraction flows, water temperature as well as dissolved oxygen (DO) have been suggested as factors affecting the timing of salmon passage at Stockton and by inference, the timing of adults arriving at tributary spawning grounds. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients may result in unsuitable water quality conditions for up-migrating salmon. Meteorology and to a minor degree, instream flows, also combine to affect exposure of up-migrating adults to changes in water temperatures. Lastly, homing fidelity of introduced hatchery fish out-planted to the Delta and other locations has been shown to be poorer than naturally reproducing salmon.

Processes/Mechanisms affecting Direct Mortality

Harvest – Ocean harvest of adult salmon that escape the ocean fishery, inland sport fishing, and illegal poaching all affect the number of adults that return to their natal streams to spawn, and in turn, affect subsequent juvenile production. The Central Valley Harvest Rate Index has been in excess of 70% in many years. Additional inland harvest occurs, mostly in the Bay and Delta, but also in the San Joaquin River system prior to the mid-October angling closure in the tributaries. Illegal poaching has not been well quantified.

Water Quality – In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of other contaminants may result in unsuitable water quality conditions for up-migrating salmon. However, mortality of adult salmon is unlikely to result from water quality impairments such as DO depletion resulting from algal and bacterial respiration or from potential toxicity events.

Water Temperature – Meteorology and to a minor degree, instream flows, combine to affect exposure of up-migrating adults to changes in water temperatures with varying probabilities of direct mortality. However, no incidences of direct mortality of up-migrant salmon have been attributed to water temperature in the lower Tuolumne River and avoidance of unsuitable water temperatures by adults would be expected.

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Exposure to changes in water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia in the lower San Joaquin River may contribute to stress and disease incidence and subsequent mortality of up-migrant adults. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants, may result in unsuitable water quality conditions for up-migrating salmon. Meteorology and to a minor degree, instream flows in the lower San Joaquin River and Delta, also combine to affect exposure of up-migrating adults to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality.

Chinook salmon Spawning

Processes/Mechanisms affecting Spawning Success

Competition and Exclusion – Competition and exclusion of up-migrant adults from accessing suitable spawning sites may occur depending upon the numbers of spawners, gravel quality, and local hydraulic characteristics of available spawning habitat area. Both gravel quality and the availability of suitable spawning habitat are affected by instream flows, meteorology, as well as factors contributing to alterations in sediment transport processes. Competition for suitable spawning sites by anthropogenically introduced hatchery fish may limit spawning success of naturally reproducing Chinook salmon.

Processes/Mechanisms affecting Direct Mortality

Poaching – Illegal poaching of adult salmon arriving in the lower Tuolumne River after mid-October has not been quantified, but potentially reduces the number of adults that successfully spawn, and in turn, affects subsequent juvenile production.

Water Temperature – Meteorology and instream flows combine to affect exposure of spawning adults to changes in water temperatures. Although little information is available relating pre-spawning mortality of Chinook salmon to water temperature in the Tuolumne River or neighboring tributaries, adult mortality can result from prolonged exposure to unsuitable water temperatures, potentially reducing the number of adults that successfully spawn, and in turn, affecting subsequent juvenile production.

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Meteorology and instream flows in the lower Tuolumne River combine to affect exposure of pre-spawning adults to changes in water temperature, which in turn, may contribute to stress and disease incidence and subsequent mortality. Disease incidence may be also related to prior exposure to unsuitable water temperatures and water quality in the Delta as well as exposure to water-borne pathogens as well as interactions with other infected/infested fish.

Chinook salmon egg incubation

Processes/Mechanisms affecting Egg/Alevin growth and Fry Emergence

Water Temperature – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures, which has a strong influence on the rate of subsequent embryo and alevin development, typically ranging from 6 to 12 weeks from fertilization to emergence.

Water Quality – Instream flows and sediment transport of bedload and suspended sediments may affect intra-gravel flow as well as interstitial water quality conditions such as DO necessary for the successful development of the embryo/alevin to fry emergence.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and instream flows may combine to affect exposure of deposited eggs to varying water temperatures, potentially reducing egg survival to emergence and subsequent juvenile production.

Redd Scour – Redd scour may result from increased rates of sediment (bedload) transport during high flow events such as flood flows. Displacement of eggs and alevin due to redd scour may cause mortality from mechanical shock, crushing or entrainment into the bedload.

Redd Superimposition – Egg displacement due to redd superimposition resulting from competition and exclusion of adult spawners and anthropgenically introduced hatchery fish may result in density-dependent mortality of previously deposited eggs that have been disturbed by the spawning activities of subsequently arriving females. Availability of suitable spawning habitat is affected by instream flows as well as gravel quality and spawning habitat area resulting from factors contributing to alterations in sediment transport processes.

Entombment – Fine sediment deposition in completed redds may effectively seal the upper layers of the redd, and obstruct the emergence of alevins, causing entombment and subsequent mortality. Entombment may be affected by gravel quality and fine sediment input due to surrounding land use practices, instream flows, as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Indirect Mortality

Bacterial & Fungal Infections – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures in the spawning reaches of the lower Tuolumne River. Although no information is available on disease incidence for

incubating eggs in the Tuolumne River, water temperature has been shown to contribute to increased rates of mortality by bacterial and fungal growth in other systems.

Chinook salmon in-river rearing

Processes/Mechanisms affecting juvenile growth and survival

Water Temperature – Meteorology and instream flows combine to affect water temperature of both in-channel and floodplain habitats and has a strong influence on growth and feeding rates of rearing juvenile Chinook salmon. Changes in water temperatures may also affect the timing of smoltification and may cause desmoltification under some circumstances.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affects the prey availability and growth rates of juvenile Chinook salmon. Both the availability of these organic matter sources as well as the physical habitat availability for benthic macro-invertebrates and terrestrial insects (drift) is in turn affected by instream flows as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile Chinook salmon to changes in water temperatures, with varying probabilities of direct mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and sediment transport processes, predation of juvenile Chinook salmon by native fish (including *O. mykiss*) as well as introduced fish is influenced by meteorology and instream flow influences on water temperatures. Anthropogenic inputs of contaminants may also affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may also affect by surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Stranding & Entrapment – Rapid reductions in instream flows, particularly during flood flow conditions, may eliminate access to available habitat and cause stranding and entrapment of fry and juvenile salmon on gravel bars and floodplains and in off-channel habitats that may become cut off when flows are reduced. Mortality of juveniles by several mechanisms often results, including desiccation, temperature shock, asphyxiation, as well as predation by birds and mammals.

Entrainment – Depending on instream flows and agricultural operations, entrainment of rearing or migrating juvenile Chinook salmon into unscreened pumps may occur, resulting in mechanical damage and mortality.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and instream flows combine to affect exposure of rearing juvenile Chinook salmon to varying water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. In addition to factors affecting instream flows in the lower Tuolumne River, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants may result in unsuitable water quality, exposing juvenile salmon to low DO, high pH (alkalinity) and unionized ammonia and contributing to stress and disease incidence.

Chinook salmon Delta rearing

Processes/Mechanisms affecting juvenile growth and survival

Water Temperature – Meteorology and to a minor degree instream flows combine to affect water temperature of both in-channel habitats in the San Joaquin River and Delta as well as water temperatures of off-channel habitats (e.g., sloughs, marshes, as well as seasonally inundated floodplains). Seasonal variations in water temperatures, in turn have a strong influence on growth and feeding rates of rearing juvenile Chinook salmon. Water temperatures may also affect the timing of smoltification and may cause desmoltification under some circumstances.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affect the prey availability and growth rates of juvenile Chinook salmon. The availability of these organic matter sources to zooplankton in the Delta is affected by anthropogenically supplied nutrients and algal productivity. For juvenile salmon rearing in floodplain locations, food web productivity and terrestrial insect drift are affected by instream flows as well as other factors contributing to alterations in floodplain inundation frequency, duration, and extent (e.g., levee construction).

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile Chinook salmon to changes in water temperatures as well as increased rates of mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and the reduced habitat availability of off-channel rearing habitats by levee construction, juvenile Chinook salmon predation by native and introduced fish is influenced by meteorology and instream flow effects upon water temperature. Anthropogenic inputs of contaminants may affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may be affected by surrounding land use practices, changes in instream flows such as Delta exports, as well as factors contributing to alterations in upstream sediment transport processes. Seasonally installed barriers have been used in years with flows below 5,000 cfs at Vernalis to reduce predator exposure of outmigrating Chinook salmon.

Entrainment – Depending on tributary instream flows to the San Joaquin River and Delta, entrainment of rearing or migrating juvenile Chinook salmon into unscreened pumps may occur, resulting in mechanical damage and mortality. Entrainment into the forebays of the Delta export facilities may result in increased rates of predation, physical damage and stress during salvage operations, as well as subsequent predation at release points for salvaged fish near the western (downstream) edge of the Delta.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile Chinook salmon to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. Exposure to unsuitable water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia due to anthropogenic inputs of contaminants in the lower San Joaquin River and Delta may also contribute to stress and disease incidence and subsequent mortality of juvenile Chinook salmon.

Chinook salmon Ocean rearing

Processes/Mechanisms affecting Adult growth and survival

Prey Availability – Meteorology, ocean water temperatures and water quality influence primary and secondary productivity of the marine food web that supports immature and adult Chinook salmon. Both direct discharge of anthropogenically supplied nutrients as well as changes in ocean circulation patterns and upwelling of nutrients affect marine water quality.

Processes/Mechanisms affecting Direct Mortality

Predation – Predation of immature Chinook salmon following ocean entry may reduce subsequent adult returns. Predation rates upon immature salmon may be affected by changes in predator species distribution with water temperature and ocean circulation patterns. Early life history exposure to anthropogenic inputs of contaminants may also affect water quality and subsequent susceptibility to predation.

Harvest – Ocean Harvest of adult Chinook salmon affects the number of adults that return to their natal streams to spawn, and in turn, affect subsequent tributary juvenile production. The Central Valley Harvest Rate Index has been in excess of 70% in many years and recent fishing bans (2009–2010) have been imposed to increase adult population levels.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and instream flow effects upon water temperature in upstream habitats may affect early life history disease incidence and subsequent mortality of adult Chinook salmon. Prior exposure to pathogens and parasites during juvenile rearing and outmigration may also contribute to increased disease incidence in the adult Chinook salmon population.

Processes and mechanisms affecting Tuolumne River steelhead/*O. mykiss* by life-stage residency

Steelhead upmigration

Processes/Mechanisms affecting arrival at Spawning Grounds

Homing/Straying/Timing – Although no data exists to evaluate homing and straying of steelhead arriving in the Tuolumne River, mechanisms explaining homing and straying include instream flows, as well as olfactory cues related to water quality and the presence of other salmon. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients may affect DO and result in unsuitable water quality conditions for up-migrating steelhead during late summer periods. Anthropogenic inputs of herbicides and pesticides may also affect water quality and impair olfactory cues necessary for homing of steelhead. Homing fidelity of introduced hatchery fish has been shown to be poorer than naturally reproducing steelhead.

Processes/Mechanisms affecting Direct Mortality

Sportfishing & Poaching – Inland sportfishing and illegal poaching affect the number of steelhead adults that return to their natal streams to spawn, and in turn, affect subsequent juvenile production. Sportfishing occurs, mostly in the Bay and Delta, but also in the San Joaquin River system prior to the mid-October angling closure in the tributaries. Illegal poaching has not been well quantified.

Water Quality – In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of other contaminants may result in unsuitable water quality conditions for up-migrating steelhead. However, mortality of adult steelhead is unlikely to result from water quality impairments such as DO depletion resulting from algal and bacterial respiration or from potential toxicity events.

Water Temperature – Meteorology and to a minor degree, instream flows, combine to affect exposure of up-migrating adults to changes in water temperatures. However, given the general up-migration timing of adult steelhead (i.e., winter-run life history), avoidance of unsuitable water temperatures by adults would be expected.

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Exposure to changes in water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia in the lower San Joaquin River may contribute to stress and disease incidence and subsequent mortality of estuarine and up-migrant adult steelhead. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants may result in unsuitable water quality conditions for up-migrating steelhead. Although meteorology and instream flows may combine to affect exposure of estuarine and up-migrating steelhead to changes in water temperature, given the general up-migration timing of adult steelhead (i.e. winter-run), linkages to temperature stress and disease incidence would be related to estuarine habitat use only.

Steelhead Spawning

Processes/Mechanisms affecting Spawning Success

Competition and Exclusion – Although riffle spawning by steelhead is uncommon and very little tributary spawning of steelhead has been observed, competition and exclusion of up-migrant adults from accessing suitable spawning sites may occur depending upon the numbers of spawners, gravel quality, and local hydraulic characteristics of available spawning habitat area. Both gravel quality and the availability of suitable spawning habitat are affected by instream flows, meteorology, as well as factors contributing to alterations in sediment transport processes. Competition for suitable spawning sites by anthropogenically introduced hatchery fish as well as resident *O. mykiss* may limit spawning success of any wild steelhead arriving in the Tuolumne River.

Processes/Mechanisms affecting Direct Mortality

Poaching – Illegal poaching of adult steelhead arriving in the lower Tuolumne River after mid-October has not been quantified, but potentially reduces the number of adults that successfully spawn, and in turn, affects subsequent juvenile production.

Water Temperature – Meteorology and instream flows combine to affect exposure of spawning adults to changes in water temperatures. Although no information is available regarding pre-spawning mortality of steelhead, given the general up-migration timing of adult steelhead (i.e., winter-run), water temperature effects upon pre-spawn mortality would be unexpected,

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Meteorology and instream flows in the lower Tuolumne River combine to affect exposure of pre-spawning adults to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. Although the general winter and spring up-migration timing of adult steelhead would not be expected to result in water temperature related diseases, disease incidence may be also related to prior exposure to unsuitable water temperatures and water quality in the Delta as well as exposure to water-borne pathogens or interactions with other infected/infested fish.

Steelhead egg incubation

Processes/Mechanisms affecting Egg/Alevin growth and Fry Emergence

Water Temperature – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures, which has a strong influence on the rate of subsequent embryo and alevin development, typically ranging from 4 to 6 weeks from fertilization to fry emergence.

Water Quality – Instream flows and sediment transport of bedload and suspended sediments may affect intra-gravel flow as well as interstitial water quality conditions such as DO necessary for the successful development of the embryo/alevin to fry emergence.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and instream flows may combine to affect exposure of deposited eggs to changes in water temperatures, potentially reducing egg survival to emergence and subsequent juvenile production.

Redd Scour –Redd scour may result from increased rates of sediment (bedload) transport during high flow events such as flood flows. Displacement of eggs and alevins due to redd scour may cause mortality from mechanical shock, crushing or entrainment into the bedload.

Redd Superimposition – Egg displacement due to redd superimposition resulting from competition and exclusion of adult spawners and anthropgenically introduced hatchery fish may result in density-dependent mortality of previously deposited eggs disturbed by the spawning activities of subsequently arriving females. Availability of suitable spawning habitat is affected by instream flows as well as gravel quality and spawning habitat area resulting from factors contributing to alterations in sediment transport processes.

Entombment – Fine sediment deposition in completed redds due to suspended sediments may effectively seal the upper layers of the redd, and obstruct the emergence of alevins, causing entombment and subsequent mortality. Entombment may be affected by gravel quality and suspended sediment input due to surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Indirect Mortality

Bacterial & Fungal Infections – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures in the spawning reaches of the lower Tuolumne River. Although no information is available on disease incidence for incubating eggs in the Tuolumne River, water temperature has been shown to contribute to increased rates of mortality by bacterial and fungal growth in other systems.

Steelhead in-river rearing

Processes/Mechanisms affecting juvenile growth and survival

Water Temperature – Meteorology and instream flows combine to affect water temperature of in-channel habitats and has a strong influence on growth and feeding rates of rearing juvenile steelhead. Summer water temperatures may affect availability of suitable habitat for steelhead/O. mykiss as well as feeding rates. Water temperatures may also affect the timing of smoltification, may result in desmoltification, and may limit the times of year for successful smolt outmigration.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affects the prey availability and growth rates of juvenile steelhead trout. Both the availability of these organic matter sources as well as the physical habitat availability for benthic macro-invertebrates and terrestrial insects (drift) is in turn affected by instream flows as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile steelhead trout to changes in water temperatures with varying probabilities of direct mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and sediment transport processes, predation of juvenile by native and introduced fish is influenced by meteorology and instream flow influences on water temperatures. Anthropogenic inputs of contaminants may also affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may also affect by surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Stranding & Entrapment – Rapid reductions in instream flows, particularly during flood flow conditions, may eliminate access to available habitat and cause stranding and entrapment of juvenile *O. mykiss* on gravel bars and floodplains and in off-channel habitats that may become cut off when flows are reduced. For juvenile *O. mykiss* using floodplain habitats, stranding of juveniles often results from rapid flow reductions and a range of mortality mechanisms may occur, including desiccation, temperature shock, asphyxiation, as well as predation by birds and mammals.

Entrainment – Depending on instream flows and agricultural operations, entrainment of rearing juvenile *O. mykiss* or outmigrating steelhead smolts into unscreened pumps may occur, resulting in mechanical damage and mortality.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and instream flows combine to affect exposure of rearing juvenile steelhead to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality of outmigrating smolts. In addition to factors affecting instream flows in the lower Tuolumne River, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants may result in unsuitable water quality, exposing juvenile steelhead to low DO, high pH (alkalinity) and unionized ammonia and contributing to stress and disease incidence in steelhead smolts.

Steelhead Delta outmigration

Processes/Mechanisms affecting growth and survival

Although extended residency in the Delta by rearing juvenile *O. mykiss* or outmigrant smolts has not been well documented in the Delta, the following mechanisms may apply to Delta habitats.

Water Temperature – Meteorology and to a minor degree instream flows combine to affect water temperature in the San Joaquin River and Delta where ambient water temperatures may limit the times of year for successful smolt outmigration from upstream tributaries to winter and spring, typically February through May.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affect the prey availability and growth rates of juvenile steelhead trout. The availability of these organic matter sources to zooplankton in the Delta is affected by anthropogenically supplied nutrients and algal productivity. For any actively feeding *O. mykiss*, food web productivity and terrestrial insect drift are affected by instream flows as well as other factors contributing to alterations in floodplain inundation frequency, duration, and extent (e.g., levee construction).

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juveniles and outmigrant steelhead smolts to changes in water temperatures, potentially resulting in increased rates of mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and the reduced habitat availability of off-channel rearing habitats by levee construction, predation of steelhead smolts by native and introduced fish is influenced by meteorology and instream flow effects upon water temperature. Anthropogenic inputs of contaminants may also affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may also affect by surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Entrainment – Depending on tributary instream flows to the San Joaquin River and Delta, entrainment of migrating steelhead smolts into unscreened pumps may occur, resulting in mechanical damage and mortality. It is unknown whether steelhead outmigration coincides with the seasonal installation of barrier at the Head of Old River, but entrainment into the forebays of the Delta export facilities may result in increased rates of predation, physical damage and stress during salvage operations.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile *O. mykiss* and outmigrant steelhead smolts to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. Exposure to varying water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia due to anthropogenic inputs of contaminants in the lower San Joaquin River and Delta may also contribute to stress and disease incidence and subsequent mortality of steelhead smolts.

Steelhead Ocean rearing

Processes/Mechanisms affecting Adult growth and survival

Prey Availability – Meteorology, ocean water temperatures and water quality influence primary and secondary productivity of the marine food web that supports immature and adult steelhead trout. Both direct discharge of anthropogenically supplied nutrients as well as changes in ocean circulation patterns and upwelling of nutrients affect marine water quality.

Processes/Mechanisms affecting Direct Mortality

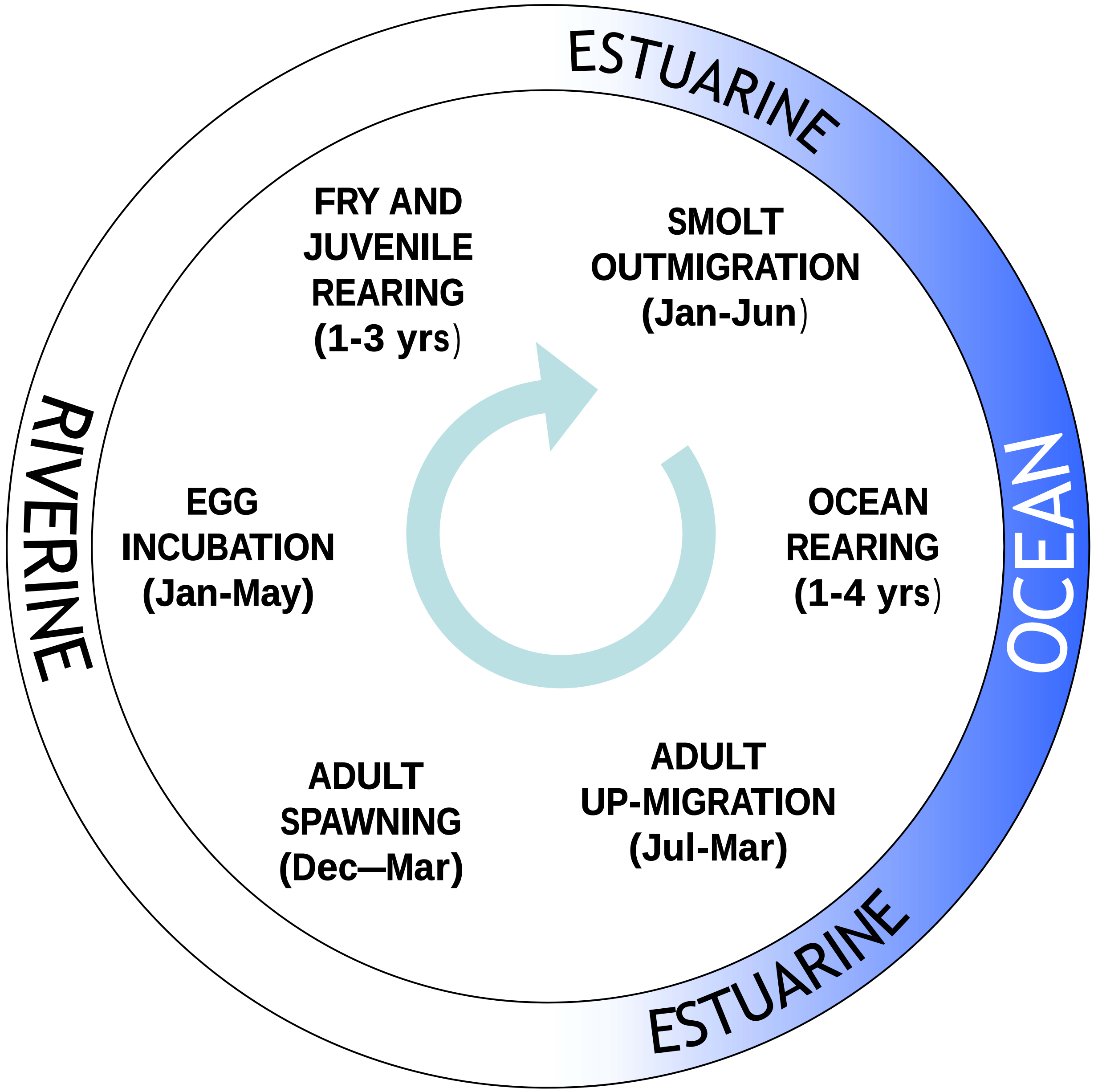
Predation – Predation of immature steelhead following ocean entry may reduce subsequent adult returns. Predation rates upon immature steelhead may be affected by changes in predator species distribution with water temperature and ocean circulation patterns. Early life history exposure to anthropogenic inputs of contaminants may also affect water quality and subsequent susceptibility to predation.

Harvest By-Catch – Although no commercial ocean harvest of adult steelhead occurs, low levels of adult mortality occurs due to by-catch of steelhead in the Pacific Ocean gill net fishery.

Processes/Mechanisms affecting Indirect Mortality

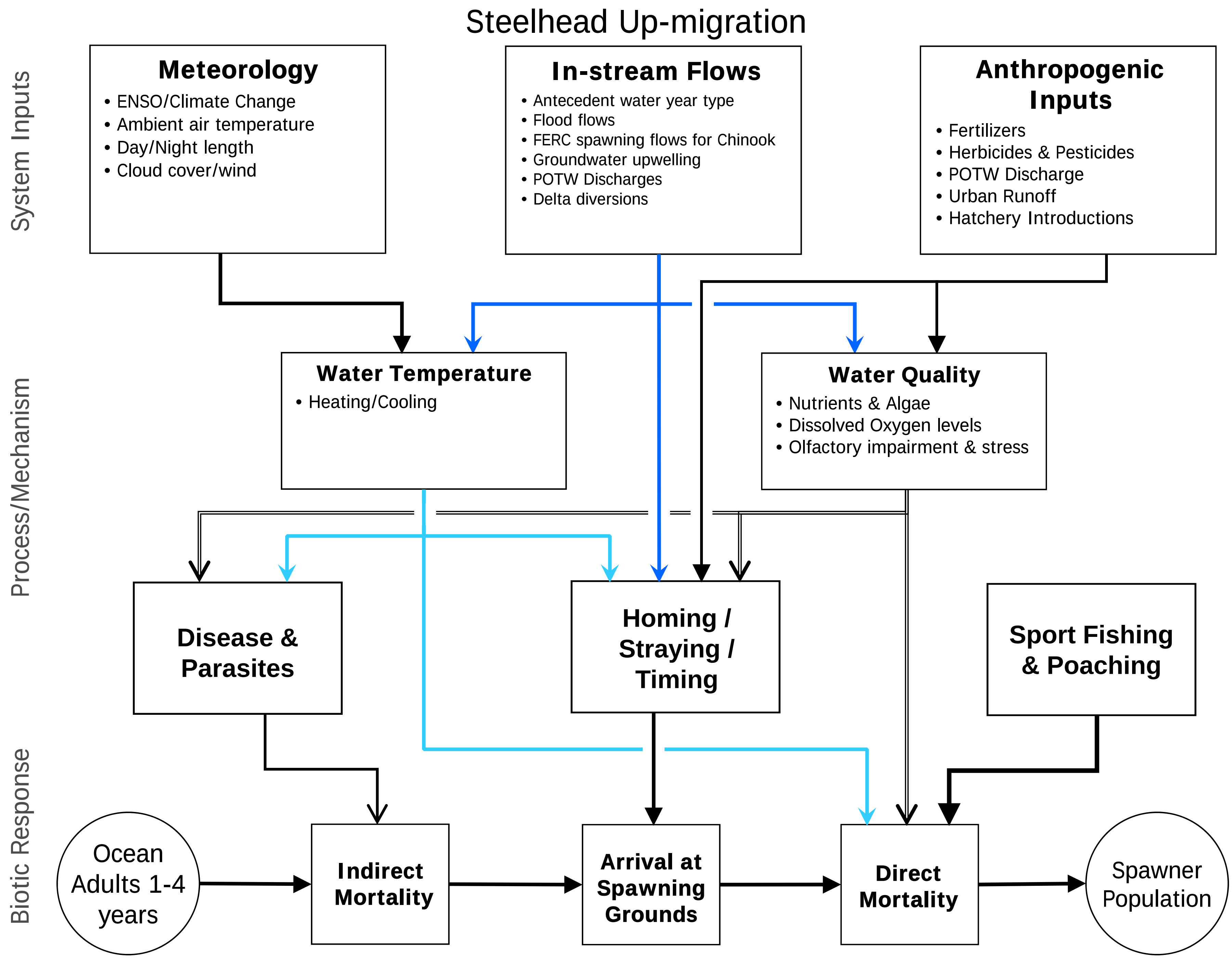
Diseases & Parasites – Meteorology and instream flow effects upon water temperature in upstream habitats may affect early life history disease incidence and subsequent mortality of steelhead. Prior exposure to pathogens and parasites during juvenile rearing and outmigration may also contribute to increased disease incidence in the adult steelhead population.

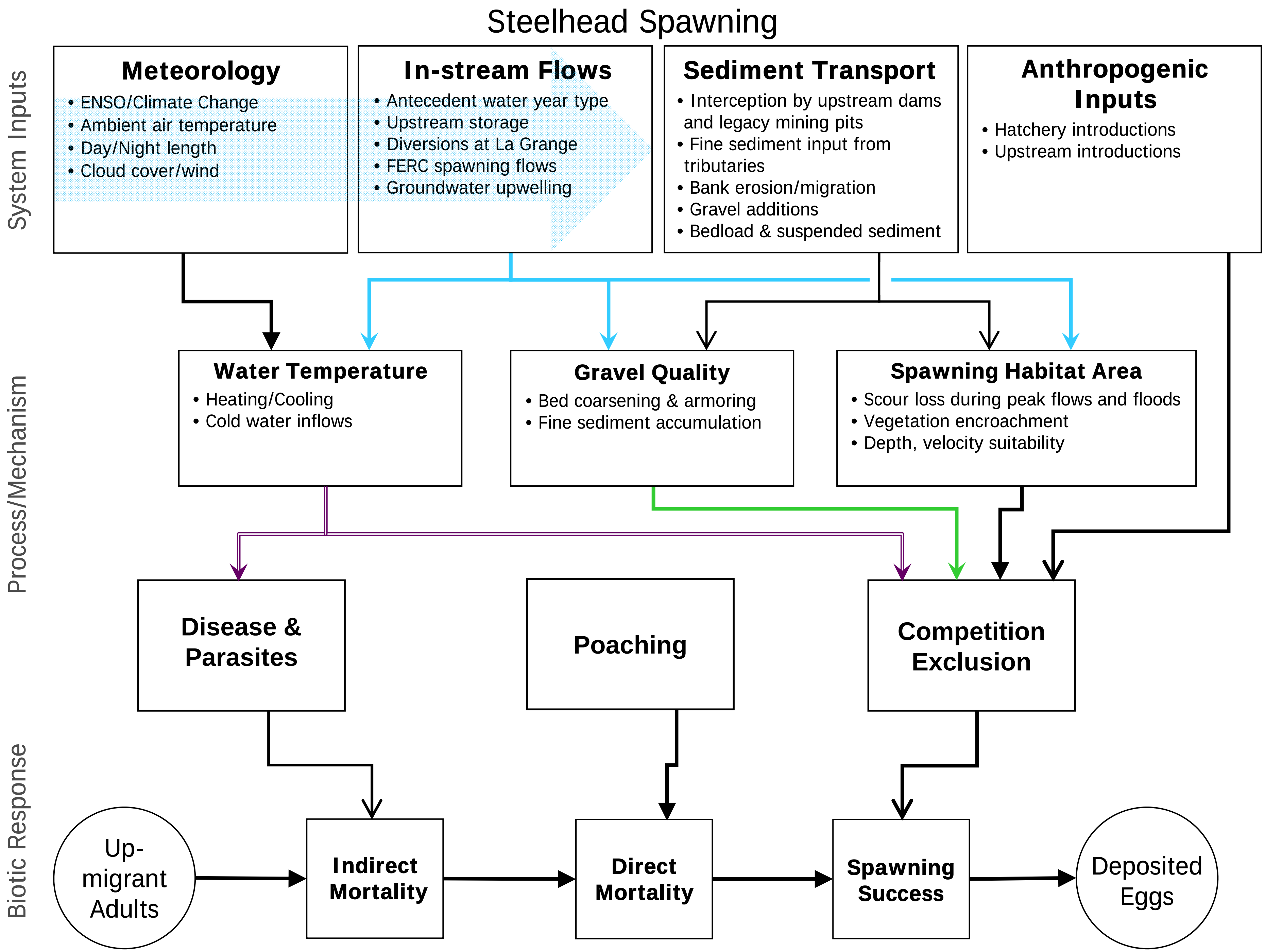
General Steelhead Life History Timing for the Tuolumne River

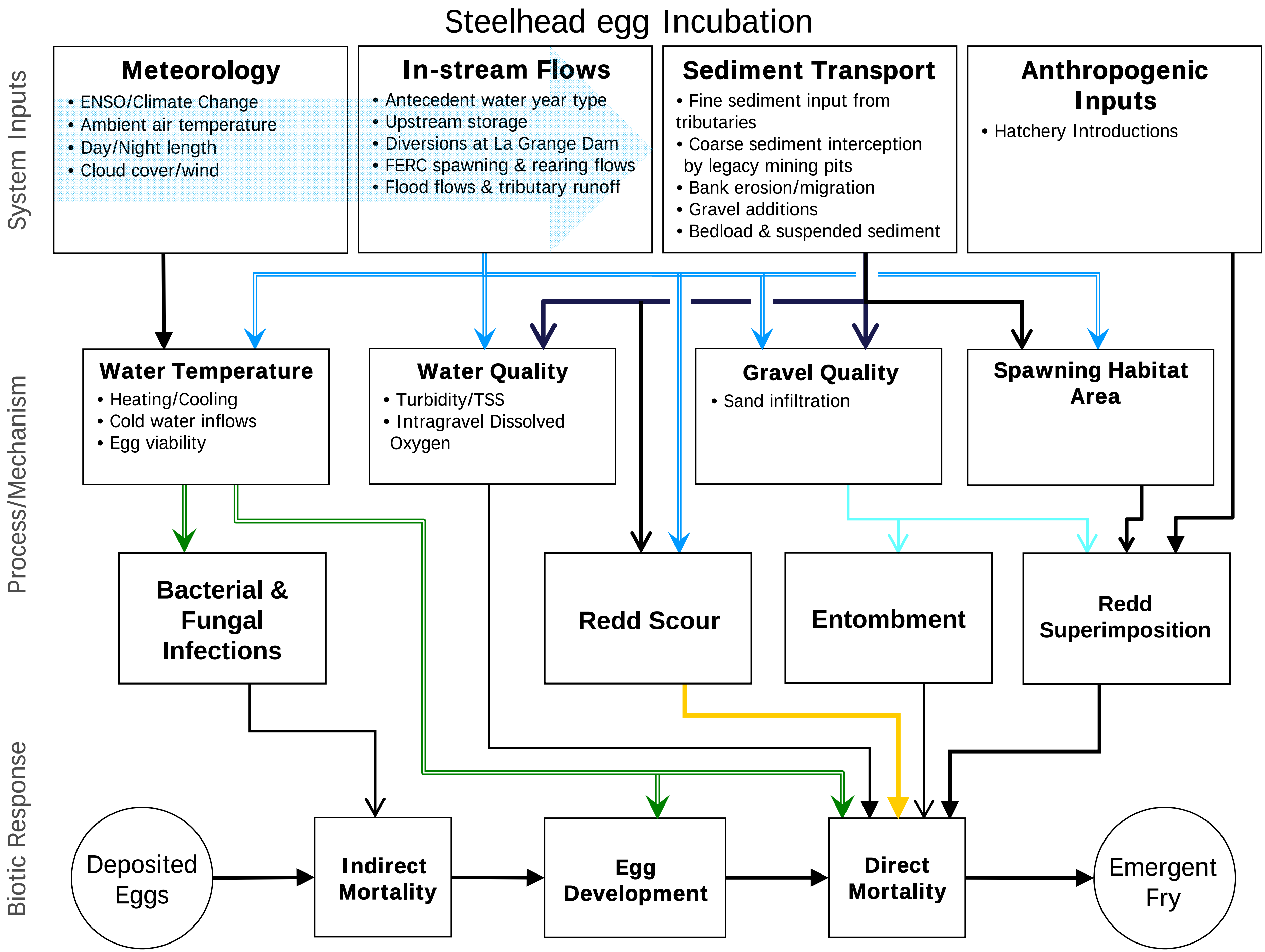


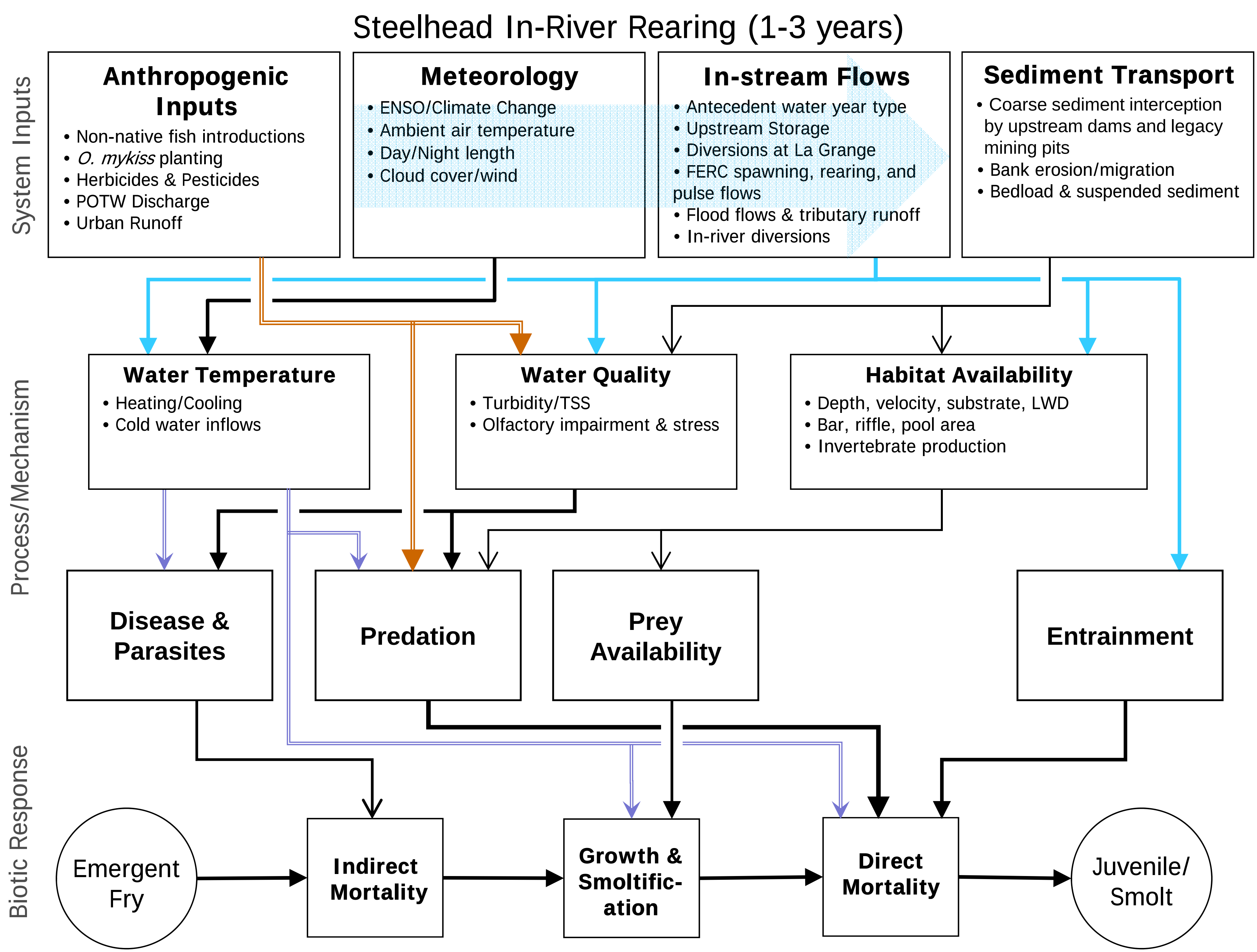
General Steelhead Life History Timing for the Tuolumne River

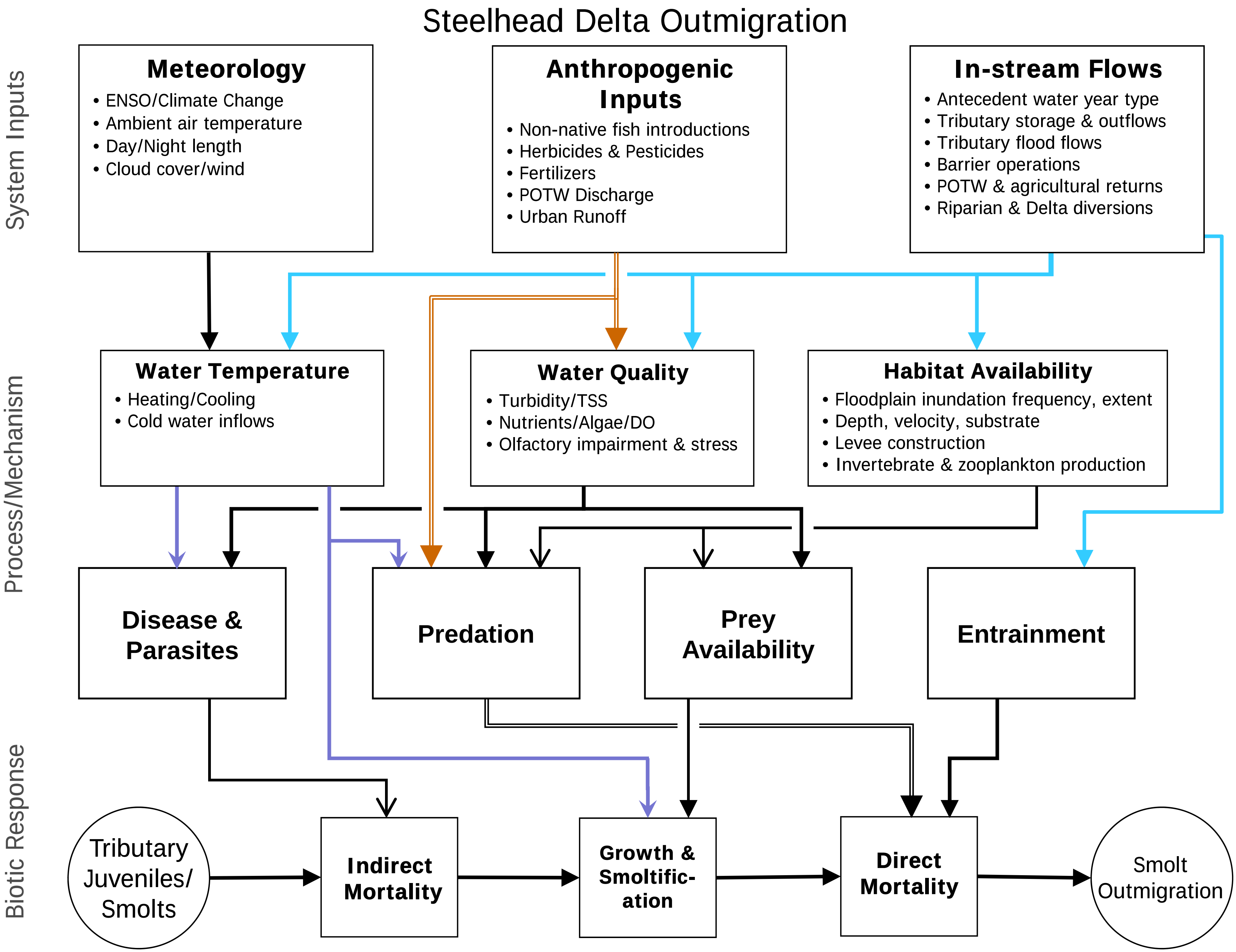
Life Stage	Fall			Winter			Spring			Summer		
	(Sep-Nov)			(Dec-Feb)			(Mar-May)			(Jun-Aug)		
Central Valley Steelhead / *O. mykiss*												
Adult upstream migration												
Adult Spawning												
Egg Incubation and Fry Emergence												
In-River Rearing												
Smolt Outmigration												

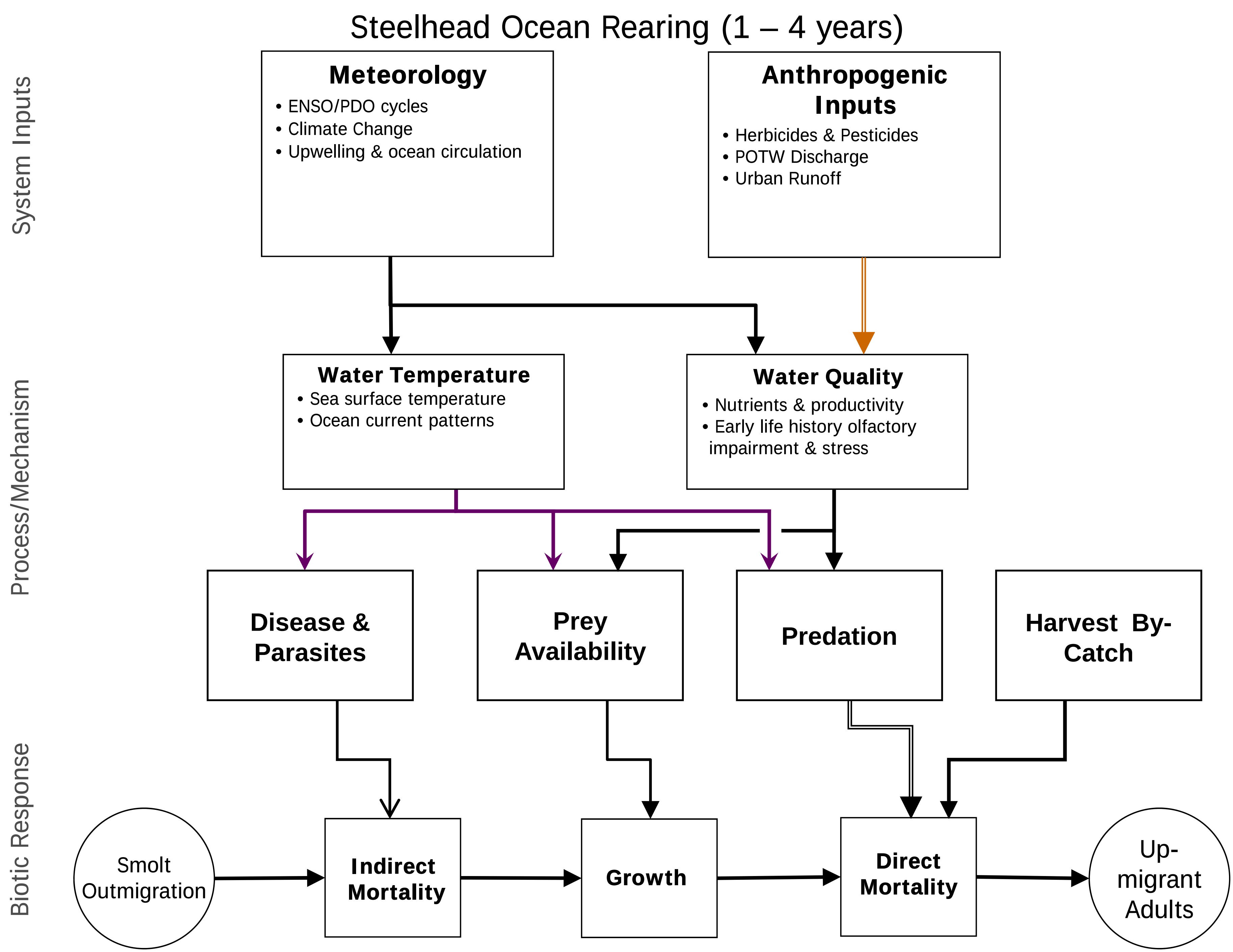

Steelhead Up-migration
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Flood flows
• FERC spawning flows for Chinook
• Groundwater upwelling
• POTW Discharges
• Delta diversions
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Hatchery Introductions
Water Temperature
• Heating/Cooling
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Sport Fishing & Poaching
Ocean Adults 1-4 years
Indirect Mortality
Arrival at Spawning Grounds
Direct Mortality
Spawner Population


Steelhead Spawning
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery introductions
• Upstream introductions
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Poaching
Competition Exclusion
Up-migrant Adults
Indirect Mortality
Direct Mortality
Spawning Success
Deposited Eggs


Steelhead egg Incubation
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange Dam
• FERC spawning & rearing flows
• Flood flows & tributary runoff
Sediment Transport
• Fine sediment input from tributaries
• Coarse sediment interception by legacy mining pits
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
• Egg viability
Water Quality
• Turbidity/TSS
• Intragravel Dissolved Oxygen
Gravel Quality
• Sand infiltration
Spawning Habitat Area
Bacterial & Fungal Infections
Redd Scour
Entombment
Redd Superimposition
Biotic Response
Deposited Eggs
Indirect Mortality
Egg Development
Direct Mortality
Emergent Fry


Steelhead In-River Rearing (1-3 years)
System Inputs
Anthropogenic Inputs
• Non-native fish introductions
• O. mykiss planting
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream Storage
• Diversions at La Grange
• FERC spawning, rearing, and pulse flows
• Flood flows & tributary runoff
• In-river diversions
Sediment Transport
• Coarse sediment interception by upstream dams and legacy mining pits
• Bank erosion/migration
• Bedload & suspended sediment
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Olfactory impairment & stress
Habitat Availability
• Depth, velocity, substrate, LWD
• Bar, riffle, pool area
• Invertebrate production
Disease & Parasites
Predation
Prey Availability
Entrainment
Biotic Response
Emergent Fry
Indirect Mortality
Growth & Smoltific-ation
Direct Mortality
Juvenile/ Smolt


Steelhead Delta Outmigration
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
Anthropogenic Inputs
• Non-native fish introductions
• Herbicides & Pesticides
• Fertilizers
• POTW Discharge
• Urban Runoff
In-stream Flows
• Antecedent water year type
• Tributary storage & outflows
• Tributary flood flows
• Barrier operations
• POTW & agricultural returns
• Riparian & Delta diversions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Nutrients/Algae/DO
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate
• Levee construction
• Invertebrate & zooplankton production
Disease & Parasites
Predation
Prey Availability
Entrainment
Biotic Response
Tributary Juveniles/ Smolts
Indirect Mortality
Growth & Smoltific-ation
Direct Mortality
Smolt Outmigration



Steelhead Ocean Rearing (1 – 4 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Water Temperature
• Sea surface temperature
• Ocean current patterns
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Prey Availability
Predation
Harvest By-Catch
Smolt Outmigration
Indirect Mortality
Growth
Direct Mortality
Up-migrant Adults

Salmonid Information Synthesis Workshop No. 2
Don Pedro Relicensing Study W&AR-5
June 26, 2012 – MID Offices, Modesto

Conference Line Call-In Number 866-994-6437; Conference Code 5424697994

AGENDA

9:00 a.m. – 9:45 a.m.	**Introductions and Background** 1. Purpose of Meeting 2. Workshop Consultation Process Overview 3. Relationship to other studies 4. Review of Workshop No. 1 Comments and Status of Responses
9:45 a.m. – 12:00 p.m.	**Preliminary Conceptual Model Presentation** 1. Primary ecosystem inputs and other factors affecting Tuolumne River salmonids 2. Processes and mechanisms affecting Chinook salmon 3. Processes and mechanisms affecting steelhead trout/*O. mykiss*
12:00p.m. – 1:00 p.m.	**Lunch (on your own)**
1:00 p.m. – 3:30 p.m.	**Discussion of Conceptual Models and Preliminary Ranking of Issues** 1. Chinook salmon 2. Steelhead/*O. mykiss*
3:30 p.m. – 4:30 p.m.	**Next Steps**
4:30 p.m. – 5:00 p.m.	**Action Items Summary**

From: Staples, Rose
Sent: Friday, June 15, 2012 9:55 PM
To: 'Alves, Jim'; 'Anderson, Craig'; 'Asay, Lynette'; 'Aud, John'; 'Barnes, James'; 'Barnes, Peter'; 'Blake, Martin'; 'Bond, Jack'; Borovansky, Jenna; 'Boucher, Allison'; 'Bowes, Stephen'; 'Bowman, Art'; 'Brenneman, Beth'; 'Brewer, Doug'; 'Buckley, John'; 'Buckley, Mark'; 'Burt, Charles'; 'Byrd, Tim'; 'Cadagan, Jerry'; 'Carlin, Michael'; 'Charles, Cindy'; 'Colvin, Tim'; 'Costa, Jan'; 'Cowan, Jeffrey'; 'Cox, Stanley Rob'; 'Cranston, Peggy'; 'Cremeen, Rebecca'; 'Day, Kevin'; 'Day, P'; 'Denean'; 'Derwin, Maryann Moise'; Devine, John; 'Donaldson, Milford Wayne'; 'Dowd, Maggie'; 'Drekmeier, Peter'; 'Edmondson, Steve'; 'Eicher, James'; 'Fargo, James'; 'Ferranti, Annee'; 'Ferrari, Chandra'; 'Fety, Lauren'; 'Findley, Timothy'; 'Fuller, Reba'; 'Furman, Donn W'; 'Ganteinbein, Julie'; 'Giglio, Deborah'; 'Gorman, Elaine'; 'Grader, Zeke'; 'Gutierrez, Monica'; 'Hackamack, Robert'; 'Hastreiter, James'; 'Hatch, Jenny'; 'Hayat, Zahra'; 'Hayden, Ann'; 'Hellam, Anita'; 'Heyne, Tim'; 'Holley, Thomas'; 'Holm, Lisa'; 'Horn, Jeff'; 'Horn, Timi'; 'Hudelson, Bill'; 'Hughes, Noah'; 'Hughes, Robert'; 'Hume, Noah'; 'Jackman, Jerry'; 'Jackson, Zac'; 'Jennings, William'; 'Jensen, Art'; 'Jensen, Laura'; 'Johannis, Mary'; 'Johnson, Brian'; 'Justin'; 'Keating, Janice'; 'Kempton, Kathryn'; 'Kinney, Teresa'; 'Koepele, Patrick'; 'Kordella, Lesley'; 'Lara, Marco'; 'Lein, Joseph'; 'Levin, Ellen'; 'Lewis, Reggie'; 'Linkard, David'; 'Looker, Mark'; Loy, Carin; 'Lwenya, Roselynn'; 'Lyons, Bill'; 'Madden, Dan'; 'Manji, Annie'; 'Marko, Paul'; 'Marshall, Mike'; 'Martin, Michael'; 'Martin, Ramon'; 'Mathiesen, Lloyd'; 'McDaniel, Dan'; 'McDevitt, Ray'; 'McDonnell, Marty'; 'McLain, Jeffrey'; 'Mills, John'; 'Monheit, Susan'; 'Morningstar Pope, Rhonda'; 'Motola, Mary'; 'Murphey, Gretchen'; 'O'Brien, Jennifer'; 'Orvis, Tom'; 'Ott, Bob'; 'Ott, Chris'; 'Paul, Duane'; 'Pavich, Steve'; 'Pinhey, Nick'; 'Pool, Richard'; 'Porter, Ruth'; 'Powell, Melissa'; 'Puccini, Stephen'; 'Raeder, Jessie'; 'Ramirez, Tim'; 'Rea, Maria'; 'Reed, Rhonda'; 'Richardson, Kevin'; 'Ridenour, Jim'; 'Robbins, Royal'; 'Romano, David O'; 'Roos-Collins, Richard'; 'Roseman, Jesse'; 'Rothert, Steve'; 'Sandkulla, Nicole'; 'Saunders, Jenan'; 'Schutte, Allison'; 'Sears, William'; 'Shakal, Sarah'; 'Shipley, Robert'; 'Shumway, Vern'; 'Shutes, Chris'; 'Sill, Todd'; 'Slay, Ron'; 'Smith, Jim'; Staples, Rose; 'Steindorf, Dave'; 'Steiner, Dan'; 'Stone, Vicki'; 'Stork, Ron'; 'Stratton, Susan'; 'Taylor, Mary Jane'; 'Terpstra, Thomas'; 'TeVelde, George'; 'Thompson, Larry'; 'Vasquez, Sandy'; 'Verkuil, Colette'; 'Vierra, Chris'; 'Wantuck, Richard'; 'Welch, Steve'; 'Wesselman, Eric'; 'Wheeler, Dan'; 'Wheeler, Dave'; 'Wheeler, Douglas'; 'Wilcox, Scott'; 'Williamson, Harry'; 'Willy, Allison'; 'Wilson, Bryan'; 'Winchell, Frank'; 'Wooster, John'; 'Workman, Michelle'; 'Yoshiyama, Ron'; 'Zipser, Wayne'
Subject: Recent Postings to the Don Pedro Relicensing Website

Hydrology Workshop No. 1 Request
At the April 9, 2012 Hydrology Workshop No. 1, there were requests to have reposted the PowerPoint presentation, made at the April 1, 2011 Relicensing Participants Meeting, which described the Hetch Hetchy Water & Power System. The presentation has been uploaded to the relicensing website in the INTRODUCTION/Announcement section. Note: the original posting was attached to the April 1, 2011 Meeting Notice under MEETINGS.

Salmonid Information Synthesis Workshops:

Workshop No. 1 - Final Meeting Notes / Relicensing Participants Comments
The Final Meeting Notes/Relicensing Participants Comments document has been e-filed with FERC (will appear on the docket as filed Monday, June 18, 2012) and has been uploaded to the relicensing website, both under INTRODUCTION/Announcements and as an attachment to the April 10, 2012 Meeting Date on the MEETINGS/Calendar.

Workshop No. 2 – AGENDA and Materials for the June 26, 2012 Workshop at the MID offices in Modesto
The AGENDA and Materials for the upcoming June 26 Workshop No. 2 has been emailed to all relicensing participants and uploaded to the relicensing website, both under INTRODUCTION/Announcements and as

attachments to the June 26th Meeting Date on MEETINGS/Calendar.

If you have difficulty locating or downloading any of these documents, please let me know. Thank you.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

970 Baxter Boulevard, Suite 301 | Portland, ME 04103
207.239.3857 | f: 207.775.1742
rose.staples@hdrinc.com | hdrinc.com

From: Staples, Rose
Sent: Monday, June 25, 2012 1:26 PM
To: 'Alves, Jim'; 'Anderson, Craig'; 'Asay, Lynette'; 'Aud, John'; 'Barnes, James'; 'Barnes, Peter'; 'Blake, Martin'; 'Bond, Jack'; Borovansky, Jenna; 'Boucher, Allison'; 'Bowes, Stephen'; 'Bowman, Art'; 'Brenneman, Beth'; 'Brewer, Doug'; 'Buckley, John'; 'Buckley, Mark'; 'Burt, Charles'; 'Byrd, Tim'; 'Cadagan, Jerry'; 'Carlin, Michael'; 'Charles, Cindy'; 'Colvin, Tim'; 'Costa, Jan'; 'Cowan, Jeffrey'; 'Cox, Stanley Rob'; 'Cranston, Peggy'; 'Cremeen, Rebecca'; 'Day, Kevin'; 'Day, P'; 'Denean'; 'Derwin, Maryann Moise'; Devine, John; 'Donaldson, Milford Wayne'; 'Dowd, Maggie'; 'Drekmeier, Peter'; 'Edmondson, Steve'; 'Eicher, James'; 'Fargo, James'; 'Ferranti, Annee'; 'Ferrari, Chandra'; 'Fety, Lauren'; 'Findley, Timothy'; 'Fuller, Reba'; 'Furman, Donn W'; 'Ganteinbein, Julie'; 'Giglio, Deborah'; 'Gorman, Elaine'; 'Grader, Zeke'; 'Gutierrez, Monica'; 'Hackamack, Robert'; 'Hastreiter, James'; 'Hatch, Jenny'; 'Hayat, Zahra'; 'Hayden, Ann'; 'Hellam, Anita'; 'Heyne, Tim'; 'Holley, Thomas'; 'Holm, Lisa'; 'Horn, Jeff'; 'Horn, Timi'; 'Hudelson, Bill'; 'Hughes, Noah'; 'Hughes, Robert'; 'Hume, Noah'; 'Jackman, Jerry'; 'Jackson, Zac'; 'Jennings, William'; 'Jensen, Art'; 'Jensen, Laura'; 'Johannis, Mary'; 'Johnson, Brian'; 'Justin'; 'Keating, Janice'; 'Kempton, Kathryn'; 'Kinney, Teresa'; 'Koepele, Patrick'; 'Kordella, Lesley'; 'Lara, Marco'; 'Lein, Joseph'; 'Levin, Ellen'; 'Lewis, Reggie'; 'Linkard, David'; 'Looker, Mark'; Loy, Carin; 'Lwenya, Roselynn'; 'Lyons, Bill'; 'Madden, Dan'; 'Manji, Annie'; 'Marko, Paul'; 'Marshall, Mike'; 'Martin, Michael'; 'Martin, Ramon'; 'Mathiesen, Lloyd'; 'McDaniel, Dan'; 'McDevitt, Ray'; 'McDonnell, Marty'; 'McLain, Jeffrey'; 'Mills, John'; 'Monheit, Susan'; 'Morningstar Pope, Rhonda'; 'Motola, Mary'; 'Murphey, Gretchen'; 'O'Brien, Jennifer'; 'Orvis, Tom'; 'Ott, Bob'; 'Ott, Chris'; 'Paul, Duane'; 'Pavich, Steve'; 'Pinhey, Nick'; 'Pool, Richard'; 'Porter, Ruth'; 'Powell, Melissa'; 'Puccini, Stephen'; 'Raeder, Jessie'; 'Ramirez, Tim'; 'Rea, Maria'; 'Reed, Rhonda'; 'Richardson, Kevin'; 'Ridenour, Jim'; 'Robbins, Royal'; 'Romano, David O'; 'Roos-Collins, Richard'; 'Roseman, Jesse'; 'Rothert, Steve'; 'Sandkulla, Nicole'; 'Saunders, Jenan'; 'Schutte, Allison'; 'Sears, William'; 'Shakal, Sarah'; 'Shipley, Robert'; 'Shumway, Vern'; 'Shutes, Chris'; 'Sill, Todd'; 'Slay, Ron'; 'Smith, Jim'; Staples, Rose; 'Steindorf, Dave'; 'Steiner, Dan'; 'Stone, Vicki'; 'Stork, Ron'; 'Stratton, Susan'; 'Taylor, Mary Jane'; 'Terpstra, Thomas'; 'TeVelde, George'; 'Thompson, Larry'; 'Vasquez, Sandy'; 'Verkuil, Colette'; 'Vierra, Chris'; 'Wantuck, Richard'; 'Welch, Steve'; 'Wesselman, Eric'; 'Wheeler, Dan'; 'Wheeler, Dave'; 'Wheeler, Douglas'; 'Wilcox, Scott'; 'Williamson, Harry'; 'Willy, Allison'; 'Wilson, Bryan'; 'Winchell, Frank'; 'Wooster, John'; 'Workman, Michelle'; 'Yoshiyama, Ron'; 'Zipser, Wayne'
Subject: Online Meeting Info for June 26 Don Pedro Salmonid Info Synthesis Study Workshop

There will be on-line meeting access for the Tuesday, June 26 (9am – 5pm Pacific) the Salmonid Information Synthesis Study (W&AR-5) Workshop.

Please use the link below for On-Line Access:

....

Join online meeting

https://meet.hdrinc.com/jenna.borovansky/Q56RYS5M

First online meeting?

....

If this is your first online meeting, PRIOR TO THE MEETING TIME you would want to CONTROL-CLICK on the above "First Online Meeting?" link to make sure your system has the necessary software downloaded to access online meetings.

NOTE: Do not use the phone line associated with the On-Line Meeting. Please continue to use the conference line and password provided on the agenda (866.994.6437; passcode 5424697994).

The agenda and meeting materials are available on the www.donpedro-relicensing.com relicensing website in two places, attached to the June 26th date on the meeting calendar, and in the Announcement section under the INTRODUCTION Tab.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

970 Baxter Boulevard, Suite 301 | Portland, ME 04103
207.239.3857 | f: 207.775.1742
rose.staples@hdrinc.com | hdrinc.com

From: Devine, John
Sent: Wednesday, July 11, 2012 2:55 PM
To: Annie Manji; Steve Rothert; Dave Steindorf; William Jennings; Paul Marko; Bill Lyons; Bob Ott; Jerry Cadagan; Robert Shipley; Steve Welch; Martin Blake; Art Jensen; Nicole Sandkulla; Allison Boucher; Beth Brenneman; James Barnes; James Eicher; Jeff Horn; Lauren Fety; Peggy Cranston; Denean; Rhonda Morningstar Pope; Roselynn Lwenya; Charles Burt; Jenny Hatch; Duane Paul; Steve Pavich; Cindy Charles; Mary Motola; Chris Vierra; Dan Wheeler; Dave Wheeler; John Buckley; Rebecca Cremeen; Annee Ferranti; Gretchen Murphey; Jennifer O'Brien; Mary Jane Taylor; Bob Hughes; Stephen Puccini; Tim Heyne; Royal Robbins; Ann Hayden; Tim Byrd; Ron Slay; John Aud; Frank Winchell; James Fargo; James Hastreiter; Lesley Kordella; Ron Stork; Robert Hackamack; Maggie Dowd; Vern Shumway; Allison Willy; Craig Anderson; Deborah Giglio; Michelle Workman; Ramon Martin; Zac Jackson; Marco Lara; Harry Williamson; Janice Keating; Jesse Roseman; Chris Ott; Allison Schutte; Ray McDevitt; Timothy Findley; Loy, Carin; Borovansky, Jenna; Staples, Rose; Mike Marshall; Douglas Wheeler; Ruth Porter; Joseph Lein; Noah Hughes; Todd Sill; Teresa Kinney; Sarah Shakal; Zeke Grader; Justin; Dan Steiner; Art Bowman; Jim Smith; David Linkard; Melissa Powell; George TeVelde; Vicki Stone; Jan Costa; Lloyd Mathiesen; Stanley Rob Cox; Reba Fuller; Kevin Day; Jim Alves; Jack Bond; Jim Ridenour; Nick Pinhey; Bryan Wilson; Colette Verkuil; P Day; Zahra Hayat; Chris Shutes; David O Romano; Lynette Asay; Jeffrey McLain; John Wooster; Kathryn Kempton; Larry Thompson; Maria Rea; Monica Gutierrez; Rhonda Reed; Richard Wantuck; Steve Edmondson; Thomas Holley; Stephen Bowes; Dan McDaniel; Jenan Saunders; Milford Wayne Donaldson; Susan Stratton; Mark Buckley; Maryann Moise Derwin; Richard Pool; Jeffrey Cowan; Jerry Jackman; Donn W Furman; Ellen Levin; Michael Carlin; Tim Ramirez; William Sears; Marty McDonnell; John Mills; Tom Orvis; Wayne Zipser; Michael Martin; Sandy Vasquez; Noah Hume; Scott Wilcox; Reggie Lewis; Tim Colvin; Doug Brewer; Thomas Terpstra; Laura Jensen; Brian Johnson; Chandra Ferrari; Eric Wesselman; Jessie Raeder; Patrick Koepele; Peter Drekmeier; Dan Madden; Ron Yoshiyama; Kevin Richardson; Lisa Holm; Mary Johannis; Peter Barnes; Susan Monheit; Julie Ganteinbein; Richard Roos-Collins; Anita Hellam; Bill Hudelson; Mark Looker; Timi Horn; Elaine Gorman
Cc: Borovansky, Jenna; Staples, Rose; Noah Hume
Subject: RE: Recent Postings to the Don Pedro Relicensing Website

Annie,

We are working on finishing the meeting notes from the June 26 meeting. These will be issued early next week. The tables you reference are part of the meeting notes. Please recall as well that we will be asking the Relicensing Participants(RPs)to review the tables again and provide us detailed comments and any specific source documentation needed to support those comments. The meeting notes, RP's review comments, and the Districts' reply comments will be following the Workshop Consultation Protocols because the W&AR-5 study meeting was one of the formal Workshops referenced in the FERC Study Plan Determination. A substantial amount of material will be included in the meeting notes, so please bear with us a bit longer while we finalize the Meeting Report.

Thank you for your continuing active participation and interest in the Don Pedro relicensing.

JOHN DEVINE
P.E.
HDR Engineering, Inc.
Senior Vice President, Hydropower Services

970 Baxter Boulevard Suite 301 | Portland, ME 04103
207.775.4495 | c: 207.776.2206 | f: 207.775.1742 john.devine@hdrinc.com | hdrinc.com

-----Original Message-----
From: Annie Manji [mailto:AManji@dfg.ca.gov]
Sent: Wednesday, July 11, 2012 1:01 PM
To: Steve Rothert; Dave Steindorf; William Jennings; Paul Marko; Bill Lyons; Bob Ott; Jerry Cadagan; Robert Shipley; Steve Welch; Martin Blake; Art Jensen; Nicole Sandkulla; Allison Boucher; Beth Brenneman; James Barnes; James Eicher; Jeff Horn; Lauren Fety; Peggy Cranston; Denean; Rhonda Morningstar Pope; Roselynn Lwenya; Charles Burt; Jenny Hatch; Duane Paul; Steve Pavich; Cindy Charles; Mary Motola; Chris Vierra; Dan Wheeler; Dave Wheeler; John Buckley; Rebecca Cremeen; Annee Ferranti; Gretchen Murphey; Jennifer O'Brien; Mary Jane Taylor; Bob Hughes; Stephen Puccini; Tim Heyne; Royal Robbins; Ann Hayden; Tim Byrd; Ron Slay; John Aud; Frank Winchell; James Fargo; James Hastreiter; Lesley Kordella; Ron Stork; Robert Hackamack; Maggie Dowd; Vern Shumway; Allison Willy; Craig Anderson; Deborah Giglio; Michelle Workman; Ramon Martin; Zac Jackson; Marco Lara; Harry Williamson; Janice Keating; Jesse Roseman; Chris Ott; Allison Schutte; Ray McDevitt; Timothy Findley; Loy, Carin; Borovansky, Jenna; Devine, John; Staples, Rose; Mike Marshall; Douglas Wheeler; Ruth Porter; Joseph Lein; Noah Hughes; Todd Sill; Teresa Kinney; Sarah Shakal; Zeke Grader; Justin; Dan Steiner; Art Bowman; Jim Smith; David Linkard; Melissa Powell; George TeVelde; Vicki Stone; Jan Costa; Lloyd Mathiesen; Stanley Rob Cox; Reba Fuller; Kevin Day; Jim Alves; Jack Bond; Jim Ridenour; Nick Pinhey; Bryan Wilson; Colette Verkuil; P Day; Zahra Hayat; Chris Shutes; David O Romano; Lynette Asay; Jeffrey McLain; John Wooster; Kathryn Kempton; Larry Thompson; Maria Rea; Monica Gutierrez; Rhonda Reed; Richard Wantuck; Steve Edmondson; Thomas Holley; Stephen Bowes; Dan McDaniel; Jenan Saunders; Milford Wayne Donaldson; Susan Stratton; Mark Buckley; Maryann Moise Derwin; Richard Pool; Jeffrey Cowan; Jerry Jackman; Donn W Furman; Ellen Levin; Michael Carlin; Tim Ramirez; William Sears; Marty McDonnell; John Mills; Tom Orvis; Wayne Zipser; Michael Martin; Sandy Vasquez; Noah Hume; Scott Wilcox; Reggie Lewis; Tim Colvin; Doug Brewer; Thomas Terpstra; Laura Jensen; Brian Johnson; Chandra Ferrari; Eric Wesselman; Jessie Raeder; Patrick Koepele; Peter Drekmeier; Dan Madden; Ron Yoshiyama; Kevin Richardson; Lisa Holm; Mary Johannis; Peter Barnes; Susan Monheit; Julie Ganteinbein; Richard Roos-Collins; Anita Hellam; Bill Hudelson; Mark Looker; Timi Horn; Elaine Gorman
Subject: Re: Recent Postings to the Don Pedro Relicensing Website

Rose

During the June 26 W&A5 Workshop No. 2 in the afternoon session there were tables generated that ranked factors Stillwater intended to include in their salmon and steelhead modeling efforts. I cannot find the tables (or any other meeting notes from that workshop) on the website - can you help me track them down?

Thank you

Annie Manji
Statewide FERC Coordinator
California Department of Fish and Game
Water Branch
601 Locust Street
Redding, CA 96001
(530) 225-2315
amanji@dfg.ca.gov

>>> "Staples, Rose" <Rose.Staples@hdrinc.com> 6/15/2012 6:59 PM >>>
Hydrology Workshop No. 1 Request
At the April 9, 2012 Hydrology Workshop No. 1, there were requests to have reposted the PowerPoint presentation, made at the April 1, 2011 Relicensing Participants Meeting, which described the Hetch Hetchy Water & Power System. The presentation has been uploaded to the relicensing website in the INTRODUCTION/Announcement section. Note: the original posting was attached to the April 1, 2011 Meeting Notice under MEETINGS.

Salmonid Information Synthesis Workshops:

Workshop No. 1 - Final Meeting Notes / Relicensing Participants Comments The Final Meeting Notes/Relicensing Participants Comments document has been e-filed with FERC (will appear on the docket as filed Monday, June 18, 2012) and has been uploaded to the relicensing website, both under INTRODUCTION/Announcements and as an attachment to the April 10, 2012 Meeting Date on the MEETINGS/Calendar.

Workshop No. 2 - AGENDA and Materials for the June 26, 2012 Workshop at the MID offices in Modesto The AGENDA and Materials for the upcoming June 26 Workshop No. 2 has been emailed to all relicensing participants and uploaded to the relicensing website, both under INTRODUCTION/Announcements and as attachments to the June 26th Meeting Date on MEETINGS/Calendar.

If you have difficulty locating or downloading any of these documents, please let me know. Thank you.

Rose staples
cAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

970 Baxter Boulevard, Suite 301 | Portland, ME 04103
207.239.3857 | f: 207.775.1742

rose.staples@hdrinc.com<mailto:rose.staples@hdrinc.com>|
hdrinc.com<http://www.hdrinc.com/>

From: Staples, Rose
Sent: Wednesday, July 25, 2012 6:08 PM
To: Alves, Jim; Anderson, Craig; Asay, Lynette; Aud, John; Barnes, James; Barnes, Peter; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackman, Jerry; Jackson, Zac; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Lara, Marco; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Looker, Mark; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; McLain, Jeffrey; Mein Janis; Mills, John; Minami Amber; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Steindorf, Dave; Steiner, Dan; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro W&AR-5 Workshop Draft Notes - Attachments for 30-Day Review
Attachments: W-AR-5_Wkshp2_Draft_Review_Package_20120725.pdf

Attached please find the DRAFT Meeting Notes from the Don Pedro Project Relicensing *W&AR-5 Salmonid Population Information Synthesis Workshop* held on July 26, 2012. In addition to the draft notes, the Districts have provided, for participant feedback, critical items to the conduct of the study:

(1) Life cycle diagrams have been edited based on meeting feedback—and these changes have been highlighted in the attachments to the Notes. These conceptual models will form the basis of the models developed under W&AR-6 (Chinook Population Model) and W&AR-10 (O. mykiss Population Model).
(2) During the workshop, the preliminary ranking of key issues affecting salmonid life stages that will be used in the development of the models was discussed. The Districts have provided, for review by relicensing participants, preliminary rankings based on information reviewed to date (with citations) as attachments to the Notes. Remember, the key elements in the development of these rankings are that there are data available to support the importance of the item to the life stage and that the potential issue can be quantified for use in the population models.

The Districts have reviewed and included available information to support the current identification of key issues, and the Districts will be moving forward with development of the models per study plans for W&AR-6 and W&AR-10 based upon the information presented at the Workshop and documented in the meeting notes and attachments. We appreciate the feedback provided to date. As discussed at the workshop, if any further changes to the rankings are recommended by participants, the Districts request source data and references to support recommendations within the 30-day review period for these notes.

Please provide any comments on the draft workshop notes and any additional source materials to Rose Staples (rose.staples@hdrinc.com) by no later than Friday, August 24, 2012.

NOTE: A copy of this announcement, and the accompanying attachments, are also being uploaded to the INTRODUCTION/ANNOUNCEMENT section of the relicensing website www.donpedro-relicensing.com.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

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rose.staples@hdrinc.com | hdrinc.com

From: Staples, Rose
Sent: Thursday, November 15, 2012 11:51 AM
To: Amerine, Bill; Asay, Lynette; Barnes, James; Barnes, Peter; Beniamine Beronia; Blake, Martin; Bond, Jack; Borovansky, Jenna; Boucher, Allison; Bowes, Stephen; Bowman, Art; Brenneman, Beth; Brewer, Doug; Buckley, John; Buckley, Mark; Burt, Charles; Byrd, Tim; Cadagan, Jerry; Carlin, Michael; Charles, Cindy; Colvin, Tim; Costa, Jan; Cowan, Jeffrey; Cox, Stanley Rob; Cranston, Peggy; Cremeen, Rebecca; Damin Nicole; Day, Kevin; Day, P; Denean; Derwin, Maryann Moise; Devine, John; Donaldson, Milford Wayne; Dowd, Maggie; Drekmeier, Peter; Edmondson, Steve; Eicher, James; Fargo, James; Ferranti, Annee; Ferrari, Chandra; Fety, Lauren; Findley, Timothy; Fleming, Mike; Fuller, Reba; Furman, Donn W; Ganteinbein, Julie; Giglio, Deborah; Gorman, Elaine; Grader, Zeke; Gutierrez, Monica; Hackamack, Robert; Hastreiter, James; Hatch, Jenny; Hayat, Zahra; Hayden, Ann; Hellam, Anita; Heyne, Tim; Holley, Thomas; Holm, Lisa; Horn, Jeff; Horn, Timi; Hudelson, Bill; Hughes, Noah; Hughes, Robert; Hume, Noah; Jackson, Zac; Jauregui, Julia; Jennings, William; Jensen, Art; Jensen, Laura; Johannis, Mary; Johnson, Brian; Justin; Keating, Janice; Kempton, Kathryn; Kinney, Teresa; Koepele, Patrick; Kordella, Lesley; Le, Bao; Lein, Joseph; Levin, Ellen; Lewis, Reggie; Linkard, David; Loy, Carin; Lwenya, Roselynn; Lyons, Bill; Madden, Dan; Manji, Annie; Marko, Paul; Marshall, Mike; Martin, Michael; Martin, Ramon; Mathiesen, Lloyd; McDaniel, Dan; McDevitt, Ray; McDonnell, Marty; Mein Janis; Mills, John; Minami Amber; Monheit, Susan; Morningstar Pope, Rhonda; Motola, Mary; Murphey, Gretchen; Murray, Shana; O'Brien, Jennifer; Orvis, Tom; Ott, Bob; Ott, Chris; Paul, Duane; Pavich, Steve; Pinhey, Nick; Pool, Richard; Porter, Ruth; Powell, Melissa; Puccini, Stephen; Raeder, Jessie; Ramirez, Tim; Rea, Maria; Reed, Rhonda; Richardson, Kevin; Ridenour, Jim; Riggs T; Robbins, Royal; Romano, David O; Roos-Collins, Richard; Roseman, Jesse; Rothert, Steve; Sandkulla, Nicole; Saunders, Jenan; Schutte, Allison; Sears, William; Shakal, Sarah; Shipley, Robert; Shumway, Vern; Shutes, Chris; Sill, Todd; Slay, Ron; Smith, Jim; Staples, Rose; Stapley, Garth; Steindorf, Dave; Steiner, Dan; Stender, John; Stone, Vicki; Stork, Ron; Stratton, Susan; Taylor, Mary Jane; Terpstra, Thomas; TeVelde, George; Thompson, Larry; Vasquez, Sandy; Verkuil, Colette; Vierra, Chris; Wantuck, Richard; Welch, Steve; Wesselman, Eric; Wheeler, Dan; Wheeler, Dave; Wheeler, Douglas; White, David K; Wilcox, Scott; Williamson, Harry; Willy, Allison; Wilson, Bryan; Winchell, Frank; Wooster, John; Workman, Michelle; Yoshiyama, Ron; Zipser, Wayne
Subject: Don Pedro Final Meeting Notes-Responses to Comments on W-AR-5 June 26 2012 Workshop No 2 Filed with FERC Today

I have uploaded to the www.donpedro-relicensing.com website today (under the INTRODUCTION tab / Announcement) a copy of the Final Meeting Notes and Responses to Relicensing Participants' Comments on the June 26, 2012 Salmonid Information Synthesis Workshop No. 2. If you have any difficulty locating and/or accessing the document, please let me know. Thank you.

ROSE STAPLES
CAP-OM

HDR Engineering, Inc.
Executive Assistant, Hydropower Services

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rose.staples@hdrinc.com | hdrinc.com

November 15, 2012 Don Pedro Project
E-Filed FERC No. 2299-075

Honorable Kimberly D. Bose, Secretary
Federal Energy Regulatory Commission
Mail Code: DHAC PJ-12.3
888 First Street NE
Washington DC 20426

RE: Turlock Irrigation District and Modesto Irrigation District
Don Pedro Project - FERC Project No. 2299
Final Meeting Notes and Responses to Relicensing Participant Comments on the June 26, 2012 Salmonid Information Synthesis Workshop No. 2

As part of the ongoing studies under the Integrated Licensing Process ("ILP") for the Don Pedro Project ("Project"), the Turlock Irrigation District and the Modesto Irrigation District, co-licensees of the Project (collectively the "Districts") held their second relicensing participants' meeting (Consultation Workshop No. 2) on June 26, 2012 as proposed in the Salmonid Populations Information Integration and Synthesis Study Plan ("Synthesis Study"; W&AR-5) and approved by FERC in its December 22, 2011 Study Plan Determination ("SPD").

The June 26, 2012 Workshop was held to present and refine preliminary conceptual models of the biology and ecology of fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead/*O. mykiss* within the Tuolumne River, San Joaquin River, Delta, and Pacific Ocean. The purpose of the information provided at the Workshop was to begin to identify the key factors that should be included in the development of in-river salmon population models as a part of studies W&AR-6 and W&AR-10 for Chinook salmon and *O. mykiss*. Materials for the Workshop—preliminary conceptual models and an accompanying narrative document—were provided to relicensing participants on June 15, 2012. At the Workshop, in addition to presenting models and discussing ecosystem inputs and other factors affecting salmonid ecology, relicensing participants were asked to provide assistance in narrowing the amount of existing information to be reviewed for the Synthesis Study and identifying the most important factors affecting salmonid populations and individual life stages. A preliminary ranking of issues affecting Chinook salmon and steelhead/*O. mykiss* developed with relicensing participants in attendance was discussed at the Workshop and subsequently refined for inclusion in the draft meeting notes with supporting citations for each of the identified issues. Draft notes along with revisions to the conceptual models and tables ranking various factors affecting salmonid life stages were provided to relicensing participants on July 25, 2012 for 30-

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day review. Relicensing participants were asked to provide additional input, including citations, to support any alternative assessments than those presented in the conceptual models or discussed at the Workshop.

Following the 30-day review period, comments on the draft notes were provided by the California Department of Fish and Game ("CDFG"), the Tuolumne River Trust and California Sportfishing Protection Alliance ("TRT-CSPA"), the U.S. Fish and Wildlife Service ("USFWS"), and the California State Water Resources Control Board ("SWRCB"). In accordance with Appendix B of FERC's December 22, 2011 Study Plan Determination and the Final Workshop Consultation Protocols filed with FERC on May 18, 2012, this letter provides draft and final meeting notes, as well as relicensing participants' comments and supplemental materials within Attachments A through G below:

Attachment A:	Final Meeting Notes – W&AR-5 Salmonid Information Synthesis Workshop No. 2 with updated conceptual models and information tables based on agency comments and further literature review
Attachment B:	Draft Meeting Notes and Workshop Materials – W&AR-5 Salmonid Information Synthesis Workshop No. 2
Attachment C:	California Dept. of Fish and Game's comments on Turlock Irrigation District and Modesto Irrigation District's Salmonid Population Information Integration and Synthesis Study Plan
Attachment D:	Tuolumne River Trust and California Sportfishing Protection Alliance's comments on W&AR-5 Salmonid Information Synthesis Workshop No. 2-Draft Meeting Notes
Attachment E:	U.S. Fish and Wildlife Service's comments on Workshop No.2 for Study W&AR-5 – Salmonid Populations Information Integration and Synthesis; W&AR-6 – Chinook Salmon Population Model; W&AR-10 – *O. mykiss* Population Study; and on the W&AR-20 – *O. mykiss* Scale Collection and Age Determination Study Plan
Attachment F:	State Water Resources Control Board's Comments on Workshop No.2 for Study W&AR-5 – Salmonid Populations Information Integration and Synthesis
Attachment G:	Draft Glossary – Salmonid Information Integration and Synthesis Study (W&AR-5)

<u>Districts' Responses to Relicensing Participant's Comments</u>

The Districts appreciate the time relicensing participants have devoted to attend the Workshop and review materials for the W&AR-5 Synthesis Study. All comments and suggestions received are being reviewed using the criteria established during Workshop No. 1 and relevant information will be incorporated into the Synthesis Study report. Given the complexity of salmonid life cycles, it is to be expected that there would be different views on the relative importance of various factors. The intent of the Synthesis Study and the supporting Workshop process is for the Districts to review all available information related to Tuolumne River salmonids, but also to narrow the focus to the most relevant factors that are supported by the identified information sources. The purpose of the information provided by the Districts prior to and at the June 26, 2012 Workshop was to provide an opportunity for discussion and review of a preliminary list of key factors affecting salmonid populations. During future Workshops and study implementation for W&AR-6 and W&AR-10, factors affecting Tuolumne River salmonids throughout their fresh and saltwater life history will be narrowed to those in-river factors that should be included in subsequent Chinook salmon and *O. mykiss* population models (*Tuolumne River Chinook Salmon Population Model* - W&AR-6; and the *O. mykiss Population Study* - W&AR-10) to be completed in 2013. As described in the Districts' Revised Study Plan (RSP) filing of November 22, 2011 and approved by FERC in its December 22, 2011 Determination, the relative importance (or "ranking") of the included factors affecting individual life stages and juvenile salmon production will be assessed through parameter sensitivity testing in these interrelated modeling studies. The models developed will be a tool used by the Districts and relicensing participants to complete more detailed examinations of the relationships between these factors and the production of juvenile life stages of Tuolumne Chinook and *O. mykiss*. During the modeling process, factors initially identified as relatively more important may be discovered to be less influential on salmonid life history progression and, likewise, factors initially viewed as being less important may prove otherwise. The intent of the W&AR-5 Workshop process was to provide an **initial** starting point informed by the literature. A discussion of which in-river factors to include in modeling of juvenile salmonid production in the lower Tuolumne River will take place as part of the population modeling workshops for the W&AR-6 and -10 studies, currently scheduled for November 15–16, 2012.

<u>Districts' Responses to California Dept of Fish and Game Comments</u>

In their letter of August 31, 2012 (Attachment C), CDFG provided comments on five areas of the Synthesis Study, including (1) additional comments on the final notes for Workshop No. 1 filed on June 18, 2012 with FERC, (2) comments on the June 26, 2012 Workshop and July 25, 2012 draft meeting notes, (3) comments on Conceptual Model flow charts, (4) comments on the preliminary ranking of issues affecting Chinook salmon and *O. mykiss* population levels discussed at the Workshop, and (5) comments on future consultation as part of the Synthesis Study.

1. *Additional comments on the Final notes for Workshop No. 1*. In CDFG's comments on the final notes for Workshop No. 1 filed with FERC on June 18, 2012, prior statements that "impaired instream flows and water temperatures are key drivers in the long term decline of the Tuolumne River fall-run Chinook salmon population" were repeated and CDFG requested a more detailed rationale to assess the role that "inadequate instream flows have in the degradation of aquatic habitat …." The conceptual models include river flows as important factors of salmonid populations at the ecosystem level and the Chinook salmon and *O. mykiss* population models (W&AR 6 & 10) will include flow as a model input. Regarding the CDFG comment on population trends, considerable uncertainty exists on the incremental responses of salmonid population to specific changes in flow magnitudes and timing, as well as on the best methods to employ to represent those relationships through mathematical modeling. It is the primary purpose of the interrelated salmonid population modeling studies to investigate the apparent relationships presented by CDFG rather than make an *a priori* assumption regarding the relative importance of incremental flows to in-river populations.

2. *Comments on the June 26, 2012 Workshop and July 25, 2012 draft meeting notes*. In its comments, CDFG cited a lack of evaluation criteria in assessing various references, resubmitted prior information on the importance of flow and water temperature included as part of their prior comments on Workshop No. 1, and provided a number of suggestions for the conceptual model diagrams. With regard to evaluation criteria, these were provided by the Districts as part of Workshop No. 1 on April 10, 2012, and included as Attachment 5 of the Final Workshop No. 1 notes submitted on June 15, 2012. Regarding CDFG's prior testimony excerpts and various flow relationships provided on pp. 3-16, there are significant uncertainties evident in the relationships and unresolved questions about some of the statistical methods used. In any event, CDFG's general comment was not directly linked to any specific mechanism that could be used in the Synthesis Study. Other ongoing relicensing studies such as the predation study (W&AR-7) as well as the planned salmonid population modeling studies are designed to improve our understanding of the key salmonid population responses to ecosystem drivers, including flow.

3. *Comments on Conceptual Model Flow Charts*. Regarding suggested changes to the conceptual models on pp. 17-21 and discussion of alternative modeling concepts and linkages, the Districts appreciate the insights of CDFG biologists in examining relevant factors affecting various salmonid life stages and these comments will be carefully considered in preparing the Synthesis Study report.

a. To clarify CDFG's comments provided on p. 17 of its letter regarding diagram layout and pathways depicted, all areas of life stage residency are depicted on individual diagrams that are interconnected by the circular symbols at the left and right margins of each chart, with growth and survival progression through the boxes along the bottom margin implied. Alternative connection pathways clarifying growth and survival as well as mortality are provided in the revised conceptual model diagrams (Attachment A).
b. Comments regarding the importance of flow upon life stage transitions on p. 17 will be addressed in the Synthesis Study report.
c. Comments regarding modeling hierarchy on p. 18 appear to misunderstand the diagram layout, which is organized in order from (1) ecosystem level inputs, (2) physical processes/mechanisms, (3) biological processes and mechanisms, to (4) individual or population level responses of Tuolumne River salmonids. The implied hierarchy is intended to indicate how the ecosystem level inputs affect river flows as well as the prevalence of various physical and biological mechanisms, which in turn result in population responses.
d. The remaining comments on pp. 19-20 include discussion regarding issues ranging from predation, competitive exclusion, flow magnitude and timing affecting juvenile and smolt emigration, Delta rearing, and discussions regarding classifications within anthropogenic or instream flow categories. These important comments are noted and the subject matter will be discussed as part of the Synthesis Study report.

4. *Comments on the preliminary ranking of issues affecting Chinook salmon and O. mykiss population levels*. Regarding the preliminary rankings table developed at the Workshop with relicensing participants, CDFG disagreed with the exclusion of flow in the table and provided a number of suggestions for inclusion in the salmonid population models (W&AR-6 and W&AR-10). However, specific citation support for alternative rankings as requested at the Workshop and in the transmittal of the draft workshop notes was not provided; therefore, no changes have been made to the current table version, now entitled "Summary Tables of Key Issues Affecting Chinook Salmon and *O. mykiss*" in Attachment A. However, the issues suggested by CDFG, including those related to flow, will be considered in development of the interrelated population modeling studies (W&AR-6 and W&AR-10). In addition, an expanded report narrative and a more comprehensive summary table of all issues evaluated in the Synthesis Study will consider issues identified by CDFG.

5. *Comments on future Consultation as part of the Synthesis Study*. The Districts appreciate the time that CDFG staff biologists have taken participating in W&AR-5

Study Plan development and scheduled workshops. The Districts encourage CDFG to continue consultation and participation in the interrelated salmonid population model development (Studies W&AR-6 and W&AR-10) and look forward to any comments on the W&AR-5 Synthesis Study report to be provided in the Initial Study Report. FERC specifically determined in its SPD that the independent peer review panel was not feasible; however, the Synthesis Study report has certainly benefited from CDFG participation to date.

Districts' Responses to Comments by Tuolumne River Trust and California Sportfishing Protection Alliance

In their letter of August 24, 2012 (Attachment D), TRT-CSPA provided comments in two areas of the Synthesis Study, including (1) general Workshop comments and (2) comments on ranking of Chinook salmon and steelhead/*O. mykiss* issues.

1. *General Workshop Comments*. In their general Workshop comments on pp. 1-2 TRT-CSPA raised procedural issues and requested an additional Workshop.

    a. With regard to the Workshop process and preliminary rankings, the Districts thank TRT-CSPA for their participation in the meeting as well as suggestions for alternative rankings made at the Workshop and in the comment letter (Attachment D). The Districts actively reflected feedback from participants during the Workshop and invited additional information to support the formulation of alternative criteria from participants.

    b. With regards to criteria used in assessing the relative importance of identified issues, the supplemental tables included as attachments to the Workshop No. 2 draft notes (Attachment B) include a collaborative assessment of the likelihood that the identified issue is affecting salmonids at either the individual or population level. The importance of many issues presented at the Workshop was assessed by consensus due to the apparent absence of particular conditions (e.g., the lack of high levels of pesticides or other adverse water quality conditions in the Tuolumne River affecting egg incubation, rearing, etc.) but in cases where an issue could be plausibly included, some level of certainty was stated based on the availability of basin-specific information. Ultimately, the relative importance of identified issues/factors affecting in-river production of juvenile salmonids will be tested through parameter sensitivity testing as part of the population modeling studies (W&AR-6, and W&AR-10).

c. With regard to procedural issues raised regarding adherence to the 2011 salmonid ILCM workshop guidelines, a glossary originally provided as part of Workshop No. 1 is repeated as an attachment to this transmittal (Attachment G) and an updated glossary will be included in the Synthesis Study report. The Districts do not believe further Workshops on W&AR-5 are necessary; questions regarding management alternatives guiding the development and application of the interrelated population models (Studies W&AR-6 and W&AR-10) will be addressed in Workshops for these studies, currently scheduled for November 15–16, 2012.

2. *Comments on ranking of Chinook salmon and steelhead/O. mykiss issues*. TRT-CSPA provided comments on alternative rankings and suggested factors on pp. 2-3 of their comment letter, including issues related to spawning, instream flow, growth and water temperature, predation, and other issues. Because the comments provided very little citation support for suggested mechanisms or alternative rankings as specifically requested at the Workshop and in the transmittal of the draft meeting notes, no changes have been made to the current version of the table, now entitled “Summary Tables of Key Issues Affecting Chinook Salmon and Steelhead/*O. mykiss*” in Attachment A. However, the suggested issues, including those related to water temperature, growth, and predation will be considered in development of the interrelated population modeling studies (W&AR-6 and W&AR-10). In addition, an expanded report narrative and a more comprehensive summary table of all issues evaluated in the Synthesis Study will be developed and included to address the identified issues of importance to TRT-CSPA reviewers. Lastly, to address the comment regarding the order of presentation of the on-screen notes prepared at the Workshop that were entitled “Preliminary Important Factors Review (6/26/2012)”, we have now included this as a separate attachment to the Workshop No. 2 Final Notes (Attachment A).

<u>Districts’ Responses to U.S. Fish and Wildlife Service Comments</u>

In its letter of August 24, 2012 (Attachment E), USFWS provided comments on (1) Draft Meeting Notes and (2) Study Plan Determination Modifications issued by FERC on July 25, 2012. USFWS also provided a general concurrence with no additional comments for materials accompanying the draft meeting notes (Attachment B), including the Conceptual Model Narratives for Salmonids (included as Attachment 1 to the draft meeting notes), as well as the Preliminary Ranking of Key Issues Affecting Salmonid Life Stages (included as Attachment 1 to the draft meeting notes).

1. *Comments on the draft meeting notes.* As requested at the Workshop, USFWS reviewers provided suggestions and citations for several issues discussed in the conceptual models. Electronic copies for all citations have been obtained, and relevant information on the identified issues will be incorporated into the Synthesis Study report.

2. *Comments on Study Plan Determination Modifications.* Unrelated to the W&AR-5 Workshop, USFWS provided comments on the Study Plan Determination Modifications issued by FERC on July 25, 2012. The comments were specifically related to the approval of the *O. mykiss Scale Collection and Age Determination Study* (W&AR-20) and a request for additional samples to be collected. The Districts have conducted field work in accordance with FERC's July 25, 2012 approval of the study plan. In addition to samples collected to the maximum extent allowed by the 4(d) permit provided by agencies for this study effort, the W&AR-20 study report will provide additional length and age information from Zimmerman et al (2008) which increases the available data per statistical length bin, as requested by the USFWS.

<u>Districts' Responses to State Water Resource Control Board Comments</u>

In its e-mail of August 31, 2012 (Attachment F), SWRCB provided comments in three areas of the Synthesis Study, including (1) general Workshop comments, (2) comments on Conceptual Model Narratives, and (3) comments on ranking of Chinook salmon and steelhead/*O. mykiss* issues.

1. *General Workshop Comments*. In their general Workshop comments, SWRCB requested additional coordination with Relicensing Participants in scheduling Workshops and other meetings and emphasized the expertise of the fishery resource agencies (CDFG, USFWS, and NMFS) in considering comments on the W&AR-5 Synthesis Study. The Districts appreciate the comments on these issues and will continue its endeavors to be inclusive as possible in the conduct of the Synthesis Study.

2. *Comments on Conceptual Model Narratives.* In their comments on the conceptual model narratives, SWRCB suggested revisions to the conceptual model diagrams related to anthropogenic linkages to Poaching and Harvest as well as pointing out inconsistencies in descriptors under particular categories within individual model diagrams. The Districts appreciate these comments and have updated them in the revised conceptual model diagrams (Attachment A).

3. *Comments on Preliminary Rankings of Issues Affecting Salmonids.* In its comments on the preliminary rankings discussed at the Workshop and provided in the Draft notes, SWRCB suggested there were many identified processes identified as “Unlikely”, “Possible” or “Inconclusive” with regards to whether they will affect life stage progression or long-term population levels. Although the Districts appreciate the importance of reaching conclusions on particular issues and factors affecting salmonids, unfortunately, for several issues related to steelhead/O. mykiss reproduction in particular, there is little information available to assess the effects of some factors. Nevertheless, additional information identified during literature reviews is reflected in the identified columns of the revised “Summary Tables of Key Issues Affecting Chinook Salmon and *O. mykiss*” in Attachment A.

Sincerely,

John Devine

John Devine, P.E.
Project Manager

Attachment A
Final Meeting Notes
W&AR-5 Salmonid Information Synthesis Workshop No. 2

Don Pedro Project Relicensing
W&AR-5 Salmonid Information Synthesis Workshop No. 2
Final Meeting Notes

Tuesday, June 26, 2012

Attendees

Peter Barnes –SWRCB	Mike Maher – SWRCB
Jenna Borovansky – HDR	Ramon Martin – FWS
Steve Boyd – TID	Dan McDaniel – Central Delta Water Agency, *by phone*
John Devine – HDR, *afternoon*	Gretchen Murphey – CDFG
Karl English – LGL, Ltd.	Bob Nees – TID
Donn Furman – CCSF, *by phone*	Tim O'Laughlin – MID, *by phone*
Art Godwin – TID/MID	Bill Paris – MID, *by phone*
Bethany Hackenjos – Stillwater	Bill Sears – CCSF
Jim Hastreiter –FERC, *by phone*	Chris Shutes – CSPA
Noah Hume – Stillwater	Bill Snider – HDR, *by phone*
Zac Jackson – FWS	Nicola Ulibarri – Researcher, Stanford Univ.
Bill Johnston – MID	Joy Warren – MID
Patrick Koepele – Tuolumne River Trust	Scott Wilcox – Stillwater
Annie Manji – CDFG, *by phone*	Ron Yoshiyama – CCSF

Introductions and Background – 9:00 AM to 9:45 AM

1. **Introductions and Purpose**. Jenna Borovansky welcomed relicensing participants (RPs), made introductions, highlighted workshop materials distributed in advance of the meeting (Attachment 1), reviewed the agenda, and described that the overall purpose of the workshop as part of the W&AR-5 study plan was to:
   - continue the process of compiling and summarizing the body of relevant and applicable information and characterize issues affecting Tuolumne River salmonid populations, both in-river and out of basin;
   - review and detail the biology and ecology of fall-run Chinook salmon and steelhead/*O. mykiss*; and
   - share and refine preliminary conceptual models as well as preliminary ranking of factors that appear to be most important for supporting fall-run Chinook salmon and steelhead/*O. mykiss* population levels and individual life-stage progression.

2. **Workshop Consultation Process Overview.** Jenna Borovansky provided an overview of the Workshop Consultation Process for Study W&AR-5:
   - An initial list of data sources was previously distributed for RP comment in January. This list was expanded in advance of Workshop No. 1 and distributed on April 2, 2012 and was further expanded as a result of comments received on Workshop No. 1 comments. The reference list will be further refined to address information needs identified during Workshop No. 2.
   - The purpose of Workshop No. 2 consultation is to gather additional feedback and assistance from RPs in narrowing down the large body of information collected to

date to address the most important factors to be considered in the planned quantitative salmon population models (W&AR-6 and W&AR-10).
- Results of preliminary information reviews were presented with an assessment of relative certainty regarding whether we know a particular factor is affecting salmonid populations, whether we don't know, or whether we just think we know that a particular factor is affecting salmonid populations. RP feedback on these factors and additional references was solicited.
- An outline of information to accompany the meeting notes included Action Items, specific areas of any agreements or disagreements, as well as any changes to the Preliminary Conceptual Models and Ranking of Issues presented as part of Workshop No. 2.

3. **Relationship with other Studies**. Jenna Borovansky described the interrelationship of Study W&AR-5 with the quantitative population model development included in the W&AR-6 and W&AR-10 studies.

4. **Review of Workshop No. 1 Comments and Status of Responses**. Jenna Borovansky provided an overview of the status of Workshop No. 1 notes and comments submitted by RPs as part of the overall workshop consultation process for Study W&AR-5:
   - Draft Workshop No. 1 notes were prepared and distributed to RPs on April 20, 2012 in accordance with the established Workshop Consultation Process.
   - CDFG, UWFWS, and the Conservation Groups provided comments and additional data sources to be considered.
   - RP comments and Workshop No. 1 notes were filed with FERC on June 18, 2012 in accordance with the established Workshop Consultation Process.
   - Additional literature and data provided by RPs is currently being reviewed for primary data sources for potential inclusion in the study report.

Preliminary Conceptual Model Presentation – 9:45 AM to 12:00 PM

Noah Hume provided an overview of the Study Plan W&AR-5 he re-stated the purpose of the conceptual modeling exercise to identify relevant factors that may affect salmonid life-history progression throughout the species range from the Tuolumne River, Delta, and Ocean. He described that the day would be separated into: 1) a morning presentation of the preliminary conceptual models (Attachment 1) discussing various physical and biological processes and mechanisms, and 2) an afternoon discussion focused on ranking the preliminary issues affecting individual salmonid life stages.

1. **Primary ecosystem inputs and other factors affecting Tuolumne River salmonids.** Reading from the Conceptual Model Narrative (Attachment 1), Noah Hume described: a) the approach taken in the development of the preliminary conceptual models, b) that the literature review was ongoing, and c) the prioritization given to various information sources, (as presented in Workshop No. 1). The accompanying pictorial models for Chinook salmon and steelhead/*O. mykiss* (Attachment 1) were structured showing primary ecosystem inputs (Meteorology, Instream Flows, Sediment Transport, and Anthropogenic Inputs) at the uppermost level, but the models were organized to examine processes affecting reproduction, growth, direct and indirect mortality from the "bottom-up". He noted that the reason for this approach was the complexity of linkages between ecosystem inputs at the uppermost level and that many factors may be shown to affect particular mechanisms. He further noted that the models were conceptual in nature and that RPs are encouraged to provide feedback on the

relative importance of each factor affecting life history progression. The RPs were also requested to provide information they may have supporting particular conclusions they recommend.

The notes below are organized by the species and life stage structure in the Conceptual Models.

2. **Processes and mechanisms affecting Chinook salmon.** Noah Hume presented the conceptual model on Chinook salmon (Attachment 1) and led a discussion of factors affecting life history progression in the Tuolumne River, Delta, and Ocean, summarizing sources of information used (timing, presence/absence, abundance etc.) for each life stage discussed below. The background information supporting inclusion of individual processes and mechanisms in the conceptual model was also discussed.

Chinook Up-migration

A. Noah Hume stated that some information on arrival timing and hatchery straying in the Tuolumne had been identified, but little to no Tuolumne or basin specific information had been identified regarding pre-spawn mortality due to temperature, disease incidence, poaching, or the effectiveness of attraction flows.

B. Patrick Koepele asked for a list of citations that were used to create the conceptual models. Noah Hume explained that relevant citations will be provided for RP review with the preliminary ranking of issues to be developed in the afternoon session.

C. Annie Manji suggested that dewatering should be included as a possible factor affecting Chinook up-migration per the 2008 dewatering incident pertaining to the La Grange powerhouse tailrace[1]. Noah Hume suggested this mechanism should be added to the Chinook egg incubation life stage and Chris Shutes agreed. However, Noah questioned whether that specific problem needed to be modeled, since precautions are now in place to prevent that problem from occurring again. Annie Manji indicated that potential dewatering due to any mechanism should be considered in the model.

D. Ramon Martin suggested that Delta cross-channel operations be added to the in-stream flow box. The participants agreed, and it was added as a bullet in the model; see revised Chinook Up-migration figure in Attachment 2.

E. Annie Manji discussed that water quantity was missing from the conceptual model. Noah Hume stated that instream flow and attraction flows were part of the ecosystem inputs, and were included at the highest level. He stated that information reviewed to date showed only broad relationships of straying between the Sacramento and San Joaquin River basin hatcheries, and that no analyses to date had shown relationships between straying/homing or timing with the application of tributary attraction flows in the San Joaquin River basin. With regards to a potential water temperature blockage at Stockton

[1] Routine dewatering of the La Grange Forebay in November 2008 resulted in dewatering of several salmon redds found in the tailrace channel by CDFG staff in November 2008. Although notifications of this event were not made to TID or MID until August 2009, the Districts have made procedural changes to provide notifications of maintenance outages to CDFG staff in advance of planned outages.

in early fall, he suggested that meteorological conditions affected water temperatures to a far greater degree than fall pulse flows arriving from upstream dams.

F. Chris Shutes recalled an increase in up-migrant numbers in the Mokelumne in response to increased flow releases. This was confirmed by Ramon Martin, recognizing that 1–2 years of monitoring study had been completed by East Bay Municipal Utilities District (EBMUD).[2]

G. Ramon Martin stated that FWS recently initiated an adult tracking study of upmigrant Chinook salmon captured at Jersey Point in the San Joaquin/Sacramento River delta. Ramon reported that no specific findings or results have been published to date. Noah requested that any relevant information available be furnished.

Chinook Spawning

A. Noah Hume stated that data and study reports exist regarding the spawning life stage, but no Tuolumne specific information examining pre-spawn mortality due to Temperature, disease incidence, parasites, or poaching incidence are generally available.

B. Ramon Martin suggested that the "Hatchery introductions" language be changed to "Hatchery straying." The group agreed, and the change was made; see revised Chinook Spawning figure in Attachment 2.

C. Annie Manji asked if blockage of access to upstream spawning habitat should be added to the model. Noah Hume stated that the history of dam construction will be included in the supporting narrative, but that only the loss of sediment transport from upstream supplies had been included as a current process. Potential ongoing effects on spawning habitat area are also in the model. Patrick Koepele pointed out that the current spawning area is limited to the available 26 linear miles of river bed. Noah Hume agreed, but emphasized that the modeling effort was looking at ongoing processes, and that the historical changes in spawning habitat access would be described in the introductory sections of the study report.

D. Zac Jackson thought that the fecundity, size at age, and sex ratios of returning spawners should be incorporated somewhere in the model. Noah Hume suggested that this may best be located as a harvest-related mechanism under Ocean Rearing; see revised Chinook Ocean rearing figure in Attachment 2. Ramon Martin suggested a paper on sex ratios and age-at return for San Joaquin River tributaries[3]. Gretchen Murphey recalled a paper by Bill Loudermilk (CDFG) and Noah Hume requested that this information be provided if located.

Chinook Egg Incubation

A. Noah Hume stated that Tuolumne specific information had been compiled covering superimposition, gravel quality, Intragravel Dissolved Oxygen (IGDO), and other effects,

[2] Later identified as Del Real and Saldate (2011).

[3] This was later identified as Mesick et al (2009a).

but said little information was identified covering egg mortality studies in the San Joaquin basin, and no information had been identified stating that egg diseases or parasites are a problem. He noted that redd dewatering would be included in the revised models per Annie Manji's comments under Chinook Up-migration above.

B. Ramon Martin suggested that egg predation by steelhead/*O. mykiss* or other species might be a factor based on anecdotal observations. Noah Hume requested RPs provide any information regarding egg predation and contributing factors to which RPs may have access [4].

C. Patrick Koepele suggested that the fraction of fertilized eggs be included as a factor. Noah Hume stated that although several egg mortality mechanisms had been identified (e.g., temperature, IGDO, fine sediment, and water quality) he does not have any information on contributing factors to assess potential changes in the fractions of fertilized eggs.

Chinook In-river Rearing

A. Noah Hume described existing information on in-river rearing, including seining and fyke netting, RST monitoring, snorkel surveys, predation studies, and invertebrate studies. No information had been found regarding mortality due to in-river diversions, or disease incidence.

B. Ramon Martin questioned the exclusion of Hetch-Hetchy diversions. Noah Hume suggested a more generic term called "Upstream diversions" be included as a bullet under In-stream Flows; see revised Chinook In-river rearing figure in Attachment 2.

C. Karl English asked for clarification on the geographical extent of the information that will be most useful for development of the conceptual model for the study. Noah Hume explained that, in general, geographically relevant information for in-river rearing includes the San Joaquin mainstem and tributaries upstream from Vernalis.

D. Chris Shutes wondered if there was information on entrainment by agricultural diversions. Noah Hume stated that he has only received information on the numbers and locations of diversions, but nothing on how many fish have been entrained. Ramon Martin said he has seen information on performance of various screen types as well as entrainment numbers (e.g., Patterson and Banta-Carbona) on the San Joaquin River. Noah Hume requested any available information be provided for use in the model development[5].

E. Ramon Martin pointed to the inclusion of *O. mykiss* planting under the Anthropogenic Inputs and suggested that this be changed to *O. mykiss* hatchery straying. The group agreed, and the change was made; see revised Chinook In-river rearing figure in Attachment 2. This opened up a larger discussion about whether or not resident *O. mykiss* were being washed over La Grange dam during high flow events. This issue may

[4] Additional references later provided by USFWS

[5] USFWS later provided a citation to Nobriga et al (2004) on this issue.

potentially be examined depending upon on whether evidence of a self-sustaining population of *O. mykiss* is inferred from abundance data collected as part of Study W&AR-13 this fall. This topic is revisited in the steelhead/*O. mykiss* discussion below.

Chinook Delta Rearing

A. Noah Hume explained that this section is intended to capture both out-migrant smolt survival and Delta rearing of Chinook salmon. He stated that a great deal of information is available regarding survival and predation, with recent results of tracking studies, but there is limited information on Delta rearing, disease and parasites.

B. Ramon Martin stated that he may be able to provide some information regarding temperature related effects on trawl catch per unit effort (CPUE). Noah Hume noted that may be useful information for the water temperature and predation linkage and requested that available information be provided.

C. Further discussion included whether timing of spring flows affect predation exposure of out-migrants. Annie Manji stated that the timing of springtime flows are related to out-migrant success and Ramon Martin agreed, stating that if the fry are flushed out too late, there will be increased predation. The group agreed to add a “flow timing” bullet under in-stream flows; see revised Chinook Delta rearing figure in Attachment 2. Chris Shutes agreed and cited a paper by Rosalie del Rosario[6]. Gretchen Murphey also volunteered information on coded wire tagged salmon and avian predation[7].

Chinook Ocean Rearing

A. Noah Hume stated that a large body of fisheries assessment information exists, including the effects of ocean circulation on food availability, predation by marine mammals, etc. The influence of harvest size selection on age-at-maturity was discussed from the Up-Migration life stage above; see revised conceptual model diagram (Attachment 2). No information was identified regarding disease incidence in adult salmon or water quality linkages to changes in food availability.

B. Ramon Martin suggested that there may be some density dependent factors such as hatchery fish competing for available food resources[8]. Ron Yoshiyama suggested work on Coho salmon off the Oregon coast also suggests this mechanism[9]. Karl English said that various publications of the Pacific Salmon Commission’s Chinook Technical Committee (CTC) have suggested that hatchery introductions make fish more susceptible to predation. Hatchery releases was added as an Anthropogenic Input to the model chart.

[6] Later identified as del Rosario et al (2009), which provides some information as it pertains to flow effects on winter-run residency and emigration from the north Delta.

[7] Later identified as Evans et al 2011.

[8] One example of density dependence identified following the workshop was from Ruggerone et al 2010 examining the effects of hatchery releases of Pink and Chum salmon upon the marine food web off of Alaska.

[9] Example later identified as Nickelson (2003).

C. Chris Shutes requested that the meteorology box point directly into the prey (food) availability box. Noah Hume proposed striking the current patterns bullet from the water temperature box in that case. The group agreed, and the change was noted; see revised Chinook Ocean rearing figure in Attachment 2.

3. **Processes and mechanisms affecting steelhead/*O. mykiss*.** Noah Hume presented the preliminary conceptual model on steelhead/*O.mykiss* (Attachment 1) and led a discussion of factors affecting life history progression in the Tuolumne River, Delta and Ocean, summarizing general sources of information used (timing, presence/absence, abundance etc.) for each life stage below, as well as information on individual processes and mechanisms. He explained the timing diagrams and that the in-river life history requirements for resident as well as anadromous steelhead should be the same and so the two life histories were not presented as separate models. Chris Shutes proposed extending the spawning activity in the steelhead/*O. mykiss* timing table to the month of April under spawning. The group agreed, and the change was noted; see revised *O. mykiss* spawning timing table in Attachment 2.

Steelhead Up-migration

Noah Hume indicated up-migration timing is generalized from Stanislaus weir operations, and that the Tuolumne weir has only been in operation since 2009. Although some information regarding sportfishing from steelhead report cards is available, factors affecting up-migration, straying, arrival timing, and mortality were generalized from information gathered outside of the San Joaquin River basin. No information has been identified regarding straying between San Joaquin River basin tributaries, poaching, or disease incidence in adult steelhead/*O. mykiss*.

Steelhead Spawning

A. Noah Hume indicated that beyond up-migration timing from recent weir reports, little Tuolumne or San Joaquin-basin specific information had been identified regarding steelhead/*O. mykiss* spawning beyond the Coarse Sediment Management Plan (CSMP) (McBain & Trush 2004). Although conditions for spawning are included in the ongoing IFIM Study (Stillwater Sciences 2009), no post-project assessment of the Tuolumne River Coalition (TRC) gravel additions at Bobcat Flat have been conducted to evaluate steelhead spawning use. No redd activity has been documented in historical CDFG surveys. Spawning gravel and habitat mapping will occur this summer as part of W&AR-4, as part of the extended surveys for steelhead redds in 2013, and will be included as part of Study W&AR-8.

B. Chris Shutes asked about steelhead feeding behavior, whether steelhead were feeding on the Chinook egg and fry to a significant amount. Ron Yoshiyama stated that Shapovalov & Taft (1954) examined feeding habits of steelhead and steelhead spawners[10].

[10] Follow-up examination of this reference indicated that steelhead did not generally feed in freshwater, although they were found to strike at prey items.

C. Zac Jackson proposed adding the same comment regarding fecundity for steelhead as for Chinook spawning salmon. Noah Hume noted the change and added it to up-migration life stage; see revised *O. mykiss* spawning figure in Attachment 2.

Steelhead Egg Incubation

A. Noah Hume indicated that since no evidence of spawning on the lower Tuolumne has been found, available information regarding factors affecting egg incubation will be drawn from spawning gravel assessments, existing Tuolumne River water temperature data summaries, as well as out-of-basin sources. Redd-dewatering was added to the model in accordance with the prior Chinook salmon discussion as this mechanism would be more likely to occur due to flood control operations in late spring than potential dewatering of the La Grange tailrace.

B. Ramon Martin suggested that the "Hatchery Introductions" bullet under Anthropogenic Inputs should be changes to "Hatchery Straying". The group agreed and the change to the model was made; see revised steelhead/*O. mykiss* egg incubation figure in Attachment 2.

Steelhead In-River Rearing

A. Noah Hume described the relevant information used to assess in-river rearing, including seine and Rotary Screw Trap (RST) monitoring, annual summer snorkel surveys, recent (2008–2011) population estimate surveys, tracking surveys (2010-2011), and invertebrate surveys. No Tuolumne-specific information has been identified regarding feeding rates, predation, or disease. Study W&AR-12 will provide a habitat assessment of steelhead/*O. mykiss* in 2012, and Study W&AR-13 will examine *O. mykiss* occurrence upstream of La Grange Dam in 2013.

B. Ramon Martin suggested adding poaching/Sportfishing mortality source due to hooking injury/stress. The appropriate changes were made; see revised steelhead/*O. mykiss* In-river rearing figure in Attachment 2.

Steelhead Delta Out-migration

A. Noah Hume summarized information sources on contributing mechanisms affecting Delta Out-migration of steelhead and stated that although Sacramento River – Yolo Bypass studies show Sacramento basin steelhead smolts are using floodplain habitat. The assumption is that steelhead are using the Delta as a migration corridor on their way to the ocean.

B. Ron Yoshiyama suggested that Jeff Kozlowski found that some outmigrant steelhead/*O. mykiss* were not migrating farther than the lower Yuba and Sacramento Rivers (i.e., "potadromous" migration) as well as presenting some information on age at emigration[11].

C. The group discussed timing of out-migration in response to pulse flows (just like for Chinook). Ramon Martin said this trend is evident in the Calaveras outmigrant monitoring (FISHBIO). Mossdale trawl data may also indicate steelhead response to San Joaquin River flows and Ramon suggested these data are available.

[11] This was later identified as Kozlowski 2004 but potadromy was not included in the investigations.

Steelhead Ocean Rearing

A. Noah Hume opened up the conversation by asking the group if the food competition from hatchery introductions could apply as previously discussed for Chinook. Ron Yoshiyama cited papers indicating hatchery and wild salmon are behaving quite differently in the ocean[12].

B. Ramon Martin suggested adding poaching/sportfishing mortality source due to hooking injury/stress and appropriate changes were made; see revised Steelhead Ocean Rearing figure in Attachment 2. Noah Hume suggested that sport fishing reports may only be used to indicate fishing pressure but may not be used to estimate mortality.

Lunch Break – 12:15 PM to 1:15 PM

Discussion of Conceptual Models and Preliminary Ranking of Issues – 1:00 PM to 3:30 PM

Jenna Borovansky opened the afternoon session and took on-screen notes while Noah Hume led a discussion with RPs regarding the preliminary issues to be addressed in the development of the interrelated population models under W&AR-6 and W&AR-10 based on their potential influence as well as preliminary reviews of available information; RPs were encouraged to provide feedback, understanding that additional comment or revisions in priority may be provided when notes are provided by the Districts for review. Attachment 1 includes the on-screen draft notes ranking issues affecting Tuolumne River salmonids that incorporate RP feedback and discussion recorded during the meeting. Attachment 3 provides an edited and expanded version of the ranking tables for RP review and additional comment. Noah Hume presented a preliminary list of factors or issues affecting each life stage, life history progression, a preliminary ranking, and rationale for classification. The goal of the discussion was to narrow the possible factors into a shorter list of most important factors by life stage. The RPs were asked to provide information to support their feedback during the discussion, or following their review of the workshop notes, particularly if they disagreed with the initial rankings discussed.

1. **Ranking of processes and mechanisms affecting Chinook salmon populations – (See Attachment No. 3).**The group was asked for input with the goal of narrowing the possible factors into a smaller list of most important factors by Chinook salmon life stage.

Chinook Up-migration

A. Noah Hume presented an initial ranking of issues affecting Chinook Up-migration as: 1) water temperature on arrival timing initially identified by Hallock (1970); 2) DO effects on arrival timing, (examined by Hallock (1970) including the subject of the Stockton

[12] This was later identified as Quinn et al 2012, but no studies on density dependence of hatchery steelhead releases were identified.

Deepwater Ship Channel [DWSC] TMDL); and 3) attraction flow effects on homing/straying.

B. Ramon Martin stated that up-migration blockage at Stockton due to low DO was cited as an important factor per USFWS (2001) Anadromous Fish Restoration Program (AFRP) final restoration Plan filed with FERC. Noah Hume said this issue had been largely mitigated with aeration measures included in the adoption of the TMDL in January 2005. Art Godwin followed that additional waste load reduction measures had been implemented, but Ramon Martin felt that it is still a problem during some water year types.

C. Annie Manji suggested that flow effects on water temperatures should be included since temperatures may be affected by upstream flow releases. Noah Hume suggested that it would take very large coordinated releases from all San Joaquin tributaries to affect the water temperature at Vernalis or Stockton[13]. Annie Manji stated that Mesick et al examined water temperatures at the Tuolumne - San Joaquin River confluence and Vernalis[14].

D. Noah Hume stated thatno reports were identified that examine salmon arrival timing in the Tuolumne as a function of water temperature or flow and that dates of arrival in the River has been generally consistent from year to year. Zac Jackson requested the up-migration timing information that was used to formulate this model. Noah Hume stated that an early report in the San Joaquin River restoration process contained some arrival timing information[15] and an updated arrival timing analysis will be included in the study report. Noah requested updated weekly spawner counts by riffle from Gretchen Murphey, as this information is not included in the CDFG spawning reports currently available to the Districts.

E. Noah Hume stated that although attraction flows were included for all of the San Joaquin River tributaries, Mesick (2001) has developed the only report that shows relationships between homing/straying of up-migrant Chinook salmon and attraction flows, and this was limited to CWT hatchery returns between the Sacramento and San Joaquin River basins. Noah also stated that no reports specific to the Tuolumne or San Joaquin River basin had been identified that show relationships between attraction flows and increased up-migrant passage or escapement. Ramon Martin and Zac Jackson both stated that

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[13] Stillwater Sciences (2011) report showed very large releases were required to affect temperatures at the confluence of the Tuolumne and San Joaquin Rivers during fall as well as during spring.

[14] Later identified as Mesick et al (2010), but subsequent review of this document suggested that only April/May conditions were examined and only broad relationships were examined (i.e., 1000 cfs up to flows of 20,000 cfs), suggesting that seasonal meteorology controls downstream water temperature to a greater degree than flow.

[15] Later identified as Stillwater Sciences (2003) which used weekly live counts to examine arrival timing. This information will be updated in the Synthesis Study report

Mokelumne attraction flows were associated with increased passage and escapement. Noah Hume requested reports supporting this conclusion.[16]

F. The group deliberated on the inclusion of inland harvest and poaching as an important factor. Little information regarding poaching is available and harvest was not included in the final ranking (Attachment 3) since this factor was included in the ocean rearing life stage.

Chinook Spawning

A. Noah Hume presented an initial ranking of issues affecting Chinook Spawning as: 1) spawning area availability; 2) spawning gravel quality, and 3) temperature related effects on pre-spawn mortality. He stated that low levels of pre-spawn mortality had been identified by CDFG in 1 or 2 years of surveys on the Stanislaus but that no information had been identified on the Tuolumne. Ramon Martin suggested that CDFG may have conducted carcass examinations on the Tuolumne and Gretchen Murphey offered to follow-up to see if any reports had been prepared. If so, Gretchen offered to provide the information for review.

B. Patrick Koepele asked if there were other spawning bed characteristics (e.g., slope, velocity etc.) that had been considered. Noah Hume stated that spawning bed characteristics had been extensively studied, including IFIM studies, historical mapping and gravel assessments (e.g., TID/MID 1992, McBain & Trush 2004), the current W&AR-4 mapping study, as well as the current spawning redd surveys (W&AR-8 study), but that gravel area and gravel quality were the relevant considerations regarding spawning success.

C. Chris Shutes asked if there were problems with the gravel size/shape used in past Tuolumne River gravel introductions? Noah Hume stated that some of this had been addressed in the McBain & Trush (2004) CSMP. He stated that although redd counts have been conducted at the 2002 and 2003 CDFG gravel introduction sites near Old La Grange Bridge, no formal post-project assessments have been made.

Chinook Egg Incubation

A. Noah Hume presented an initial ranking of issues affecting Chinook egg incubation as: 1) temperature effects on incubation rates; 2) redd superimposition at higher run sizes; 3) potential entombment due to fine sediment; and 4) potential for redd dewatering (*Note: this issue was promoted later in the meeting during a discussion regarding the corresponding steelhead egg incubation ranking*).

B. Ramon Martin suggested adding direct mortality from water temperature to the list. Noah Hume said there is only limited information available from laboratory experiments that don't seem to be applicable to the Tuolumne River. Ramon stated that egg viability

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[16] Subsequent review of Del Real and Saldate (2011) showed that variations in daily passage at Woodbridge was partially explained by flow (R^2=0.41), water temperature (R^2=0.46), and precipitation (R^2=0.15).

studies were ongoing on the Merced River and that some references had been included in the FWS-3 egg viability study[17].

Chinook In-River Rearing

A. Noah Hume presented an initial ranking of issues affecting Chinook in-river rearing as: 1) predation; 2) prey/food availability; and 3) water temperature mortality. Annie Manji offered the suggestion that floodplain habitat be included as number 1 on the list of important factors. Noah Hume proposed putting it as a bullet under both predation and prey/food availability since it had been included in the models in this manner. He stated that the Stillwater Sciences (2012) Pulse Flow report examined the relationship of floodplain inundation and predator habitat and that the ongoing predation study (W&AR-7) was also examining flow and predation relationships.

B. Noah Hume stated that only the Yolo and Cosumnes studies (e.g., Sommer et al 2001, Jeffres et al 2005), reports had floodplain growth benefits or food limitations within in-channel habitats. Ramon Martin volunteered to provide information showing larger sized fish during wet years and Zac Jackson will provide a USBR Floodplain Food Production Tech Memo (still in draft form) and a Denver Tech Center document (still in draft) once he gets the approval to share externally.

C. Annie Manji expressed concerns that the Workshop was not being conducted in a collaborative manner, as she did not agree with the rankings. Noah Hume recognized her concern and indicated that the purpose of the live-meeting and tracking of rankings was to gather input. He also indicated that in person attendance at the meeting may improve information exchange. Noah requested that if Annie disagreed with the rankings being put on the screen and discussed in the room, to please speak up, and to also provide additional comments on the rankings and other notes following the workshop.

D. Annie Manji stated that out-migration was missing from the in-river rearing model and data for that is more easily extrapolated than out-migrant information through the Delta. Noah Hume agreed and although outmigrant survival was addressed by the predation mechanism that had been included, he proposed changing the title from In-River Rearing to In-River Rearing/Out-migration. The group agreed and the change was made; see revised Chinook In-river rearing/Delta outmigration figure in Attachment 2.

E. Chris Shutes questioned the exclusion of water temperature effects on smoltification, and pointed to Carl Mesick 2010 or 2011 paper that suggests it to be a larger factor than floodplain inundation[18]. Ramon Martin offered to provide another reference which provides an assessment of temperature effects by lifestage in the San Joaquin River basin by Alice Rich[19].

[17] Follow-up review of the FWS-3 study request letter referenced in the Districts November 22, 2011 Don Pedro Project Revised Study did not identify studies examining water temperature effects.

[18] This document was not identified subsequent to the meeting, but relationships of temperature with smoltification were added to the preliminary ranking tables (Attachment 3).

[19] Later identified as Rich (2007). Report is not currently available on-line.

Chinook Delta Rearing/Out-migration

A. Noah Hume presented an initial ranking of issues affecting Chinook Delta-rearing and out-migration as: 1) entrainment; 2) predation; 3) water temperature mortality; and 4) prey/food availability. Chris Shutes suggested that entrainment should also be related to flow direction, or reversed flows in the Delta, and the level of export pumping rate. The group agreed.

B. Ramon Martin suggested adding flow timing to the list, under instream flow inputs of the overall model and the change was made; see revised Chinook Delta Rearing/ Outmigration figure in Attachment 2.

Chinook Ocean Rearing

Noah Hume presented an initial ranking of issues affecting Chinook Ocean rearing as: 1) Food availability; 2) Ocean Harvest; and 3) predation. Other than a discussion of marine mammal predation, no other comments or alternative suggestions were made.

2. **Ranking of processes and mechanisms affecting steelhead/*O. mykiss* populations – (See Attachment No. 3).** The group was asked for input with the goal of narrowing the possible factors into a smaller list of most important factors by steelhead/*O. mykiss* life stage; the earlier discussion regarding Chinook were used as a reference point on priorities where potential factors were similar. RPs were asked to provide information to support their feedback on items detailed in Attachment 3. RPs were also encouraged to provide supporting information following the workshop in the reviews of the notes, particularly if they disagreed with the initial rankings below.

Steelhead Up-migration

Noah Hume presented an initial ranking of issues affecting steelhead Up-migration as: 1) Homing/Straying related to instream flows, 2) potential water temperature blockage for any Delta up-migrants in late summer; and 3) mortality from Delta/in-river sport-fishing/poaching. No comments or alternative suggestions were provided.

Steelhead/O. mykiss Spawning

Noah Hume presented an initial ranking of issues affecting steelhead/*O. mykiss* spawning as: 1) spawning area availability; 2) spawning gravel quality, and 3) temperature related effects on pre-spawn mortality. He stated that little information was available beyond the existing gravel assessments (e.g., TID/MID 1992, Apps 6, 7; McBain & Trush 2004), the current W&AR-4 spawning gravel assessment and the current redd mapping (W&AR-8) studies. No comments or suggestions were provided on the preliminary rankings.

Steelhead Egg Incubation

A. Noah Hume presented an initial ranking of issues affecting steelhead/*O. mykiss* egg incubation as: 1) Temperature effects on incubation rates; 2) temperature related egg mortality from early/late arriving spawners; and 3) potential entombment due to fine sediment. He stated that no studies were found that examined the entombment issue. He added that without documentation of steelhead/*O. mykiss* spawning in the Tuolumne, any inferences on impacts would have to be drawn from regional references.

B. Ramon Martin proposed adding redd dewatering on both the Chinook and steelhead egg incubation lists. This factor was ranked as No. 3 for steelhead/*O. mykiss* and No. 4 for Chinook salmon (Attachments 1 and 3). Zac Jackson recalled that eggs have been exposed on the Stanislaus, Calaveras, and American rivers due to flow ramping. Gretchen Murphey offered to look for any verification regarding that information.

Steelhead In-river Rearing

A. Noah Hume presented an initial ranking of issues affecting steelhead/*O. mykiss* in-river rearing as: 1) Food availability and growth rate as related to water temperature/ration effects; 2) Predation effects on Age 0+ fish due to limited habitat area (cover, LWD, suitable temperature); 3) Direct mortality effects due to water temperature for Age 0-3 fish; and 4) Temperature effects on Smoltification.

B. Ramon Martin proposed suggested adding density dependence under food availability to capture the phenomenon of territoriality. Noah Hume stated that this would be addressed in the updated ranking table (Attachment 3).

C. Noah Hume asked the group whether hooking mortality from sportfishing should be included as an important factor affecting steelhead/*O. mykiss* populations but since little information on this factor is available, no consensus was reached. This was not subsequently added to the revised rankings table (Attachment 3).

Steelhead Delta Rearing/Out-migration

A. Noah Hume presented an initial ranking of issues affecting steelhead/*O. mykiss* Delta out-migration as: 1) entrainment (multiple effects were discussed including loss of direction, direct entrainment); 2) predation; 3) water temperature effects on smoltification; and 4) direct mortality effects of water temperature. Ramon Martin highlighted the prior discussions regarding the linkage between instream flows and water temperature.

B. Noah Hume repeated brief comments from the morning session regarding conditions favoring anadromy/residency. He stated that general life-history theory suggests that in-river conditions, Delta conditions, and Ocean conditions all combine to favor one life history strategy over another, but few studies had been identified that demonstrated variables affecting various life history strategies.

Steelhead Ocean Rearing

Noah Hume presented an initial ranking of issues affecting steelhead Ocean Rearing as: 1) Food availability; 2) Predation; and 3) Potential Harvest bycatch. Chris Shutes stated that gill net capture and mortality is likely very low since the gill net ban off California in 1990. No comments or suggestions were provided on the preliminary rankings.

Next Steps/Action Items – 4:30 PM to 5:00 PM

1. Jenna Borovansky completed edits to the on-screen ranking table (see Attachment 3) and indicated that revisions to the table as well as supporting references would be provided with the Workshop notes. These are provided as Attachments 4 and 5.

2. Jenna Borovansky provided a timeline of the Workshop note preparation, distribution and comment period. The notes were scheduled to be provided to RPs by July 9th and comments were planned to be due back to the Districts by August 6th. Note that the review dates have been revised to allow 30-day review from RP receipt of the drafty Workshop notes. Meeting dates for the W&AR-6 and W&AR-10 population models were set for November 15–16, 2012; RPs were asked to hold both days open in their schedule.

3. John Devine summarized Action Items from the meeting.

    a. The Districts will provide draft notes and citations for priority issues per the March 20, 2011 Consultation Protocol.

    b. RPs are requested to provide any additional references supporting comments made at the workshop within the 30-day comment period of the Workshop Notes.

4. Chris Shutes identified a possible conflict with the Temperature Modeling Workshop (scheduled for September 18) with some State Board workshops on September 18th and 19th. The Districts will review the meeting schedule and propose an alternative date, if necessary.

Attachments

Attachment 1: Meeting materials W&AR-5 Salmonid Information Synthesis Workshop No. 2[20]

Attachment 2: Revised conceptual model diagrams for Chinook salmon and steelhead/*O. mykiss*

Attachment 3: On-Screen Notes of Important Factors Affecting Salmonid Life Stages

Attachment 4: Summary Tables of Key Issues affecting Chinook salmon and steelhead/*O. mykiss*[21]

Attachment 5: Supplemental references provided in notes and ranking of salmonid issues

[20] Includes Meeting Agenda, Conceptual Model Narrative for Tuolumne River Salmonids; Preliminary Conceptual model Diagrams for Chinook salmon; and Preliminary Conceptual model Diagrams for steelhead/*O. mykiss*.

[21] Expanded with supporting references (Attachment 5) from draft Preliminary Important Factors Review Table (Attachment 3).

Attachment 1
Meeting materials
W&AR-5 Salmonid Information Synthesis Workshop No. 2

Salmonid Information Synthesis Workshop No. 2
Don Pedro Relicensing Study W&AR-5
June 26, 2012 – MID Offices, Modesto

Conference Line Call-In Number 866-994-6437; Conference Code 5424697994

AGENDA

9:00 a.m. – 9:45 a.m.	**Introductions and Background** 1. Purpose of Meeting 2. Workshop Consultation Process Overview 3. Relationship to other studies 4. Review of Workshop No. 1 Comments and Status of Responses
9:45 a.m. – 12:00 p.m.	**Preliminary Conceptual Model Presentation** 1. Primary ecosystem inputs and other factors affecting Tuolumne River salmonids 2. Processes and mechanisms affecting Chinook salmon 3. Processes and mechanisms affecting steelhead trout/*O. mykiss*
12:00p.m. – 1:00 p.m.	**Lunch (on your own)**
1:00 p.m. – 3:30 p.m.	**Discussion of Conceptual Models and Preliminary Ranking of Issues** 1. Chinook salmon 2. Steelhead/*O. mykiss*
3:30 p.m. – 4:30 p.m.	**Next Steps**
4:30 p.m. – 5:00 p.m.	**Action Items Summary**

Conceptual Model Narrative
for Tuolumne River Salmonids
Don Pedro Relicensing Study W&AR-5
Workshop No. 2 - June 26, 2012

Purpose of this Document

The purpose of this document is to provide a framework for discussion at the June 26, 2012 Salmonid Information Synthesis Study Workshop No. 2. As outlined in the Study Plan, this narrative has been prepared as a companion to accompanying diagrammatic models regarding processes and mechanisms affecting various life stages of Central Valley Fall run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*O. mykiss*) in the Tuolumne River, Delta, and Pacific Ocean. Recognizing that not all factors affecting Tuolumne River salmonids may be known or well understood, the model diagrams and narrative attempt to identify factors that may potentially affect salmonid life-history progression throughout the species range, separated into mechanisms affecting reproduction, growth, direct and indirect mortality.

This document is separated into three sections describing ecosystem inputs, Chinook salmon life history, and steelhead/*O. mykiss* life history in and downstream of the lower Tuolumne River. To provide context for historical and ongoing ecosystem modifications and variation of habitat conditions across the species range (i.e., Tuolumne River to the Pacific Ocean), primary ecosystem inputs and other factors affecting Tuolumne River salmonids are described without attempting to separate their relative contributions or importance from the "top-down". Instead, the accompanying conceptual models are intended to be used from the "bottom-up" by examining the most proximate processes affecting individual life stages (e.g., predation, prey availability, etc.). Although we have made preliminary assessments regarding whether mechanisms may or may not be affecting a given life stage in some instances, it is intended that their relative importance be discussed with Workshop participants with an opportunity for comment and potential revision of the conceptual models.

As outlined in the Study Plan, following review and potential revision of the broader conceptual models presented here, conceptual models of the relevant density-dependent and density-independent factors affecting each salmonid life-stage in the Tuolumne River will be developed and refined as part of numerical population model development in the interrelated Tuolumne River Chinook Salmon Population Model and the *O. mykiss* Population studies (Studies W&AR-6 and W&AR-10).

Primary ecosystem inputs and other Factors affecting Tuolumne River salmonids

Water Supply and Instream Flows

Upstream Dam Construction – Early dams (Wheaton [ca 1871] and La Grange [1893]) reduced summer base flows but were too small to affect high flows. Later dams (Hetch Hetchy [1923; expanded 1938], Don Pedro [1923; expanded 1971], Cherry Lake [1955] reduced the magnitude and frequency of flood flows and snowmelt runoff to the lower Tuolumne River.

Upstream Diversions by CCSF – Out of basin diversions by CCSF to the San Francisco Bay Area began in 1934. Depending on water year type, upstream diversions by CCSF may exceed 250 TAF per year.

Antecedent Water Year Type and Carryover Storage – In addition to FERC flows, based in part on antecedent precipitation and water year type, the 1995 FERC Settlement Agreement (FSA) provides for carryover of up to 5 TAF from wet water years. To date this provision has not been used.

Flood Control Releases – The Districts are required under ACOE flood control requirements to maintain flood storage space in the Don Pedro Reservoir as well as to limit flows at Modesto below 9,000 cfs.

Diversions at La Grange – Depending upon water year type, the Districts divert on average approximately 900 TAF per year from the river at La Grange Dam for irrigation and M&I uses in the basin.

Minimum FERC Flow Requirements – Depending upon water year type, the current license prescribes annual release and pulse flow volumes, rate changes, and minimum flow requirements measured at La Grange for spawning, rearing, and over-summering of Tuolumne River salmonids.

Accretion Flows – Local rainfall runoff, tributary inflow (primarily from Dry Creek at Modesto), operational outflows from the Districts' canal systems, agricultural drainage return flows, urban runoff, as well as groundwater accretion contribute to the flows of the lower Tuolumne River below La Grange Dam.

Riparian and Delta Diversions – Numerous unscreened riparian diversions exist on the lower Tuolumne River, lower San Joaquin River, and the Delta. There are four larger diversions between the Merced River confluence and the Delta, with screen and bypass facilities only installed recently at the Patterson Irrigation District, West Stanislaus Irrigation District and Banta Carbona Irrigation District.

Delta Exports – The federal Central Valley Project C.W. Bill Jones Pumping Plant (1951) and the California State Water Project Harvey O. Banks Pumping Plant (1968) withdraw large volumes of water from the Old River channel of the San Joaquin River in the south Delta. Average annual diversions (exports) have increased by a factor of two from the years prior to the 1996 FERC Order up to the 2007 court-ordered flow reductions, put in place for the protection of delta smelt entrained by these facilities. Outside of flood periods, Delta exports exceed instream flows at Vernalis at all times of year except during the April 15 to May 15 period when pumping restrictions are imposed on the State and Federal Pumping plants and pulse flows are provided from the San Joaquin River tributaries.

Sediment Supply and Transport

Interception of Upstream Gravels by Dams – Coarse sediment production from the upper watershed is blocked at La Grange Dam and Don Pedro Dam as well as locations farther upstream. Under current conditions, coarse sediment sources to the lower Tuolumne River are limited to bed mobilizing events and bank erosion.

Historical Gravel Mining – Historical gold dredge mining during the early twentieth century excavated in-channel and floodplain sediments and left a legacy of dredger tailing deposits between RM 50.5–38. Beginning in the 1940s, aggregate mines extracted sand and gravel directly from the active river channel, creating a legacy of in-channel mining pits ("special run-pools" [SRPs]) up to 400 feet (120 m) wide and 35 feet (11 m) deep and occupying 32% of the length of the channel in the gravel bedded reach (RM 52–24). Historical dredger tailings upstream of RM 45 were removed as part of the New Don Pedro Dam construction and more recent mining operations have excavated sand and gravel from floodplains and terraces immediately adjacent to the river channel at several locations downstream of Robert's Ferry Bridge (RM 39.5). Floodplain and terrace mining pits are typically separated from the river by narrow un-engineered berms that are susceptible to failure during high flows such as the 1997 flood event.

Loss of Channel Migration – In addition to the large cobble-armored windrows of dredger tailings remaining in the reach from RM 45.4–40.3, historical dredger tailings (RM 50.5–38) served to confine the active river channel, resulting in channel down-cutting and prevention of sediment recruitment from channel migration. Channel migration has been nearly eliminated due to these historical and present day mining operations. In reaches with functionally connected floodplains, flow regulation by upstream dams limits the frequency, duration, and magnitude of high flow events affecting channel migration and floodplain processes.

1997 Flood Impacts – During the 1997 flood, high flows in excess of 60,000 cfs were released over the Don Pedro spillway, resulting in the erosion of approximately 200,000 yd^3 (150,000 m^3) of sediment**.** Much of this sediment was deposited behind La Grange Dam. The remainder was transported downstream and deposited in the river and on the floodplain or was transported downstream to the San Joaquin River and the Delta.

Tributary Fine Sediment Inputs – Tributaries entering the river downstream of La Grange Dam do not contribute coarse sediment to the mainstem channel. A sediment basin installation at Gasburg Creek was completed in 2007, but fine sediments continue to enter the river during runoff events from Peaslee and Dominici creeks. For example, failure of sediment controls following grading operations along Lake Road resulted in extended periods of high turbidity during May 2009.

Gravel Augmentation Projects – To date, gravel augmentation has been limited to two sites near Old La Grange Bridge (RM 50.5) between 1999 and 2001. In addition to predator isolation projects at SRP 9 (RM 25.7), riffle and floodplain reconstruction projects have been completed at Bobcat Flat (RM 43.5) and at 7/11 Materials (RM 37.7), with designs and preliminary permitting completed for additional gravel augmentation projects at upstream locations.

Anthropogenic Inputs

Non-Native Fish Introductions – Predation studies in the Tuolumne River identified 10 non-native and two native fish species that could potentially prey on juvenile Chinook salmon and *O. mykiss*, with the majority of these fish concentrated in slower moving waters found at SRP mining pits.

Hatchery Fish Introductions – Release of marked and unmarked hatchery fish in the San Joaquin basin may result in genetic impacts, reduced naturally spawning population productivity, as well as food and other habitat resource competition in freshwater, estuarine, and ocean environments. Although the proportions of hatchery fish identified in escapement surveys has been historically low, constant fractional marking programs have shown the present day Chinook salmon runs are dominated by hatchery origin fish. Genetic analyses also indicate the majority of Central Valley Steelhead are of common out-of-basin broodstock (Eel River) used at the Nimbus (American River) and other hatcheries, suggesting that hatchery introductions have largely altered the genetic structure of the population. Several studies outside of the San Joaquin River basin have shown lower reproductive success of hatchery fish as compared to wild fish spawning in the same rivers.

Agricultural Development – Historical land clearing as well as levee construction has eliminated access to marsh habitats throughout the Delta. Continued discharge of residual nutrients (N, P) from agricultural fertilizers results in biostimulation of algae, associated DO variations, as well as changes in algal community structure and the Delta food web. In addition to discharges of salts to the San Joaquin River basin, herbicides and pesticides are discharged throughout the Delta. Exposure of common herbicides and pesticides is associated with direct toxicity to planktonic species as well as olfactory impairments in juvenile salmon.

POTW Discharges – Treated municipal wastewater is discharged to Delta waterways from over 300 municipal sources including numerous Publicly Owned Treatment Works

(POTWs). Discharges contain residual nutrients (N, P) associated with biostimulation of algae, DO variations, alterations of the food web, as well as a number of poorly characterized impacts from emerging contaminants associated with endocrine disruption and other effects.

Urban Runoff – In addition to agricultural return flows, urban runoff may contain a range of contaminants from petroleum, heavy metals, trash, to fertilizers (N, P) and pesticides from lawns. Recent studies sampling of urban runoff indicated consistently high levels of pyrethroid pesticides, with effects ranging from invertebrate toxicity to olfactory impairment in salmonid juveniles.

Meteorology

ENSO and PDO Cycles – The Pacific Decadal Oscillation and shorter term El Niño/Southern Oscillation both appear to change ocean productivity through complex processes. The mechanisms of how salmon populations are affected are not well understood, but ocean circulation affects nutrient upwelling and primary and secondary productivity of the marine food web that supports adult rearing of Tuolumne River and other Pacific salmonids.

Climate Change – In addition to future climate change impacts on ENSO and PDO cycles, recent USBR evaluations suggest slight temperature increases will occur in the San Joaquin River basin with variable, but slightly decreasing precipitation by 2050, on the order of 5% below recent averages. Due to early snowmelt and relatively higher winter runoff from warmer conditions, flood control capacity will be reduced, and reductions in basin yield may also result in reduced cold water storage for salmon as well as increased habitat for warm-water adapted invasive species.

Processes and mechanisms affecting Tuolumne River Chinook salmon by life-stage residency

Chinook salmon upmigration

Processes/Mechanisms affecting arrival at Spawning Grounds

Homing/Straying/Timing – Although existing data does not show relationships between homing, straying, or variations in arrival timing with Tuolumne River fall attraction flows, water temperature as well as dissolved oxygen (DO) have been suggested as factors affecting the timing of salmon passage at Stockton and by inference, the timing of adults arriving at tributary spawning grounds. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients may result in unsuitable water quality conditions for up-migrating salmon. Meteorology and to a minor degree, instream flows, also combine to affect exposure of up-migrating adults to changes in water temperatures. Lastly, homing fidelity of introduced hatchery fish out-planted to the Delta and other locations has been shown to be poorer than naturally reproducing salmon.

Processes/Mechanisms affecting Direct Mortality

Harvest – Ocean harvest of adult salmon that escape the ocean fishery, inland sport fishing, and illegal poaching all affect the number of adults that return to their natal streams to spawn, and in turn, affect subsequent juvenile production. The Central Valley Harvest Rate Index has been in excess of 70% in many years. Additional inland harvest occurs, mostly in the Bay and Delta, but also in the San Joaquin River system prior to the mid-October angling closure in the tributaries. Illegal poaching has not been well quantified.

Water Quality – In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of other contaminants may result in unsuitable water quality conditions for up-migrating salmon. However, mortality of adult salmon is unlikely to result from water quality impairments such as DO depletion resulting from algal and bacterial respiration or from potential toxicity events.

Water Temperature – Meteorology and to a minor degree, instream flows, combine to affect exposure of up-migrating adults to changes in water temperatures with varying probabilities of direct mortality. However, no incidences of direct mortality of up-migrant salmon have been attributed to water temperature in the lower Tuolumne River and avoidance of unsuitable water temperatures by adults would be expected.

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Exposure to changes in water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia in the lower San Joaquin River may contribute to stress and disease incidence and subsequent mortality of up-migrant adults. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants, may result in unsuitable water quality conditions for up-migrating salmon. Meteorology and to a minor degree, instream flows in the lower San Joaquin River and Delta, also combine to affect exposure of up-migrating adults to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality.

Chinook salmon Spawning

Processes/Mechanisms affecting Spawning Success

Competition and Exclusion – Competition and exclusion of up-migrant adults from accessing suitable spawning sites may occur depending upon the numbers of spawners, gravel quality, and local hydraulic characteristics of available spawning habitat area. Both gravel quality and the availability of suitable spawning habitat are affected by instream flows, meteorology, as well as factors contributing to alterations in sediment transport processes. Competition for suitable spawning sites by anthropogenically introduced hatchery fish may limit spawning success of naturally reproducing Chinook salmon.

Processes/Mechanisms affecting Direct Mortality

Poaching – Illegal poaching of adult salmon arriving in the lower Tuolumne River after mid-October has not been quantified, but potentially reduces the number of adults that successfully spawn, and in turn, affects subsequent juvenile production.

Water Temperature – Meteorology and instream flows combine to affect exposure of spawning adults to changes in water temperatures. Although little information is available relating pre-spawning mortality of Chinook salmon to water temperature in the Tuolumne River or neighboring tributaries, adult mortality can result from prolonged exposure to unsuitable water temperatures, potentially reducing the number of adults that successfully spawn, and in turn, affecting subsequent juvenile production.

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Meteorology and instream flows in the lower Tuolumne River combine to affect exposure of pre-spawning adults to changes in water temperature, which in turn, may contribute to stress and disease incidence and subsequent mortality. Disease incidence may be also related to prior exposure to unsuitable water temperatures and water quality in the Delta as well as exposure to water-borne pathogens as well as interactions with other infected/infested fish.

Chinook salmon egg incubation

Processes/Mechanisms affecting Egg/Alevin growth and Fry Emergence

Water Temperature – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures, which has a strong influence on the rate of subsequent embryo and alevin development, typically ranging from 6 to 12 weeks from fertilization to emergence.

Water Quality – Instream flows and sediment transport of bedload and suspended sediments may affect intra-gravel flow as well as interstitial water quality conditions such as DO necessary for the successful development of the embryo/alevin to fry emergence.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and instream flows may combine to affect exposure of deposited eggs to varying water temperatures, potentially reducing egg survival to emergence and subsequent juvenile production.

Redd Scour – Redd scour may result from increased rates of sediment (bedload) transport during high flow events such as flood flows. Displacement of eggs and alevin due to redd scour may cause mortality from mechanical shock, crushing or entrainment into the bedload.

Redd Superimposition – Egg displacement due to redd superimposition resulting from competition and exclusion of adult spawners and anthropgenically introduced hatchery fish may result in density-dependent mortality of previously deposited eggs that have been disturbed by the spawning activities of subsequently arriving females. Availability of suitable spawning habitat is affected by instream flows as well as gravel quality and spawning habitat area resulting from factors contributing to alterations in sediment transport processes.

Entombment – Fine sediment deposition in completed redds may effectively seal the upper layers of the redd, and obstruct the emergence of alevins, causing entombment and subsequent mortality. Entombment may be affected by gravel quality and fine sediment input due to surrounding land use practices, instream flows, as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Indirect Mortality

Bacterial & Fungal Infections – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures in the spawning reaches of the lower Tuolumne River. Although no information is available on disease incidence for

incubating eggs in the Tuolumne River, water temperature has been shown to contribute to increased rates of mortality by bacterial and fungal growth in other systems.

Chinook salmon in-river rearing

Processes/Mechanisms affecting juvenile growth and survival

Water Temperature – Meteorology and instream flows combine to affect water temperature of both in-channel and floodplain habitats and has a strong influence on growth and feeding rates of rearing juvenile Chinook salmon. Changes in water temperatures may also affect the timing of smoltification and may cause desmoltification under some circumstances.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affects the prey availability and growth rates of juvenile Chinook salmon. Both the availability of these organic matter sources as well as the physical habitat availability for benthic macro-invertebrates and terrestrial insects (drift) is in turn affected by instream flows as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile Chinook salmon to changes in water temperatures, with varying probabilities of direct mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and sediment transport processes, predation of juvenile Chinook salmon by native fish (including *O. mykiss*) as well as introduced fish is influenced by meteorology and instream flow influences on water temperatures. Anthropogenic inputs of contaminants may also affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may also affect by surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Stranding & Entrapment – Rapid reductions in instream flows, particularly during flood flow conditions, may eliminate access to available habitat and cause stranding and entrapment of fry and juvenile salmon on gravel bars and floodplains and in off-channel habitats that may become cut off when flows are reduced. Mortality of juveniles by several mechanisms often results, including desiccation, temperature shock, asphyxiation, as well as predation by birds and mammals.

Entrainment – Depending on instream flows and agricultural operations, entrainment of rearing or migrating juvenile Chinook salmon into unscreened pumps may occur, resulting in mechanical damage and mortality.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and instream flows combine to affect exposure of rearing juvenile Chinook salmon to varying water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. In addition to factors affecting instream flows in the lower Tuolumne River, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants may result in unsuitable water quality, exposing juvenile salmon to low DO, high pH (alkalinity) and unionized ammonia and contributing to stress and disease incidence.

Chinook salmon Delta rearing

Processes/Mechanisms affecting juvenile growth and survival

Water Temperature – Meteorology and to a minor degree instream flows combine to affect water temperature of both in-channel habitats in the San Joaquin River and Delta as well as water temperatures of off-channel habitats (e.g., sloughs, marshes, as well as seasonally inundated floodplains). Seasonal variations in water temperatures, in turn have a strong influence on growth and feeding rates of rearing juvenile Chinook salmon. Water temperatures may also affect the timing of smoltification and may cause desmoltification under some circumstances.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affect the prey availability and growth rates of juvenile Chinook salmon. The availability of these organic matter sources to zooplankton in the Delta is affected by anthropogenically supplied nutrients and algal productivity. For juvenile salmon rearing in floodplain locations, food web productivity and terrestrial insect drift are affected by instream flows as well as other factors contributing to alterations in floodplain inundation frequency, duration, and extent (e.g., levee construction).

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile Chinook salmon to changes in water temperatures as well as increased rates of mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and the reduced habitat availability of off-channel rearing habitats by levee construction, juvenile Chinook salmon predation by native and introduced fish is influenced by meteorology and instream flow effects upon water temperature. Anthropogenic inputs of contaminants may affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may be affected by surrounding land use practices, changes in instream flows such as Delta exports, as well as factors contributing to alterations in upstream sediment transport processes. Seasonally installed barriers have been used in years with flows below 5,000 cfs at Vernalis to reduce predator exposure of outmigrating Chinook salmon.

Entrainment – Depending on tributary instream flows to the San Joaquin River and Delta, entrainment of rearing or migrating juvenile Chinook salmon into unscreened pumps may occur, resulting in mechanical damage and mortality. Entrainment into the forebays of the Delta export facilities may result in increased rates of predation, physical damage and stress during salvage operations, as well as subsequent predation at release points for salvaged fish near the western (downstream) edge of the Delta.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile Chinook salmon to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. Exposure to unsuitable water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia due to anthropogenic inputs of contaminants in the lower San Joaquin River and Delta may also contribute to stress and disease incidence and subsequent mortality of juvenile Chinook salmon.

Chinook salmon Ocean rearing

Processes/Mechanisms affecting Adult growth and survival

Prey Availability – Meteorology, ocean water temperatures and water quality influence primary and secondary productivity of the marine food web that supports immature and adult Chinook salmon. Both direct discharge of anthropogenically supplied nutrients as well as changes in ocean circulation patterns and upwelling of nutrients affect marine water quality.

Processes/Mechanisms affecting Direct Mortality

Predation – Predation of immature Chinook salmon following ocean entry may reduce subsequent adult returns. Predation rates upon immature salmon may be affected by changes in predator species distribution with water temperature and ocean circulation patterns. Early life history exposure to anthropogenic inputs of contaminants may also affect water quality and subsequent susceptibility to predation.

Harvest – Ocean Harvest of adult Chinook salmon affects the number of adults that return to their natal streams to spawn, and in turn, affect subsequent tributary juvenile production. The Central Valley Harvest Rate Index has been in excess of 70% in many years and recent fishing bans (2009–2010) have been imposed to increase adult population levels.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and instream flow effects upon water temperature in upstream habitats may affect early life history disease incidence and subsequent mortality of adult Chinook salmon. Prior exposure to pathogens and parasites during juvenile rearing and outmigration may also contribute to increased disease incidence in the adult Chinook salmon population.

Processes and mechanisms affecting Tuolumne River steelhead/*O. mykiss* by life-stage residency

Steelhead upmigration

Processes/Mechanisms affecting arrival at Spawning Grounds

Homing/Straying/Timing – Although no data exists to evaluate homing and straying of steelhead arriving in the Tuolumne River, mechanisms explaining homing and straying include instream flows, as well as olfactory cues related to water quality and the presence of other salmon. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients may affect DO and result in unsuitable water quality conditions for up-migrating steelhead during late summer periods. Anthropogenic inputs of herbicides and pesticides may also affect water quality and impair olfactory cues necessary for homing of steelhead. Homing fidelity of introduced hatchery fish has been shown to be poorer than naturally reproducing steelhead.

Processes/Mechanisms affecting Direct Mortality

Sportfishing & Poaching – Inland sportfishing and illegal poaching affect the number of steelhead adults that return to their natal streams to spawn, and in turn, affect subsequent juvenile production. Sportfishing occurs, mostly in the Bay and Delta, but also in the San Joaquin River system prior to the mid-October angling closure in the tributaries. Illegal poaching has not been well quantified.

Water Quality – In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of other contaminants may result in unsuitable water quality conditions for up-migrating steelhead. However, mortality of adult steelhead is unlikely to result from water quality impairments such as DO depletion resulting from algal and bacterial respiration or from potential toxicity events.

Water Temperature – Meteorology and to a minor degree, instream flows, combine to affect exposure of up-migrating adults to changes in water temperatures. However, given the general up-migration timing of adult steelhead (i.e., winter-run life history), avoidance of unsuitable water temperatures by adults would be expected.

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Exposure to changes in water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia in the lower San Joaquin River may contribute to stress and disease incidence and subsequent mortality of estuarine and up-migrant adult steelhead. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants may result in unsuitable water quality conditions for up-migrating steelhead. Although meteorology and instream flows may combine to affect exposure of estuarine and up-migrating steelhead to changes in water temperature, given the general up-migration timing of adult steelhead (i.e. winter-run), linkages to temperature stress and disease incidence would be related to estuarine habitat use only.

Steelhead Spawning

Processes/Mechanisms affecting Spawning Success

Competition and Exclusion – Although riffle spawning by steelhead is uncommon and very little tributary spawning of steelhead has been observed, competition and exclusion of up-migrant adults from accessing suitable spawning sites may occur depending upon the numbers of spawners, gravel quality, and local hydraulic characteristics of available spawning habitat area. Both gravel quality and the availability of suitable spawning habitat are affected by instream flows, meteorology, as well as factors contributing to alterations in sediment transport processes. Competition for suitable spawning sites by anthropogenically introduced hatchery fish as well as resident *O. mykiss* may limit spawning success of any wild steelhead arriving in the Tuolumne River.

Processes/Mechanisms affecting Direct Mortality

Poaching – Illegal poaching of adult steelhead arriving in the lower Tuolumne River after mid-October has not been quantified, but potentially reduces the number of adults that successfully spawn, and in turn, affects subsequent juvenile production.

Water Temperature – Meteorology and instream flows combine to affect exposure of spawning adults to changes in water temperatures. Although no information is available regarding pre-spawning mortality of steelhead, given the general up-migration timing of adult steelhead (i.e., winter-run), water temperature effects upon pre-spawn mortality would be unexpected,

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Meteorology and instream flows in the lower Tuolumne River combine to affect exposure of pre-spawning adults to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. Although the general winter and spring up-migration timing of adult steelhead would not be expected to result in water temperature related diseases, disease incidence may be also related to prior exposure to unsuitable water temperatures and water quality in the Delta as well as exposure to water-borne pathogens or interactions with other infected/infested fish.

Steelhead egg incubation

Processes/Mechanisms affecting Egg/Alevin growth and Fry Emergence

Water Temperature – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures, which has a strong influence on the rate of subsequent embryo and alevin development, typically ranging from 4 to 6 weeks from fertilization to fry emergence.

Water Quality – Instream flows and sediment transport of bedload and suspended sediments may affect intra-gravel flow as well as interstitial water quality conditions such as DO necessary for the successful development of the embryo/alevin to fry emergence.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and instream flows may combine to affect exposure of deposited eggs to changes in water temperatures, potentially reducing egg survival to emergence and subsequent juvenile production.

Redd Scour –Redd scour may result from increased rates of sediment (bedload) transport during high flow events such as flood flows. Displacement of eggs and alevins due to redd scour may cause mortality from mechanical shock, crushing or entrainment into the bedload.

Redd Superimposition – Egg displacement due to redd superimposition resulting from competition and exclusion of adult spawners and anthropgenically introduced hatchery fish may result in density-dependent mortality of previously deposited eggs disturbed by the spawning activities of subsequently arriving females. Availability of suitable spawning habitat is affected by instream flows as well as gravel quality and spawning habitat area resulting from factors contributing to alterations in sediment transport processes.

Entombment – Fine sediment deposition in completed redds due to suspended sediments may effectively seal the upper layers of the redd, and obstruct the emergence of alevins, causing entombment and subsequent mortality. Entombment may be affected by gravel quality and suspended sediment input due to surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Indirect Mortality

Bacterial & Fungal Infections – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures in the spawning reaches of the lower Tuolumne River. Although no information is available on disease incidence for incubating eggs in the Tuolumne River, water temperature has been shown to contribute to increased rates of mortality by bacterial and fungal growth in other systems.

Steelhead in-river rearing

Processes/Mechanisms affecting juvenile growth and survival

Water Temperature – Meteorology and instream flows combine to affect water temperature of in-channel habitats and has a strong influence on growth and feeding rates of rearing juvenile steelhead. Summer water temperatures may affect availability of suitable habitat for steelhead/O. mykiss as well as feeding rates. Water temperatures may also affect the timing of smoltification, may result in desmoltification, and may limit the times of year for successful smolt outmigration.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affects the prey availability and growth rates of juvenile steelhead trout. Both the availability of these organic matter sources as well as the physical habitat availability for benthic macro-invertebrates and terrestrial insects (drift) is in turn affected by instream flows as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile steelhead trout to changes in water temperatures with varying probabilities of direct mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and sediment transport processes, predation of juvenile by native and introduced fish is influenced by meteorology and instream flow influences on water temperatures. Anthropogenic inputs of contaminants may also affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may also affect by surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Stranding & Entrapment – Rapid reductions in instream flows, particularly during flood flow conditions, may eliminate access to available habitat and cause stranding and entrapment of juvenile *O. mykiss* on gravel bars and floodplains and in off-channel habitats that may become cut off when flows are reduced. For juvenile *O. mykiss* using floodplain habitats, stranding of juveniles often results from rapid flow reductions and a range of mortality mechanisms may occur, including desiccation, temperature shock, asphyxiation, as well as predation by birds and mammals.

Entrainment – Depending on instream flows and agricultural operations, entrainment of rearing juvenile *O. mykiss* or outmigrating steelhead smolts into unscreened pumps may occur, resulting in mechanical damage and mortality.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and instream flows combine to affect exposure of rearing juvenile steelhead to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality of outmigrating smolts. In addition to factors affecting instream flows in the lower Tuolumne River, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants may result in unsuitable water quality, exposing juvenile steelhead to low DO, high pH (alkalinity) and unionized ammonia and contributing to stress and disease incidence in steelhead smolts.

Steelhead Delta outmigration

Processes/Mechanisms affecting growth and survival

Although extended residency in the Delta by rearing juvenile *O. mykiss* or outmigrant smolts has not been well documented in the Delta, the following mechanisms may apply to Delta habitats.

Water Temperature – Meteorology and to a minor degree instream flows combine to affect water temperature in the San Joaquin River and Delta where ambient water temperatures may limit the times of year for successful smolt outmigration from upstream tributaries to winter and spring, typically February through May.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affect the prey availability and growth rates of juvenile steelhead trout. The availability of these organic matter sources to zooplankton in the Delta is affected by anthropogenically supplied nutrients and algal productivity. For any actively feeding *O. mykiss*, food web productivity and terrestrial insect drift are affected by instream flows as well as other factors contributing to alterations in floodplain inundation frequency, duration, and extent (e.g., levee construction).

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juveniles and outmigrant steelhead smolts to changes in water temperatures, potentially resulting in increased rates of mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and the reduced habitat availability of off-channel rearing habitats by levee construction, predation of steelhead smolts by native and introduced fish is influenced by meteorology and instream flow effects upon water temperature. Anthropogenic inputs of contaminants may also affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may also affect by surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Entrainment – Depending on tributary instream flows to the San Joaquin River and Delta, entrainment of migrating steelhead smolts into unscreened pumps may occur, resulting in mechanical damage and mortality. It is unknown whether steelhead outmigration coincides with the seasonal installation of barrier at the Head of Old River, but entrainment into the forebays of the Delta export facilities may result in increased rates of predation, physical damage and stress during salvage operations.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile *O. mykiss* and outmigrant steelhead smolts to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. Exposure to varying water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia due to anthropogenic inputs of contaminants in the lower San Joaquin River and Delta may also contribute to stress and disease incidence and subsequent mortality of steelhead smolts.

Steelhead Ocean rearing

Processes/Mechanisms affecting Adult growth and survival

Prey Availability – Meteorology, ocean water temperatures and water quality influence primary and secondary productivity of the marine food web that supports immature and adult steelhead trout. Both direct discharge of anthropogenically supplied nutrients as well as changes in ocean circulation patterns and upwelling of nutrients affect marine water quality.

Processes/Mechanisms affecting Direct Mortality

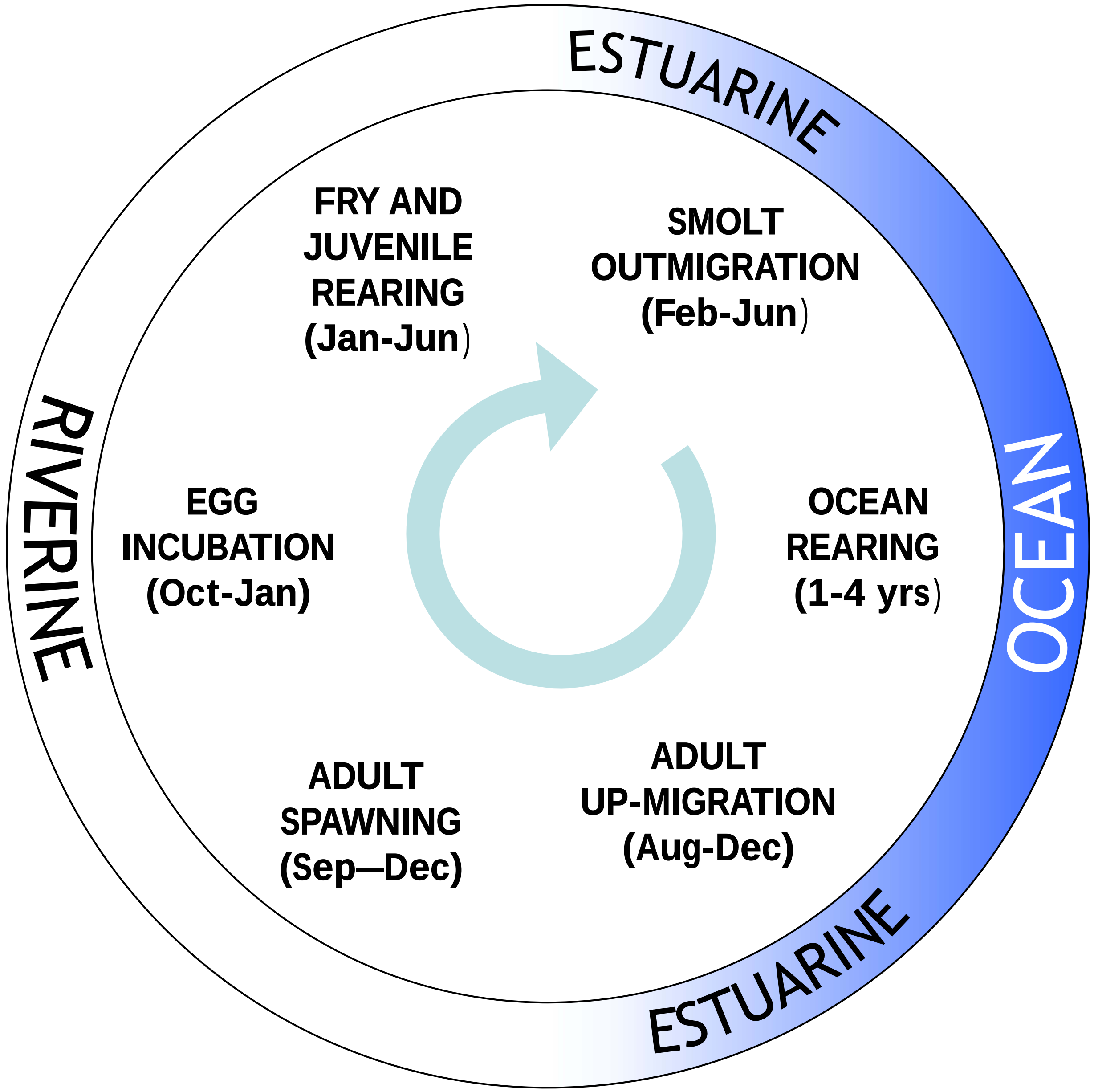
Predation – Predation of immature steelhead following ocean entry may reduce subsequent adult returns. Predation rates upon immature steelhead may be affected by changes in predator species distribution with water temperature and ocean circulation patterns. Early life history exposure to anthropogenic inputs of contaminants may also affect water quality and subsequent susceptibility to predation.

Harvest By-Catch – Although no commercial ocean harvest of adult steelhead occurs, low levels of adult mortality occurs due to by-catch of steelhead in the Pacific Ocean gill net fishery.

Processes/Mechanisms affecting Indirect Mortality

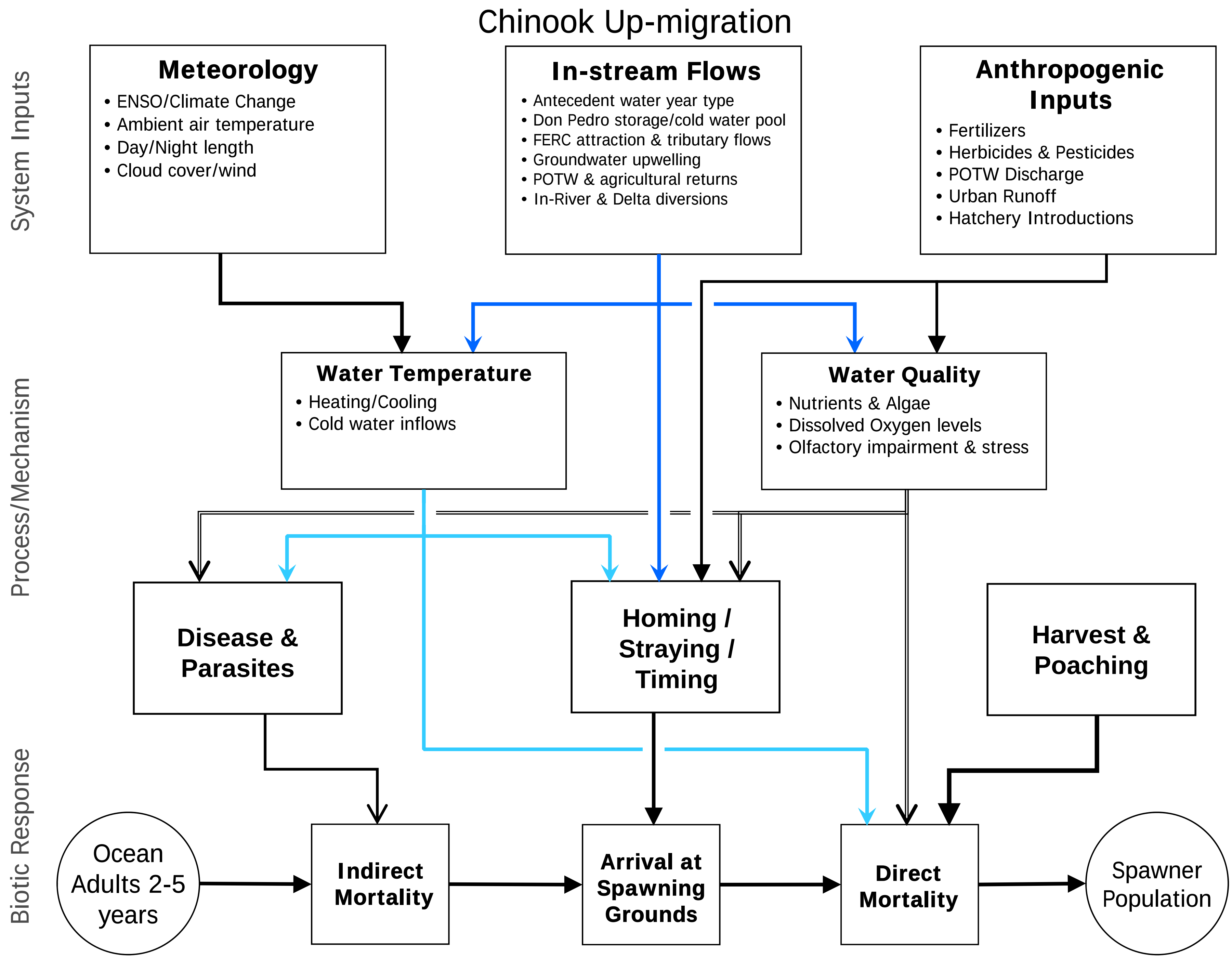
Diseases & Parasites – Meteorology and instream flow effects upon water temperature in upstream habitats may affect early life history disease incidence and subsequent mortality of steelhead. Prior exposure to pathogens and parasites during juvenile rearing and outmigration may also contribute to increased disease incidence in the adult steelhead population.

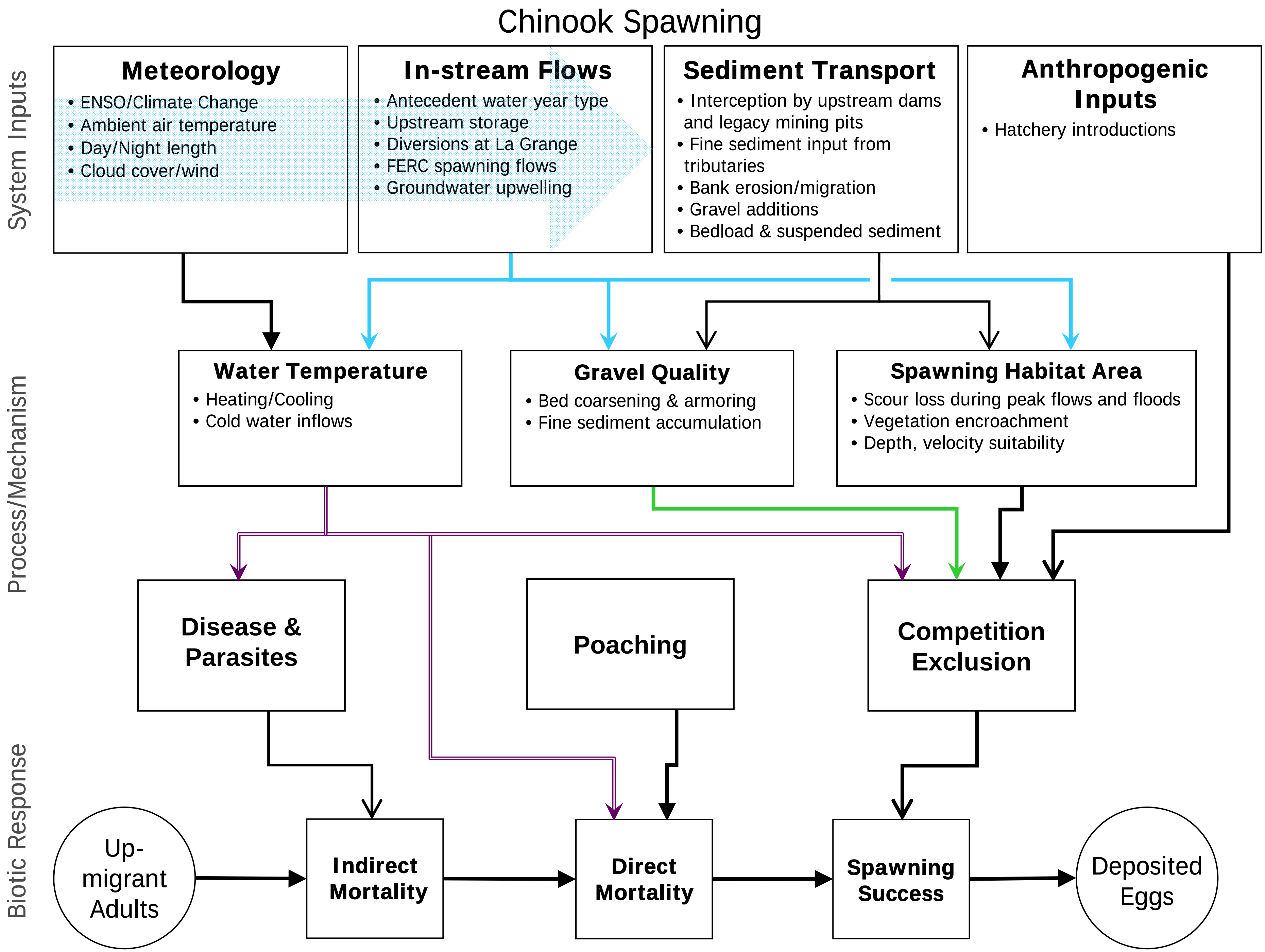
General Chinook salmon Life History Timing for the Tuolumne River



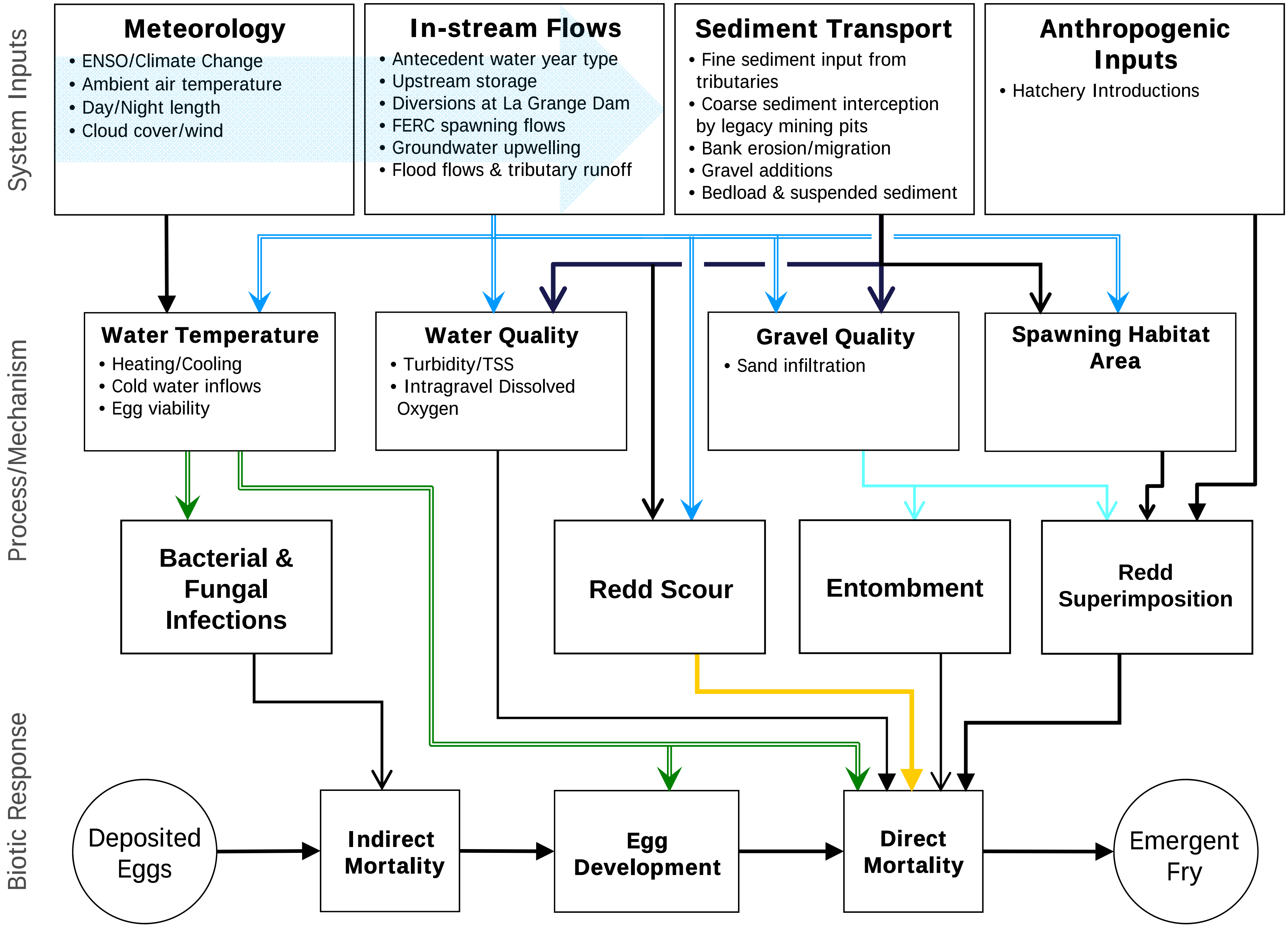
General Chinook salmon Life History Timing for the Tuolumne River

Life Stage	Fall			Winter			Spring			Summer		
	(Sep-Nov)			(Dec-Feb)			(Mar-May)			(Jun-Aug)		
Central Valley Fall-Run Chinook salmon												
Adult upstream migration												
Adult Spawning												
Egg Incubation and Fry Emergence												
In-river Rearing												
Delta Juvenile Rearing												
Smolt Outmigration												

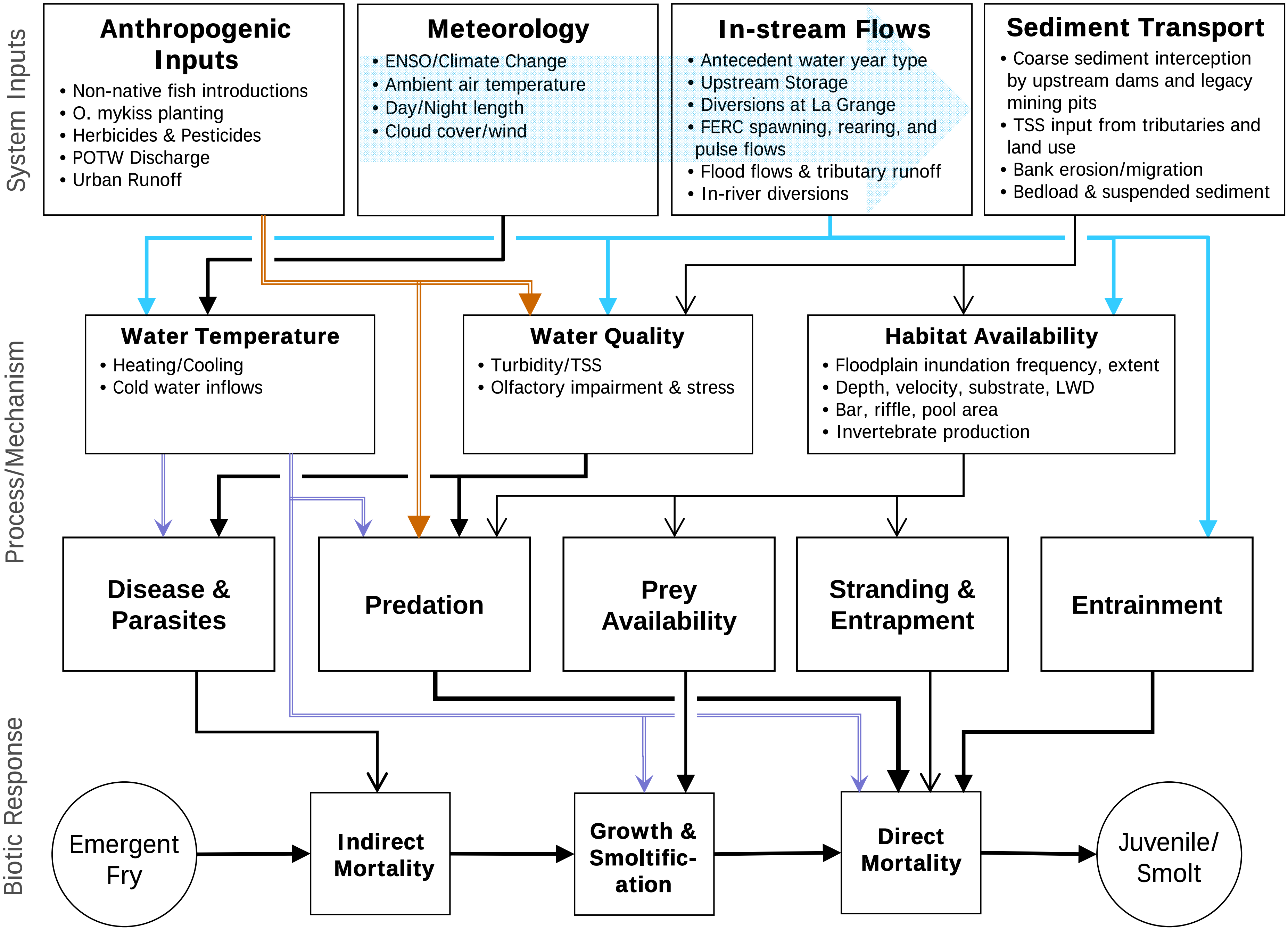

Chinook Up-migration
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Don Pedro storage/cold water pool
• FERC attraction & tributary flows
• Groundwater upwelling
• POTW & agricultural returns
• In-River & Delta diversions
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Hatchery Introductions
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Harvest & Poaching
Ocean Adults 2-5 years
Indirect Mortality
Arrival at Spawning Grounds
Direct Mortality
Spawner Population

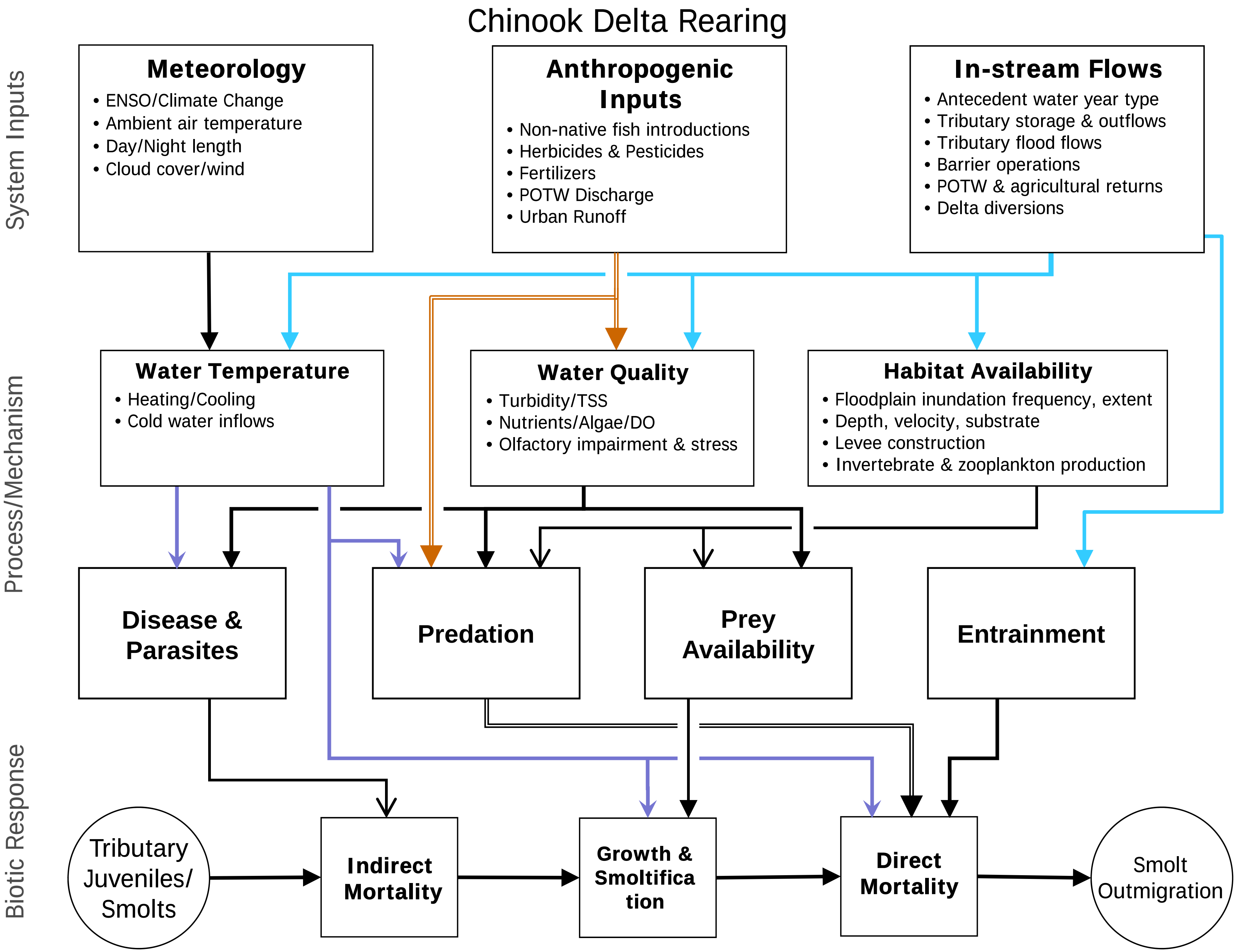

Chinook Spawning
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery introductions
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Poaching
Competition Exclusion
Up-migrant Adults
Indirect Mortality
Direct Mortality
Spawning Success
Deposited Eggs

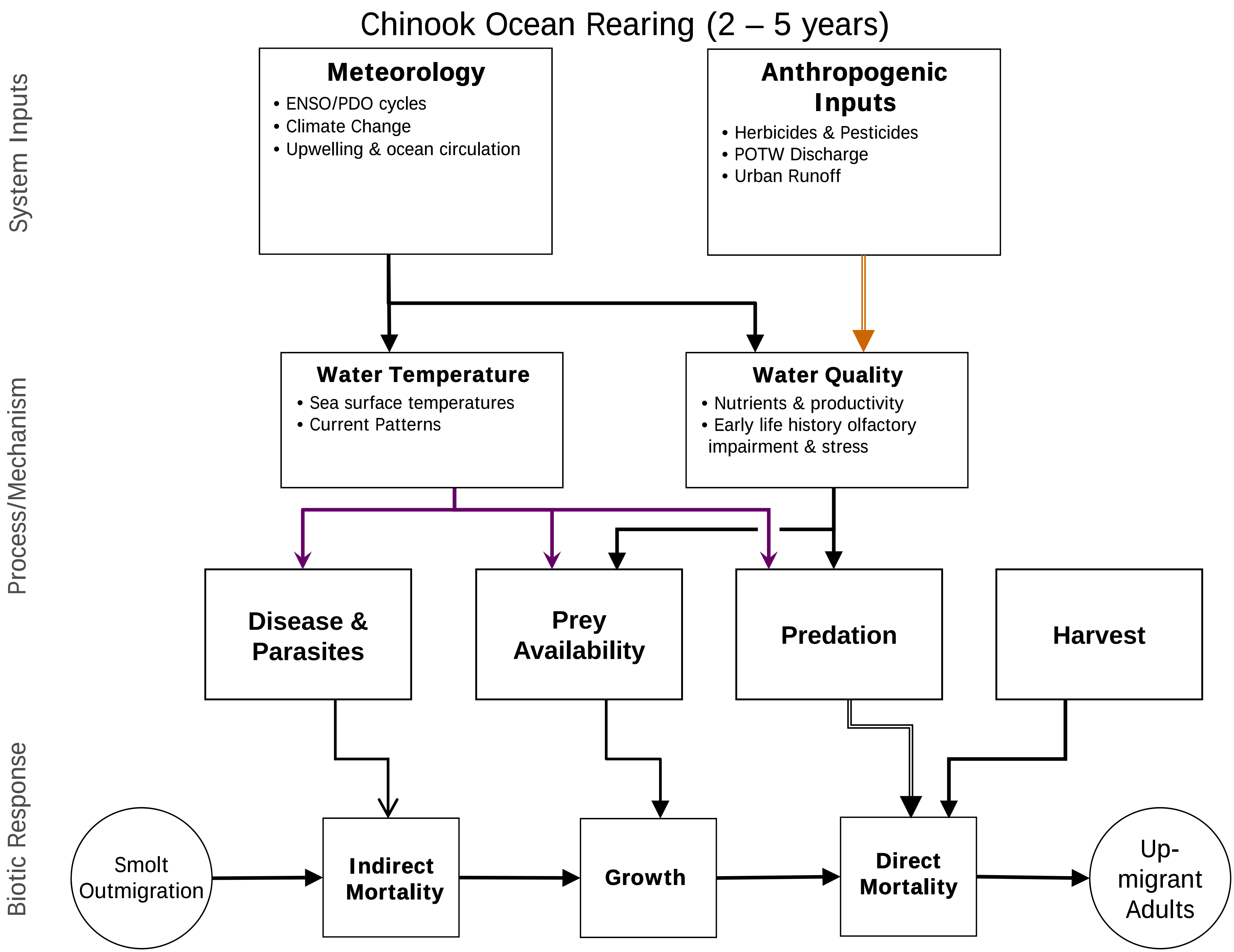
Chinook egg Incubation



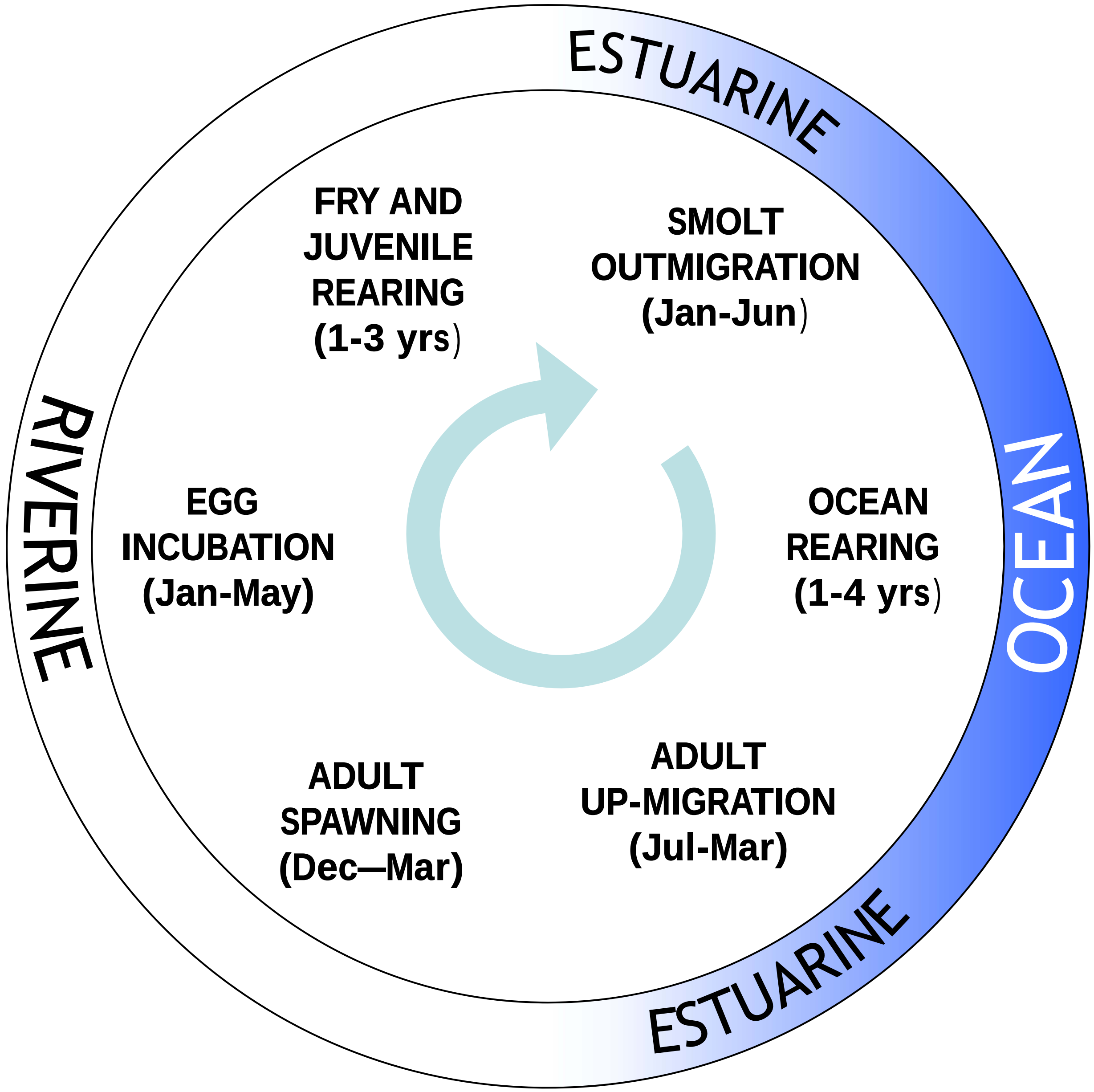
Chinook In-River Rearing




Chinook Delta Rearing
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
Anthropogenic Inputs
• Non-native fish introductions
• Herbicides & Pesticides
• Fertilizers
• POTW Discharge
• Urban Runoff
In-stream Flows
• Antecedent water year type
• Tributary storage & outflows
• Tributary flood flows
• Barrier operations
• POTW & agricultural returns
• Delta diversions
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Nutrients/Algae/DO
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate
• Levee construction
• Invertebrate & zooplankton production
Disease & Parasites
Predation
Prey Availability
Entrainment
Tributary Juveniles/ Smolts
Indirect Mortality
Growth & Smoltification
Direct Mortality
Smolt Outmigration

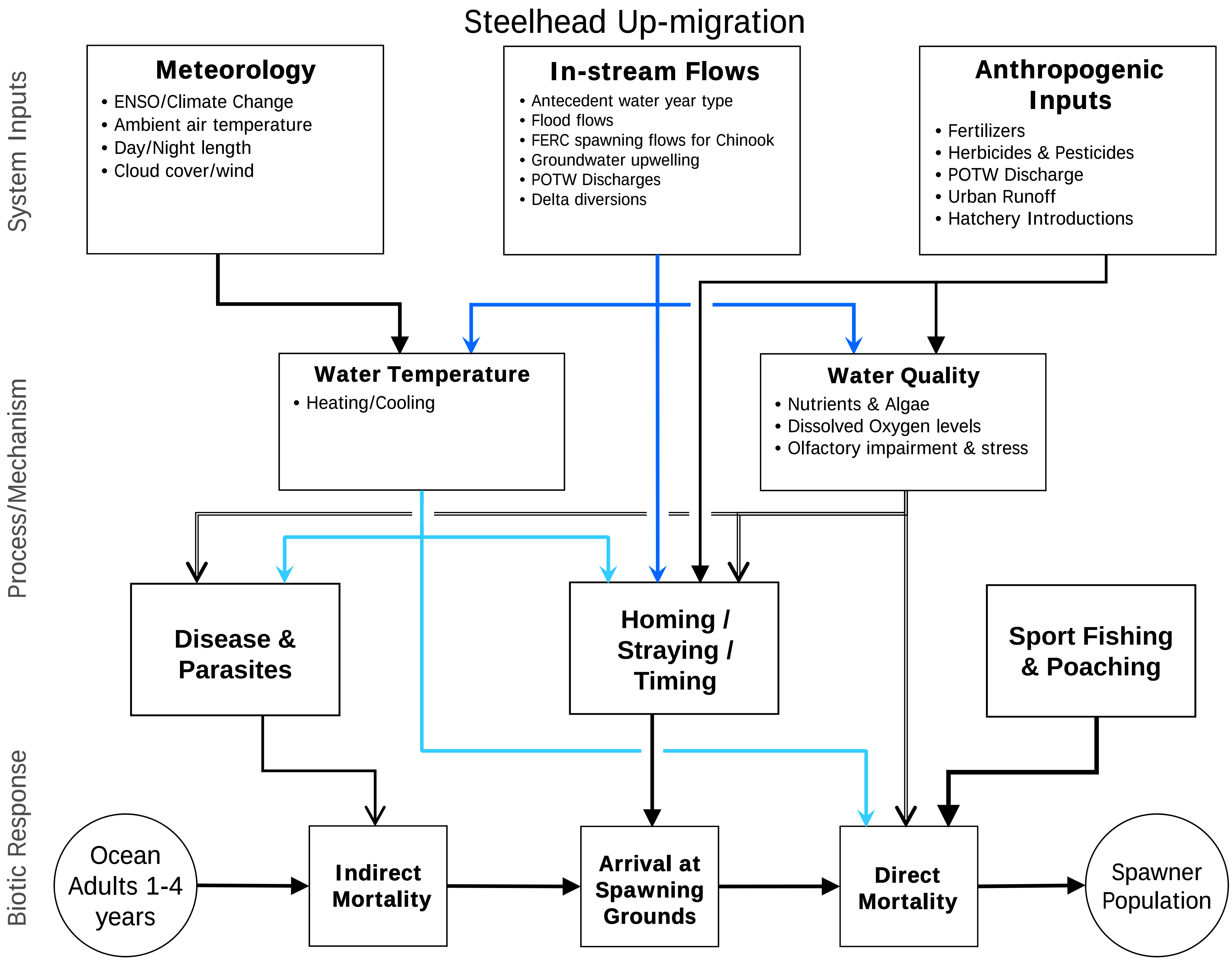

Chinook Ocean Rearing (2 – 5 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Water Temperature
• Sea surface temperatures
• Current Patterns
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Prey Availability
Predation
Harvest
Smolt Outmigration
Indirect Mortality
Growth
Direct Mortality
Up-migrant Adults

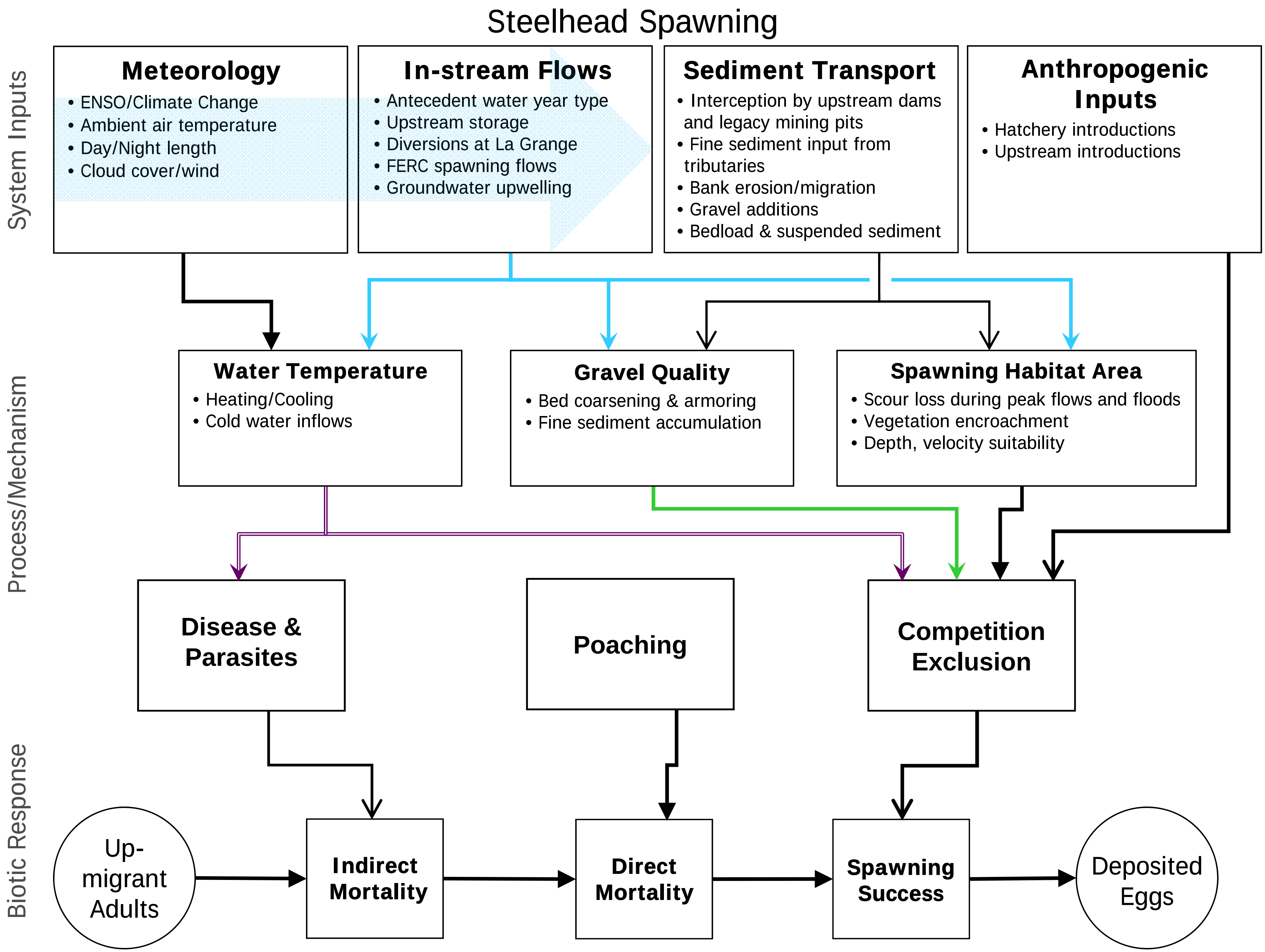
General Steelhead Life History Timing for the Tuolumne River

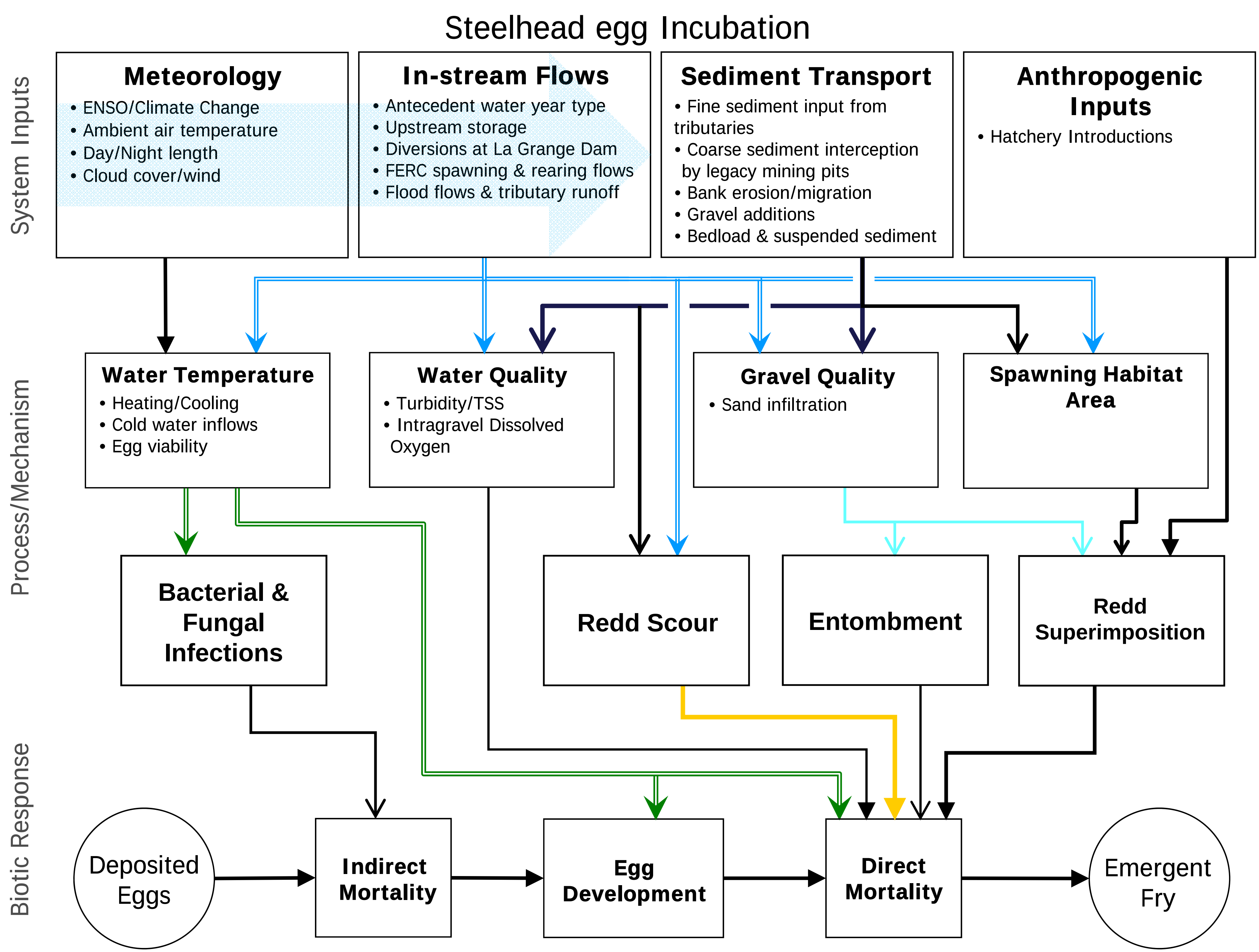


General Steelhead Life History Timing for the Tuolumne River

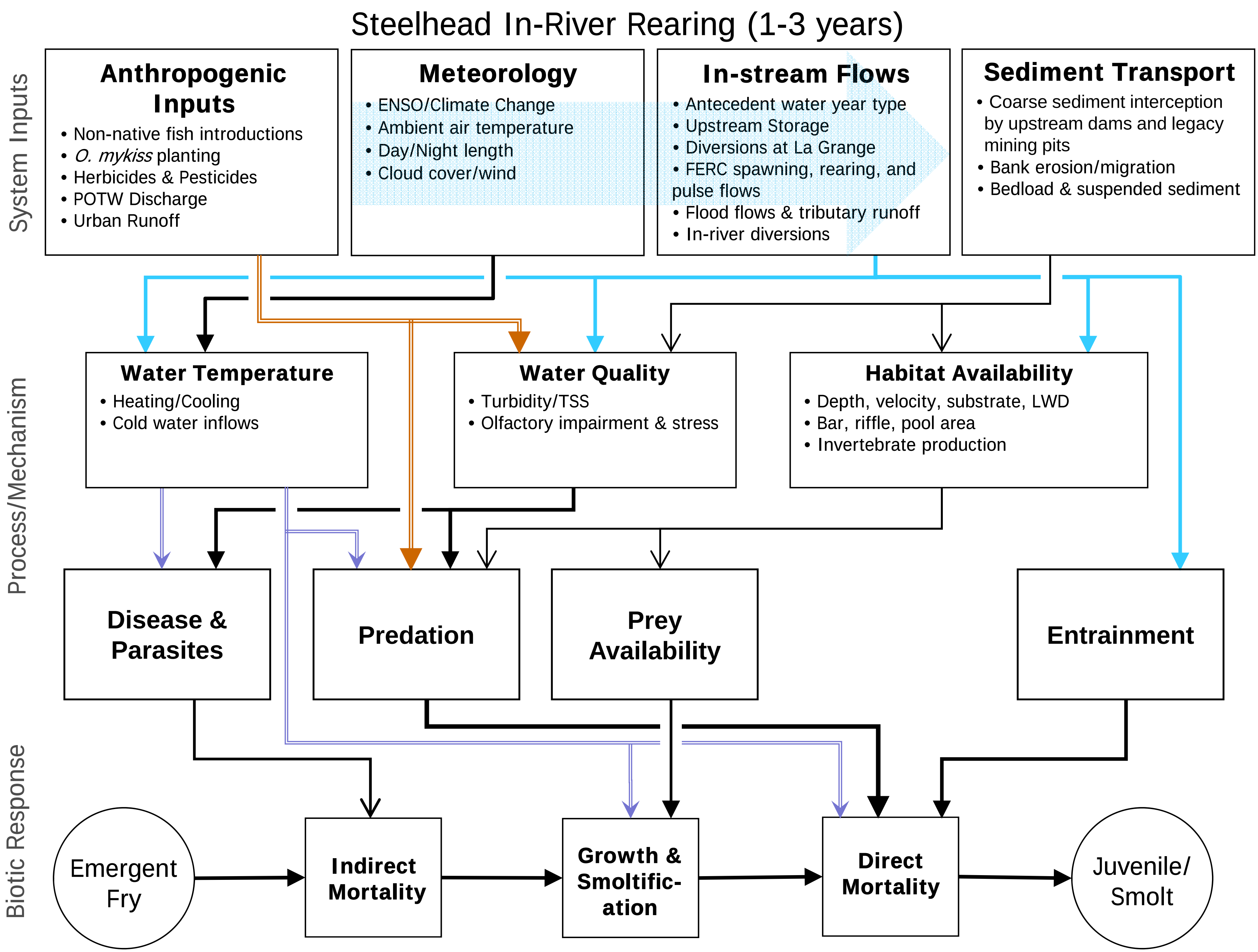
Life Stage	Fall			Winter			Spring			Summer		
	(Sep-Nov)			(Dec-Feb)			(Mar-May)			(Jun-Aug)		
Central Valley Steelhead / *O. mykiss*												
Adult upstream migration												
Adult Spawning												
Egg Incubation and Fry Emergence												
In-River Rearing												
Smolt Outmigration												


Steelhead Up-migration
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Flood flows
• FERC spawning flows for Chinook
• Groundwater upwelling
• POTW Discharges
• Delta diversions
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Hatchery Introductions
Water Temperature
• Heating/Cooling
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Sport Fishing & Poaching
Ocean Adults 1-4 years
Indirect Mortality
Arrival at Spawning Grounds
Direct Mortality
Spawner Population

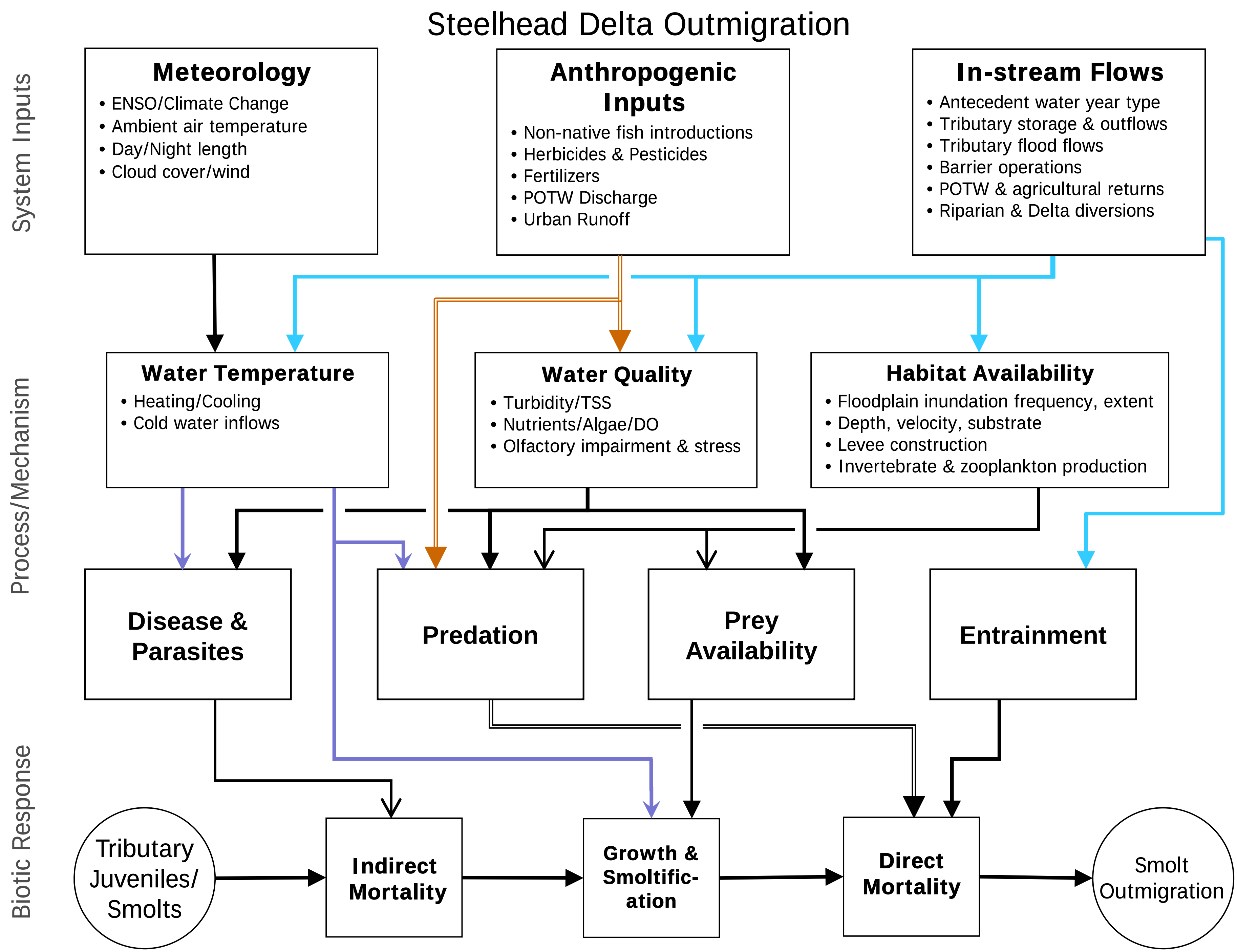

Steelhead Spawning
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery introductions
• Upstream introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Poaching
Competition Exclusion
Biotic Response
Up-migrant Adults
Indirect Mortality
Direct Mortality
Spawning Success
Deposited Eggs

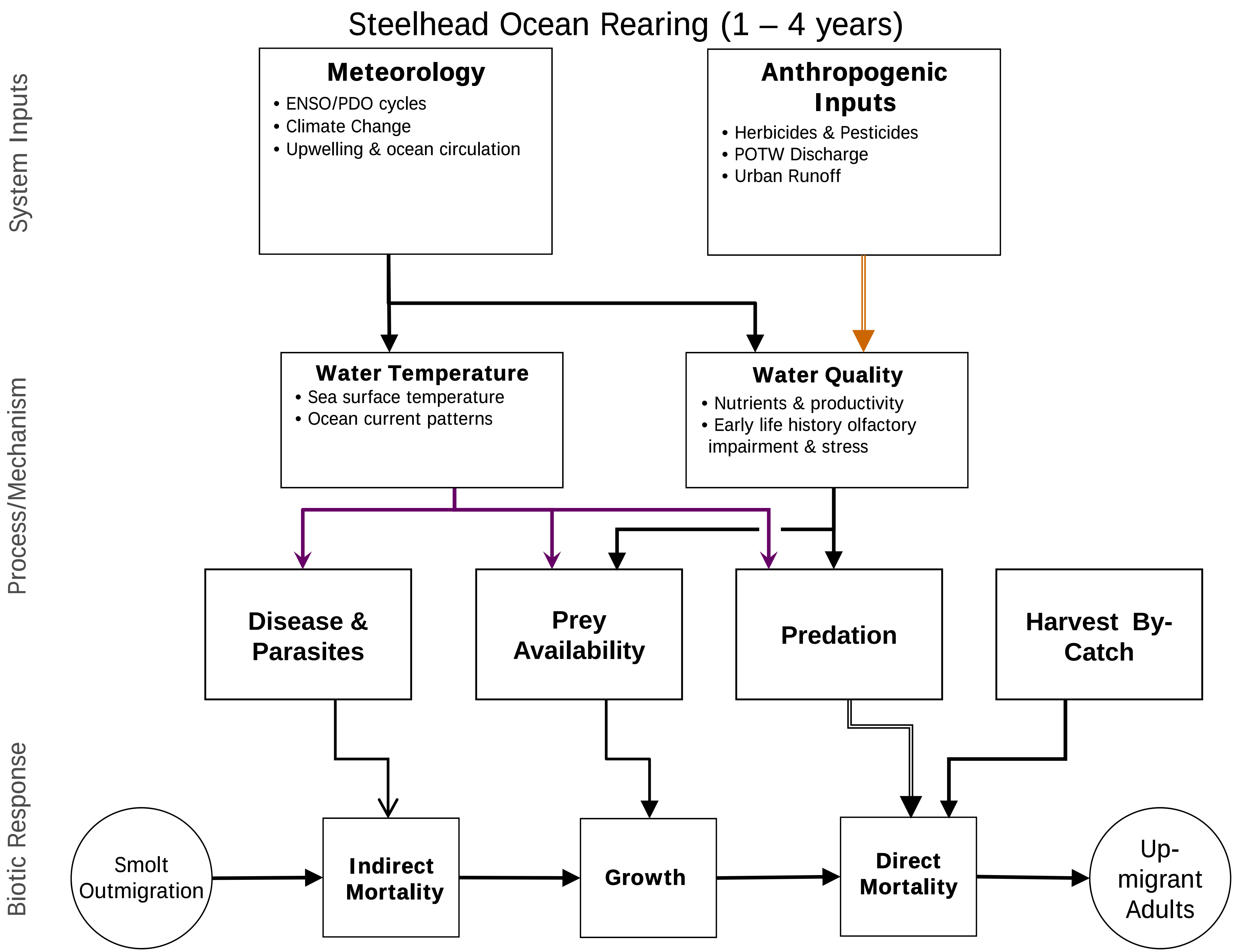


Steelhead egg Incubation
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange Dam
• FERC spawning & rearing flows
• Flood flows & tributary runoff
Sediment Transport
• Fine sediment input from tributaries
• Coarse sediment interception by legacy mining pits
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
• Egg viability
Water Quality
• Turbidity/TSS
• Intragravel Dissolved Oxygen
Gravel Quality
• Sand infiltration
Spawning Habitat Area
Bacterial & Fungal Infections
Redd Scour
Entombment
Redd Superimposition
Biotic Response
Deposited Eggs
Indirect Mortality
Egg Development
Direct Mortality
Emergent Fry



Steelhead In-River Rearing (1-3 years)
System Inputs
Anthropogenic Inputs
• Non-native fish introductions
• O. mykiss planting
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream Storage
• Diversions at La Grange
• FERC spawning, rearing, and pulse flows
• Flood flows & tributary runoff
• In-river diversions
Sediment Transport
• Coarse sediment interception by upstream dams and legacy mining pits
• Bank erosion/migration
• Bedload & suspended sediment
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Olfactory impairment & stress
Habitat Availability
• Depth, velocity, substrate, LWD
• Bar, riffle, pool area
• Invertebrate production
Disease & Parasites
Predation
Prey Availability
Entrainment
Biotic Response
Emergent Fry
Indirect Mortality
Growth & Smoltific-ation
Direct Mortality
Juvenile/ Smolt

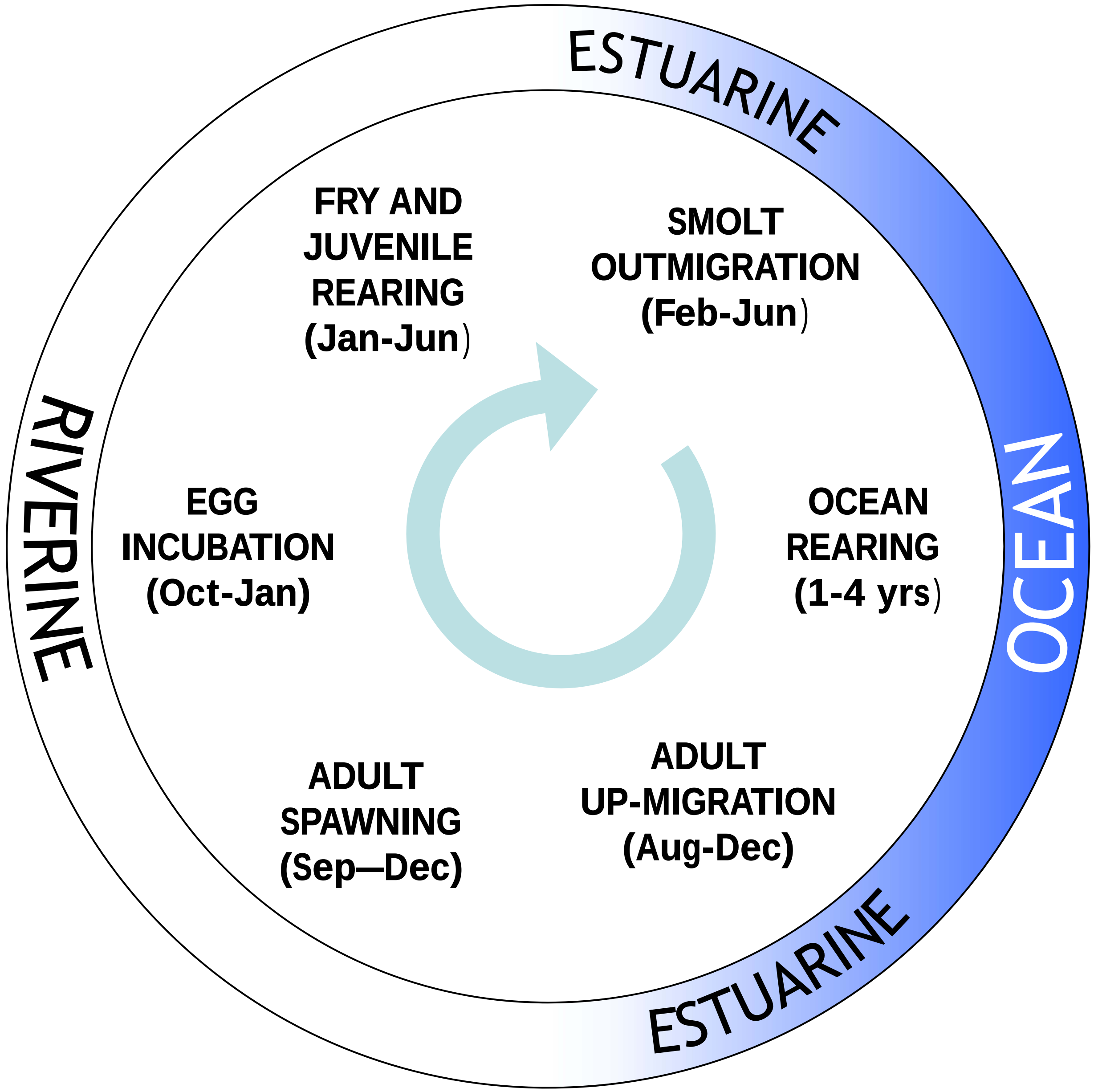

Steelhead Delta Outmigration
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
Anthropogenic Inputs
• Non-native fish introductions
• Herbicides & Pesticides
• Fertilizers
• POTW Discharge
• Urban Runoff
In-stream Flows
• Antecedent water year type
• Tributary storage & outflows
• Tributary flood flows
• Barrier operations
• POTW & agricultural returns
• Riparian & Delta diversions
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Nutrients/Algae/DO
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate
• Levee construction
• Invertebrate & zooplankton production
Disease & Parasites
Predation
Prey Availability
Entrainment
Tributary Juveniles/ Smolts
Indirect Mortality
Growth & Smoltific-ation
Direct Mortality
Smolt Outmigration



Steelhead Ocean Rearing (1 – 4 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Water Temperature
• Sea surface temperature
• Ocean current patterns
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Prey Availability
Predation
Harvest By-Catch
Smolt Outmigration
Indirect Mortality
Growth
Direct Mortality
Up-migrant Adults

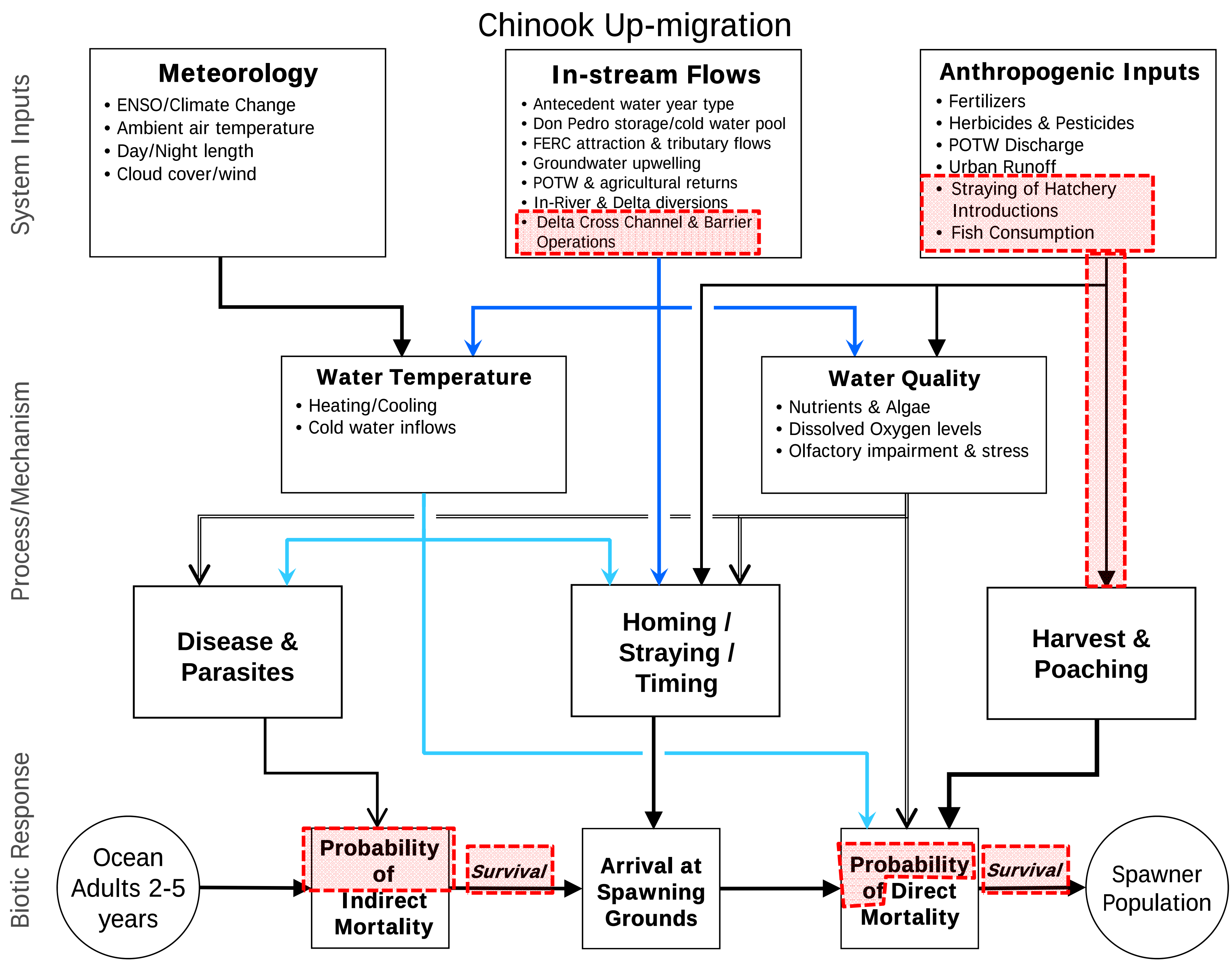
Attachment 2
Revised conceptual model diagrams for
Chinook salmon and steelhead/*O. mykiss*

General Chinook salmon Life History Timing for the Tuolumne River

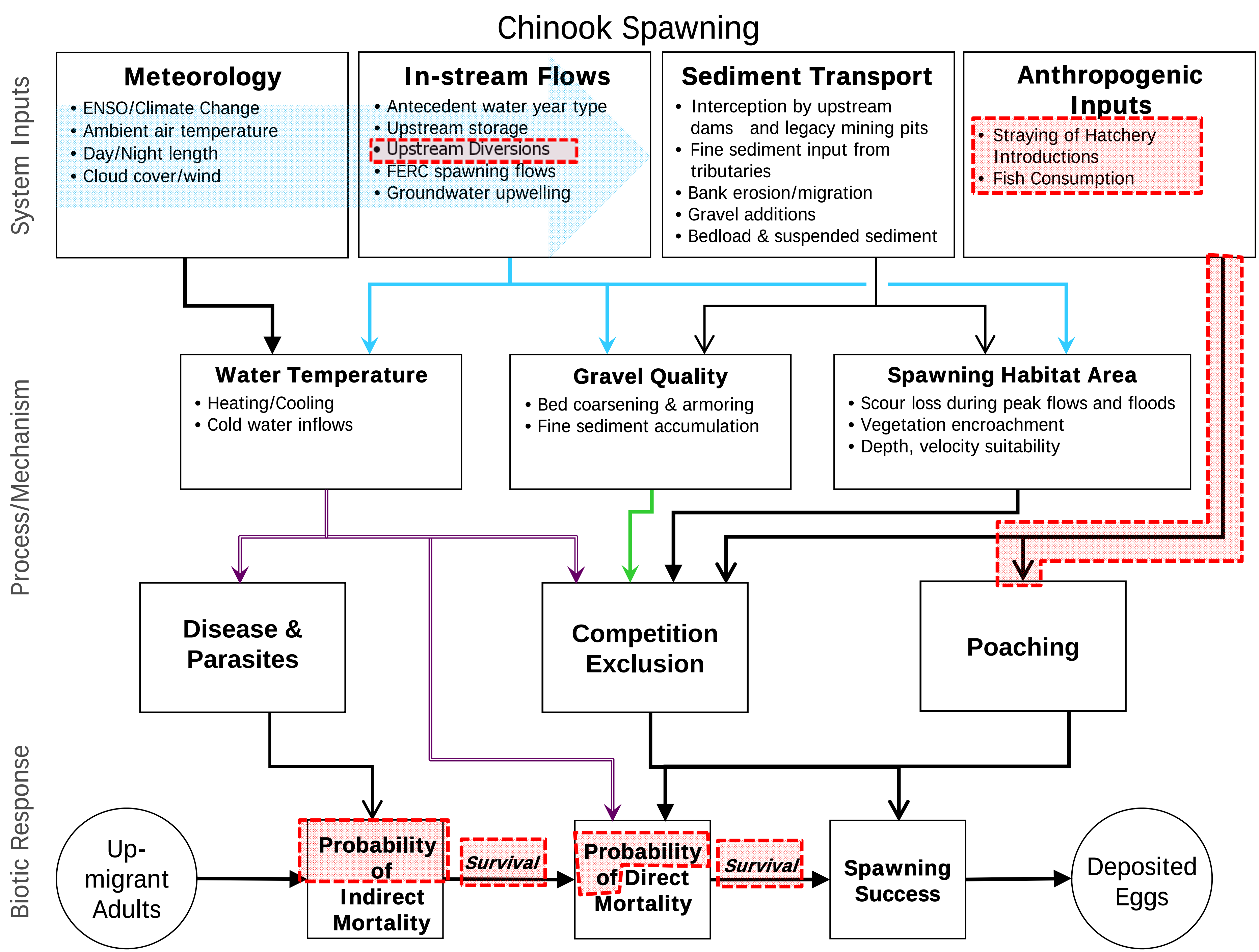


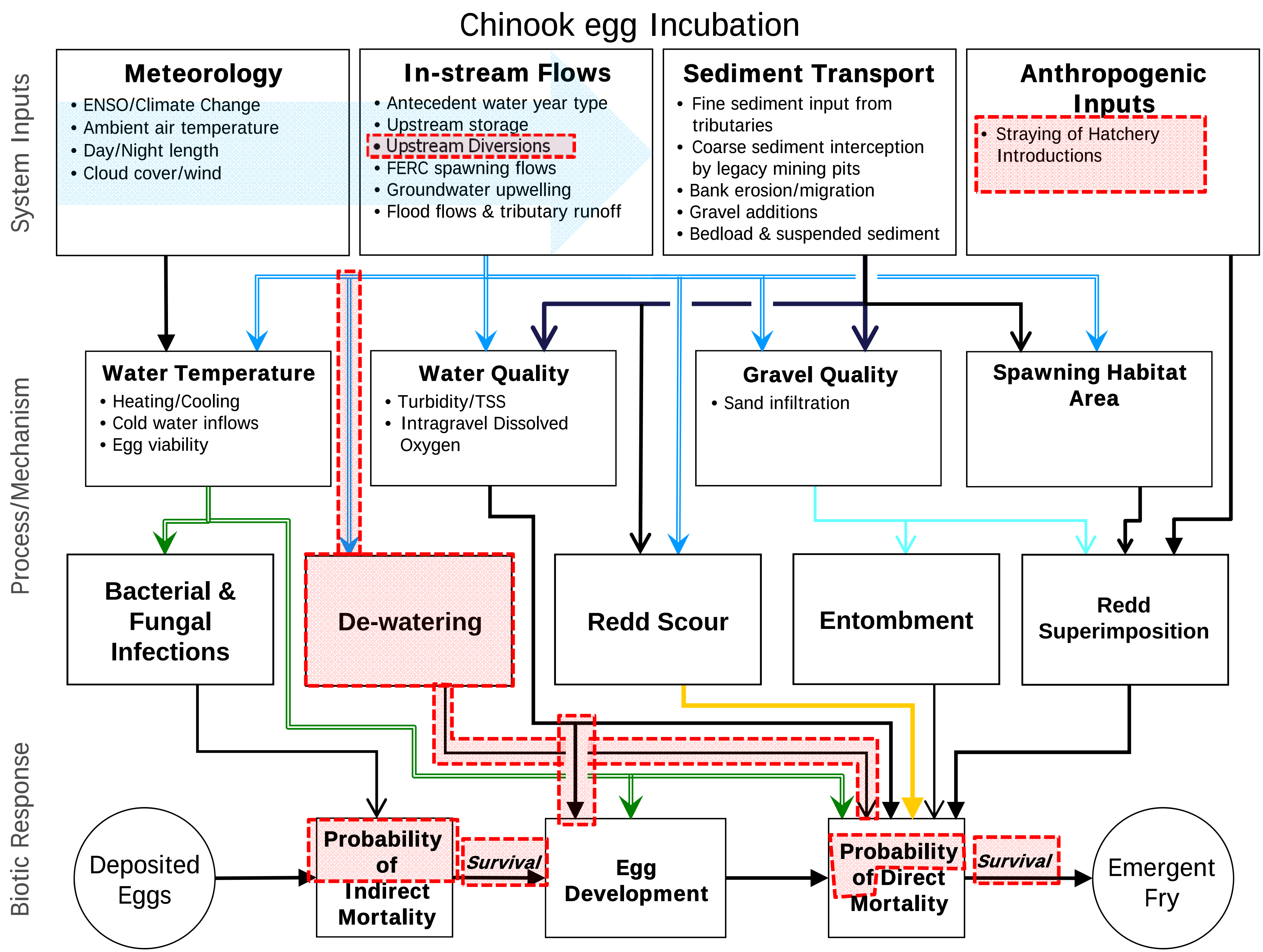
General Chinook salmon Life History Timing for the Tuolumne River

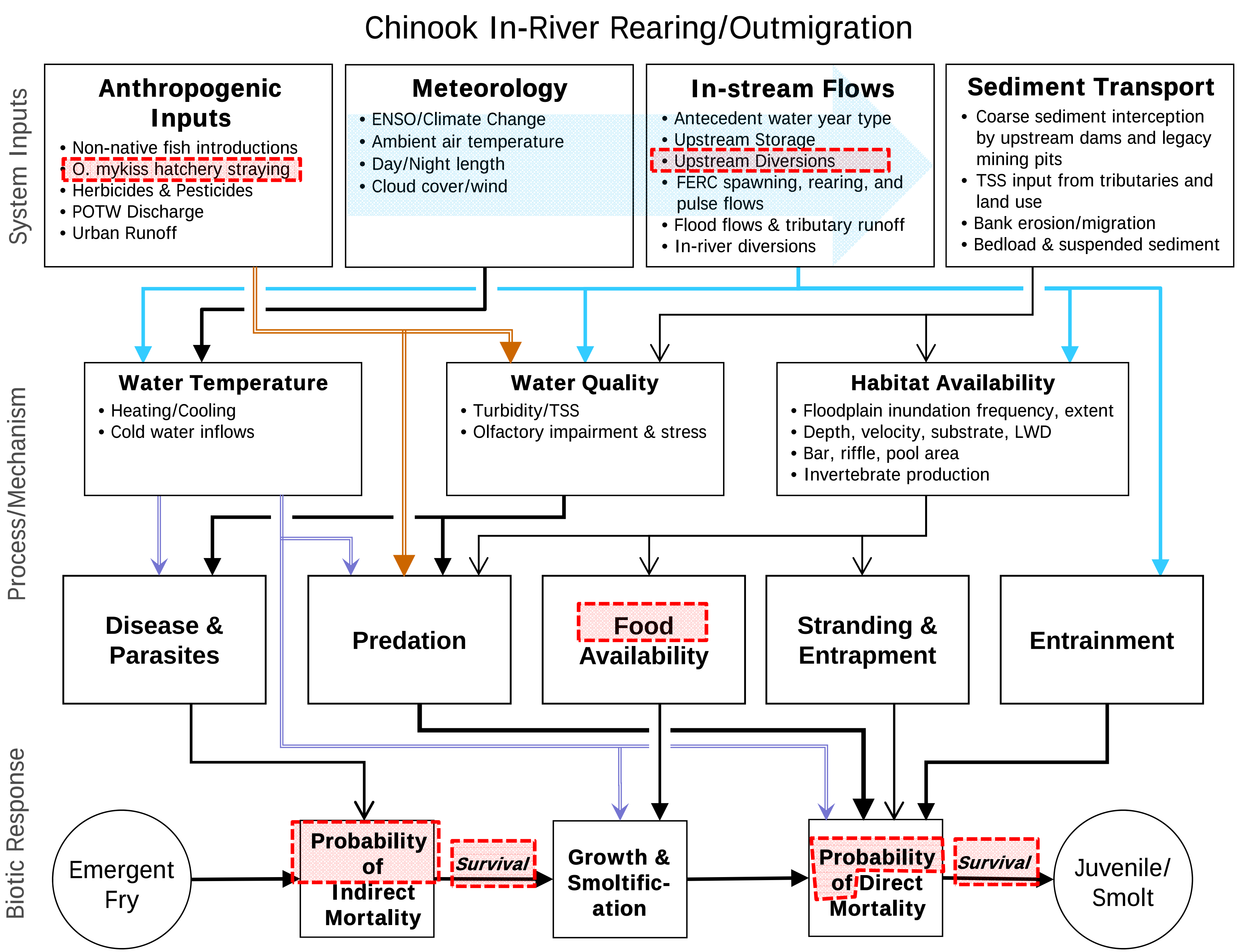
Life Stage	Fall			Winter			Spring			Summer		
	(Sep-Nov)			(Dec-Feb)			(Mar-May)			(Jun-Aug)		
Central Valley Fall-Run Chinook salmon												
Adult upstream migration												
Adult Spawning												
Egg Incubation and Fry Emergence												
In-river Rearing												
Delta Juvenile Rearing												
Smolt Outmigration												



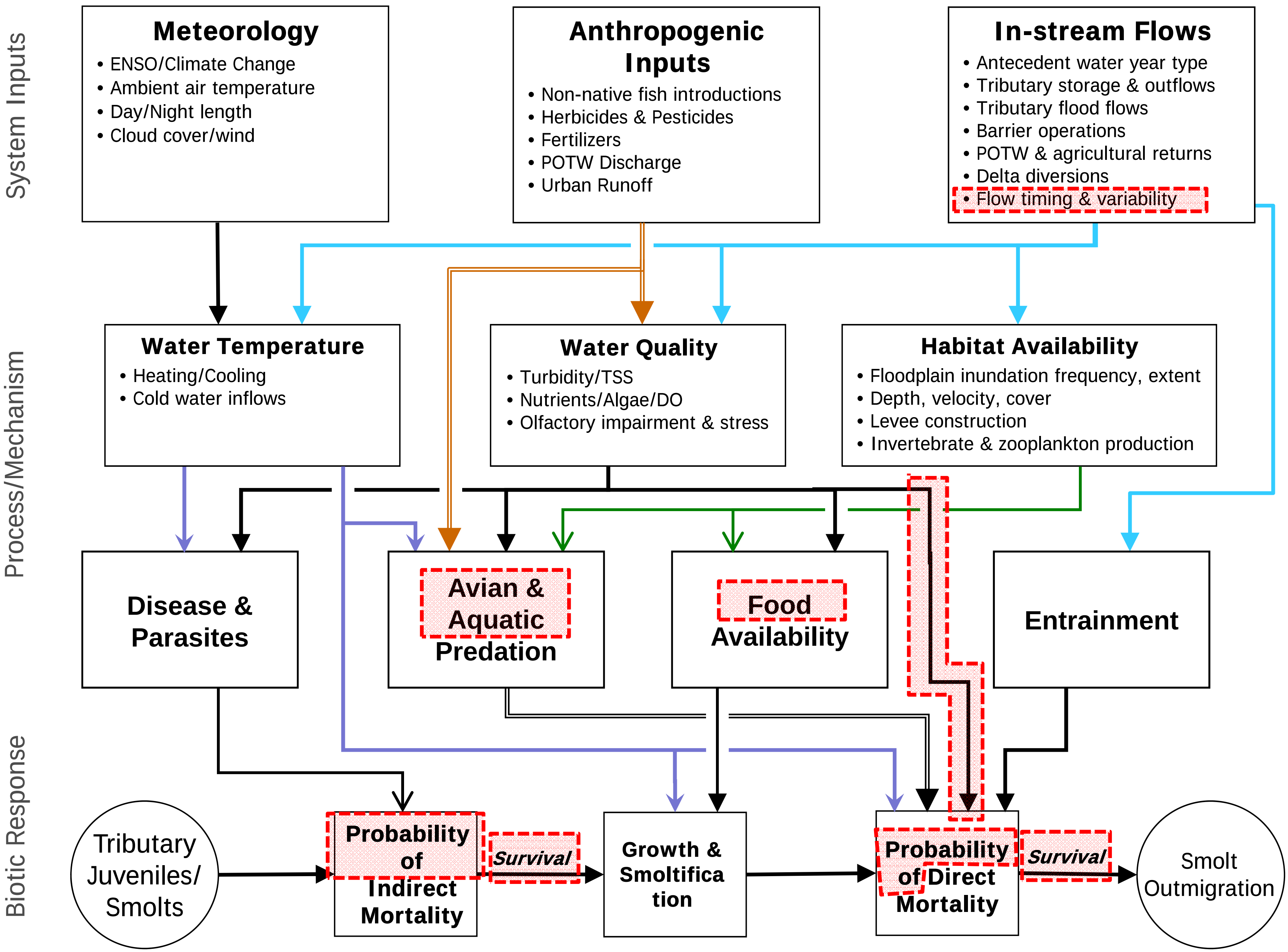
Chinook Up-migration
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Don Pedro storage/cold water pool
• FERC attraction & tributary flows
• Groundwater upwelling
• POTW & agricultural returns
• In-River & Delta diversions
• Delta Cross Channel & Barrier Operations
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Straying of Hatchery Introductions
• Fish Consumption
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Harvest & Poaching
Ocean Adults 2-5 years
Probability of Indirect Mortality
Survival
Arrival at Spawning Grounds
Probability of Direct Mortality
Survival
Spawner Population

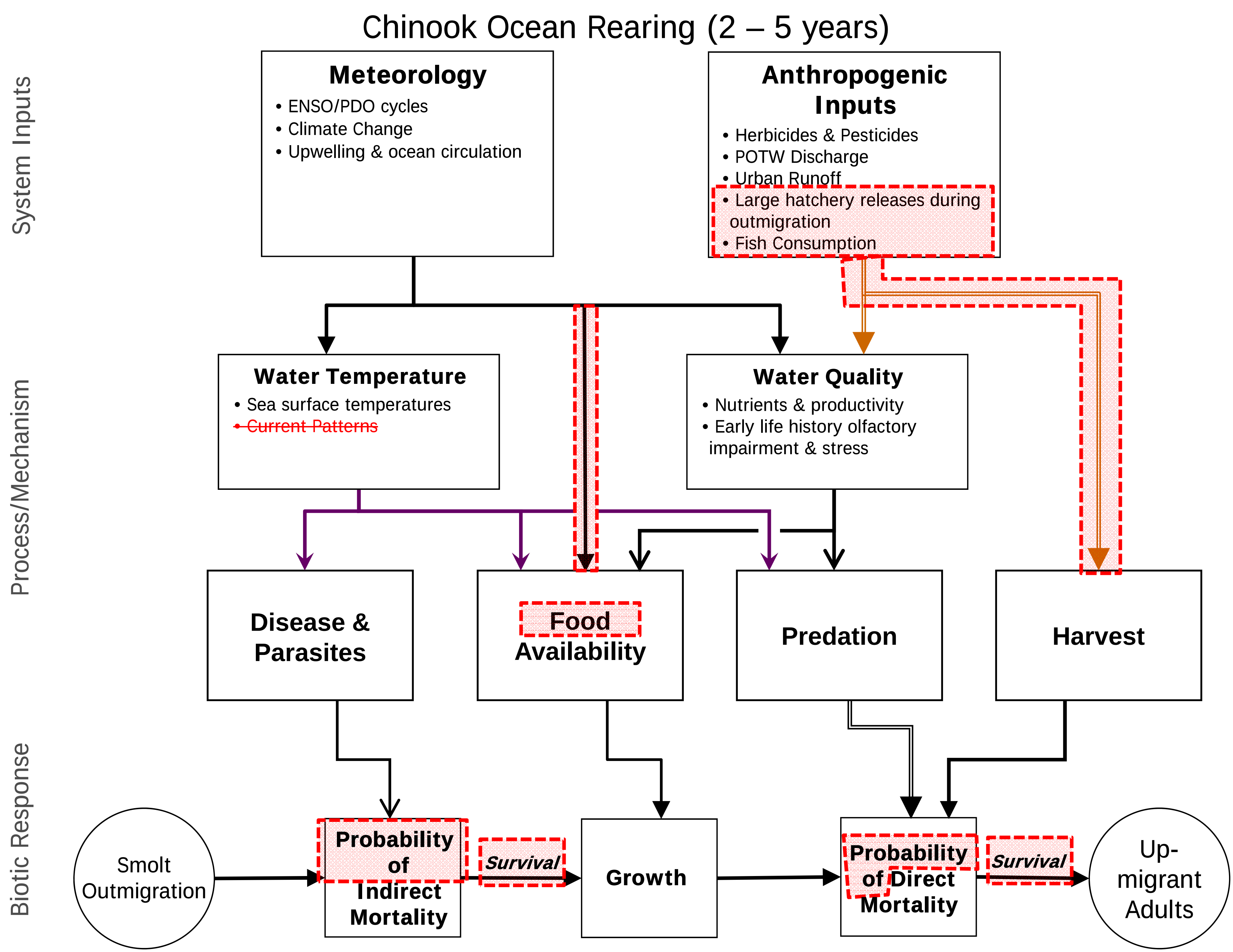

Chinook Spawning
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Upstream Diversions
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Straying of Hatchery Introductions
• Fish Consumption
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Competition Exclusion
Poaching
Biotic Response
Up-migrant Adults
Probability of Indirect Mortality
Survival
Probability of Direct Mortality
Survival
Spawning Success
Deposited Eggs


Chinook egg Incubation
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Upstream Diversions
• FERC spawning flows
• Groundwater upwelling
• Flood flows & tributary runoff
Sediment Transport
• Fine sediment input from tributaries
• Coarse sediment interception by legacy mining pits
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Straying of Hatchery Introductions
Water Temperature
• Heating/Cooling
• Cold water inflows
• Egg viability
Water Quality
• Turbidity/TSS
• Intragravel Dissolved Oxygen
Gravel Quality
• Sand infiltration
Spawning Habitat Area
Bacterial & Fungal Infections
De-watering
Redd Scour
Entombment
Redd Superimposition
Deposited Eggs
Probability of Indirect Mortality
Survival
Egg Development
Probability of Direct Mortality
Survival
Emergent Fry

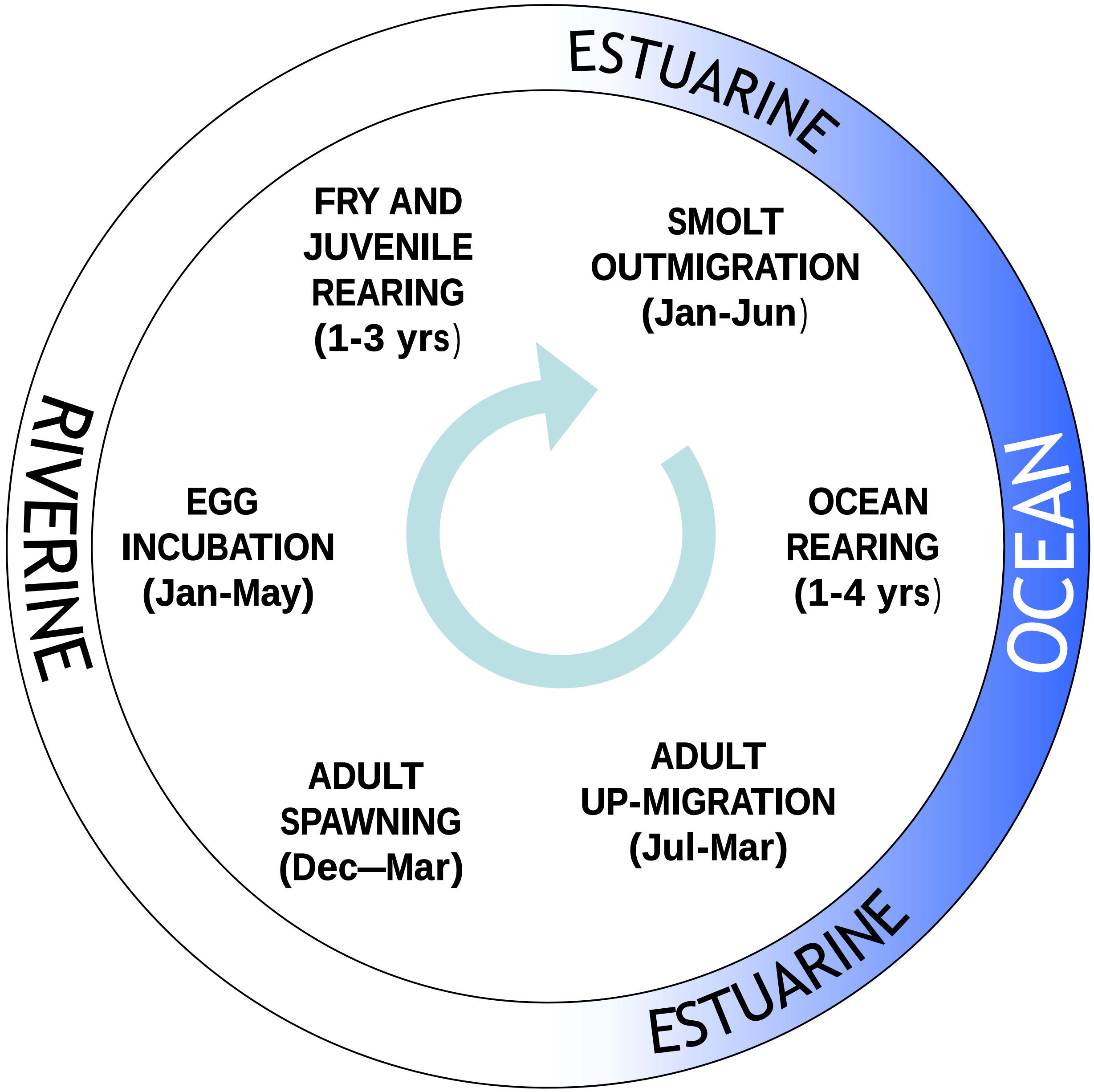

Chinook In-River Rearing/Outmigration
System Inputs
Process/Mechanism
Biotic Response
Anthropogenic Inputs
• Non-native fish introductions
• O. mykiss hatchery straying
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream Storage
• Upstream Diversions
• FERC spawning, rearing, and pulse flows
• Flood flows & tributary runoff
• In-river diversions
Sediment Transport
• Coarse sediment interception by upstream dams and legacy mining pits
• TSS input from tributaries and land use
• Bank erosion/migration
• Bedload & suspended sediment
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate, LWD
• Bar, riffle, pool area
• Invertebrate production
Disease & Parasites
Predation
Food Availability
Stranding & Entrapment
Entrainment
Emergent Fry
Probability of Indirect Mortality
Survival
Growth & Smoltific-ation
Probability of Direct Mortality
Survival
Juvenile/ Smolt

Chinook Delta Rearing/Outmigration



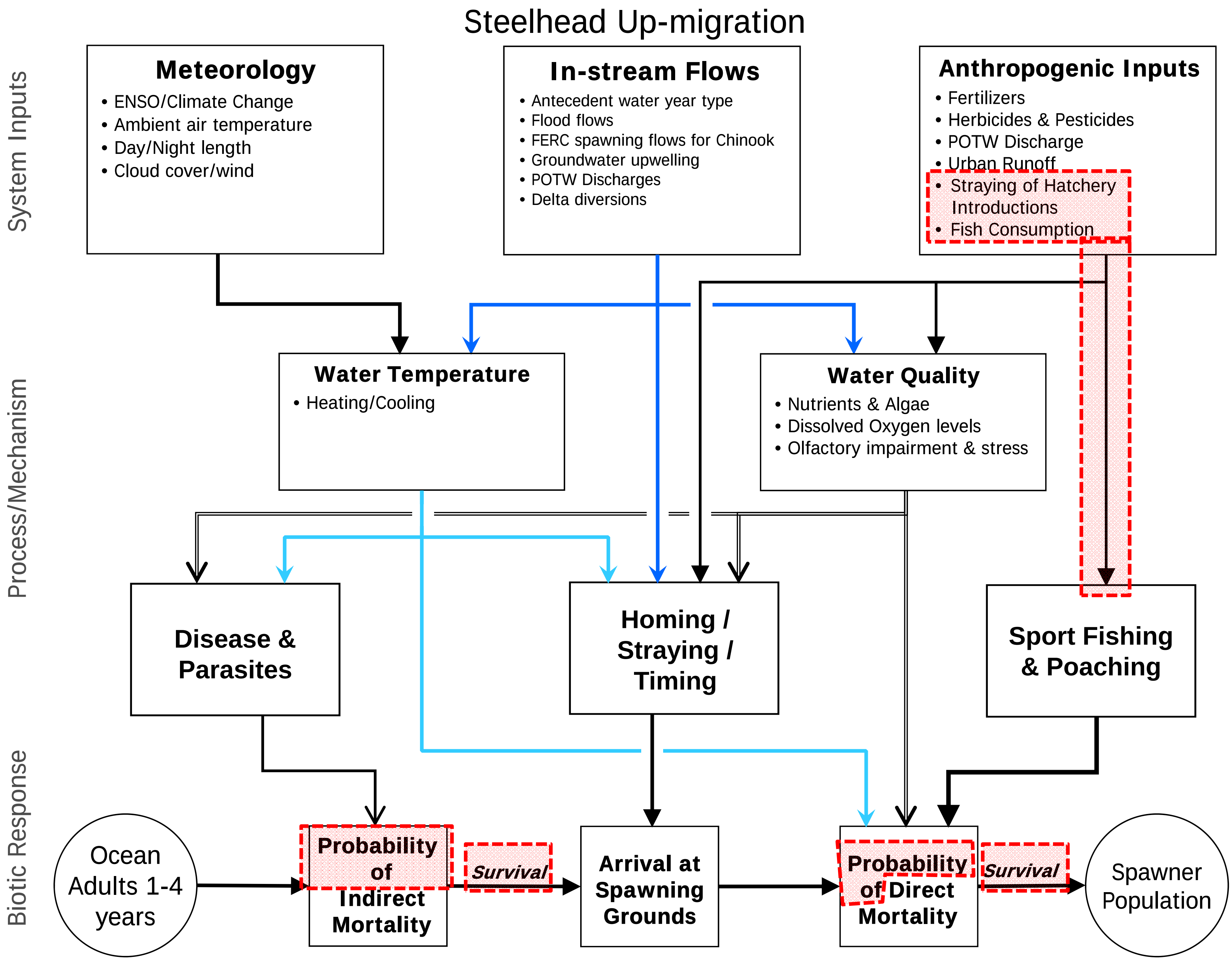

Chinook Ocean Rearing (2 – 5 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Large hatchery releases during outmigration
• Fish Consumption
Water Temperature
• Sea surface temperatures
• ~~Current Patterns~~
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Food Availability
Predation
Harvest
Smolt Outmigration
Probability of Indirect Mortality
Survival
Growth
Probability of Direct Mortality
Survival
Up-migrant Adults

General Steelhead Life History Timing for the Tuolumne River

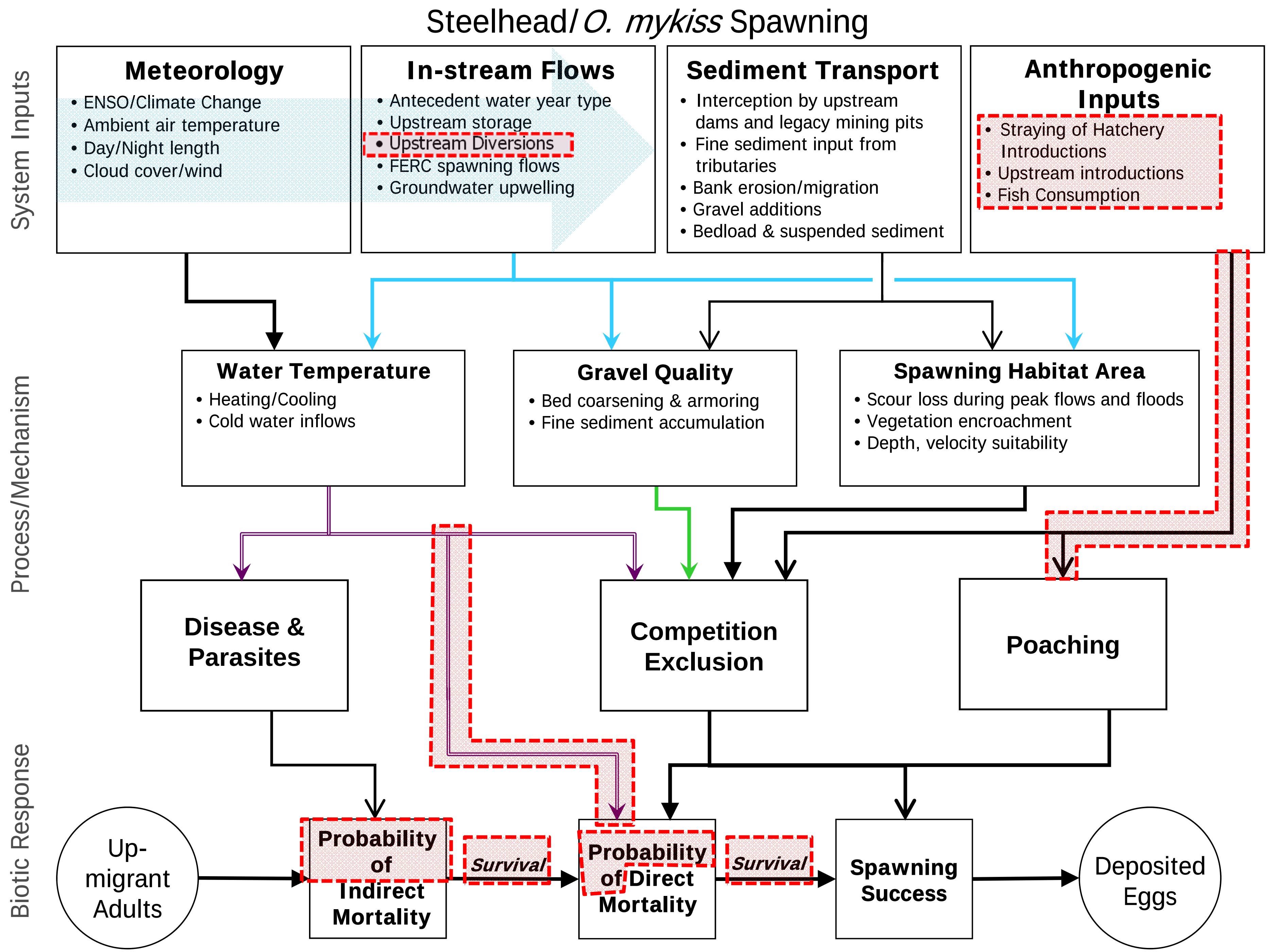


General Steelhead Life History Timing for the Tuolumne River

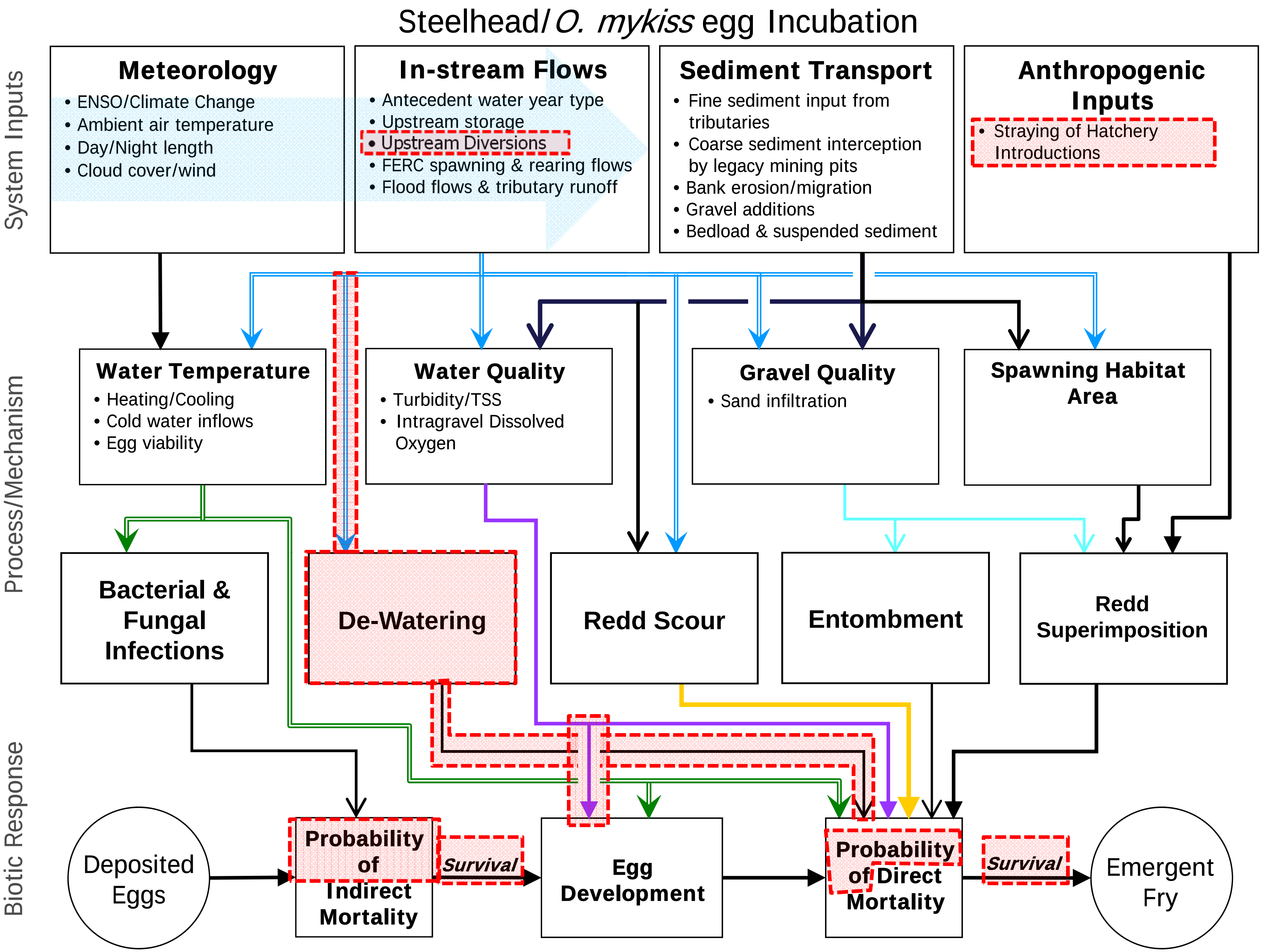
Life Stage	Fall (Sep-Nov)			Winter (Dec-Feb)			Spring (Mar-May)			Summer (Jun-Aug)		
Central Valley Steelhead / *O. mykiss*												
Adult upstream migration												
Adult Spawning												
Egg Incubation and Fry Emergence												
In-River Rearing												
Smolt Outmigration												



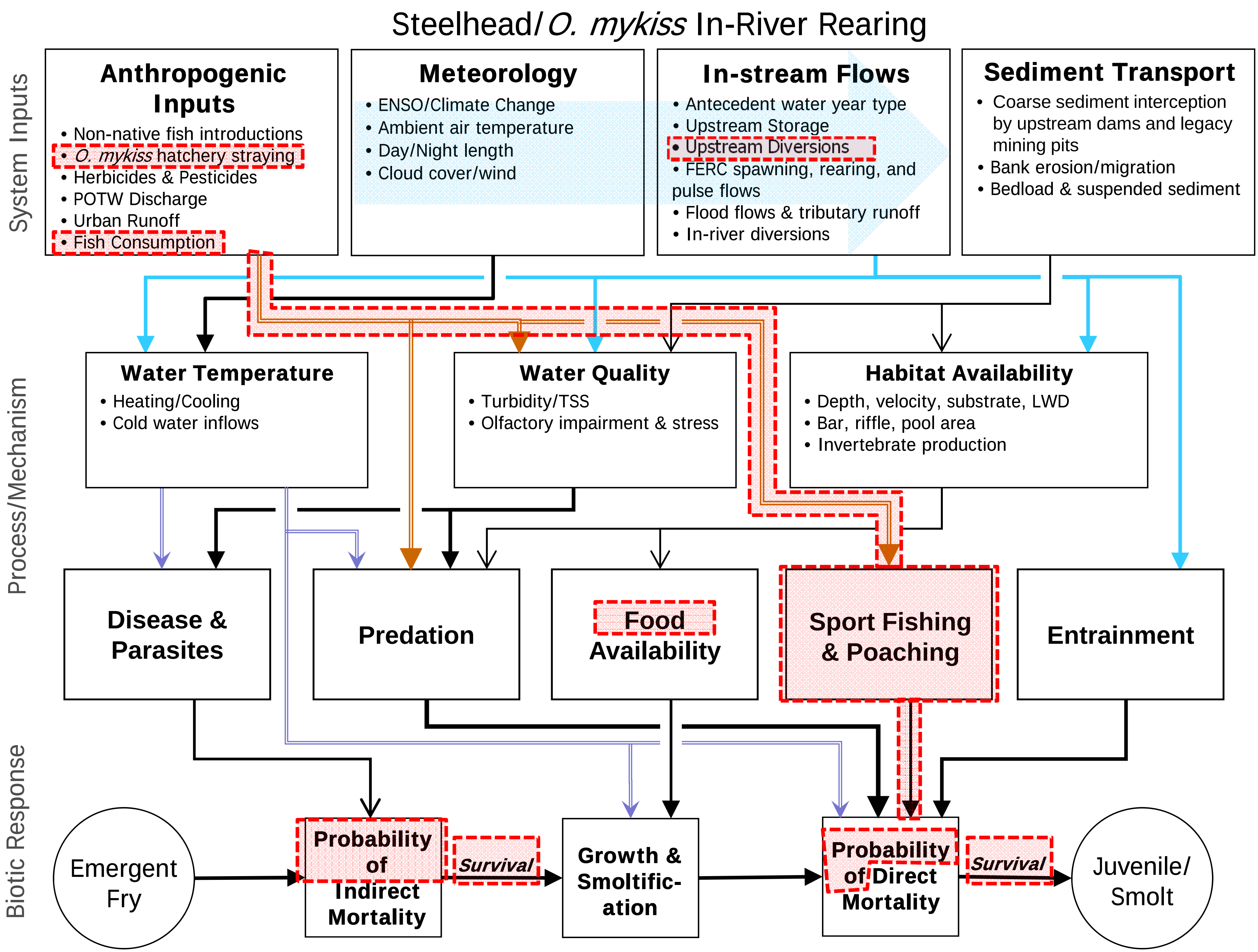
Steelhead Up-migration
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Flood flows
• FERC spawning flows for Chinook
• Groundwater upwelling
• POTW Discharges
• Delta diversions
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Straying of Hatchery Introductions
• Fish Consumption
Water Temperature
• Heating/Cooling
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Sport Fishing & Poaching
Ocean Adults 1-4 years
Probability of Indirect Mortality
Survival
Arrival at Spawning Grounds
Probability of Direct Mortality
Survival
Spawner Population

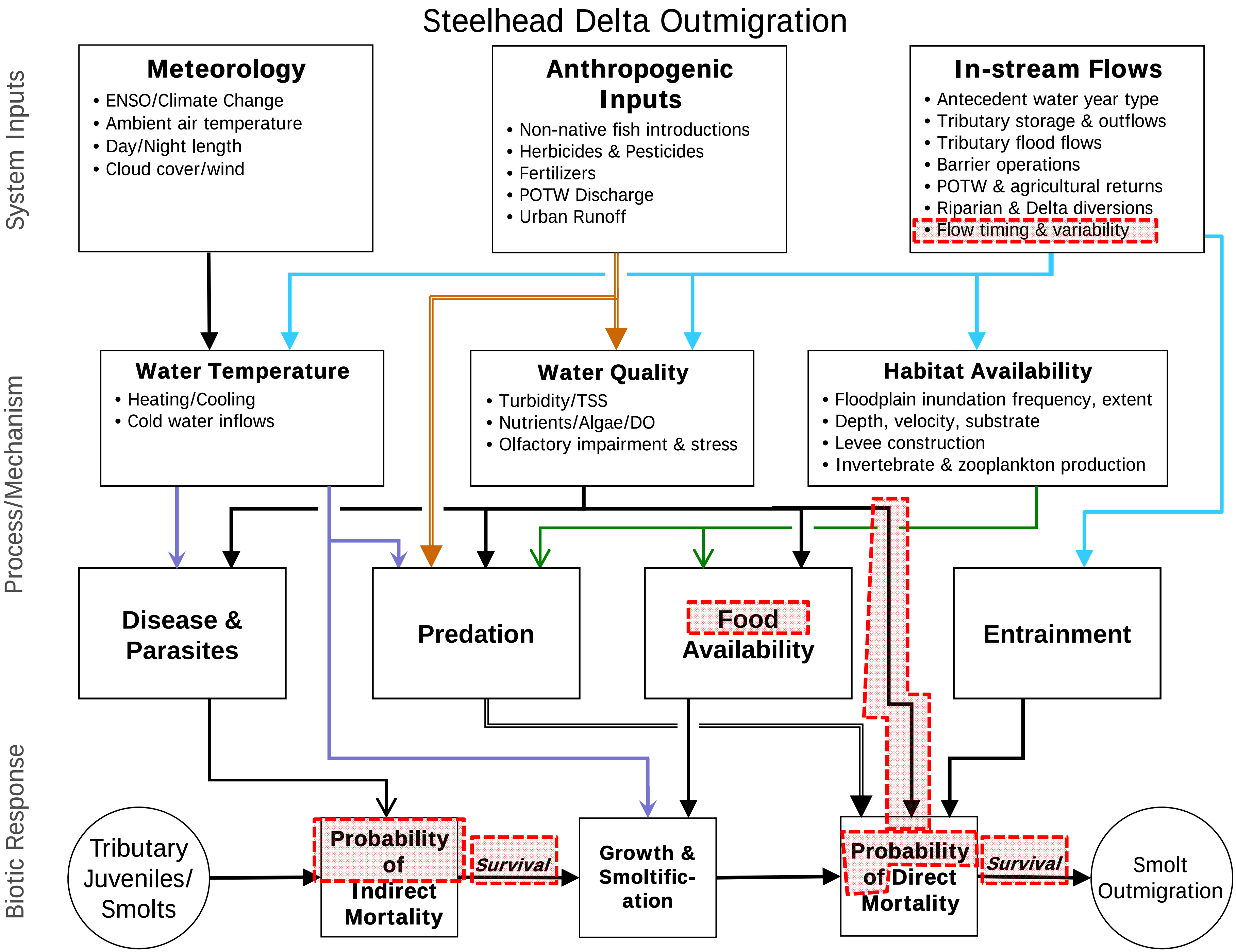


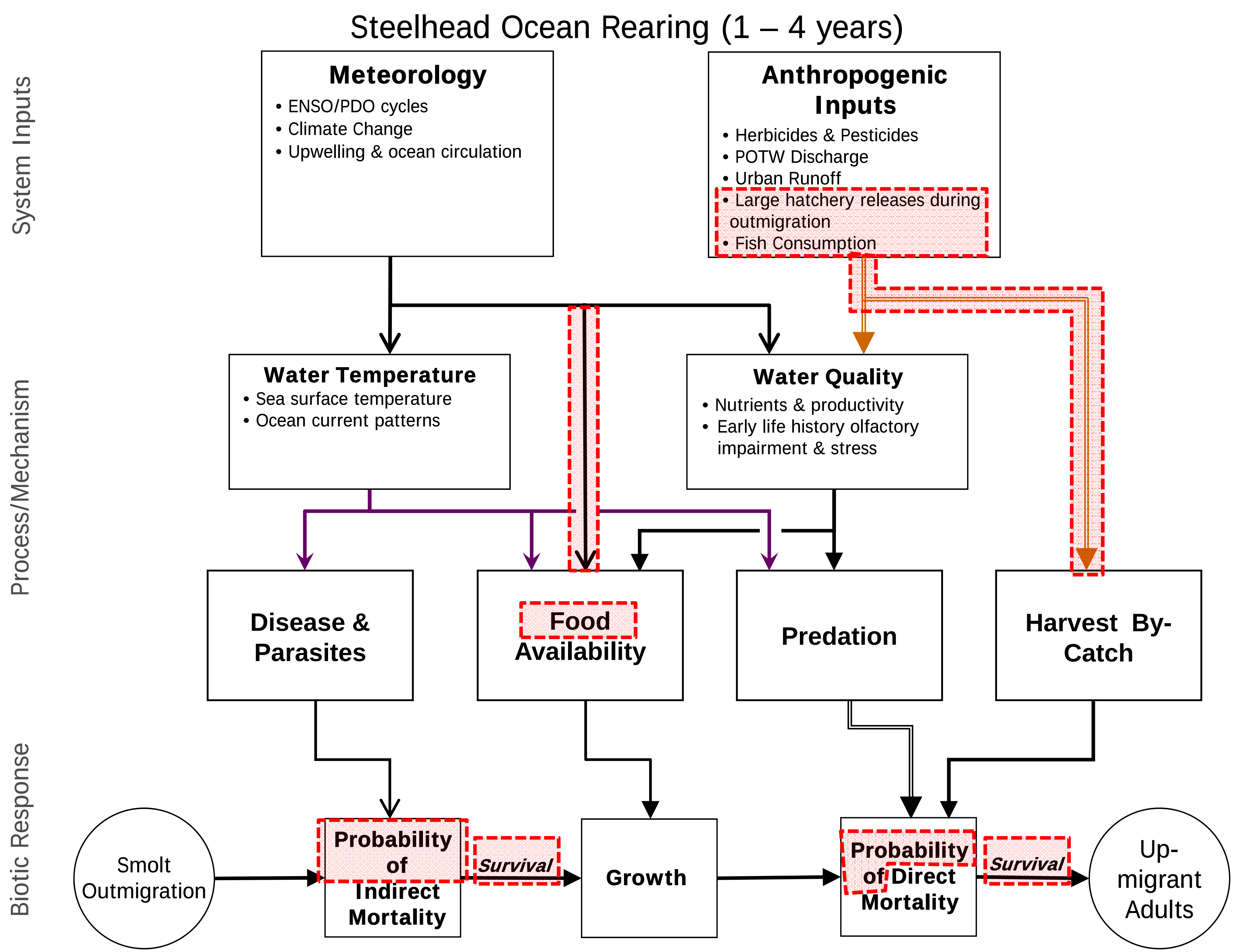
Steelhead/*O. mykiss* Spawning
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Upstream Diversions
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Straying of Hatchery Introductions
• Upstream introductions
• Fish Consumption
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Competition Exclusion
Poaching
Biotic Response
Up-migrant Adults
Probability of Indirect Mortality
Survival
Probability of Direct Mortality
Survival
Spawning Success
Deposited Eggs



Steelhead/O. mykiss egg Incubation
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Upstream Diversions
• FERC spawning & rearing flows
• Flood flows & tributary runoff
Sediment Transport
• Fine sediment input from tributaries
• Coarse sediment interception by legacy mining pits
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Straying of Hatchery Introductions
Water Temperature
• Heating/Cooling
• Cold water inflows
• Egg viability
Water Quality
• Turbidity/TSS
• Intragravel Dissolved Oxygen
Gravel Quality
• Sand infiltration
Spawning Habitat Area
Bacterial & Fungal Infections
De-Watering
Redd Scour
Entombment
Redd Superimposition
Deposited Eggs
Probability of Indirect Mortality
Survival
Egg Development
Probability of Direct Mortality
Survival
Emergent Fry


Steelhead/O. mykiss In-River Rearing
System Inputs
Anthropogenic Inputs
• Non-native fish introductions
• O. mykiss hatchery straying
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Fish Consumption
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream Storage
• Upstream Diversions
• FERC spawning, rearing, and pulse flows
• Flood flows & tributary runoff
• In-river diversions
Sediment Transport
• Coarse sediment interception by upstream dams and legacy mining pits
• Bank erosion/migration
• Bedload & suspended sediment
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Olfactory impairment & stress
Habitat Availability
• Depth, velocity, substrate, LWD
• Bar, riffle, pool area
• Invertebrate production
Disease & Parasites
Predation
Food Availability
Sport Fishing & Poaching
Entrainment
Biotic Response
Emergent Fry
Probability of Indirect Mortality
Survival
Growth & Smoltific-ation
Probability of Direct Mortality
Survival
Juvenile/ Smolt


Steelhead Delta Outmigration
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
Anthropogenic Inputs
• Non-native fish introductions
• Herbicides & Pesticides
• Fertilizers
• POTW Discharge
• Urban Runoff
In-stream Flows
• Antecedent water year type
• Tributary storage & outflows
• Tributary flood flows
• Barrier operations
• POTW & agricultural returns
• Riparian & Delta diversions
• Flow timing & variability
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Nutrients/Algae/DO
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate
• Levee construction
• Invertebrate & zooplankton production
Disease & Parasites
Predation
Food Availability
Entrainment
Biotic Response
Tributary Juveniles/ Smolts
Probability of Indirect Mortality
Survival
Growth & Smoltific-ation
Probability of Direct Mortality
Survival
Smolt Outmigration


Steelhead Ocean Rearing (1 – 4 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Large hatchery releases during outmigration
• Fish Consumption
Water Temperature
• Sea surface temperature
• Ocean current patterns
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Food Availability
Predation
Harvest By-Catch
Smolt Outmigration
Probability of Indirect Mortality
Survival
Growth
Probability of Direct Mortality
Survival
Up-migrant Adults

Attachment 3
On-Screen Notes of Important Factors Affecting Salmonid Life Stages

Preliminary Important Factors Review (6/26/2012) –

Draft WAR-5 Meeting Discussion Notes

Chinook Life Stages	**Information Needed/ other notes**
Up-Migration 1. Seasonal water temperature influences on timing • Include T.R. temp – diff. year types • Trib flow influence on water temps/blockage 2. Seasonal DO blockage in lower S. J. • Comp Plan Recommendation (water board data re: DO, 2001; may not relate DO levels to salmon presence; CDFG may have more data this fall) • May be more or less of an issue in different years/flushing flows (e.g., Chen?) • Priority level difficult to know without review of data	**Up-Migration** *Attraction Flows* (CDFG – tag data, etc, testimony citations – need specific page numbers/part of record to demonstrate issue) *Inland Harvest and Poaching*
Spawning **1.** Spawning area availability **2.** Gravel quality • Site specific velocity, depth, upwelling • IFIM study results • WAR-4 mapping results • WAR-8 Redd Mapping **3.** Water Temp pre-spawn mortality (not T.R. specific info.; CDFG may have data)	*Other spawning bed characteristics (vel. ,slope, etc)* *Post-project assessment* of CFDG gravel augmentation study (follow-up docs)

Egg Incubation 1. Temperature/incubation rates 2. Redd superimposition at high run sizes 3. Entombment due to fine sediment 4. Redd de-watering due to changes in flow	*Water temp mortality* – have not seen in T.R. (USFWS has Merce study, reference in the study request for incubation; also study on-going on the Merced – being conducted this fall; USFWS study with the San j. prelim report) Spawning reports from Stan and Calvaris, American and Sacramento (CDFG data? FishBio data?)
In-River Rearing/Out-migration **1.** Predation – water temp and habitat availability for predators • Floodplain inundation and predator avoidance (addressed by pulse flow report) • WAR-7 Predation Study **2.** Prey availability (Habitat availability) • Floodplain food production (? – Yolo bypass studies, do not have specific T.R. info,/may not be applicable to T.R.; USFWS – size data specific to T.R. in diff. water year types – mechanisms may not be clear; hatch data inferences?) 3. Water Temp mortality (?) • Lack of smoltification (Mesick? 2010 or 2011)	Water temp relationship to food availability Floodplain food production Technical Memo (Bureau in draft) Denver Tech Center – floodplain restoration goals (in draft) Rich (2007)

<u>Delta Rearing/Out-migration</u> **1.** Entrainment • Loss of direction/reverse flows • Direct • Tributary flow magnitude and timing • Level of export pumping rates **2.** Predation • Habitat availability • Temp conditions • Hydraulic conditions/reverse flows/barrier operations/predation hotspots **3.** Water Temperature **4.** Prey/Food Availability	
<u>Ocean Rearing</u> 1. Food availability – meteorology/ocean conditions 2. Harvest – numbers of fish entering 3. Predation – marine mammals, etc	

<table>
<tr><th><u>O. mykiss Life Stages</u></th><th><u>Information Needed/
Other notes</u></th></tr>
<tr><td><u>Up-Migration</u>
1. Homing/Straying – instream flows
2. Water temperature blockage (late summer)
3. Delta/in-river sport-fishing/poaching</td><td></td></tr>
<tr><td><u>Spawning</u>
1. Gravel Area
2. Gravel Quality
3. Water temperature suitability</td><td>Little citation support; conceptual</td></tr>
<tr><td><u>Egg Incubation</u>
1. Temperature/incubation rates
2. Temperature related egg mortality from early/late spawners
3. Redd de-watering due to changes in flow
4. Entombment due to fine sediment</td><td></td></tr>
<tr><td><u>In-River Rearing/Out-migration</u>
1. Food availability and growth rate – water temperature
• Area of suitable habitat/Habitat availability (cover, LWD, etc) – spatial distribution/density dependence
2. Age 0+ Predation – water temp/suitability
3. Age 0-3 – water temp mortality
4. Smoltification (?)
• Water temp
• Tributary flow magnitude and timing</td><td>Sport-fishing/poaching – hooking mortality (voluntary reporting 16+)</td></tr>
</table>

<table>
<tr><td><u>Delta Rearing/Out-migration</u>
1. Entrainment
• Loss of direction/reverse flows
• Direct
• Level of export pumping rates
2. Predation
3. Smoltification (?)
a. Water temp
b. Tributary flow magnitude and timing
4. Water Temperature – mortality (?)</td><td>% anadromous vs. resident - factors</td></tr>
<tr><td><u>Ocean Rearing</u>
1. Food availability – meteorology/ocean conditions
2. Predation – marine mammals, etc
3. Harvest bycatch</td><td></td></tr>
<tr><td></td><td></td></tr>
</table>

Action Items:

1. Districts to provide citation support for life stage analysis presented in diagrams.
    - Districts to provide T.R. specific citations for the important issues identified in the workshop tables with the draft workshop notes for RP review and comment.
2. RPs to provide references as referenced during workshop.
3. Districts to provide information basis for distribution/arrival data – Chinook weir data tables. (To be in the study report as data tables.)
4. Next Steps:

WAR-5 Action Items	**Timeline**
Draft Meeting Notes to RPs - Draft meeting notes will include preliminary ranking of issues discussed during meeting	~July 9, 2012
Comments by RPs on Draft Meeting Notes and preliminary ranking of issues	30-days ~August 8, 2012
Districts review comments from RPs on meeting notes and issues. Submit to FERC response to RP comments and revised ranking of issues and meeting notes.	~60-days Early-October 2012
Workshop to Discuss WAR-6 and WAR-10	November 15 and November 16, 2012

Attachment 4
Summary Tables of Key Issues affecting Chinook salmon and steelhead/*O. mykiss*

Revised list of Key Issues affecting Chinook salmon population levels
W&AR-5 Salmonid Information Synthesis Workshop No. 2

Processes / Mechanisms	Time of Year	Initial Assessment of Relative Importance	Geographic source and Notes on Supporting Information			
			Tuolumne	San Joaquin	Other	References/Notes
Adult Upmigration through Sacramento/San Joaquin River Delta and lower Tuolumne River						
Arrival Timing – Blockage/delay in lower San Joaquin River due to water temperature	Sep-Oct	Unlikely	X	X		Water temperature blockage suggested by Hallock et al. (1970). However, Delta water temperatures are largely unaffected by pulse flows from tributaries. Although no Tuolumne data shows variations in arrival timing with flow or water temperature, Del Real and Saldate (2011) show partial relationships on the Mokelumne River.
Arrival Timing – Blockage/delay in San Joaquin River (e.g. Stockton DWSC) due to dissolved oxygen	Sep-Oct	Unlikely		X		No relationship in San Joaquin basin timing other than Hallock et al. (1970) tracking study before DO improvements at Stockton (Newcomb and Pierce 2010).
Homing/Straying – Attraction flows to improve tributary homing fidelity and spawner returns	October	Inconclusive	X	X		Although no data are available to assess homing on the Tuolumne River a broad relationship of San Joaquin vs. Sacramento straying with flow (Mesick 2001).
Spawning in the lower Tuolumne River						
Spawning Area Availability	Oct-Dec	Inconclusive	X			Evidence of competition for suitable spawning areas and exclusion of spawners at high escapement levels (TID/MID 1992, Appendix 6; TID/MID 1997, Reports 96-5 and 96-7). Gravel losses at upstream spawning riffles during flood of January 1997 (McBain & Trush 2004) may have resulted in increased competition for available spawning areas.
Spawning Gravel Quality	Oct-Dec	Inconclusive	X			Although prior reports suggest competition for suitable spawning areas may occur in some years with higher escapement levels (TID/MID 1992, Appendix 6; TID/MID 1997, Reports 96-5 and 96-7), previous gravel ripping experiments to improve gravel quality did not result in increased spawning activity (TID/MID 1992, Appendix 11). Chinook salmon are able to spawn in a wide range of gravel sizes (Kondolf and Wolman 1993).

Pre-spawn mortality due to Water Temperature	Sep-Oct	Unlikely		X	X	Low levels of pre-spawn mortality has been documented in the Stanislaus River (Guignard 2006). Pre-spawn mortality is typically associated with early arriving spawners.
Egg Incubation and larval development in the lower Tuolumne River						
Incubation rate due to Water Temperature	Oct-Jan	Yes	X	X	X	Water temperature exposure history is routinely used to predict emergence timing of Chinook salmon fry (TID/MID 2007, Report 2006-7) as well as in prior Tuolumne River population models (Jager and Rose 2003).
Redd superimposition egg mortality	Oct-Jan	Inconclusive	X			Previous studies (TID/MID 1997, Reports 96-5 and 96-6, TID/MID 1992, Appendix 2) suggest that redd superimposition has the potential to increase density dependent egg mortality and delayed fry emergence at moderately high escapement.
Gravel quality associated egg mortality and fry entombment	Oct-Jan	Inconclusive	X	X		Although fine sediment intrusion was suggested to contribute to mortality in prior survival-to-emergence modeling and redd trapping (TID/MID 1992, Appendix 8; TID/MID 2001, Report 2000-7), intra-gravel water quality measurements found suitable DO on the Tuolumne (TID/MID 2007, Report 2006-7) and Stanislaus Rivers (Mesick 2002). Excavations documenting very low rates of entombment (TID/MID 1992, Appendix 7; TID/MID 2007, Report 2005-7) as well as the recent (2007) completion of a sedimentation basin on Gasburg Creek, suggest low entombment mortality risk due to fine sediments..
Redd de-watering due to changes in flow	Oct-Jan	No	X	X		Because of FERC (1996) requirements for steady spawning flows, redd dewatering is not considered to contribute to high rates of direct mortality.
In-River Rearing, juvenile and smolt emigration from the lower Tuolumne River						
Predation – Water Temperature and habitat for Introduced Species	Feb-Jun	Yes	X			In addition to in-channel mining (McBain & Trush 2000), predator distribution (Brown and Ford 2002), year class success (McBain & Trush and Stillwater Sciences 2006), smolt survival (TID/MID 2003, Report 2002-4), and relative habitat suitability of salmon and predators (McBain & Trush and Stillwater Sciences 2006, Stillwater Sciences 2012b) vary with flow and water temperature.
Growth – Prey/Food within available habitat area.	Jan-Jun	No	X	X		BMI monitoring (e.g., TID/MID 1997, Report 96-4; TID/MID 2003, Report 2002-8) and smolt evaluations (Nichols and Foott 2002) suggest adequate food supply. Growth rate estimates from multiple seine surveys (TID/MID 2012, Report 2011-3) are within the range reported by Williams (2006) for Central Valley Chinook.
Mortality – Water Temperature	Apr-Jun	Unlikely	X	X		Temperature or predation mortality suggested by reduced juveniles in summer and fall surveys (TID/MID 2011, Report 2010-5). Although water temperatures are below thresholds in Myrick and Cech (2001) during springtime rearing and emigration and no mortality events have been reported, critical thermal maxima may be exceeded at downstream locations in the Tuolumne and San Joaquin Rivers in late Spring (TID/MID 1992, Appendices 17, 19, and 21).

Smoltification – Water Temperature	Mar-Jun	Unlikely, except in late spring	X	X		Although elevated water temperatures may delay or impair smoltification (Marine 1997), water temperatures are generally suitable during in-river rearing and emigration periods. Smolt evaluations (Nichols and Foott 2002) suggest adequate food supply.
Delta Rearing and smolt emigration from the Sacramento/San Joaquin River Delta						
Entrainment due to instream diversions and Delta Exports	Jan-Jun	Yes		X		Kimmerer et al (2008) shows salvage losses of Chinook salmon at the CVP and SWP increases with increasing proportion of exports to Delta outflow. Pre-screen losses of 63–99% for all fish entrained into the forebay (Gingras 1997).
Predation – Water Temperature and habitat for Introduced Species	Feb-Jun	Yes		X		Predation has been documented in both near shore (Nobriga and Feyrer 2007) and open water habitats (Lindley and Mohr 2003) as well as in Clifton Court Forebay (Gingras 1997).
Mortality – Water Temperature	Apr-Jun	Yes, in late Spring		X		Temperatures associated with increased mortality (Myrick and Cech 2001) are routinely found in the South Delta by mid-May. Baker et al. (1995) show water temperature explains much of the variation in Delta smolt survival study results.
Smoltification – Water Temperature	Mar-Jun	Yes		X		Although high growth rates of juveniles reared in the Delta (Kjelson et al. 1982) and on floodplains (Sommer et al 2001) are associated with higher water temperatures as compared to upstream habitats, elevated water temperatures may delay or impair smoltification (Marine 1997) and subsequent ocean survival of fish reared in the Delta.
Growth – Prey/Food within available habitat area.	Jan-Jun	Yes		X		Food web changes (Durand et al. 2008) and low growth rates (MacFarlane and Norton 2002; Kjelson et al. 1982) suggest limited food supplies in the Delta.
Ocean Rearing						
Food availability – meteorology/ocean conditions	Year-round	Yes		X	X	PDO and ENSO influence coastal productivity and salmon abundance (MacFarlane et al. 2005; Mantua and Hare 2007). Central Valley as well as Southern Oregon/ Northern California Coastal Chinook Salmon growth are dependent on prevailing coastal conditions for their growth (MacFarlane and Norton, 2002; MacFarlane, 2010; Lindley et al, 2009; Wells et al. 2007). Hatchery releases may result in density-dependent competition for food resources during early ocean rearing (Ruggerone et al. 2010).
Harvest – numbers of fish entering	Apr-Oct	Yes		X	X	Central Valley stocks have been exploited at average rates of more than 60 percent and selecting for larger fish for many years, a pattern that may reduce fish size and fecundity (Lindley et al. 2009, NMFS 2006).
Predation – marine mammals, etc.	Apr-Oct	Inconclusive			X	Avian predation in San Francisco Bay (Evans et al. 2011) as well as pinniped predation along the California coast (Scordino 2010) has been documented but population-level impacts have not been assessed.

Revised list of Key Issues affecting steelhead/*O. mykiss* population levels
W&AR-5 Salmonid Information Synthesis Workshop No. 2

Processes / Mechanisms	Time of Year	Initial Assessment of Relative Importance	Geographic source and Notes on Supporting Information			
			Tuolumne	San Joaquin	Other	References/Notes
Adult Upmigration through Sacramento/San Joaquin River Delta and lower Tuolumne River						
Homing/Straying – Instream flows	Sep-Feb	Inconclusive	X	X	X	Because homing is related to olfaction (Dittman and Quinn 1996), CVP/SWP flows, tributary attraction and flood flows all potentially affect the numbers of Tuolumne River upmigrants. Approx. 1,300 cfs flow limit on RM 24.5 counting weir operation preclude assessment of this issue under flood conditions.
Water temperature blockage (late summer)	Sep-Oct	Unknown/ Unlikely	X	X	X	Since 2009, few upmigrant *O. mykiss* arrived earlier than October (TID/MID 2012, Report 2011-4) when water temperatures could be high.
Delta/In-river sport-fishing/Poaching	Sep-Oct	Unknown/ Unlikely		X		Annual fishing report cards (Jackson 2007) do not provide data to quantitatively assess hooking mortality or other sportfishing impacts, and no data are available to evaluate potential impacts of poaching.
Spawning in the lower Tuolumne River						
Spawning Area Availability	Dec-Mar	Inconclusive	X			Steelhead/*O. mykiss* spawning has not been documented (TID/MID, Report 2011-2). Current *Spawning Gravel Study* (W&AR-4) provides spawning habitat area estimates. *Redd Mapping Study* (W&AR-4) may document spawning use. Ongoing IFIM study (Stillwater Sciences 2009b) will estimate habitat maximizing flows.
Spawning Gravel Quality	Dec-Mar	Inconclusive	X			Spawning gravels are larger on Tuolumne River than typically used by steelhead/ *O. mykiss* (McBain & Trush 2004, Kondolf and Wolman 1993). Current *Redd Mapping Study* (W&AR-8) will examine gravel sizes at any spawning sites.
Water Temperature Suitability	Dec-Mar	Unlikely	X			Steelhead spawning generally occurs December through April (NMFS 2009), so water temperature is unlikely to affect spawning success.

Egg Incubation and larval development in the lower Tuolumne River						
Temperature/incubation rates	Jan-May	Yes	X			Myrick and Cech (2001) provide simple models of egg incubation with water temperature.
Temperature related egg mortality from early/late spawners	Jan-May	Unlikely	X			Intragravel temperatures during in winter 1991 ranged between 11–15°C (51–58°F)(TID/MID 1997, Report 96-11). Low mortality potential earlier than April.
Redd de-watering due to changes in flow	Jan-May	Unlikely	X			Steelhead/*O. mykiss* spawning has not been documented (TID/MID, Report 2011-2) and likelihood of spawning under flood flows subject to flow reductions is low.
Entombment due to fine sediment	Jan-May	Unlikely	X			Based upon suitable intra-gravel dissolved oxygen and the absence of entombment in Chinook salmon survival-to-emergence studies (TID/MID 2001, Report 2000-7), steelhead/*O. mykiss* egg/alevin entombment mortality is unlikely.
In-River Rearing, juvenile and smolt emigration from the lower Tuolumne River						
Food availability and growth rate – water temperature	Year-round	Likely	X	X	X	Although BMI monitoring (TID/MID 1997, Report 1996-4; TID/MID 2003, Report 2002-8; TID/MID 2005, Report 2004-9; TID/MID 2009, Report 2008-7) show consistently high densities of salmonid prey organisms, increased Age 0+ and Age 1+ fish densities and distribution since increased flows under FERC (1996) order suggest temperature related rearing habitat limitation during summer. Prior modeling combining water temperature suitability (Stillwater Sciences 2003) suggests habitat maximizing flows for larger fish (300–350 cfs) may limit juvenile habitat (maximized at 150–200 cfs).
Age 0+ Predation – water temperature/suitability	Year-round	Unlikely in most conditions	X			Predator distribution (Brown and Ford 2002) and relative habitat suitability with Age 0+ steelhead/*O. mykiss* (McBain & Trush and Stillwater Sciences 2006; Stillwater Sciences 2012b) suggest low risk of encounter in most conditions.
Age 0+ and Age 1+ water temperature related mortality	Apr-Oct	Likely in downstream habitats	X	X		Mortality due to water temperature or predation is suggested by reduced numbers of over-summering Age 0+ steelhead/*O. mykiss* in years with multiple surveys. Temperatures generally below thresholds in Myrick and Cech (2001) in upstream habitats used by Age 1+ fish, but increased probability of mortality downstream of Roberts Ferry Bridge (RM 39.5) where Age 0+ fish have been observed.
Smoltification – Water Temperature	Mar-Jun	Yes			X	Stable flows and temperatures in summer may select for a largely residential life history (T.R. Payne and S.P. Cramer 2005).
Delta Rearing and smolt emigration from the Sacramento/San Joaquin River Delta						
Entrainment due to instream diversions and Delta Exports	Jan-Jun	Likely		X		It is likely that much steelhead outmigration occurs outside of HORB window of April 15th to May 15th in most years. For entrained fish, high rates of pre-screening (78–82 %) estimated by Clark et al. (2009).

Predation – Water Temperature and habitat for Introduced Species	Jan-Jun	No		X		Older steelhead smolts are too large to suffer high predation rates and few steelhead juveniles found in predator stomachs at Chipps Island (USBR 2008).
Smoltification – Water Temperature	Jan-Jun	Unknown/ Unlikely		X	X	Although steelhead smoltification occurs at fairly low temperatures found in primarily in upstream habitats during winter and early spring, temperatures at Vernalis generally range from below 18–21°C (65–70°F) from mid-April to mid-May across a wide range of water years. It is likely that Delta conditions are suitable for smolt emigration as late as June in some years.
Ocean Rearing						
Food availability – meteorology/ocean conditions	Year-round	Yes		X	X	PDO and ENSO influence coastal productivity, but less is known about how steelhead respond to changes in coastal productivity patterns. Atcheson (2010) found age-related influences in steelhead growth at sea with density-dependent factors prevailing after the first year.
Predation – marine mammals, etc.	Apr-Oct	Unknown		X	X	Scordino (2010) reviews monitoring of pinniped predation on Pacific coast salmonids, but does not assess steelhead impacts.
Harvest (Bycatch) – numbers of fish returning	Apr-Oct	Unknown/ Unlikely		X	X	USBR (2008) suggest broad mortality estimates (5–30%) for steelhead may be caught in either unauthorized drift net fisheries, or as bycatch in other authorized fisheries such as salmon troll fisheries.

Attachment 5
Supplemental references provided in Workshop No. 2 notes and Summary Tables of Key Issues affecting Chinook salmon and steelhead/*O. mykiss*

Revised Supplemental References from W&AR-5 Salmonid Information Synthesis Workshop No. 2

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Attachment B
Draft Meeting Notes and Workshop Materials
W&AR-5 Salmonid Information Synthesis Workshop No. 2

Don Pedro Project Relicensing
W&AR-5 Salmonid Information Synthesis Workshop No. 2
Draft Meeting Notes – For Relicensing Participant Review

Tuesday, June 26, 2012

Attendees

Peter Barnes –SWRCB	Mike Maher – SWRCB
Jenna Borovansky – HDR	Ramon Martin – FWS
Steve Boyd – TID	Dan McDaniel – Central Delta Water Agency, *by phone*
John Devine – HDR, *afternoon*	Gretchen Murphy – CDFG
Karl English – LGL, Ltd.	Bob Nees – TID
Donn Furman – CCSF, *by phone*	Tim O'Laughlin – MID, *by phone*
Art Godwin – TID/MID	Bill Paris – MID, *by phone*
Bethany Hackenjos – Stillwater	Bill Sears – CCSF
Jim Hastreiter –FERC, *by phone*	Chris Shutes – CSPA
Noah Hume – Stillwater	Bill Snider – HDR, *by phone*
Zac Jackson – FWS	Nicola Ulibarri – Researcher, Stanford Univ.
Bill Johnston – MID	Joy Warren – MID
Patrick Koepele – Tuolumne River Trust	Scott Wilcox – Stillwater
Annie Manji – CDFG, *by phone*	Ron Yoshiyama – CCSF

Introductions and Background – 9:00 AM to 9:45 AM

1. **Introductions and Purpose**. Jenna Borovansky welcomed relicensing participants (RPs), made introductions, highlighted workshop materials distributed in advance of the meeting (Attachment 1), reviewed the agenda, and described that the overall purpose of the workshop as part of the W&AR-5 study plan was to:
   - continue the process of compiling and summarizing the body of relevant and applicable information and characterize issues affecting Tuolumne River salmonid populations, both in-river and out of basin;
   - review and detail the biology and ecology of fall-run Chinook salmon and steelhead/*O. mykiss*; and
   - share and refine preliminary conceptual models as well as preliminary ranking of factors that appear to be most important for supporting fall-run Chinook salmon and steelhead/*O. mykiss* population levels and individual life-stage progression.

2. **Workshop Consultation Process Overview.** Jenna Borovansky provided an overview of the Workshop Consultation Process for Study W&AR-5:
   - An initial list of data sources was previously distributed for RP comment in January. This list was expanded in advance of Workshop No. 1 and distributed on April 2, 2012 and was further expanded as a result of comments received on Workshop No. 1 comments. The reference list will be further refined to address information needs identified during Workshop No. 2.
   - The purpose of Workshop No. 2 consultation is to gather additional feedback and assistance from RPs in narrowing down the large body of information collected to

date to address the most important factors to be considered in the planned quantitative salmon population models (W&AR-6 and W&AR-10).

- Results of preliminary information reviews were presented with an assessment of relative certainty regarding whether we know a particular factor is affecting salmonid populations, whether we don't know, or whether we just think we know that a particular factor is affecting salmonid populations. RP feedback on these factors and additional references was solicited.
- An outline of information to accompany the meeting notes included Action Items, specific areas of any agreements or disagreements, as well as any changes to the Preliminary Conceptual Models and Ranking of Issues presented as part of Workshop No. 2.

3. **Relationship with other Studies**. Jenna Borovansky described the interrelationship of Study W&AR-5 with the quantitative population model development included in the W&AR-6 and W&AR-10 studies.

4. **Review of Workshop No. 1 Comments and Status of Responses**. Jenna Borovansky provided an overview of the status of Workshop No. 1 notes and comments submitted by RPs as part of the overall workshop consultation process for Study W&AR-5:
   - Draft Workshop No. 1 notes were prepared and distributed to RPs on April 20, 2012 in accordance with the established Workshop Consultation Process.
   - CDFG, UWFWS, and the Conservation Groups provided comments and additional data sources to be considered.
   - RP comments and Workshop No. 1 notes were filed with FERC on June 18, 2012 in accordance with the established Workshop Consultation Process.
   - Additional literature and data provided by RPs is currently being reviewed for primary data sources for potential inclusion in the study report.

Preliminary Conceptual Model Presentation – 9:45 AM to 12:00 PM

Noah Hume provided an overview of the Study Plan W&AR-5 he re-stated the purpose of the conceptual modeling exercise to identify relevant factors that may affect salmonid life-history progression throughout the species range from the Tuolumne River, Delta, and Ocean. He described that the day would be separated into: 1) a morning presentation of the preliminary conceptual models (Attachment 1) discussing various physical and biological processes and mechanisms, and 2) an afternoon discussion focused on ranking the preliminary issues affecting individual salmonid life stages.

1. **Primary ecosystem inputs and other factors affecting Tuolumne River salmonids.** Reading from the Conceptual Model Narrative (Attachment 1), Noah Hume described: a) the approach taken in the development of the preliminary conceptual models, b) that the literature review was ongoing, and c) the prioritization given to various information sources, (as presented in Workshop No. 1). The accompanying pictorial models for Chinook salmon and steelhead/*O. mykiss* (Attachment 1) were structured showing primary ecosystem inputs (Meteorology, Instream Flows, Sediment Transport, and Anthropogenic Inputs) at the uppermost level, but the models were organized to examine processes affecting reproduction, growth, direct and indirect mortality from the "bottom-up". He noted that the reason for this approach was the complexity of linkages between ecosystem inputs at the uppermost level and that many factors may be shown to affect particular mechanisms. He further noted that the models were conceptual in nature and that RPs are encouraged to provide feedback on the

relative importance of each factor affecting life history progression. The RPs were also requested to provide information they may have supporting particular conclusions they recommend.

The notes below are organized by the species and life stage structure in the Conceptual Models.

2. **Processes and mechanisms affecting Chinook salmon.** Noah Hume presented the conceptual model on Chinook salmon (Attachment 1) and led a discussion of factors affecting life history progression in the Tuolumne River, Delta, and Ocean, summarizing sources of information used (timing, presence/absence, abundance etc.) for each life stage discussed below. The background information supporting inclusion of individual processes and mechanisms in the conceptual model was also discussed.

Chinook Up-migration

A. Noah Hume stated that some information on arrival timing and hatchery straying in the Tuolumne had been identified, but little to no Tuolumne or basin specific information had been identified regarding pre-spawn mortality due to temperature, disease incidence, poaching, or the effectiveness of attraction flows.

B. Patrick Koepele asked for a list of citations that were used to create the conceptual models. Noah Hume explained that relevant citations will be provided for RP review with the preliminary ranking of issues to be developed in the afternoon session.

C. Annie Manji suggested that dewatering should be included as a possible factor affecting Chinook up-migration per the 2008 dewatering incident pertaining to the La Grange powerhouse tailrace[1]. Noah Hume suggested this mechanism should be added to the Chinook egg incubation life stage and Chris Shutes agreed. However, Noah questioned whether that specific problem needed to be modeled, since precautions are now in place to prevent that problem from occurring again. Annie Manji indicated that potential dewatering due to any mechanism should be considered in the model.

D. Ramon Martin suggested that Delta cross-channel operations be added to the in-stream flow box. The participants agreed, and it was added as a bullet in the model; see revised Chinook Up-migration figure in Attachment 2.

E. Annie Manji discussed that water quantity was missing from the conceptual model. Noah Hume stated that instream flow and attraction flows were part of the ecosystem inputs, and were included at the highest level. He stated that information reviewed to date showed only broad relationships of straying between the Sacramento and San Joaquin River basin hatcheries, and that no analyses to date had shown relationships between straying/homing or timing with the application of tributary attraction flows in the San Joaquin River basin. With regards to a potential water temperature blockage at Stockton

[1] Routine dewatering of the La Grange Forebay in November 2008 resulted in dewatering of several salmon redds found in the tailrace channel by CDFG staff in November 2008. Although notifications of this event were not made to TID or MID until August 2009, the Districts have made procedural changes to provide notifications of maintenance outages to CDFG staff in advance of planned outages.

in early fall, he suggested that meteorological conditions affected water temperatures to a far greater degree than fall pulse flows arriving from upstream dams.

F. Chris Shutes recalled an increase in up-migrant numbers in the Mokelumne in response to increased flow releases. This was confirmed by Ramon Martin, recognizing that 1–2 years of monitoring study had been completed by East Bay Municipal Utilities District (EBMUD), but no specific findings had been reported or published. Noah Hume requested that any relevant information be provided for review of applicability on the Tuolumne River.

G. Ramon Martin stated that FWS recently initiated an adult tracking study of upmigrant Chinook salmon captured at Jersey Point in the San Joaquin/Sacramento River delta. Ramon reported that no specific findings or results have been published to date. Noah requested that any relevant information available be furnished.

Chinook Spawning

A. Noah Hume stated that data and study reports exist regarding the spawning life stage, but no Tuolumne specific information examining pre-spawn mortality due to Temperature, disease incidence, parasites, or poaching incidence are generally available.

B. Ramon Martin suggested that the “Hatchery introductions” language be changed to “Hatchery straying.” The group agreed, and the change was made; see revised Chinook Spawning figure in Attachment 2.

C. Annie Manji asked if blockage of access to upstream spawning habitat should be added to the model. Noah Hume stated that the history of dam construction will be included in the supporting narrative, but that only the loss of sediment transport from upstream supplies had been included as a current process. Potential ongoing effects on spawning habitat area are also in the model. Patrick Koepele pointed out that the current spawning area is limited to the available 26 linear miles of river bed. Noah Hume agreed, but emphasized that the modeling effort was looking at ongoing processes, and that the historical changes in spawning habitat access would be described in the introductory sections of the study report.

D. Zac Jackson thought that the fecundity, size at age, and sex ratios of returning spawners should be incorporated somewhere in the model. Noah Hume suggested that this may best be located as a harvest-related mechanism under Ocean Rearing; see revised Chinook Ocean rearing figure in Attachment 2. Ramon Martin suggested a paper on sex ratios and age-at return for San Joaquin River tributaries[2]. Gretchen Murphy recalled a paper by Bill Loudermilk (CDFG) and Noah Hume requested that this information be provided if located.

Chinook Egg Incubation

A. Noah Hume stated that Tuolumne specific information had been compiled covering superimposition, gravel quality, Intragravel Dissolved Oxygen (IGDO), and other effects,

[2] This was later identified as Mesick et al (2009a).

but said little information was identified covering egg mortality studies in the San Joaquin basin, and no information had been identified stating that egg diseases or parasites are a problem. He noted that redd dewatering would be included in the revised models per Annie Manji's comments under Chinook Up-migration above.

B. Ramon Martin suggested that egg predation by steelhead/*O. mykiss* or other species might be a factor based on anecdotal observations. Noah Hume requested RPs provide any information regarding egg predation and contributing factors to which RPs may have access.

C. Patrick Koepele suggested that the fraction of fertilized eggs be included as a factor. Noah Hume stated that although several egg mortality mechanisms had been identified (e.g., temperature, IGDO, fine sediment, and water quality) he does not have any information on contributing factors to assess potential changes in the fractions of fertilized eggs.

Chinook In-river Rearing

A. Noah Hume described existing information on in-river rearing, including seining and fyke netting, RST monitoring, snorkel surveys, predation studies, and invertebrate studies. No information had been found regarding mortality due to in-river diversions, or disease incidence.

B. Ramon Martin questioned the exclusion of Hetch-Hetchy diversions. Noah Hume suggested a more generic term called "Upstream diversions" be included as a bullet under In-stream Flows; see revised Chinook In-river rearing figure in Attachment 2.

C. Karl English asked for clarification on the geographical extent of the information that will be most useful for development of the conceptual model for the study. Noah Hume explained that, in general, geographically relevant information for in-river rearing includes the San Joaquin mainstem and tributaries upstream from Vernalis.

D. Chris Shutes wondered if there was information on entrainment by agricultural diversions. Noah Hume stated that he has only received information on the numbers and locations of diversions, but nothing on how many fish have been entrained. Ramon Martin said he has seen information on performance of various screen types as well as entrainment numbers (e.g., Patterson and Banta-Carbona) on the San Joaquin River. Noah Hume requested any available information be provided for use in the model development.

E. Ramon Martin pointed to the inclusion of *O. mykiss* planting under the Anthropogenic Inputs and suggested that this be changed to *O. mykiss* hatchery straying. The group agreed, and the change was made; see revised Chinook In-river rearing figure in Attachment 2. This opened up a larger discussion about whether or not resident *O. mykiss* were being washed over La Grange dam during high flow events. This issue may potentially be examined depending upon on whether evidence of a self-sustaining population of *O. mykiss* is inferred from abundance data collected as part of Study W&AR-13 this fall. This topic is revisited in the steelhead/*O. mykiss* discussion below.

Chinook Delta Rearing

A. Noah Hume explained that this section is intended to capture both out-migrant smolt survival and Delta rearing of Chinook salmon. He stated that a great deal of information is available regarding survival and predation, with recent results of tracking studies, but there is limited information on Delta rearing, disease and parasites.

B. Ramon Martin stated that he may be able to provide some information regarding temperature related effects on trawl catch per unit effort (CPUE). Noah Hume noted that may be useful information for the water temperature and predation linkage and requested that available information be provided.

C. Further discussion included whether timing of spring flows affect predation exposure of out-migrants. Annie Manji stated that the timing of springtime flows are related to out-migrant success and Ramon Martin agreed, stating that if the fry are flushed out too late, there will be increased predation. The group agreed to add a "flow timing" bullet under in-stream flows; see revised Chinook Delta rearing figure in Attachment 2. Chris Shutes agreed and cited a paper by Rosalie del Rosario[3]. Gretchen Murphy also volunteered information on coded wire tagged salmon and avian predation[4].

Chinook Ocean Rearing

A. Noah Hume stated that a large body of fisheries assessment information exists, including the effects of ocean circulation on food availability, predation by marine mammals, etc. The influence of harvest size selection on age-at-maturity was discussed from the Up-Migration life stage above; see revised conceptual model diagram (Attachment 2). No information was identified regarding disease incidence in adult salmon or water quality linkages to changes in food availability.

B. Ramon Martin suggested that there may be some density dependent factors such as hatchery fish competing for available food resources[5]. Ron Yoshiyama suggested work on Coho salmon off the Oregon coast also suggests this mechanism[6]. Karl English said that various publications of the Pacific Salmon Commission's Chinook Technical Committee (CTC) have suggested that hatchery introductions make fish more susceptible to predation.

C. Chris Shutes requested that the meteorology box point directly into the prey (food) availability box. Noah Hume proposed striking the current patterns bullet from the water

[3] Later identified as del Rosario et al (2009), which provides some information as it pertains to flow effects on winter-run residency and emigration from the north Delta.

[4] Later identified as Evans et al 2011.

[5] One example of density dependence identified following the workshop was from Ruggerone et al 2010 examining the effects of hatchery releases of Pink and Chum salmon upon the marine food web off of Alaska.

[6] Example later identified as Nickelson (2003).

temperature box in that case. The group agreed, and the change was noted; see revised Chinook Ocean rearing figure in Attachment 2.

3. **Processes and mechanisms affecting steelhead/*O. mykiss*.** Noah Hume presented the preliminary conceptual model on steelhead/*O.mykiss* (Attachment 1) and led a discussion of factors affecting life history progression in the Tuolumne River, Delta and Ocean, summarizing general sources of information used (timing, presence/absence, abundance etc.) for each life stage below, as well as information on individual processes and mechanisms. He explained the timing diagrams and that the in-river life history requirements for resident as well as anadromous steelhead should be the same and so the two life histories were not presented as separate models. Chris Shutes proposed extending the spawning activity in the steelhead/*O. mykiss* timing table to the month of April under spawning. The group agreed, and the change was noted; see revised *O. mykiss* spawning timing table in Attachment 2.

Steelhead Up-migration

Noah Hume indicated up-migration timing is generalized from Stanislaus weir operations, and that the Tuolumne weir has only been in operation since 2009. Although some information regarding sportfishing from steelhead report cards is available, factors affecting up-migration, straying, arrival timing, and mortality were generalized from information gathered outside of the San Joaquin River basin. No information has been identified regarding straying between San Joaquin River basin tributaries, poaching, or disease incidence in adult steelhead/*O. mykiss*.

Steelhead Spawning

A. Noah Hume indicated that beyond up-migration timing from recent weir reports, little Tuolumne or San Joaquin-basin specific information had been identified regarding steelhead/*O. mykiss* spawning beyond the Coarse Sediment Management Plan (CSMP) (McBain & Trush 2004). Although conditions for spawning are included in the ongoing IFIM Study (Stillwater Sciences 2009), no post-project assessment of the Tuolumne River Coalition (TRC) gravel additions at Bobcat Flat have been conducted to evaluate steelhead spawning use. No redd activity has been documented in historical CDFG surveys. Spawning gravel and habitat mapping will occur this summer as part of W&AR-4, as part of the extended surveys for steelhead redds in 2013, and will be included as part of Study W&AR-8.

B. Chris Shutes asked about steelhead feeding behavior, whether steelhead were feeding on the Chinook egg and fry to a significant amount. Ron Yoshiyama stated that Shapovalov & Taft (1954) examined feeding habits of steelhead and steelhead spawners[7].

C. Zac Jackson proposed adding the same comment regarding fecundity for steelhead as for Chinook spawning salmon. Noah Hume noted the change and added it to up-migration life stage; see revised *O. mykiss* spawning figure in Attachment 2.

[7] Follow-up examination of this reference indicated that steelhead did not generally feed in freshwater, although they were found to strike at prey items.

Steelhead Egg Incubation

A. Noah Hume indicated that since no evidence of spawning on the lower Tuolumne has been found, available information regarding factors affecting egg incubation will be drawn from spawning gravel assessments, existing Tuolumne River water temperature data summaries, as well as out-of-basin sources. Redd-dewatering was added to the model in accordance with the prior Chinook salmon discussion as this mechanism would be more likely to occur due to flood control operations in late spring than potential dewatering of the La Grange tailrace.

B. Ramon Martin suggested that the "Hatchery Introductions" bullet under Anthropogenic Inputs should be changes to "Hatchery Straying". The group agreed and the change to the model was made; see revised steelhead/*O. mykiss* egg incubation figure in Attachment 2.

Steelhead In-River Rearing

A. Noah Hume described the relevant information used to assess in-river rearing, including seine and Rotary Screw Trap (RST) monitoring, annual summer snorkel surveys, recent (2008–2011) population estimate surveys, tracking surveys (2010-2011), and invertebrate surveys. No Tuolumne-specific information has been identified regarding feeding rates, predation, or disease. Study W&AR-12 will provide a habitat assessment of steelhead/*O. mykiss* in 2012, and Study W&AR-13 will examine *O. mykiss* occurrence upstream of La Grange Dam in 2013.

B. Ramon Martin suggested adding poaching/Sportfishing mortality source due to hooking injury/stress. The appropriate changes were made; see revised steelhead/*O. mykiss* In-river rearing figure in Attachment 2.

Steelhead Delta Out-migration

A. Noah Hume summarized information sources on contributing mechanisms affecting Delta Out-migration of steelhead and stated that although Sacramento River – Yolo Bypass studies show Sacramento basin steelhead smolts are using floodplain habitat. The assumption is that steelhead are using the Delta as a migration corridor on their way to the ocean.

B. Ron Yoshiyama suggested that Jeff Kozlowski found that some outmigrant steelhead/*O. mykiss* were not migrating farther than the lower Yuba and Sacramento Rivers (i.e., "potadromous" migration) as well as presenting some information on age at emigration[8].

C. The group discussed timing of out-migration in response to pulse flows (just like for Chinook). Ramon Martin said this trend is evident in the Calaveras outmigrant monitoring (FISHBIO). Mossdale trawl data may also indicate steelhead response to San Joaquin River flows and Ramon suggested these data are available.

[8] This was later identified as Kozlowski 2004 but potadromy was not included in the investigations.

Steelhead Ocean Rearing

A. Noah Hume opened up the conversation by asking the group if the food competition from hatchery introductions could apply as previously discussed for Chinook. Ron Yoshiyama cited papers indicating hatchery and wild salmon are behaving quite differently in the ocean[9].

B. Ramon Martin suggested adding poaching/sportfishing mortality source due to hooking injury/stress and appropriate changes were made; see revised Steelhead Ocean Rearing figure in Attachment 2. Noah Hume suggested that sport fishing reports may only be used to indicate fishing pressure but may not be used to estimate mortality.

Lunch Break – 12:15 PM to 1:15 PM

Discussion of Conceptual Models and Preliminary Ranking of Issues – 1:00 PM to 3:30 PM

Jenna Borovansky opened the afternoon session and took on-screen notes while Noah Hume led a discussion with RPs regarding the preliminary issues to be addressed in the development of the interrelated population models under W&AR-6 and W&AR-10 based on their potential influence as well as preliminary reviews of available information; RPs were encouraged to provide feedback, understanding that additional comment or revisions in priority may be provided when notes are provided by the Districts for review. Attachment 1 includes the on-screen draft notes ranking issues affecting Tuolumne River salmonids that incorporate RP feedback and discussion recorded during the meeting. Attachment 3 provides an edited and expanded version of the ranking tables for RP review and additional comment. Noah Hume presented a preliminary list of factors or issues affecting each life stage, life history progression, a preliminary ranking, and rationale for classification. The goal of the discussion was to narrow the possible factors into a shorter list of most important factors by life stage. The RPs were asked to provide information to support their feedback during the discussion, or following their review of the workshop notes, particularly if they disagreed with the initial rankings discussed.

1. **Ranking of processes and mechanisms affecting Chinook salmon populations – (See Attachment No. 3).**The group was asked for input with the goal of narrowing the possible factors into a smaller list of most important factors by Chinook salmon life stage.

Chinook Up-migration

A. Noah Hume presented an initial ranking of issues affecting Chinook Up-migration as: 1) water temperature on arrival timing initially identified by Hallock (1970); 2) DO effects on arrival timing, (examined by Hallock (1970) including the subject of the Stockton

[9] This was later identified as Quinn et al 2012, but no studies on density dependence of hatchery steelhead releases were identified.

Deepwater Ship Channel [DWSC] TMDL); and 3) attraction flow effects on homing/straying.

B. Ramon Martin stated that up-migration blockage at Stockton due to low DO was cited as an important factor per USFWS (2001) Anadromous Fish Restoration Program (AFRP) final restoration Plan filed with FERC. Noah Hume said this issue had been largely mitigated with aeration measures included in the adoption of the TMDL in January 2005. Art Godwin followed that additional waste load reduction measures had been implemented, but Ramon Martin felt that it is still a problem during some water year types.

C. Annie Manji suggested that flow effects on water temperatures should be included since temperatures may be affected by upstream flow releases. Noah Hume suggested that it would take very large coordinated releases from all San Joaquin tributaries to affect the water temperature at Vernalis or Stockton[10]. Annie Manji stated that Mesick et al examined water temperatures at the Tuolumne - San Joaquin River confluence and Vernalis[11].

D. Noah Hume stated thatno reports were identified that examine salmon arrival timing in the Tuolumne as a function of water temperature or flow and that dates of arrival in the River has been generally consistent from year to year. Zac Jackson requested the up-migration timing information that was used to formulate this model. Noah Hume stated that an early rport in the San Joaquin River restoration process contained some arrival timing information[12] and an updated arrival timing analysis will be included in the study report. Noah requested updated weekly spawner counts by riffle from Gretchen Murphy, as this information is not included in the CDFG spawning reports currently available to the Districts.

E. Noah Hume stated that although attraction flows were included for all of the San Joaquin River tributaries, Mesick (2001) has developed the only report that shows relationships between homing/straying of up-migrant Chinook salmon and attraction flows, and this was limited to CWT hatchery returns between the Sacramento and San Joaquin River basins. Noah also stated that no reports specific to the Tuolumne or San Joaquin River basin had been identified that show relationships between attraction flows and increased up-migrant passage or escapement. Ramon Martin and Zac Jackson both stated that

[10] Stillwater Sciences (2011) report showed very large releases were required to affect temperatures at the confluence of the Tuolumne and San Joaquin Rivers during fall as well as during spring.

[11] Later identified as Mesick et al (2010), but subsequent review of this document suggested that only April/May conditions were examined and only broad relationships were examined (i.e., 1000 cfs up to flows of 20,000 cfs), suggesting that seasonal meteorology controls downstream water temperature to a greater degree than flow.

[12] Later identified as Stillwater Sciences (2003) which used weekly live counts to examine arrival timing.

Mokelumne attraction flows were associated with increased passage and escapement. Noah Hume requested reports supporting this conclusion.[13]

F. The group deliberated on the inclusion of inland harvest and poaching as an important factor. Little information regarding poaching is available and harvest was not included in the final ranking (Attachment 3) since this factor was included in the ocean rearing life stage.

Chinook Spawning

A. Noah Hume presented an initial ranking of issues affecting Chinook Spawning as: 1) spawning area availability; 2) spawning gravel quality, and 3) temperature related effects on pre-spawn mortality. He stated that low levels of pre-spawn mortality had been identified by CDFG in 1 or 2 years of surveys on the Stanislaus but that no information had been identified on the Tuolumne. Ramon Martin suggested that CDFG may have conducted carcass examinations on the Tuolumne and Gretchen Murphy offered to follow-up to see if any reports had been prepared. If so, Gretchen offered to provide the information for review.

B. Patrick Koepele asked if there were other spawning bed characteristics (e.g., slope, velocity etc.) that had been considered. Noah Hume stated that spawning bed characteristics had been extensively studied, including IFIM studies, historical mapping and gravel assessments (e.g., TID/MID 1992, McBain & Trush 2004), the current W&AR-4 mapping study, as well as the current spawning redd surveys (W&AR-8 study), but that gravel area and gravel quality were the relevant considerations regarding spawning success.

C. Chris Shutes asked if there were problems with the gravel size/shape used in past Tuolumne River gravel introductions? Noah Hume stated that some of this had been addressed in the McBain & Trush (2004) CSMP. He stated that although redd counts have been conducted at the 2002 and 2003 CDFG gravel introduction sites near Old La Grange Bridge, no formal post-project assessments have been made.

Chinook Egg Incubation

A. Noah Hume presented an initial ranking of issues affecting Chinook egg incubation as: 1) temperature effects on incubation rates; 2) redd superimposition at higher run sizes; 3) potential entombment due to fine sediment; and 4) potential for redd dewatering (*Note: this issue was promoted later in the meeting during a discussion regarding the corresponding steelhead egg incubation ranking*).

B. Ramon Martin suggested adding direct mortality from water temperature to the list. Noah Hume said there is only limited information available from laboratory experiments that don't seem to be applicable to the Tuolumne River. Ramon stated that egg viability

[13] Subsequent review of Del Real and Soldate (2011) showed that variations in daily passage at Woodbridge was partially explained by flow (R^2=0.41), water temperature (R^2=0.46), and precipitation (R^2=0.15).

studies were ongoing on the Merced River and that some references had been included in the FWS-3 egg viability study[14].

Chinook In-River Rearing

A. Noah Hume presented an initial ranking of issues affecting Chinook in-river rearing as: 1) predation; 2) prey/food availability; and 3) water temperature mortality. Annie Manji offered the suggestion that floodplain habitat be included as number 1 on the list of important factors. Noah Hume proposed putting it as a bullet under both predation and prey/food availability since it had been included in the models in this manner. He stated that the Stillwater Sciences (2012) Pulse Flow report examined the relationship of floodplain inundation and predator habitat and that the ongoing predation study (W&AR-7) was also examining flow and predation relationships.

B. Noah Hume stated that only the Yolo and Cosumnes studies (e.g., Sommer et al 2001, Jeffres et al 2005), reports had floodplain growth benefits or food limitations within in-channel habitats. Ramon Martin volunteered to provide information showing larger sized fish during wet years and Zac Jackson will provide a USBR Floodplain Food Production Tech Memo (still in draft form) and a Denver Tech Center document (still in draft) once he gets the approval to share externally.

C. Annie Manji expressed concerns that the Workshop was not being conducted in a collaborative manner, as she did not agree with the rankings. Noah Hume recognized her concern and indicated that the purpose of the live-meeting and tracking of rankings was to gather input. He also indicated that in person attendance at the meeting may improve information exchange. Noah requested that if Annie disagreed with the rankings being put on the screen and discussed in the room, to please speak up, and to also provide additional comments on the rankings and other notes following the workshop.

D. Annie Manji stated that out-migration was missing from the in-river rearing model and data for that is more easily extrapolated than out-migrant information through the Delta. Noah Hume agreed and although outmigrant survival was addressed by the predation mechanism that had been included, he proposed changing the title from In-River Rearing to In-River Rearing/Out-migration. The group agreed and the change was made; see revised Chinook In-river rearing/Delta outmigration figure in Attachment 2.

E. Chris Shutes questioned the exclusion of water temperature effects on smoltification, and pointed to Carl Mesick 2010 or 2011 paper that suggests it to be a larger factor than floodplain inundation[15]. Ramon Martin offered to provide another reference which provides an assessment of temperature effects by lifestage in the San Joaquin River basin by Alice Rich[16].

[14] Follow-up review of the FWS-3 study request letter referenced in the Districts November 22, 2011 Don Pedro Project Revised Study did not identify studies examining water temperature effects.

[15] This document was not identified subsequent to the meeting, but relationships of temperature with smoltification were added to the preliminary ranking tables (Attachment 3).

[16] Later identified as Rich (2007). Report is not currently available on-line.

Chinook Delta Rearing/Out-migration

A. Noah Hume presented an initial ranking of issues affecting Chinook Delta-rearing and out-migration as: 1) entrainment; 2) predation; 3) water temperature mortality; and 4) prey/food availability. Chris Shutes suggested that entrainment should also be related to flow direction, or reversed flows in the Delta, and the level of export pumping rate. The group agreed.

B. Ramon Martin suggested adding flow timing to the list, under instream flow inputs of the overall model and the change was made; see revised Chinook Delta Rearing/ Outmigration figure in Attachment 2.

Chinook Ocean Rearing

Noah Hume presented an initial ranking of issues affecting Chinook Ocean rearing as: 1) Food availability; 2) Ocean Harvest; and 3) predation. Other than a discussion of marine mammal predation, no other comments or alternative suggestions were made.

2. **Ranking of processes and mechanisms affecting steelhead/*O. mykiss* populations – (See Attachment No. 3).** The group was asked for input with the goal of narrowing the possible factors into a smaller list of most important factors by steelhead/*O. mykiss* life stage; the earlier discussion regarding Chinook were used as a reference point on priorities where potential factors were similar. RPs were asked to provide information to support their feedback on items detailed in Attachment 3. RPs were also encouraged to provide supporting information following the workshop in the reviews of the notes, particularly if they disagreed with the initial rankings below.

Steelhead Up-migration

Noah Hume presented an initial ranking of issues affecting steelhead Up-migration as: 1) Homing/Straying related to instream flows, 2) potential water temperature blockage for any Delta up-migrants in late summer; and 3) mortality from Delta/in-river sport-fishing/poaching. No comments or alternative suggestions were provided.

Steelhead/O. mykiss Spawning

Noah Hume presented an initial ranking of issues affecting steelhead/*O. mykiss* spawning as: 1) spawning area availability; 2) spawning gravel quality, and 3) temperature related effects on pre-spawn mortality. He stated that little information was available beyond the existing gravel assessments (e.g., TID/MID 1992, Apps 6, 7; McBain & Trush 2004), the current W&AR-4 spawning gravel assessment and the current redd mapping (W&AR-8) studies. No comments or suggestions were provided on the preliminary rankings.

Steelhead Egg Incubation

A. Noah Hume presented an initial ranking of issues affecting steelhead/*O. mykiss* egg incubation as: 1) Temperature effects on incubation rates; 2) temperature related egg mortality from early/late arriving spawners; and 3) potential entombment due to fine sediment. He stated that no studies were found that examined the entombment issue. He added that without documentation of steelhead/*O. mykiss* spawning in the Tuolumne, any inferences on impacts would have to be drawn from regional references.

B. Ramon Martin proposed adding redd dewatering on both the Chinook and steelhead egg incubation lists. This factor was ranked as No. 3 for steelhead/*O. mykiss* and No. 4 for Chinook salmon (Attachments 1 and 3). Zac Jackson recalled that eggs have been exposed on the Stanislaus, Calaveras, and American rivers due to flow ramping. Gretchen Murphy offered to look for any verification regarding that information.

Steelhead In-river Rearing

A. Noah Hume presented an initial ranking of issues affecting steelhead/*O. mykiss* in-river rearing as: 1) Food availability and growth rate as related to water temperature/ration effects; 2) Predation effects on Age 0+ fish due to limited habitat area (cover, LWD, suitable temperature); 3) Direct mortality effects due to water temperature for Age 0-3 fish; and 4) Temperature effects on Smoltification.

B. Ramon Martin proposed suggested adding density dependence under food availability to capture the phenomenon of territoriality. Noah Hume stated that this would be addressed in the updated ranking table (Attachment 3).

C. Noah Hume asked the group whether hooking mortality from sportfishing should be included as an important factor affecting steelhead/*O. mykiss* populations but since little information on this factor is available, no consensus was reached. This was not subsequently added to the revised rankings table (Attachment 3).

Steelhead Delta Rearing/Out-migration

A. Noah Hume presented an initial ranking of issues affecting steelhead/*O. mykiss* Delta out-migration as: 1) entrainment (multiple effects were discussed including loss of direction, direct entrainment); 2) predation; 3) water temperature effects on smoltification; and 4) direct mortality effects of water temperature. Ramon Martin highlighted the prior discussions regarding the linkage between instream flows and water temperature.

B. Noah Hume repeated brief comments from the morning session regarding conditions favoring anadromy/residency. He stated that general life-history theory suggests that in-river conditions, Delta conditions, and Ocean conditions all combine to favor one life history strategy over another, but few studies had been identified that demonstrated variables affecting various life history strategies.

Steelhead Ocean Rearing

Noah Hume presented an initial ranking of issues affecting steelhead Ocean Rearing as: 1) Food availability; 2) Predation; and 3) Potential Harvest bycatch. Chris Shutes stated that gill net capture and mortality is likely very low since the gill net ban off California in 1990. No comments or suggestions were provided on the preliminary rankings.

Next Steps/Action Items – 4:30 PM to 5:00 PM

1. Jenna Borovansky completed edits to the on-screen ranking table (see Attachment 1) and indicated that revisions to the table (Attachment 3) as well as supporting references (Attachment 4) would be provided with the Workshop notes.

2. Jenna Borovansky provided a timeline of the Workshop note preparation, distribution and comment period. The notes were scheduled to be provided to RPs by July 9th and comments were planned to be due back to the Districts by August 6th. Note that the review dates have been revised to allow 30-day review from RP receipt of the drafty Workshop notes. Meeting dates for the W&AR-6 and W&AR-10 population models were set for November 15–16, 2012; RPs were asked to hold both days open in their schedule.

3. John Devine summarized Action Items from the meeting.

    a. The Districts will provide draft notes and citations for priority issues per the March 20, 2011 Consultation Protocol.

    b. RPs are requested to provide any additional references supporting comments made at the workshop within the 30-day comment period of the Workshop Notes.

4. Chris Shutes identified a possible conflict with the Temperature Modeling Workshop (scheduled for September 18) with some State Board workshops on September 18th and 19th. The Districts will review the meeting schedule and propose an alternative date, if necessary.

Attachments

Attachment 1: Meeting materials W&AR-5 Salmonid Information Synthesis Workshop No. 2[17]

Attachment 2: Revised conceptual model diagrams for Chinook salmon and steelhead/*O. mykiss*

Attachment 3: Preliminary ranking of issues affecting Chinook salmon and steelhead/*O. mykiss*[18]

Attachment 4: Supplemental references provided in notes and ranking of salmonid issues

[17] Includes Meeting Agenda, Conceptual Model Narrative for Tuolumne River Salmonids; Preliminary Conceptual model Diagrams for Chinook salmon; Preliminary Conceptual model Diagrams for steelhead/*O. mykiss*; Preliminary Important Factors Review Tables (on-screen notes).

[18] Expanded with supporting references (Attachment 4) from draft Preliminary Important Factors Review Table (Attachment 1).

Attachment 1

Meeting materials – W&AR-5 Salmonid Information Synthesis Workshop No. 2.

Salmonid Information Synthesis Workshop No. 2
Don Pedro Relicensing Study W&AR-5
June 26, 2012 – MID Offices, Modesto

Conference Line Call-In Number 866-994-6437; Conference Code 5424697994

AGENDA

9:00 a.m. – 9:45 a.m.	**Introductions and Background** 1. Purpose of Meeting 2. Workshop Consultation Process Overview 3. Relationship to other studies 4. Review of Workshop No. 1 Comments and Status of Responses
9:45 a.m. – 12:00 p.m.	**Preliminary Conceptual Model Presentation** 1. Primary ecosystem inputs and other factors affecting Tuolumne River salmonids 2. Processes and mechanisms affecting Chinook salmon 3. Processes and mechanisms affecting steelhead trout/*O. mykiss*
12:00p.m. – 1:00 p.m.	**Lunch (on your own)**
1:00 p.m. – 3:30 p.m.	**Discussion of Conceptual Models and Preliminary Ranking of Issues** 1. Chinook salmon 2. Steelhead/*O. mykiss*
3:30 p.m. – 4:30 p.m.	**Next Steps**
4:30 p.m. – 5:00 p.m.	**Action Items Summary**

Conceptual Model Narrative
for Tuolumne River Salmonids
Don Pedro Relicensing Study W&AR-5
Workshop No. 2 - June 26, 2012

Purpose of this Document

The purpose of this document is to provide a framework for discussion at the June 26, 2012 Salmonid Information Synthesis Study Workshop No. 2. As outlined in the Study Plan, this narrative has been prepared as a companion to accompanying diagrammatic models regarding processes and mechanisms affecting various life stages of Central Valley Fall run Chinook salmon (*Oncorhynchus tshawytscha*) and Central Valley steelhead (*O. mykiss*) in the Tuolumne River, Delta, and Pacific Ocean. Recognizing that not all factors affecting Tuolumne River salmonids may be known or well understood, the model diagrams and narrative attempt to identify factors that may potentially affect salmonid life-history progression throughout the species range, separated into mechanisms affecting reproduction, growth, direct and indirect mortality.

This document is separated into three sections describing ecosystem inputs, Chinook salmon life history, and steelhead/*O. mykiss* life history in and downstream of the lower Tuolumne River. To provide context for historical and ongoing ecosystem modifications and variation of habitat conditions across the species range (i.e., Tuolumne River to the Pacific Ocean), primary ecosystem inputs and other factors affecting Tuolumne River salmonids are described without attempting to separate their relative contributions or importance from the "top-down". Instead, the accompanying conceptual models are intended to be used from the "bottom-up" by examining the most proximate processes affecting individual life stages (e.g., predation, prey availability, etc.). Although we have made preliminary assessments regarding whether mechanisms may or may not be affecting a given life stage in some instances, it is intended that their relative importance be discussed with Workshop participants with an opportunity for comment and potential revision of the conceptual models.

As outlined in the Study Plan, following review and potential revision of the broader conceptual models presented here, conceptual models of the relevant density-dependent and density-independent factors affecting each salmonid life-stage in the Tuolumne River will be developed and refined as part of numerical population model development in the interrelated Tuolumne River Chinook Salmon Population Model and the *O. mykiss* Population studies (Studies W&AR-6 and W&AR-10).

Primary ecosystem inputs and other Factors affecting Tuolumne River salmonids

Water Supply and Instream Flows

Upstream Dam Construction – Early dams (Wheaton [ca 1871] and La Grange [1893]) reduced summer base flows but were too small to affect high flows. Later dams (Hetch Hetchy [1923; expanded 1938], Don Pedro [1923; expanded 1971], Cherry Lake [1955] reduced the magnitude and frequency of flood flows and snowmelt runoff to the lower Tuolumne River.

Upstream Diversions by CCSF – Out of basin diversions by CCSF to the San Francisco Bay Area began in 1934. Depending on water year type, upstream diversions by CCSF may exceed 250 TAF per year.

Antecedent Water Year Type and Carryover Storage – In addition to FERC flows, based in part on antecedent precipitation and water year type, the 1995 FERC Settlement Agreement (FSA) provides for carryover of up to 5 TAF from wet water years. To date this provision has not been used.

Flood Control Releases – The Districts are required under ACOE flood control requirements to maintain flood storage space in the Don Pedro Reservoir as well as to limit flows at Modesto below 9,000 cfs.

Diversions at La Grange – Depending upon water year type, the Districts divert on average approximately 900 TAF per year from the river at La Grange Dam for irrigation and M&I uses in the basin.

Minimum FERC Flow Requirements – Depending upon water year type, the current license prescribes annual release and pulse flow volumes, rate changes, and minimum flow requirements measured at La Grange for spawning, rearing, and over-summering of Tuolumne River salmonids.

Accretion Flows – Local rainfall runoff, tributary inflow (primarily from Dry Creek at Modesto), operational outflows from the Districts' canal systems, agricultural drainage return flows, urban runoff, as well as groundwater accretion contribute to the flows of the lower Tuolumne River below La Grange Dam.

Riparian and Delta Diversions – Numerous unscreened riparian diversions exist on the lower Tuolumne River, lower San Joaquin River, and the Delta. There are four larger diversions between the Merced River confluence and the Delta, with screen and bypass facilities only installed recently at the Patterson Irrigation District, West Stanislaus Irrigation District and Banta Carbona Irrigation District.

Delta Exports – The federal Central Valley Project C.W. Bill Jones Pumping Plant (1951) and the California State Water Project Harvey O. Banks Pumping Plant (1968) withdraw large volumes of water from the Old River channel of the San Joaquin River in the south Delta. Average annual diversions (exports) have increased by a factor of two from the years prior to the 1996 FERC Order up to the 2007 court-ordered flow reductions, put in place for the protection of delta smelt entrained by these facilities. Outside of flood periods, Delta exports exceed instream flows at Vernalis at all times of year except during the April 15 to May 15 period when pumping restrictions are imposed on the State and Federal Pumping plants and pulse flows are provided from the San Joaquin River tributaries.

Sediment Supply and Transport

Interception of Upstream Gravels by Dams – Coarse sediment production from the upper watershed is blocked at La Grange Dam and Don Pedro Dam as well as locations farther upstream. Under current conditions, coarse sediment sources to the lower Tuolumne River are limited to bed mobilizing events and bank erosion.

Historical Gravel Mining – Historical gold dredge mining during the early twentieth century excavated in-channel and floodplain sediments and left a legacy of dredger tailing deposits between RM 50.5–38. Beginning in the 1940s, aggregate mines extracted sand and gravel directly from the active river channel, creating a legacy of in-channel mining pits ("special run-pools" [SRPs]) up to 400 feet (120 m) wide and 35 feet (11 m) deep and occupying 32% of the length of the channel in the gravel bedded reach (RM 52–24). Historical dredger tailings upstream of RM 45 were removed as part of the New Don Pedro Dam construction and more recent mining operations have excavated sand and gravel from floodplains and terraces immediately adjacent to the river channel at several locations downstream of Robert's Ferry Bridge (RM 39.5). Floodplain and terrace mining pits are typically separated from the river by narrow un-engineered berms that are susceptible to failure during high flows such as the 1997 flood event.

Loss of Channel Migration – In addition to the large cobble-armored windrows of dredger tailings remaining in the reach from RM 45.4–40.3, historical dredger tailings (RM 50.5–38) served to confine the active river channel, resulting in channel down-cutting and prevention of sediment recruitment from channel migration. Channel migration has been nearly eliminated due to these historical and present day mining operations. In reaches with functionally connected floodplains, flow regulation by upstream dams limits the frequency, duration, and magnitude of high flow events affecting channel migration and floodplain processes.

1997 Flood Impacts – During the 1997 flood, high flows in excess of 60,000 cfs were released over the Don Pedro spillway, resulting in the erosion of approximately 200,000 yd^3 (150,000 m^3) of sediment**.** Much of this sediment was deposited behind La Grange Dam. The remainder was transported downstream and deposited in the river and on the floodplain or was transported downstream to the San Joaquin River and the Delta.

Tributary Fine Sediment Inputs – Tributaries entering the river downstream of La Grange Dam do not contribute coarse sediment to the mainstem channel. A sediment basin installation at Gasburg Creek was completed in 2007, but fine sediments continue to enter the river during runoff events from Peaslee and Dominici creeks. For example, failure of sediment controls following grading operations along Lake Road resulted in extended periods of high turbidity during May 2009.

Gravel Augmentation Projects – To date, gravel augmentation has been limited to two sites near Old La Grange Bridge (RM 50.5) between 1999 and 2001. In addition to predator isolation projects at SRP 9 (RM 25.7), riffle and floodplain reconstruction projects have been completed at Bobcat Flat (RM 43.5) and at 7/11 Materials (RM 37.7), with designs and preliminary permitting completed for additional gravel augmentation projects at upstream locations.

Anthropogenic Inputs

Non-Native Fish Introductions – Predation studies in the Tuolumne River identified 10 non-native and two native fish species that could potentially prey on juvenile Chinook salmon and *O. mykiss*, with the majority of these fish concentrated in slower moving waters found at SRP mining pits.

Hatchery Fish Introductions – Release of marked and unmarked hatchery fish in the San Joaquin basin may result in genetic impacts, reduced naturally spawning population productivity, as well as food and other habitat resource competition in freshwater, estuarine, and ocean environments. Although the proportions of hatchery fish identified in escapement surveys has been historically low, constant fractional marking programs have shown the present day Chinook salmon runs are dominated by hatchery origin fish. Genetic analyses also indicate the majority of Central Valley Steelhead are of common out-of-basin broodstock (Eel River) used at the Nimbus (American River) and other hatcheries, suggesting that hatchery introductions have largely altered the genetic structure of the population. Several studies outside of the San Joaquin River basin have shown lower reproductive success of hatchery fish as compared to wild fish spawning in the same rivers.

Agricultural Development – Historical land clearing as well as levee construction has eliminated access to marsh habitats throughout the Delta. Continued discharge of residual nutrients (N, P) from agricultural fertilizers results in biostimulation of algae, associated DO variations, as well as changes in algal community structure and the Delta food web. In addition to discharges of salts to the San Joaquin River basin, herbicides and pesticides are discharged throughout the Delta. Exposure of common herbicides and pesticides is associated with direct toxicity to planktonic species as well as olfactory impairments in juvenile salmon.

POTW Discharges – Treated municipal wastewater is discharged to Delta waterways from over 300 municipal sources including numerous Publicly Owned Treatment Works

(POTWs). Discharges contain residual nutrients (N, P) associated with biostimulation of algae, DO variations, alterations of the food web, as well as a number of poorly characterized impacts from emerging contaminants associated with endocrine disruption and other effects.

Urban Runoff – In addition to agricultural return flows, urban runoff may contain a range of contaminants from petroleum, heavy metals, trash, to fertilizers (N, P) and pesticides from lawns. Recent studies sampling of urban runoff indicated consistently high levels of pyrethroid pesticides, with effects ranging from invertebrate toxicity to olfactory impairment in salmonid juveniles.

Meteorology

ENSO and PDO Cycles – The Pacific Decadal Oscillation and shorter term El Niño/Southern Oscillation both appear to change ocean productivity through complex processes. The mechanisms of how salmon populations are affected are not well understood, but ocean circulation affects nutrient upwelling and primary and secondary productivity of the marine food web that supports adult rearing of Tuolumne River and other Pacific salmonids.

Climate Change – In addition to future climate change impacts on ENSO and PDO cycles, recent USBR evaluations suggest slight temperature increases will occur in the San Joaquin River basin with variable, but slightly decreasing precipitation by 2050, on the order of 5% below recent averages. Due to early snowmelt and relatively higher winter runoff from warmer conditions, flood control capacity will be reduced, and reductions in basin yield may also result in reduced cold water storage for salmon as well as increased habitat for warm-water adapted invasive species.

Processes and mechanisms affecting Tuolumne River Chinook salmon by life-stage residency

Chinook salmon upmigration

Processes/Mechanisms affecting arrival at Spawning Grounds

Homing/Straying/Timing – Although existing data does not show relationships between homing, straying, or variations in arrival timing with Tuolumne River fall attraction flows, water temperature as well as dissolved oxygen (DO) have been suggested as factors affecting the timing of salmon passage at Stockton and by inference, the timing of adults arriving at tributary spawning grounds. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients may result in unsuitable water quality conditions for up-migrating salmon. Meteorology and to a minor degree, instream flows, also combine to affect exposure of up-migrating adults to changes in water temperatures. Lastly, homing fidelity of introduced hatchery fish out-planted to the Delta and other locations has been shown to be poorer than naturally reproducing salmon.

Processes/Mechanisms affecting Direct Mortality

Harvest – Ocean harvest of adult salmon that escape the ocean fishery, inland sport fishing, and illegal poaching all affect the number of adults that return to their natal streams to spawn, and in turn, affect subsequent juvenile production. The Central Valley Harvest Rate Index has been in excess of 70% in many years. Additional inland harvest occurs, mostly in the Bay and Delta, but also in the San Joaquin River system prior to the mid-October angling closure in the tributaries. Illegal poaching has not been well quantified.

Water Quality – In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of other contaminants may result in unsuitable water quality conditions for up-migrating salmon. However, mortality of adult salmon is unlikely to result from water quality impairments such as DO depletion resulting from algal and bacterial respiration or from potential toxicity events.

Water Temperature – Meteorology and to a minor degree, instream flows, combine to affect exposure of up-migrating adults to changes in water temperatures with varying probabilities of direct mortality. However, no incidences of direct mortality of up-migrant salmon have been attributed to water temperature in the lower Tuolumne River and avoidance of unsuitable water temperatures by adults would be expected.

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Exposure to changes in water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia in the lower San Joaquin River may contribute to stress and disease incidence and subsequent mortality of up-migrant adults. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants, may result in unsuitable water quality conditions for up-migrating salmon. Meteorology and to a minor degree, instream flows in the lower San Joaquin River and Delta, also combine to affect exposure of up-migrating adults to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality.

Chinook salmon Spawning

Processes/Mechanisms affecting Spawning Success

Competition and Exclusion – Competition and exclusion of up-migrant adults from accessing suitable spawning sites may occur depending upon the numbers of spawners, gravel quality, and local hydraulic characteristics of available spawning habitat area. Both gravel quality and the availability of suitable spawning habitat are affected by instream flows, meteorology, as well as factors contributing to alterations in sediment transport processes. Competition for suitable spawning sites by anthropogenically introduced hatchery fish may limit spawning success of naturally reproducing Chinook salmon.

Processes/Mechanisms affecting Direct Mortality

Poaching – Illegal poaching of adult salmon arriving in the lower Tuolumne River after mid-October has not been quantified, but potentially reduces the number of adults that successfully spawn, and in turn, affects subsequent juvenile production.

Water Temperature – Meteorology and instream flows combine to affect exposure of spawning adults to changes in water temperatures. Although little information is available relating pre-spawning mortality of Chinook salmon to water temperature in the Tuolumne River or neighboring tributaries, adult mortality can result from prolonged exposure to unsuitable water temperatures, potentially reducing the number of adults that successfully spawn, and in turn, affecting subsequent juvenile production.

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Meteorology and instream flows in the lower Tuolumne River combine to affect exposure of pre-spawning adults to changes in water temperature, which in turn, may contribute to stress and disease incidence and subsequent mortality. Disease incidence may be also related to prior exposure to unsuitable water temperatures and water quality in the Delta as well as exposure to water-borne pathogens as well as interactions with other infected/infested fish.

Chinook salmon egg incubation

Processes/Mechanisms affecting Egg/Alevin growth and Fry Emergence

Water Temperature – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures, which has a strong influence on the rate of subsequent embryo and alevin development, typically ranging from 6 to 12 weeks from fertilization to emergence.

Water Quality – Instream flows and sediment transport of bedload and suspended sediments may affect intra-gravel flow as well as interstitial water quality conditions such as DO necessary for the successful development of the embryo/alevin to fry emergence.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and instream flows may combine to affect exposure of deposited eggs to varying water temperatures, potentially reducing egg survival to emergence and subsequent juvenile production.

Redd Scour – Redd scour may result from increased rates of sediment (bedload) transport during high flow events such as flood flows. Displacement of eggs and alevin due to redd scour may cause mortality from mechanical shock, crushing or entrainment into the bedload.

Redd Superimposition – Egg displacement due to redd superimposition resulting from competition and exclusion of adult spawners and anthropgenically introduced hatchery fish may result in density-dependent mortality of previously deposited eggs that have been disturbed by the spawning activities of subsequently arriving females. Availability of suitable spawning habitat is affected by instream flows as well as gravel quality and spawning habitat area resulting from factors contributing to alterations in sediment transport processes.

Entombment – Fine sediment deposition in completed redds may effectively seal the upper layers of the redd, and obstruct the emergence of alevins, causing entombment and subsequent mortality. Entombment may be affected by gravel quality and fine sediment input due to surrounding land use practices, instream flows, as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Indirect Mortality

Bacterial & Fungal Infections – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures in the spawning reaches of the lower Tuolumne River. Although no information is available on disease incidence for

incubating eggs in the Tuolumne River, water temperature has been shown to contribute to increased rates of mortality by bacterial and fungal growth in other systems.

Chinook salmon in-river rearing

Processes/Mechanisms affecting juvenile growth and survival

Water Temperature – Meteorology and instream flows combine to affect water temperature of both in-channel and floodplain habitats and has a strong influence on growth and feeding rates of rearing juvenile Chinook salmon. Changes in water temperatures may also affect the timing of smoltification and may cause desmoltification under some circumstances.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affects the prey availability and growth rates of juvenile Chinook salmon. Both the availability of these organic matter sources as well as the physical habitat availability for benthic macro-invertebrates and terrestrial insects (drift) is in turn affected by instream flows as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile Chinook salmon to changes in water temperatures, with varying probabilities of direct mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and sediment transport processes, predation of juvenile Chinook salmon by native fish (including *O. mykiss*) as well as introduced fish is influenced by meteorology and instream flow influences on water temperatures. Anthropogenic inputs of contaminants may also affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may also affect by surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Stranding & Entrapment – Rapid reductions in instream flows, particularly during flood flow conditions, may eliminate access to available habitat and cause stranding and entrapment of fry and juvenile salmon on gravel bars and floodplains and in off-channel habitats that may become cut off when flows are reduced. Mortality of juveniles by several mechanisms often results, including desiccation, temperature shock, asphyxiation, as well as predation by birds and mammals.

Entrainment – Depending on instream flows and agricultural operations, entrainment of rearing or migrating juvenile Chinook salmon into unscreened pumps may occur, resulting in mechanical damage and mortality.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and instream flows combine to affect exposure of rearing juvenile Chinook salmon to varying water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. In addition to factors affecting instream flows in the lower Tuolumne River, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants may result in unsuitable water quality, exposing juvenile salmon to low DO, high pH (alkalinity) and unionized ammonia and contributing to stress and disease incidence.

Chinook salmon Delta rearing

Processes/Mechanisms affecting juvenile growth and survival

Water Temperature – Meteorology and to a minor degree instream flows combine to affect water temperature of both in-channel habitats in the San Joaquin River and Delta as well as water temperatures of off-channel habitats (e.g., sloughs, marshes, as well as seasonally inundated floodplains). Seasonal variations in water temperatures, in turn have a strong influence on growth and feeding rates of rearing juvenile Chinook salmon. Water temperatures may also affect the timing of smoltification and may cause desmoltification under some circumstances.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affect the prey availability and growth rates of juvenile Chinook salmon. The availability of these organic matter sources to zooplankton in the Delta is affected by anthropogenically supplied nutrients and algal productivity. For juvenile salmon rearing in floodplain locations, food web productivity and terrestrial insect drift are affected by instream flows as well as other factors contributing to alterations in floodplain inundation frequency, duration, and extent (e.g., levee construction).

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile Chinook salmon to changes in water temperatures as well as increased rates of mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and the reduced habitat availability of off-channel rearing habitats by levee construction, juvenile Chinook salmon predation by native and introduced fish is influenced by meteorology and instream flow effects upon water temperature. Anthropogenic inputs of contaminants may affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may be affected by surrounding land use practices, changes in instream flows such as Delta exports, as well as factors contributing to alterations in upstream sediment transport processes. Seasonally installed barriers have been used in years with flows below 5,000 cfs at Vernalis to reduce predator exposure of outmigrating Chinook salmon.

Entrainment – Depending on tributary instream flows to the San Joaquin River and Delta, entrainment of rearing or migrating juvenile Chinook salmon into unscreened pumps may occur, resulting in mechanical damage and mortality. Entrainment into the forebays of the Delta export facilities may result in increased rates of predation, physical damage and stress during salvage operations, as well as subsequent predation at release points for salvaged fish near the western (downstream) edge of the Delta.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile Chinook salmon to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. Exposure to unsuitable water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia due to anthropogenic inputs of contaminants in the lower San Joaquin River and Delta may also contribute to stress and disease incidence and subsequent mortality of juvenile Chinook salmon.

Chinook salmon Ocean rearing

Processes/Mechanisms affecting Adult growth and survival

Prey Availability – Meteorology, ocean water temperatures and water quality influence primary and secondary productivity of the marine food web that supports immature and adult Chinook salmon. Both direct discharge of anthropogenically supplied nutrients as well as changes in ocean circulation patterns and upwelling of nutrients affect marine water quality.

Processes/Mechanisms affecting Direct Mortality

Predation – Predation of immature Chinook salmon following ocean entry may reduce subsequent adult returns. Predation rates upon immature salmon may be affected by changes in predator species distribution with water temperature and ocean circulation patterns. Early life history exposure to anthropogenic inputs of contaminants may also affect water quality and subsequent susceptibility to predation.

Harvest – Ocean Harvest of adult Chinook salmon affects the number of adults that return to their natal streams to spawn, and in turn, affect subsequent tributary juvenile production. The Central Valley Harvest Rate Index has been in excess of 70% in many years and recent fishing bans (2009–2010) have been imposed to increase adult population levels.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and instream flow effects upon water temperature in upstream habitats may affect early life history disease incidence and subsequent mortality of adult Chinook salmon. Prior exposure to pathogens and parasites during juvenile rearing and outmigration may also contribute to increased disease incidence in the adult Chinook salmon population.

Processes and mechanisms affecting Tuolumne River steelhead/*O. mykiss* by life-stage residency

Steelhead upmigration

Processes/Mechanisms affecting arrival at Spawning Grounds

Homing/Straying/Timing – Although no data exists to evaluate homing and straying of steelhead arriving in the Tuolumne River, mechanisms explaining homing and straying include instream flows, as well as olfactory cues related to water quality and the presence of other salmon. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients may affect DO and result in unsuitable water quality conditions for up-migrating steelhead during late summer periods. Anthropogenic inputs of herbicides and pesticides may also affect water quality and impair olfactory cues necessary for homing of steelhead. Homing fidelity of introduced hatchery fish has been shown to be poorer than naturally reproducing steelhead.

Processes/Mechanisms affecting Direct Mortality

Sportfishing & Poaching – Inland sportfishing and illegal poaching affect the number of steelhead adults that return to their natal streams to spawn, and in turn, affect subsequent juvenile production. Sportfishing occurs, mostly in the Bay and Delta, but also in the San Joaquin River system prior to the mid-October angling closure in the tributaries. Illegal poaching has not been well quantified.

Water Quality – In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of other contaminants may result in unsuitable water quality conditions for up-migrating steelhead. However, mortality of adult steelhead is unlikely to result from water quality impairments such as DO depletion resulting from algal and bacterial respiration or from potential toxicity events.

Water Temperature – Meteorology and to a minor degree, instream flows, combine to affect exposure of up-migrating adults to changes in water temperatures. However, given the general up-migration timing of adult steelhead (i.e., winter-run life history), avoidance of unsuitable water temperatures by adults would be expected.

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Exposure to changes in water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia in the lower San Joaquin River may contribute to stress and disease incidence and subsequent mortality of estuarine and up-migrant adult steelhead. In addition to factors affecting instream flows in the San Joaquin River and Delta, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants may result in unsuitable water quality conditions for up-migrating steelhead. Although meteorology and instream flows may combine to affect exposure of estuarine and up-migrating steelhead to changes in water temperature, given the general up-migration timing of adult steelhead (i.e. winter-run), linkages to temperature stress and disease incidence would be related to estuarine habitat use only.

Steelhead Spawning

Processes/Mechanisms affecting Spawning Success

Competition and Exclusion – Although riffle spawning by steelhead is uncommon and very little tributary spawning of steelhead has been observed, competition and exclusion of up-migrant adults from accessing suitable spawning sites may occur depending upon the numbers of spawners, gravel quality, and local hydraulic characteristics of available spawning habitat area. Both gravel quality and the availability of suitable spawning habitat are affected by instream flows, meteorology, as well as factors contributing to alterations in sediment transport processes. Competition for suitable spawning sites by anthropogenically introduced hatchery fish as well as resident *O. mykiss* may limit spawning success of any wild steelhead arriving in the Tuolumne River.

Processes/Mechanisms affecting Direct Mortality

Poaching – Illegal poaching of adult steelhead arriving in the lower Tuolumne River after mid-October has not been quantified, but potentially reduces the number of adults that successfully spawn, and in turn, affects subsequent juvenile production.

Water Temperature – Meteorology and instream flows combine to affect exposure of spawning adults to changes in water temperatures. Although no information is available regarding pre-spawning mortality of steelhead, given the general up-migration timing of adult steelhead (i.e., winter-run), water temperature effects upon pre-spawn mortality would be unexpected,

Processes/Mechanisms affecting Indirect Mortality

Disease and Parasites – Meteorology and instream flows in the lower Tuolumne River combine to affect exposure of pre-spawning adults to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. Although the general winter and spring up-migration timing of adult steelhead would not be expected to result in water temperature related diseases, disease incidence may be also related to prior exposure to unsuitable water temperatures and water quality in the Delta as well as exposure to water-borne pathogens or interactions with other infected/infested fish.

Steelhead egg incubation

Processes/Mechanisms affecting Egg/Alevin growth and Fry Emergence

Water Temperature – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures, which has a strong influence on the rate of subsequent embryo and alevin development, typically ranging from 4 to 6 weeks from fertilization to fry emergence.

Water Quality – Instream flows and sediment transport of bedload and suspended sediments may affect intra-gravel flow as well as interstitial water quality conditions such as DO necessary for the successful development of the embryo/alevin to fry emergence.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and instream flows may combine to affect exposure of deposited eggs to changes in water temperatures, potentially reducing egg survival to emergence and subsequent juvenile production.

Redd Scour –Redd scour may result from increased rates of sediment (bedload) transport during high flow events such as flood flows. Displacement of eggs and alevins due to redd scour may cause mortality from mechanical shock, crushing or entrainment into the bedload.

Redd Superimposition – Egg displacement due to redd superimposition resulting from competition and exclusion of adult spawners and anthropgenically introduced hatchery fish may result in density-dependent mortality of previously deposited eggs disturbed by the spawning activities of subsequently arriving females. Availability of suitable spawning habitat is affected by instream flows as well as gravel quality and spawning habitat area resulting from factors contributing to alterations in sediment transport processes.

Entombment – Fine sediment deposition in completed redds due to suspended sediments may effectively seal the upper layers of the redd, and obstruct the emergence of alevins, causing entombment and subsequent mortality. Entombment may be affected by gravel quality and suspended sediment input due to surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Indirect Mortality

Bacterial & Fungal Infections – Meteorology and instream flows combine to affect exposure of deposited eggs to varying water temperatures in the spawning reaches of the lower Tuolumne River. Although no information is available on disease incidence for incubating eggs in the Tuolumne River, water temperature has been shown to contribute to increased rates of mortality by bacterial and fungal growth in other systems.

Steelhead in-river rearing

Processes/Mechanisms affecting juvenile growth and survival

Water Temperature – Meteorology and instream flows combine to affect water temperature of in-channel habitats and has a strong influence on growth and feeding rates of rearing juvenile steelhead. Summer water temperatures may affect availability of suitable habitat for steelhead/O. mykiss as well as feeding rates. Water temperatures may also affect the timing of smoltification, may result in desmoltification, and may limit the times of year for successful smolt outmigration.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affects the prey availability and growth rates of juvenile steelhead trout. Both the availability of these organic matter sources as well as the physical habitat availability for benthic macro-invertebrates and terrestrial insects (drift) is in turn affected by instream flows as well as factors contributing to alterations in sediment transport processes.

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile steelhead trout to changes in water temperatures with varying probabilities of direct mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and sediment transport processes, predation of juvenile by native and introduced fish is influenced by meteorology and instream flow influences on water temperatures. Anthropogenic inputs of contaminants may also affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may also affect by surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Stranding & Entrapment – Rapid reductions in instream flows, particularly during flood flow conditions, may eliminate access to available habitat and cause stranding and entrapment of juvenile *O. mykiss* on gravel bars and floodplains and in off-channel habitats that may become cut off when flows are reduced. For juvenile *O. mykiss* using floodplain habitats, stranding of juveniles often results from rapid flow reductions and a range of mortality mechanisms may occur, including desiccation, temperature shock, asphyxiation, as well as predation by birds and mammals.

Entrainment – Depending on instream flows and agricultural operations, entrainment of rearing juvenile *O. mykiss* or outmigrating steelhead smolts into unscreened pumps may occur, resulting in mechanical damage and mortality.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and instream flows combine to affect exposure of rearing juvenile steelhead to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality of outmigrating smolts. In addition to factors affecting instream flows in the lower Tuolumne River, anthropogenic inputs of nutrients, as well as accidental discharges of ammonia or other contaminants may result in unsuitable water quality, exposing juvenile steelhead to low DO, high pH (alkalinity) and unionized ammonia and contributing to stress and disease incidence in steelhead smolts.

Steelhead Delta outmigration

Processes/Mechanisms affecting growth and survival

Although extended residency in the Delta by rearing juvenile *O. mykiss* or outmigrant smolts has not been well documented in the Delta, the following mechanisms may apply to Delta habitats.

Water Temperature – Meteorology and to a minor degree instream flows combine to affect water temperature in the San Joaquin River and Delta where ambient water temperatures may limit the times of year for successful smolt outmigration from upstream tributaries to winter and spring, typically February through May.

Prey Availability – Allochthonous sources of organic matter (e.g., leaf litter, LWD decomposition, soil runoff) as well as autochthonous sources (e.g., algae, diatoms) affect the prey availability and growth rates of juvenile steelhead trout. The availability of these organic matter sources to zooplankton in the Delta is affected by anthropogenically supplied nutrients and algal productivity. For any actively feeding *O. mykiss*, food web productivity and terrestrial insect drift are affected by instream flows as well as other factors contributing to alterations in floodplain inundation frequency, duration, and extent (e.g., levee construction).

Processes/Mechanisms affecting Direct Mortality

Water Temperature – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juveniles and outmigrant steelhead smolts to changes in water temperatures, potentially resulting in increased rates of mortality.

Predation – In addition to the creation of suitable predator habitat due to changes in instream flows and the reduced habitat availability of off-channel rearing habitats by levee construction, predation of steelhead smolts by native and introduced fish is influenced by meteorology and instream flow effects upon water temperature. Anthropogenic inputs of contaminants may also affect water quality and susceptibility to predation. Predation efficiency has been shown to be influenced by turbidity, which may also affect by surrounding land use practices, instream flows as well as factors contributing to alterations in sediment transport processes.

Entrainment – Depending on tributary instream flows to the San Joaquin River and Delta, entrainment of migrating steelhead smolts into unscreened pumps may occur, resulting in mechanical damage and mortality. It is unknown whether steelhead outmigration coincides with the seasonal installation of barrier at the Head of Old River, but entrainment into the forebays of the Delta export facilities may result in increased rates of predation, physical damage and stress during salvage operations.

Processes/Mechanisms affecting Indirect Mortality

Diseases & Parasites – Meteorology and to a minor degree instream flows combine to affect exposure of rearing juvenile *O. mykiss* and outmigrant steelhead smolts to changes in water temperatures, which in turn, may contribute to stress and disease incidence and subsequent mortality. Exposure to varying water temperature as well as water quality conditions such as low DO, high pH (alkalinity) and unionized ammonia due to anthropogenic inputs of contaminants in the lower San Joaquin River and Delta may also contribute to stress and disease incidence and subsequent mortality of steelhead smolts.

Steelhead Ocean rearing

Processes/Mechanisms affecting Adult growth and survival

Prey Availability – Meteorology, ocean water temperatures and water quality influence primary and secondary productivity of the marine food web that supports immature and adult steelhead trout. Both direct discharge of anthropogenically supplied nutrients as well as changes in ocean circulation patterns and upwelling of nutrients affect marine water quality.

Processes/Mechanisms affecting Direct Mortality

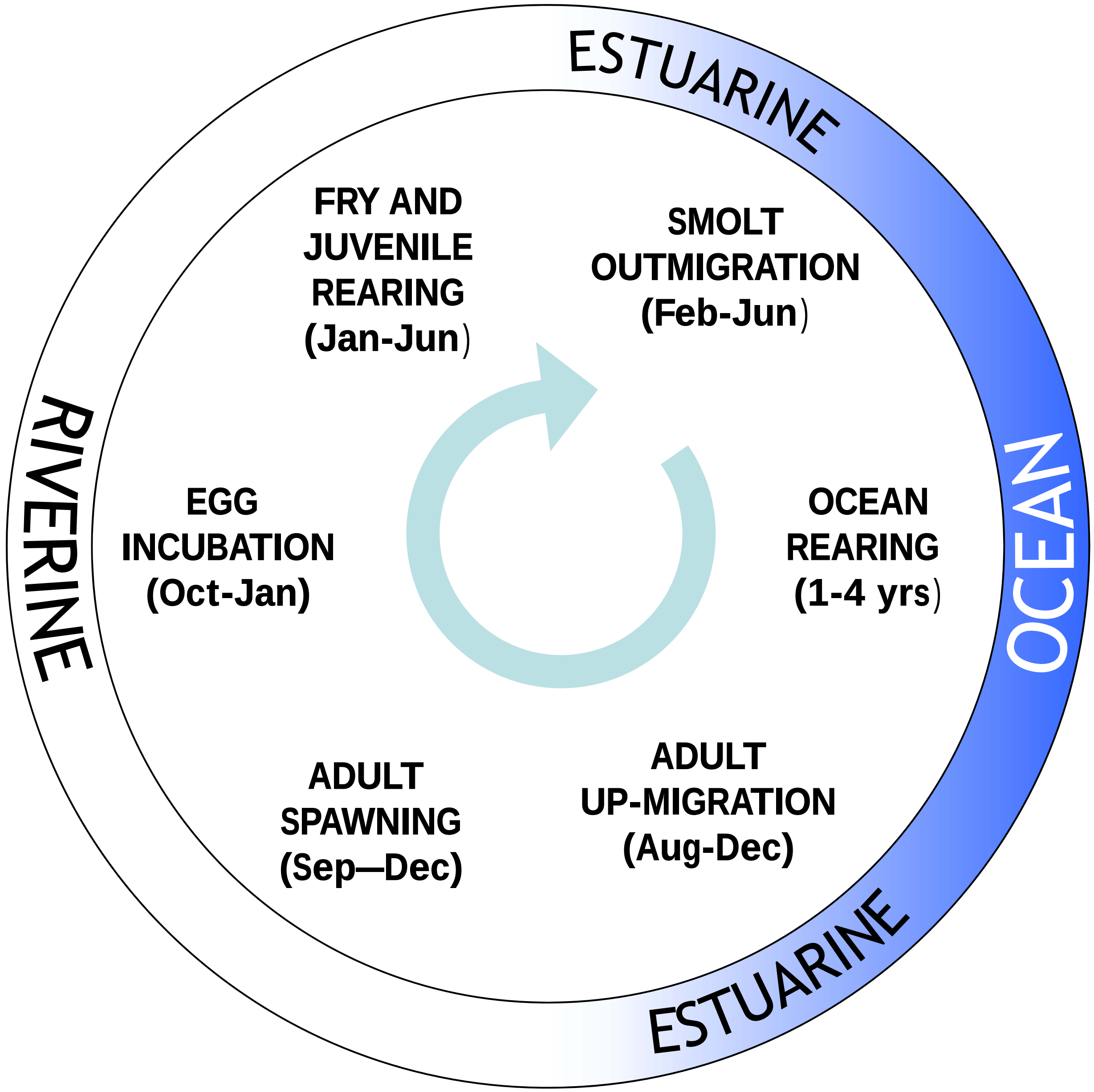
Predation – Predation of immature steelhead following ocean entry may reduce subsequent adult returns. Predation rates upon immature steelhead may be affected by changes in predator species distribution with water temperature and ocean circulation patterns. Early life history exposure to anthropogenic inputs of contaminants may also affect water quality and subsequent susceptibility to predation.

Harvest By-Catch – Although no commercial ocean harvest of adult steelhead occurs, low levels of adult mortality occurs due to by-catch of steelhead in the Pacific Ocean gill net fishery.

Processes/Mechanisms affecting Indirect Mortality

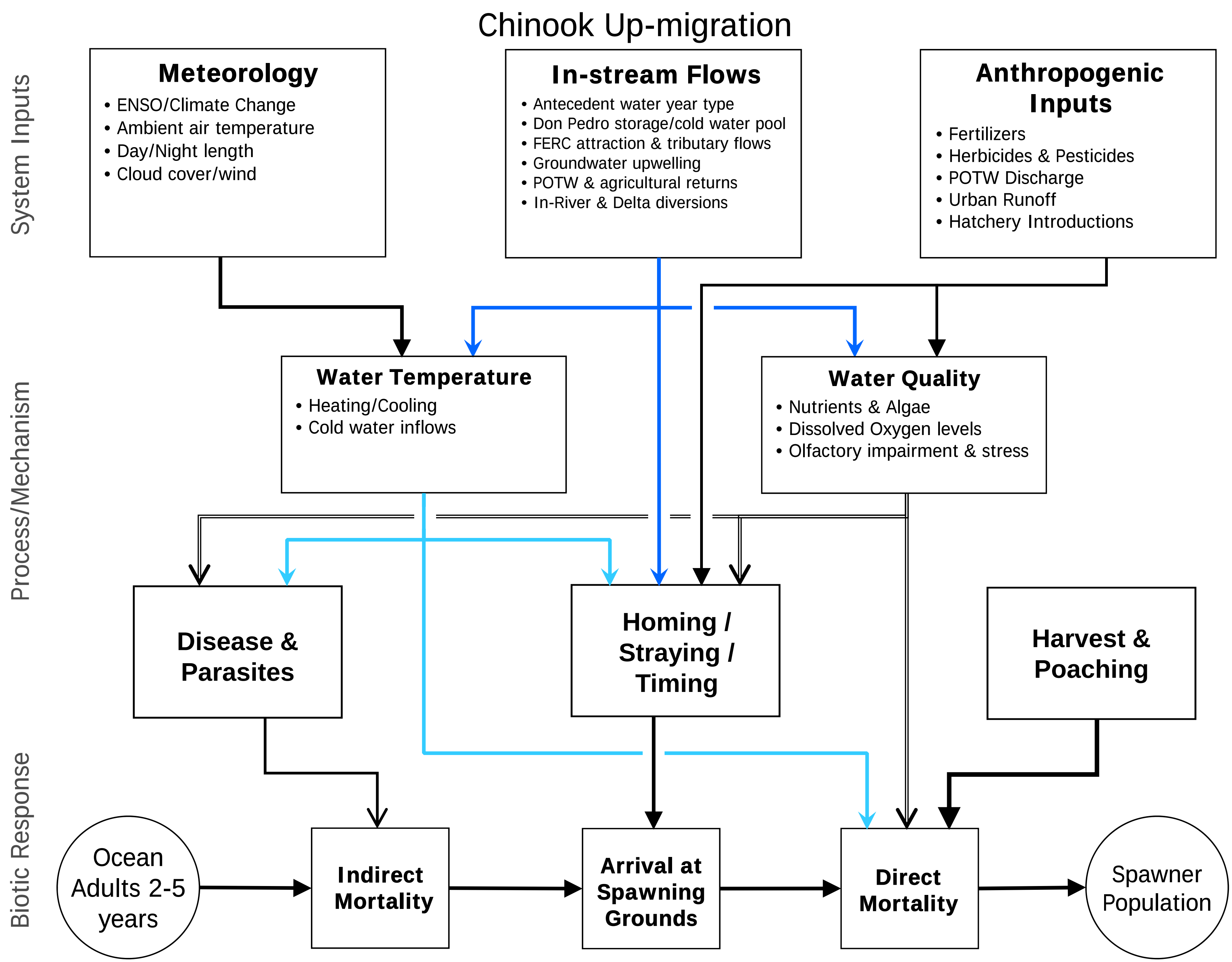
Diseases & Parasites – Meteorology and instream flow effects upon water temperature in upstream habitats may affect early life history disease incidence and subsequent mortality of steelhead. Prior exposure to pathogens and parasites during juvenile rearing and outmigration may also contribute to increased disease incidence in the adult steelhead population.

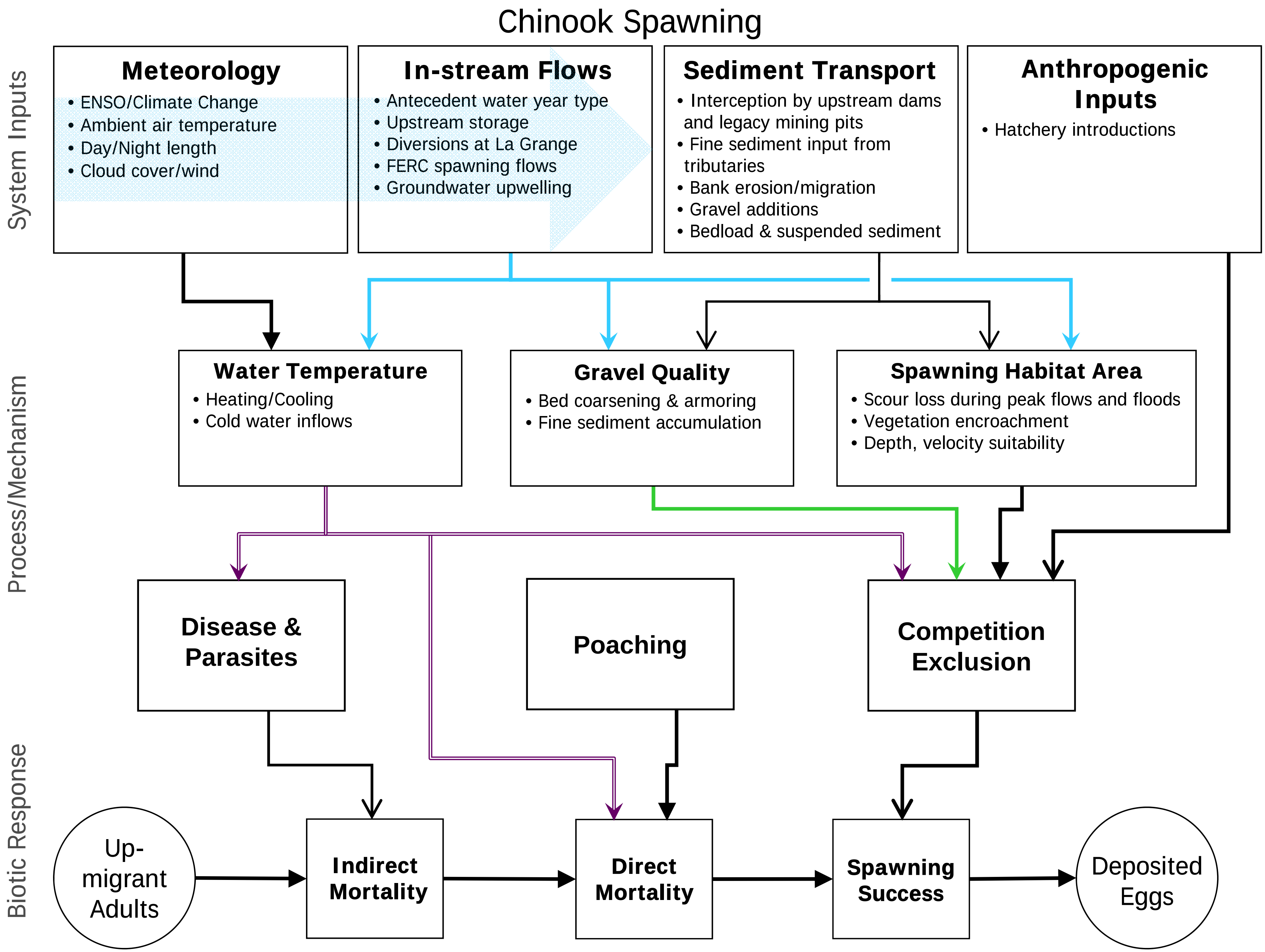
General Chinook salmon Life History Timing for the Tuolumne River

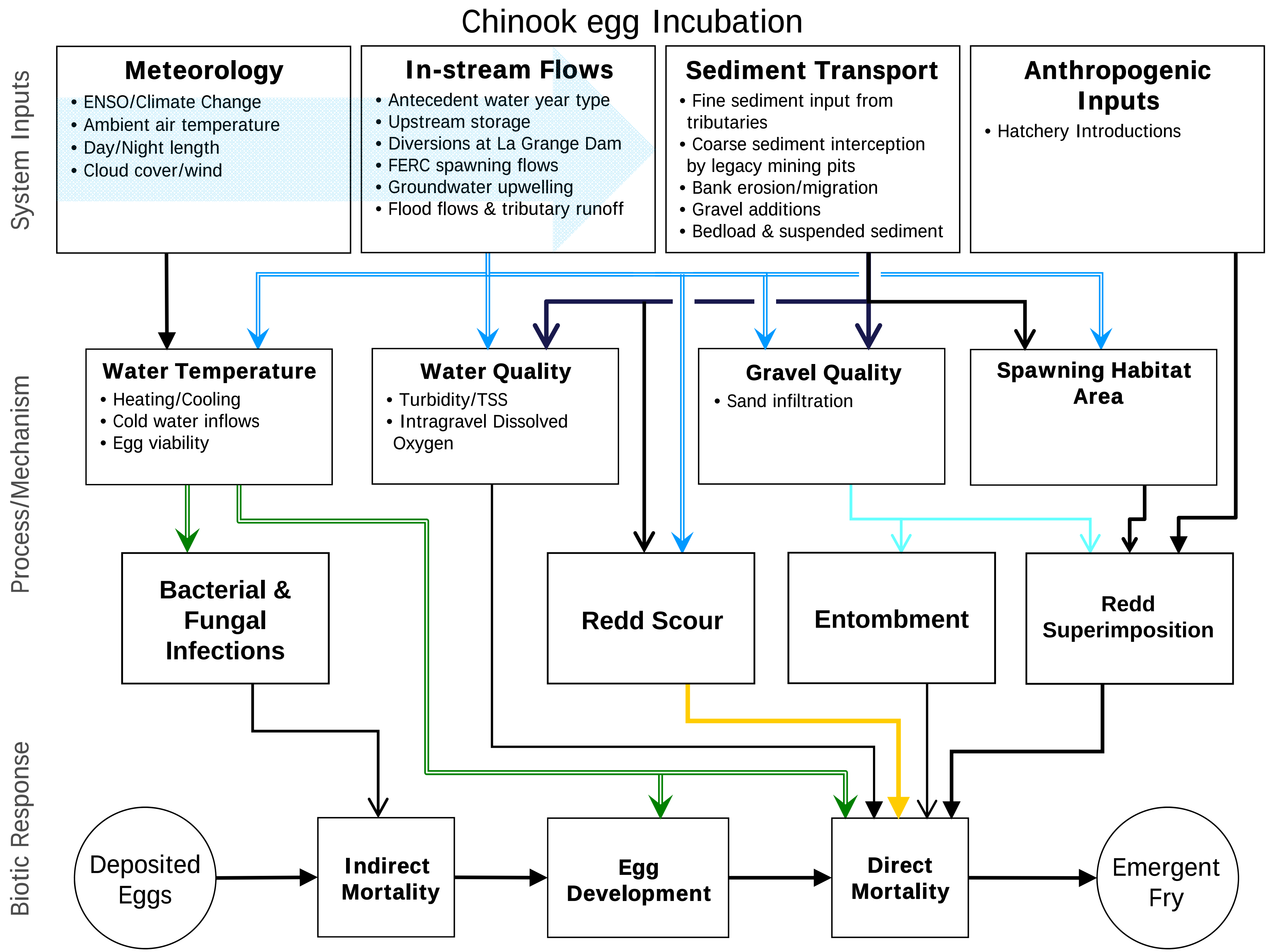


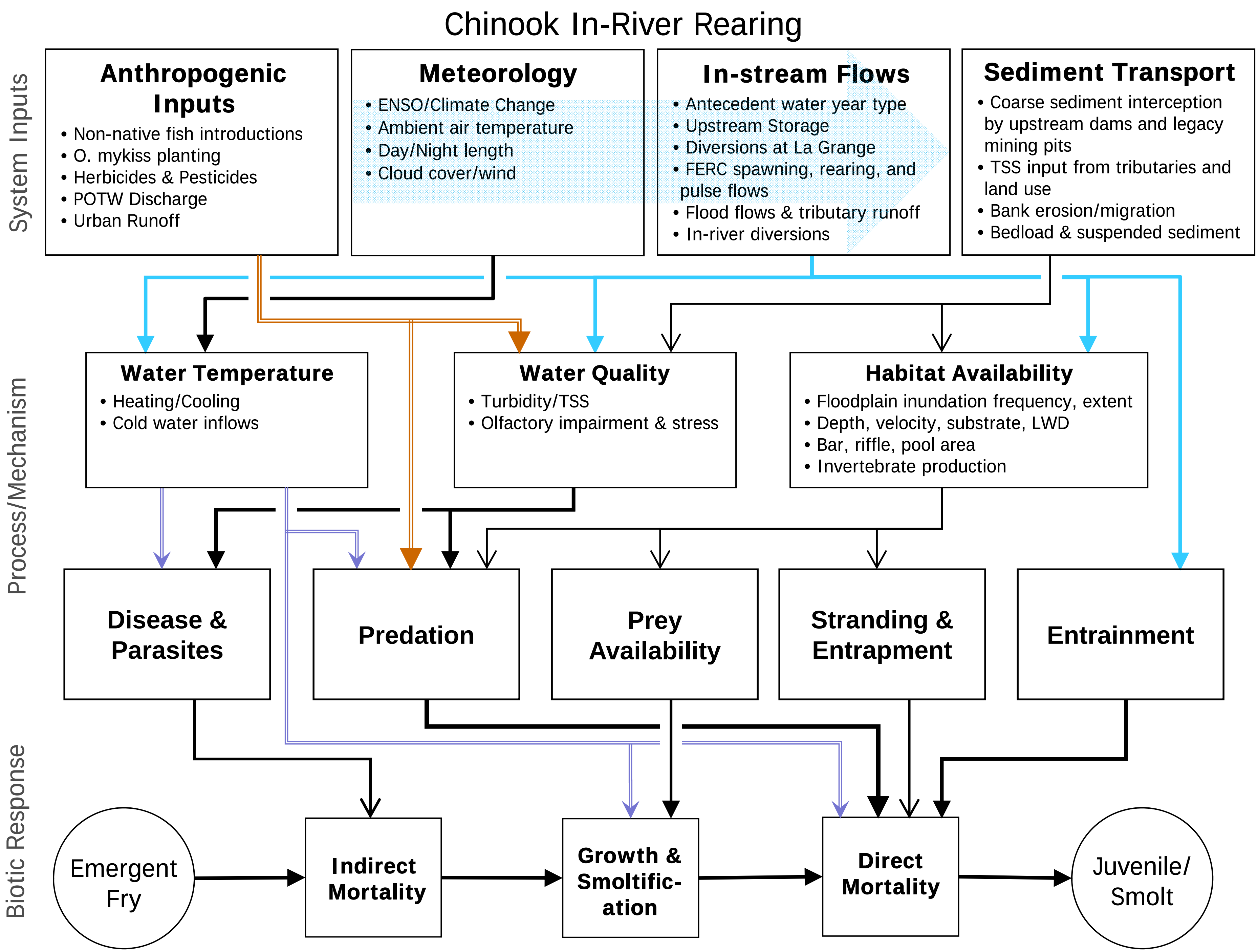
General Chinook salmon Life History Timing for the Tuolumne River

Life Stage	Fall			Winter			Spring			Summer		
	(Sep-Nov)			(Dec-Feb)			(Mar-May)			(Jun-Aug)		
Central Valley Fall-Run Chinook salmon												
Adult upstream migration												
Adult Spawning												
Egg Incubation and Fry Emergence												
In-river Rearing												
Delta Juvenile Rearing												
Smolt Outmigration												

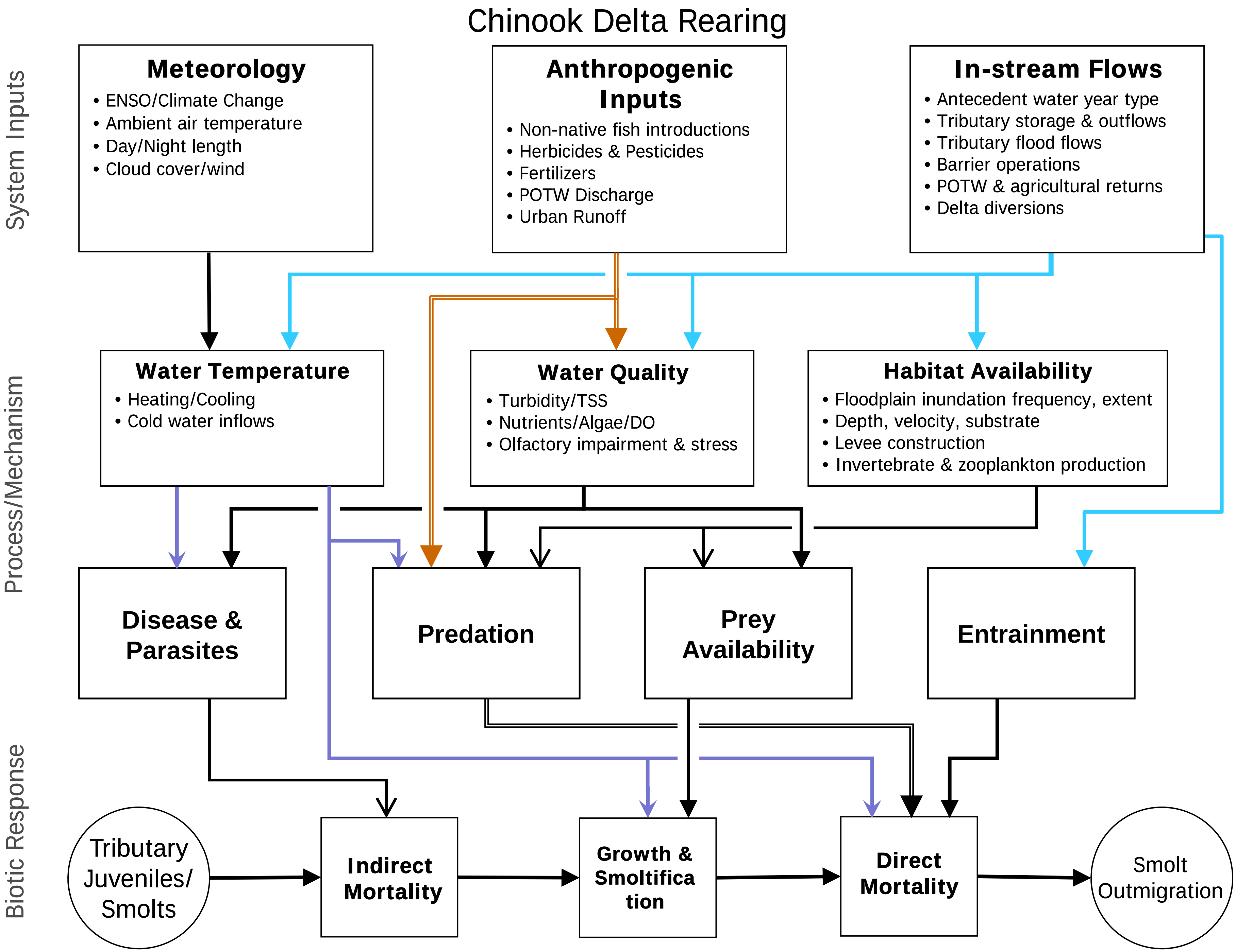

Chinook Up-migration
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Don Pedro storage/cold water pool
• FERC attraction & tributary flows
• Groundwater upwelling
• POTW & agricultural returns
• In-River & Delta diversions
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Hatchery Introductions
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Harvest & Poaching
Ocean Adults 2-5 years
Indirect Mortality
Arrival at Spawning Grounds
Direct Mortality
Spawner Population


Chinook Spawning
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Poaching
Competition Exclusion
Biotic Response
Up-migrant Adults
Indirect Mortality
Direct Mortality
Spawning Success
Deposited Eggs

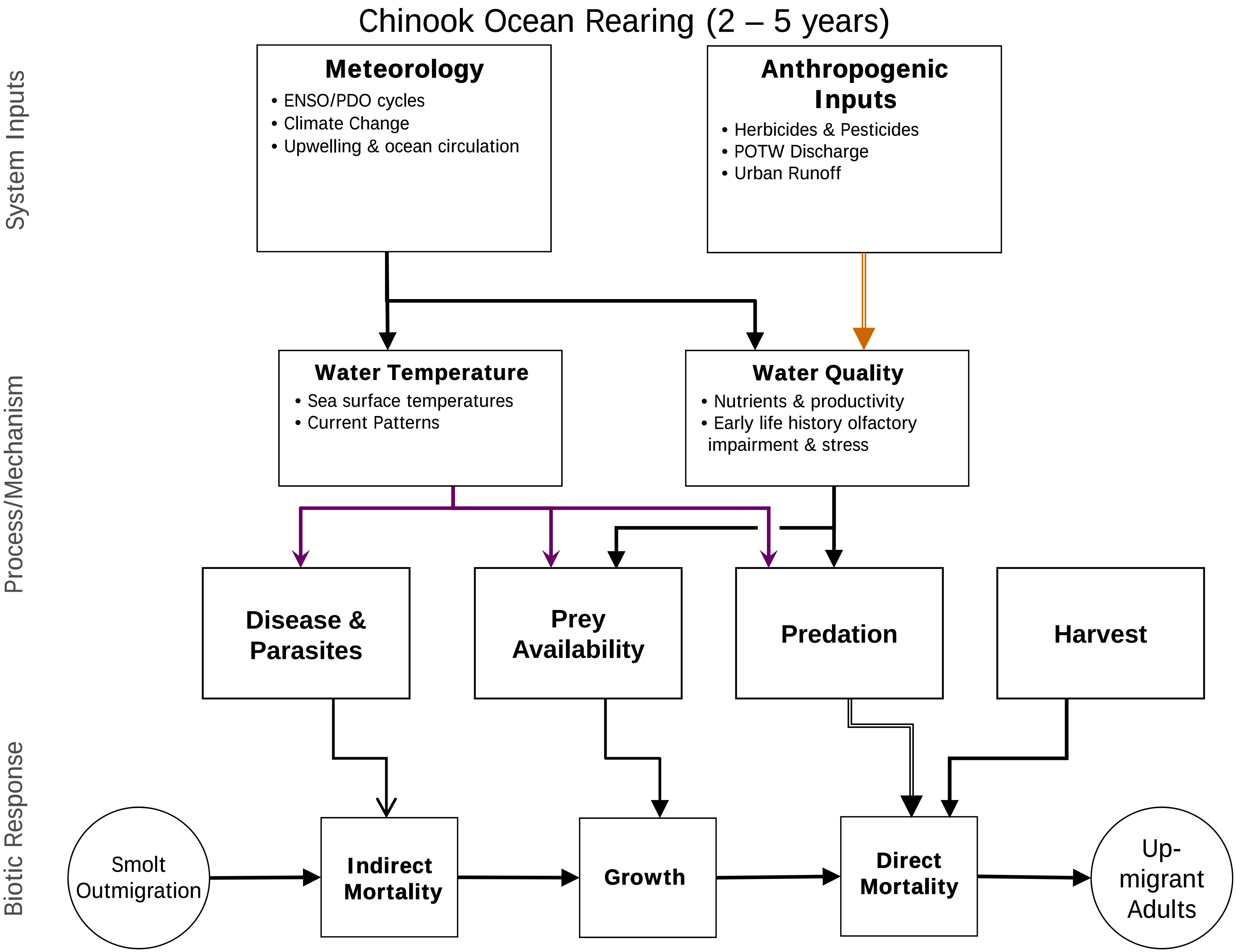

Chinook egg Incubation
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange Dam
• FERC spawning flows
• Groundwater upwelling
• Flood flows & tributary runoff
Sediment Transport
• Fine sediment input from tributaries
• Coarse sediment interception by legacy mining pits
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
• Egg viability
Water Quality
• Turbidity/TSS
• Intragravel Dissolved Oxygen
Gravel Quality
• Sand infiltration
Spawning Habitat Area
Bacterial & Fungal Infections
Redd Scour
Entombment
Redd Superimposition
Biotic Response
Deposited Eggs
Indirect Mortality
Egg Development
Direct Mortality
Emergent Fry



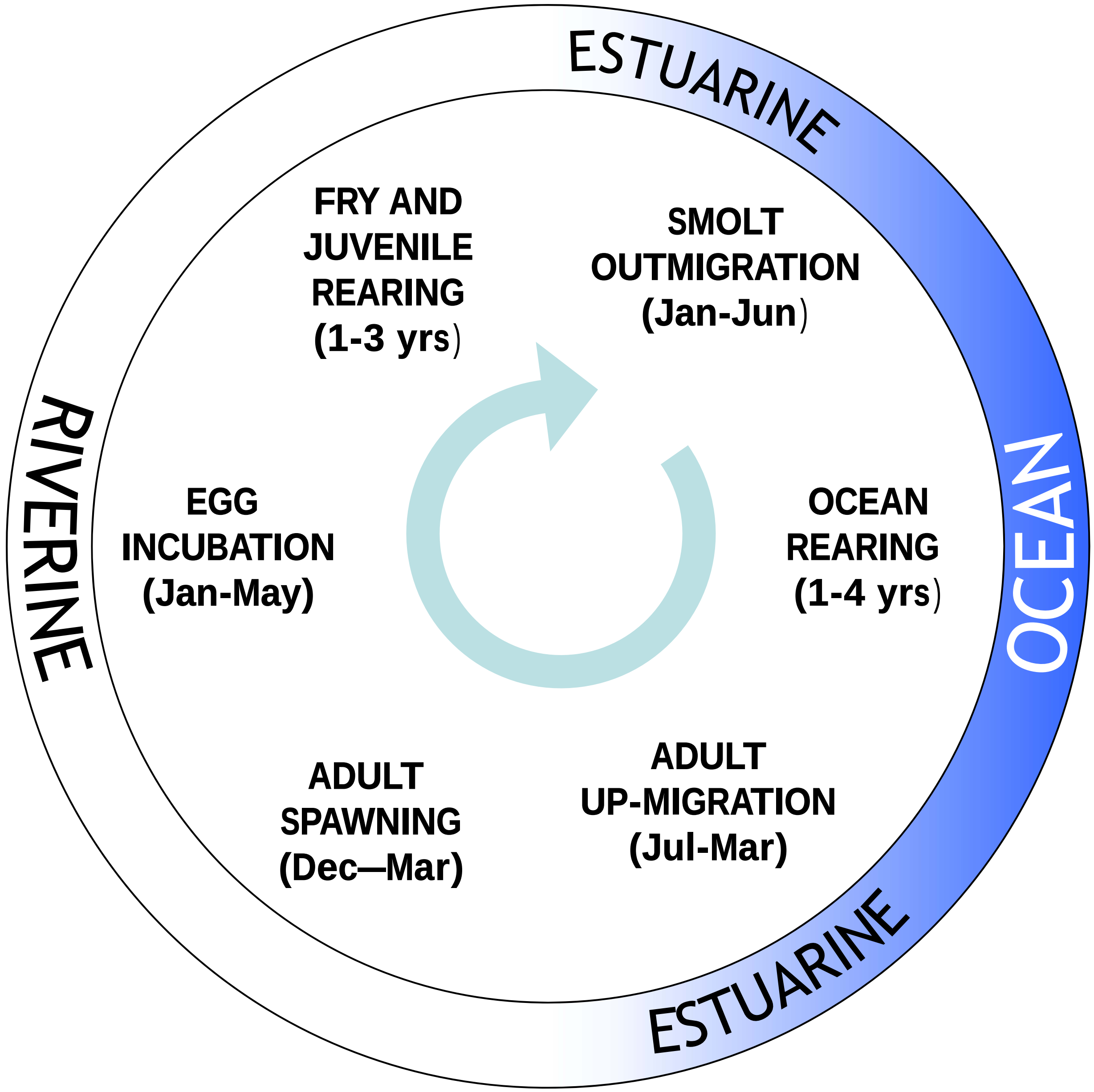
Chinook In-River Rearing
System Inputs
Anthropogenic Inputs
• Non-native fish introductions
• O. mykiss planting
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream Storage
• Diversions at La Grange
• FERC spawning, rearing, and pulse flows
• Flood flows & tributary runoff
• In-river diversions
Sediment Transport
• Coarse sediment interception by upstream dams and legacy mining pits
• TSS input from tributaries and land use
• Bank erosion/migration
• Bedload & suspended sediment
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate, LWD
• Bar, riffle, pool area
• Invertebrate production
Disease & Parasites
Predation
Prey Availability
Stranding & Entrapment
Entrainment
Biotic Response
Emergent Fry
Indirect Mortality
Growth & Smoltific-ation
Direct Mortality
Juvenile/ Smolt



Chinook Delta Rearing
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
Anthropogenic Inputs
• Non-native fish introductions
• Herbicides & Pesticides
• Fertilizers
• POTW Discharge
• Urban Runoff
In-stream Flows
• Antecedent water year type
• Tributary storage & outflows
• Tributary flood flows
• Barrier operations
• POTW & agricultural returns
• Delta diversions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Nutrients/Algae/DO
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate
• Levee construction
• Invertebrate & zooplankton production
Disease & Parasites
Predation
Prey Availability
Entrainment
Biotic Response
Tributary Juveniles/ Smolts
Indirect Mortality
Growth & Smoltification
Direct Mortality
Smolt Outmigration

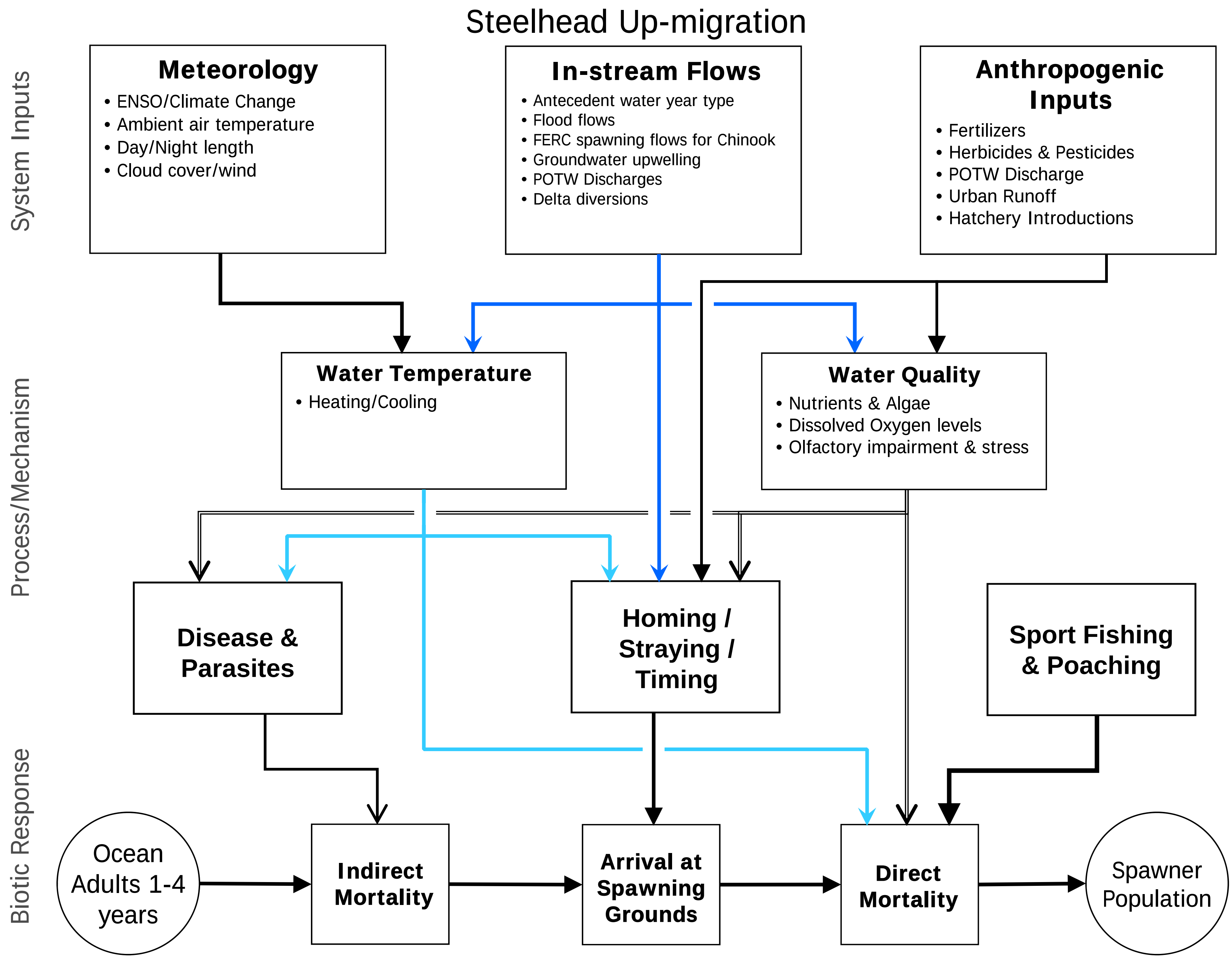

Chinook Ocean Rearing (2 – 5 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Water Temperature
• Sea surface temperatures
• Current Patterns
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Prey Availability
Predation
Harvest
Smolt Outmigration
Indirect Mortality
Growth
Direct Mortality
Up-migrant Adults

General Steelhead Life History Timing for the Tuolumne River

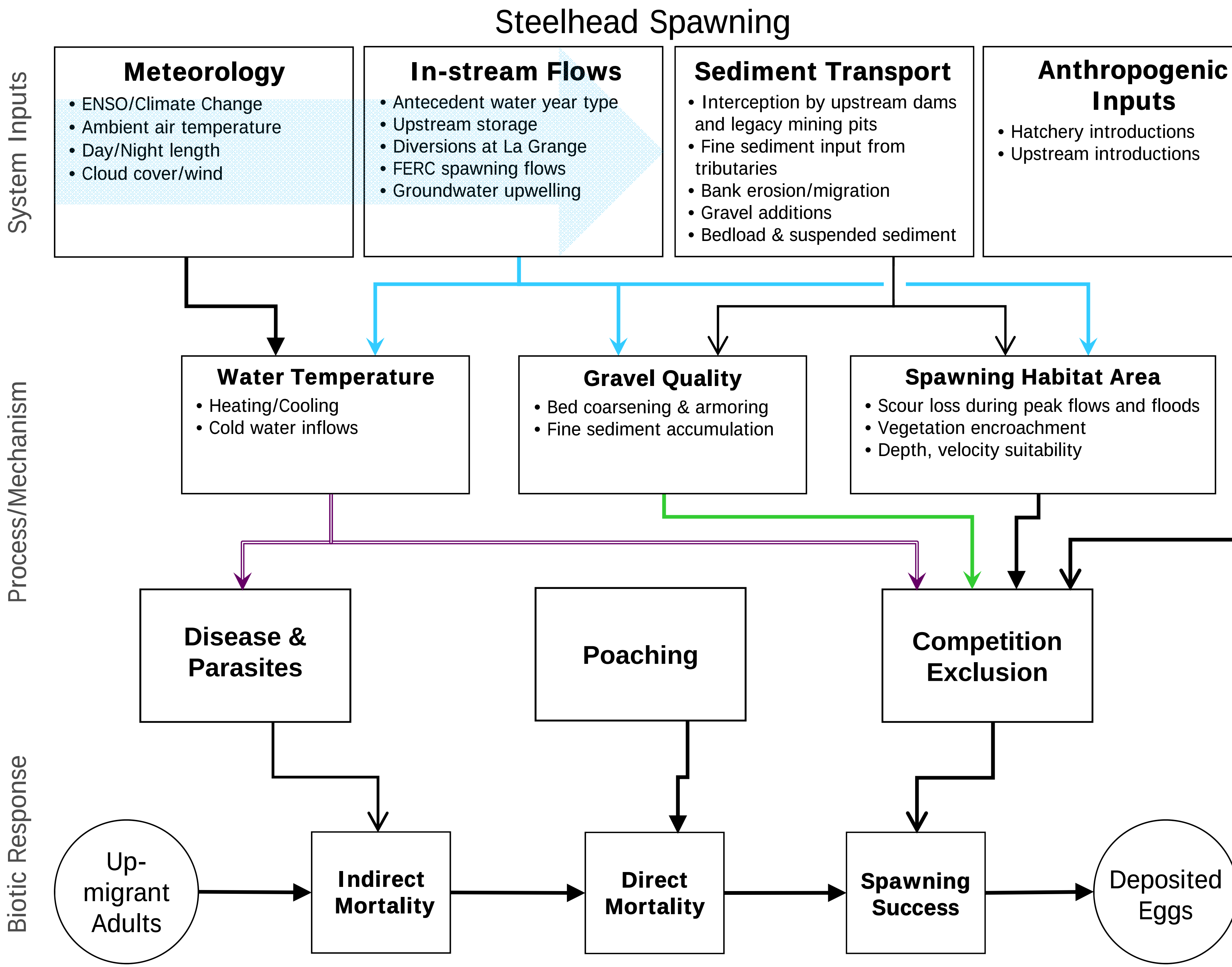


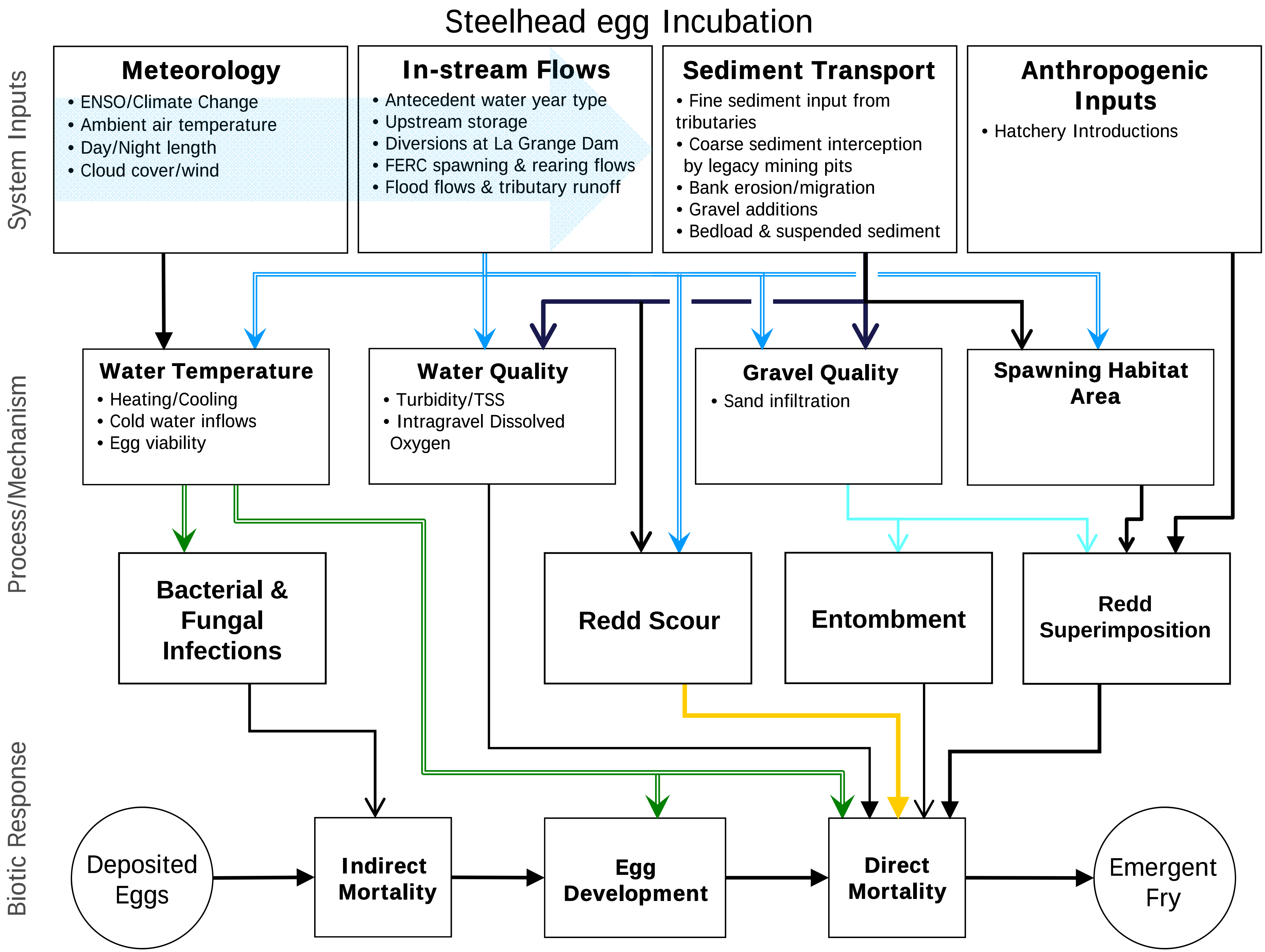
General Steelhead Life History Timing for the Tuolumne River

Life Stage	Fall			Winter			Spring			Summer		
	(Sep-Nov)			(Dec-Feb)			(Mar-May)			(Jun-Aug)		
Central Valley Steelhead / *O. mykiss*												
Adult upstream migration												
Adult Spawning												
Egg Incubation and Fry Emergence												
In-River Rearing												
Smolt Outmigration												

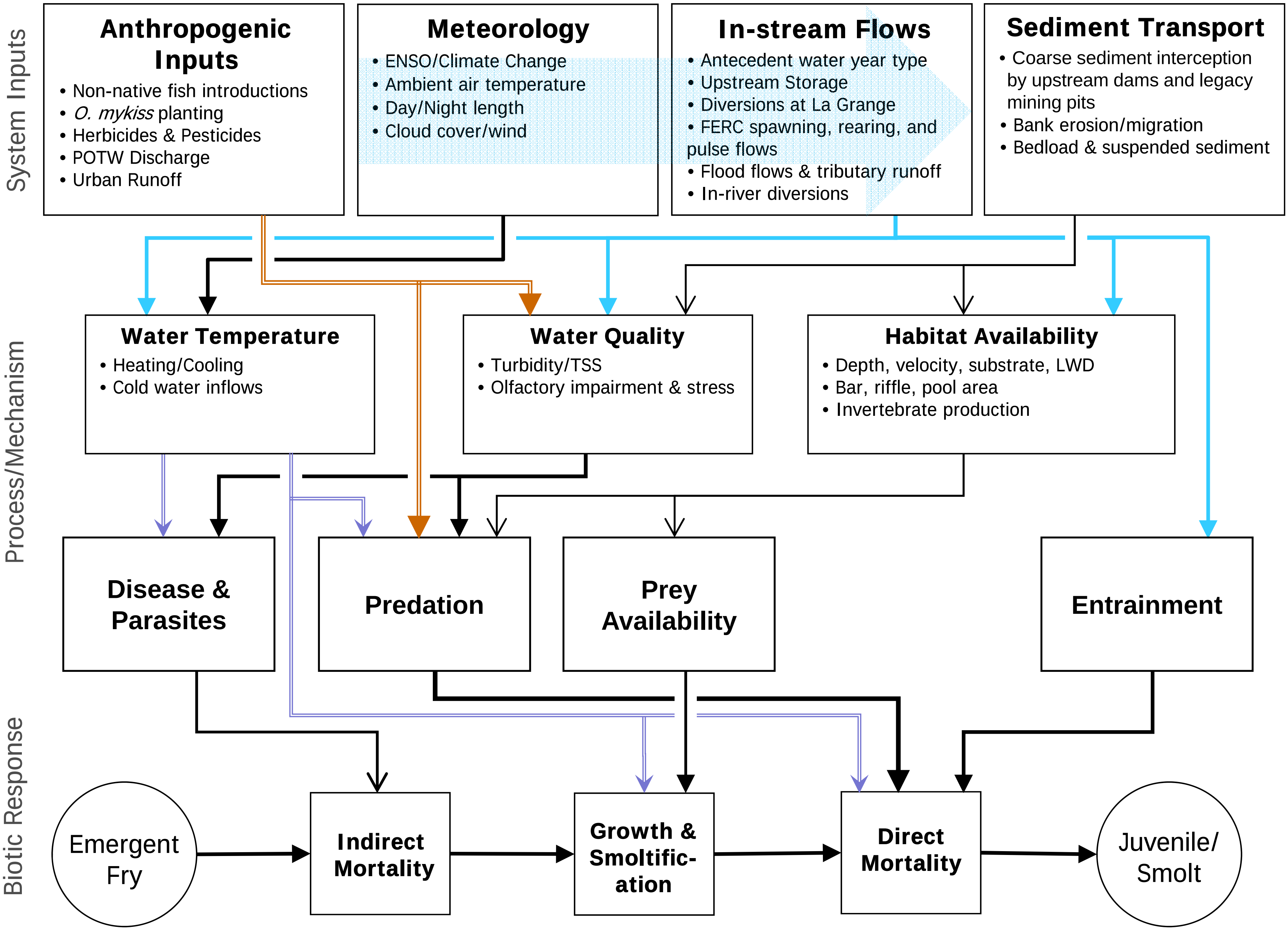


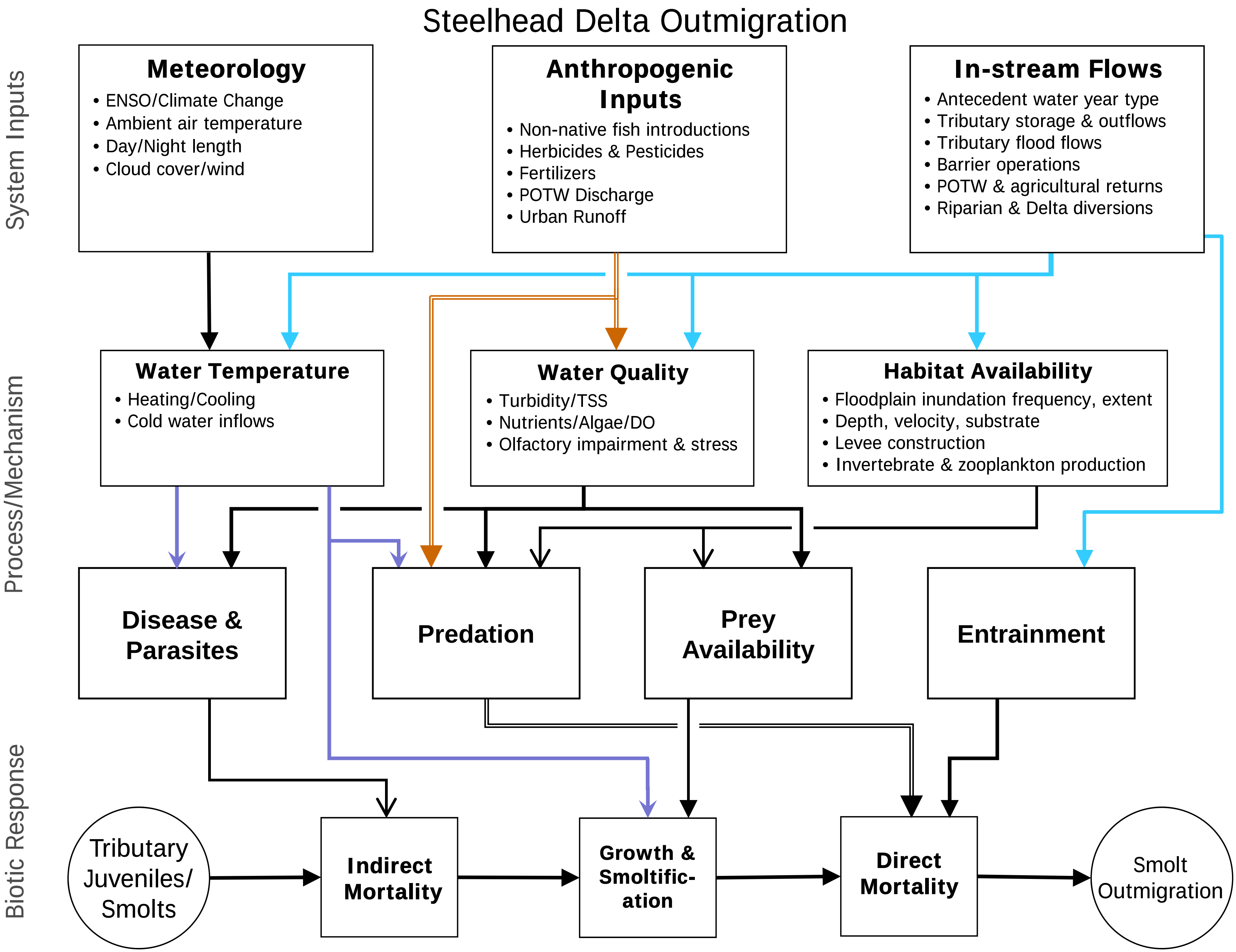
Steelhead Up-migration
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Flood flows
• FERC spawning flows for Chinook
• Groundwater upwelling
• POTW Discharges
• Delta diversions
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Sport Fishing & Poaching
Biotic Response
Ocean Adults 1-4 years
Indirect Mortality
Arrival at Spawning Grounds
Direct Mortality
Spawner Population


Steelhead Spawning
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery introductions
• Upstream introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Poaching
Competition Exclusion
Biotic Response
Up-migrant Adults
Indirect Mortality
Direct Mortality
Spawning Success
Deposited Eggs

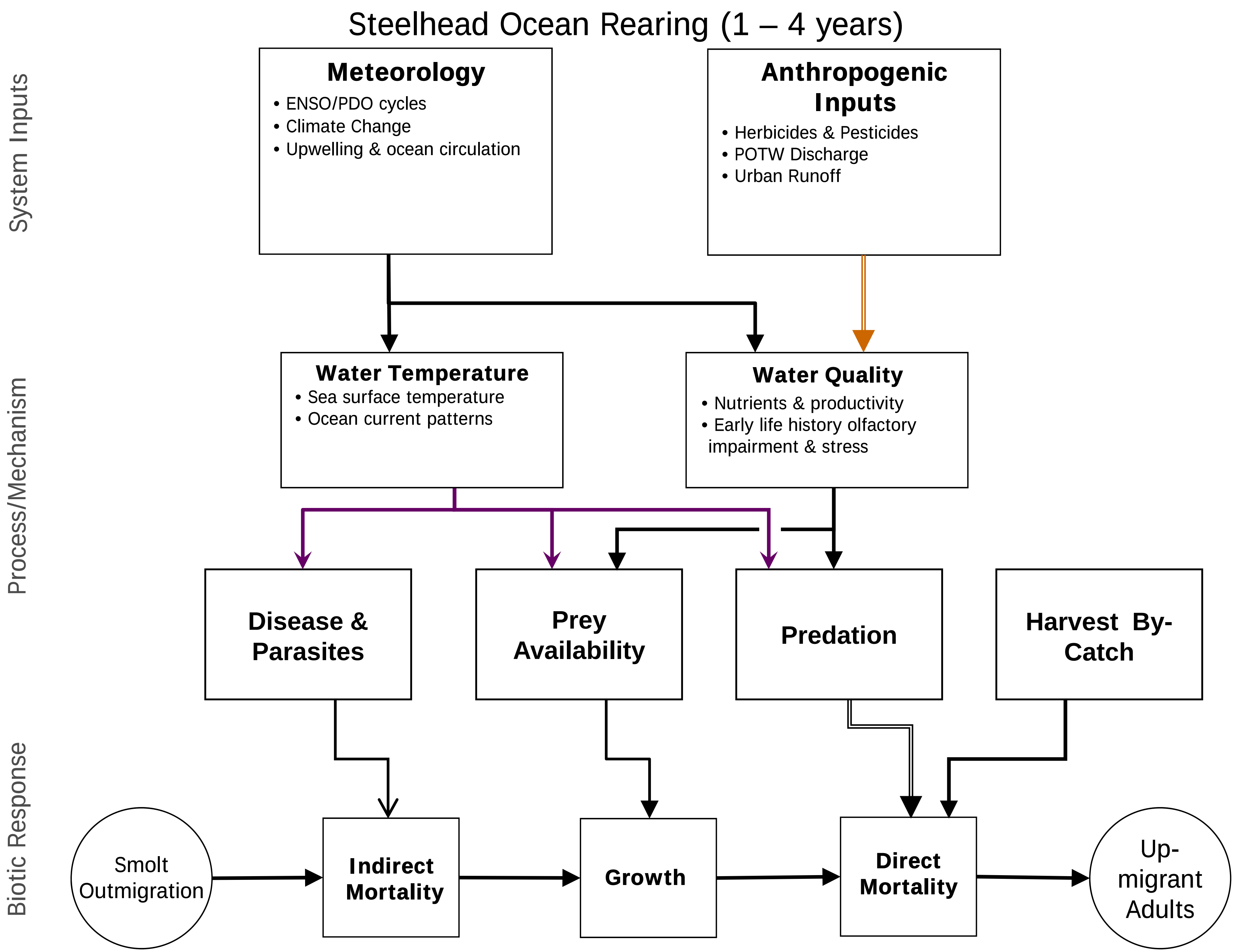

Steelhead egg Incubation
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange Dam
• FERC spawning & rearing flows
• Flood flows & tributary runoff
Sediment Transport
• Fine sediment input from tributaries
• Coarse sediment interception by legacy mining pits
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
• Egg viability
Water Quality
• Turbidity/TSS
• Intragravel Dissolved Oxygen
Gravel Quality
• Sand infiltration
Spawning Habitat Area
Bacterial & Fungal Infections
Redd Scour
Entombment
Redd Superimposition
Biotic Response
Deposited Eggs
Indirect Mortality
Egg Development
Direct Mortality
Emergent Fry

Steelhead In-River Rearing (1-3 years)





Steelhead Delta Outmigration
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
Anthropogenic Inputs
• Non-native fish introductions
• Herbicides & Pesticides
• Fertilizers
• POTW Discharge
• Urban Runoff
In-stream Flows
• Antecedent water year type
• Tributary storage & outflows
• Tributary flood flows
• Barrier operations
• POTW & agricultural returns
• Riparian & Delta diversions
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Nutrients/Algae/DO
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate
• Levee construction
• Invertebrate & zooplankton production
Disease & Parasites
Predation
Prey Availability
Entrainment
Tributary Juveniles/ Smolts
Indirect Mortality
Growth & Smoltific-ation
Direct Mortality
Smolt Outmigration


Steelhead Ocean Rearing (1 – 4 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Water Temperature
• Sea surface temperature
• Ocean current patterns
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Prey Availability
Predation
Harvest By-Catch
Smolt Outmigration
Indirect Mortality
Growth
Direct Mortality
Up-migrant Adults

<u>Preliminary Important Factors Review (6/26/2012) –</u>

<u>Draft WAR-5 Meeting Discussion Notes</u>

<u>Chinook Life Stages</u>	**<u>Information Needed/ other notes</u>**
<u>Up-Migration</u> 1. Seasonal water temperature influences on timing • Include T.R. temp – diff. year types • Trib flow influence on water temps/blockage 2. Seasonal DO blockage in lower S. J. • Comp Plan Recommendation (water board data re: DO, 2001; may not relate DO levels to salmon presence; CDFG may have more data this fall) • May be more or less of an issue in different years/flushing flows (e.g., Chen?) • Priority level difficult to know without review of data	**<u>Up-Migration</u>** *Attraction Flows* (CDFG – tag data, etc, testimony citations – need specific page numbers/part of record to demonstrate issue) *Inland Harvest and Poaching*
<u>Spawning</u> **1.** Spawning area availability **2.** Gravel quality • Site specific velocity, depth, upwelling • IFIM study results • WAR-4 mapping results • WAR-8 Redd Mapping **3.** Water Temp pre-spawn mortality (not T.R. specific info.; CDFG may have data)	*Other spawning bed characteristics (vel. ,slope, etc)* *Post-project assessment* of CFDG gravel augmentation study (follow-up docs)

Egg Incubation 1. Temperature/incubation rates 2. Redd superimposition at high run sizes 3. Entombment due to fine sediment 4. Redd de-watering due to changes in flow	*Water temp mortality* – have not seen in T.R. (USFWS has Merce study, reference in the study request for incubation; also study on-going on the Merced – being conducted this fall; USFWS study with the San j. prelim report) Spawning reports from Stan and Calvaris, American and Sacramento (CDFG data? FishBio data?)
In-River Rearing/Out-migration **1.** Predation – water temp and habitat availability for predators • Floodplain inundation and predator avoidance (addressed by pulse flow report) • WAR-7 Predation Study **2.** Prey availability (Habitat availability) • Floodplain food production (? – Yolo bypass studies, do not have specific T.R. info,/may not be applicable to T.R.; USFWS – size data specific to T.R. in diff. water year types – mechanisms may not be clear; hatch data inferences?) 3. Water Temp mortality (?) • Lack of smoltification (Mesick? 2010 or 2011)	Water temp relationship to food availability Floodplain food production Technical Memo (Bureau in draft) Denver Tech Center – floodplain restoration goals (in draft) Rich (2007)

<u>Delta Rearing/Out-migration</u> **1.** Entrainment • Loss of direction/reverse flows • Direct • Tributary flow magnitude and timing • Level of export pumping rates **2.** Predation • Habitat availability • Temp conditions • Hydraulic conditions/reverse flows/barrier operations/predation hotspots **3.** Water Temperature **4.** Prey/Food Availability	
<u>Ocean Rearing</u> 1. Food availability – meteorology/ocean conditions 2. Harvest – numbers of fish entering 3. Predation – marine mammals, etc	

<table>
<tr><th><u>O. mykiss Life Stages</u></th><th><u>Information Needed/
Other notes</u></th></tr>
<tr><td><u>Up-Migration</u>
1. Homing/Straying – instream flows
2. Water temperature blockage (late summer)
3. Delta/in-river sport-fishing/poaching</td><td></td></tr>
<tr><td><u>Spawning</u>
1. Gravel Area
2. Gravel Quality
3. Water temperature suitability</td><td>Little citation support; conceptual</td></tr>
<tr><td><u>Egg Incubation</u>
1. Temperature/incubation rates
2. Temperature related egg mortality from early/late spawners
3. Redd de-watering due to changes in flow
4. Entombment due to fine sediment</td><td></td></tr>
<tr><td><u>In-River Rearing/Out-migration</u>
1. Food availability and growth rate – water temperature
• Area of suitable habitat/Habitat availability (cover, LWD, etc) – spatial distribution/density dependence
2. Age 0+ Predation – water temp/suitability
3. Age 0-3 – water temp mortality
4. Smoltification (?)
• Water temp
• Tributary flow magnitude and timing</td><td>Sport-fishing/poaching – hooking mortality (voluntary reporting 16+)</td></tr>
</table>

<table>
<tr><td><u>Delta Rearing/Out-migration</u>
1. Entrainment
• Loss of direction/reverse flows
• Direct
• Level of export pumping rates
2. Predation
3. Smoltification (?)
a. Water temp
b. Tributary flow magnitude and timing
4. Water Temperature – mortality (?)</td><td>% anadromous vs. resident - factors</td></tr>
<tr><td><u>Ocean Rearing</u>
1. Food availability – meteorology/ocean conditions
2. Predation – marine mammals, etc
3. Harvest bycatch</td><td></td></tr>
<tr><td></td><td></td></tr>
</table>

Action Items:

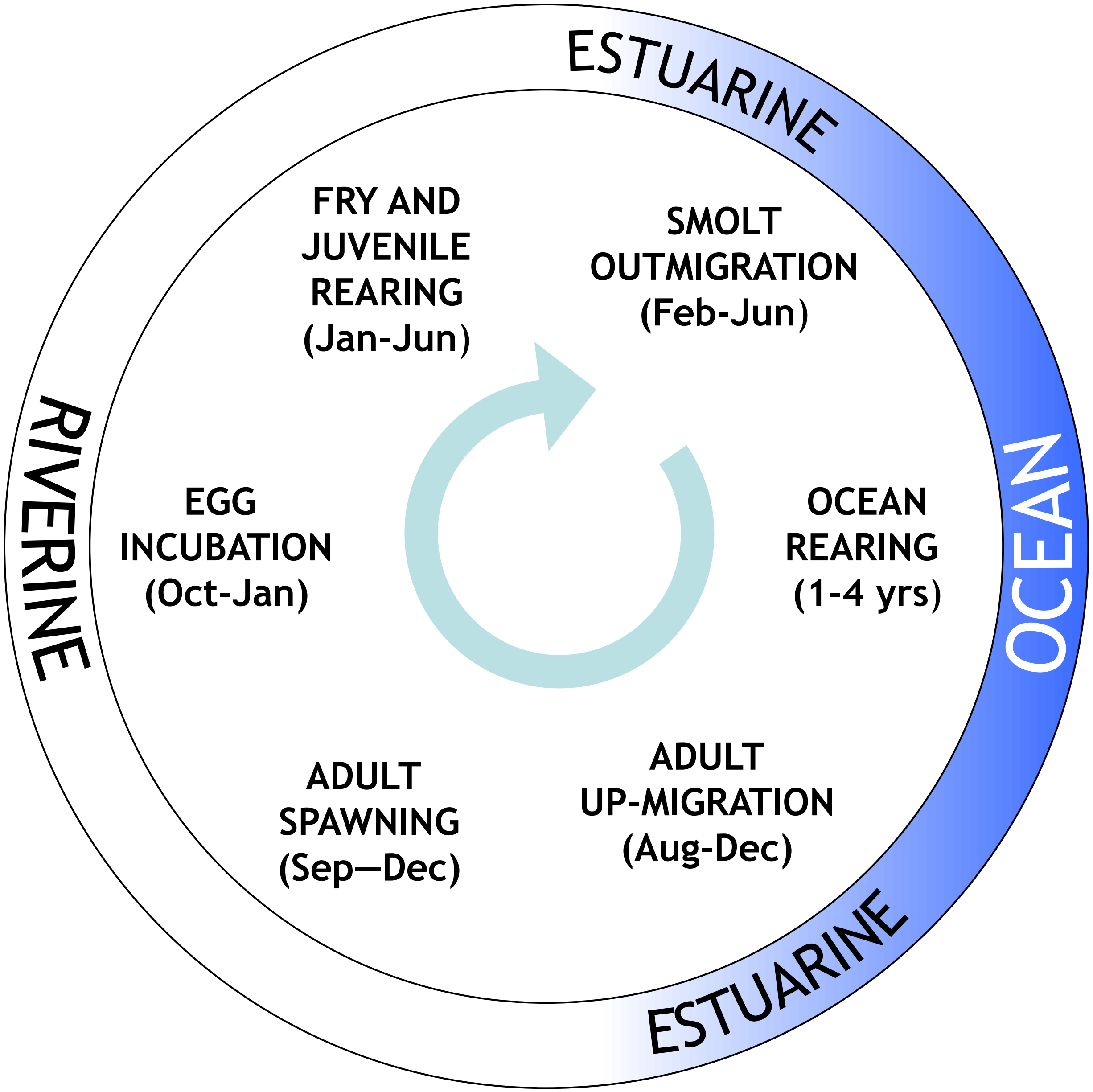
1. Districts to provide citation support for life stage analysis presented in diagrams.
    - Districts to provide T.R. specific citations for the important issues identified in the workshop tables with the draft workshop notes for RP review and comment.
2. RPs to provide references as referenced during workshop.
3. Districts to provide information basis for distribution/arrival data – Chinook weir data tables. (To be in the study report as data tables.)
4. Next Steps:

WAR-5 Action Items	**Timeline**
Draft Meeting Notes to RPs - Draft meeting notes will include preliminary ranking of issues discussed during meeting	~July 9, 2012
Comments by RPs on Draft Meeting Notes and preliminary ranking of issues	30-days ~August 8, 2012
Districts review comments from RPs on meeting notes and issues. Submit to FERC response to RP comments and revised ranking of issues and meeting notes.	~60-days Early-October 2012
Workshop to Discuss WAR-6 and WAR-10	November 15 and November 16, 2012

Attachment 2:

Revised conceptual model diagrams for Chinook salmon and steelhead/*O. mykiss*

General Chinook salmon Life History Timing for the Tuolumne River



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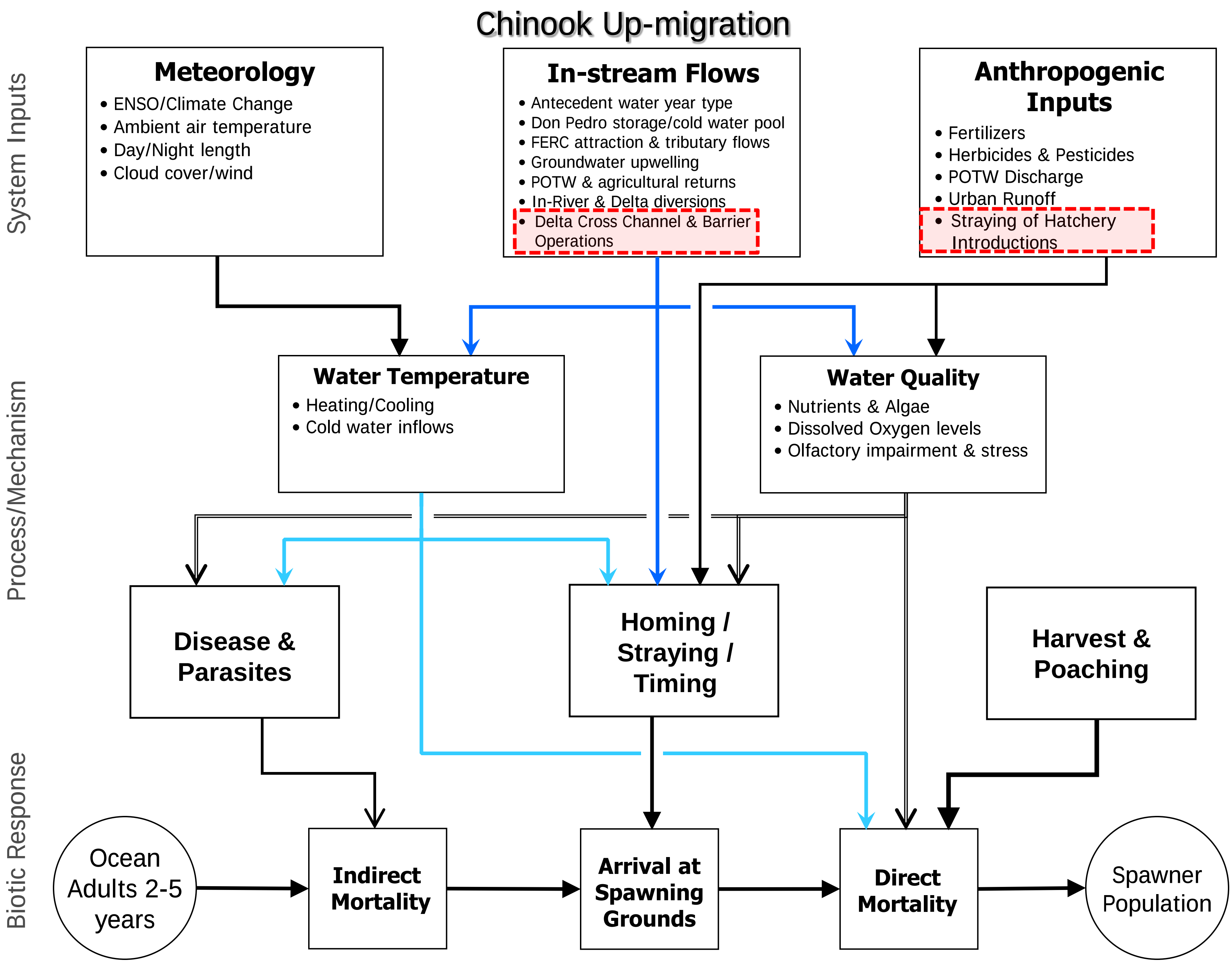
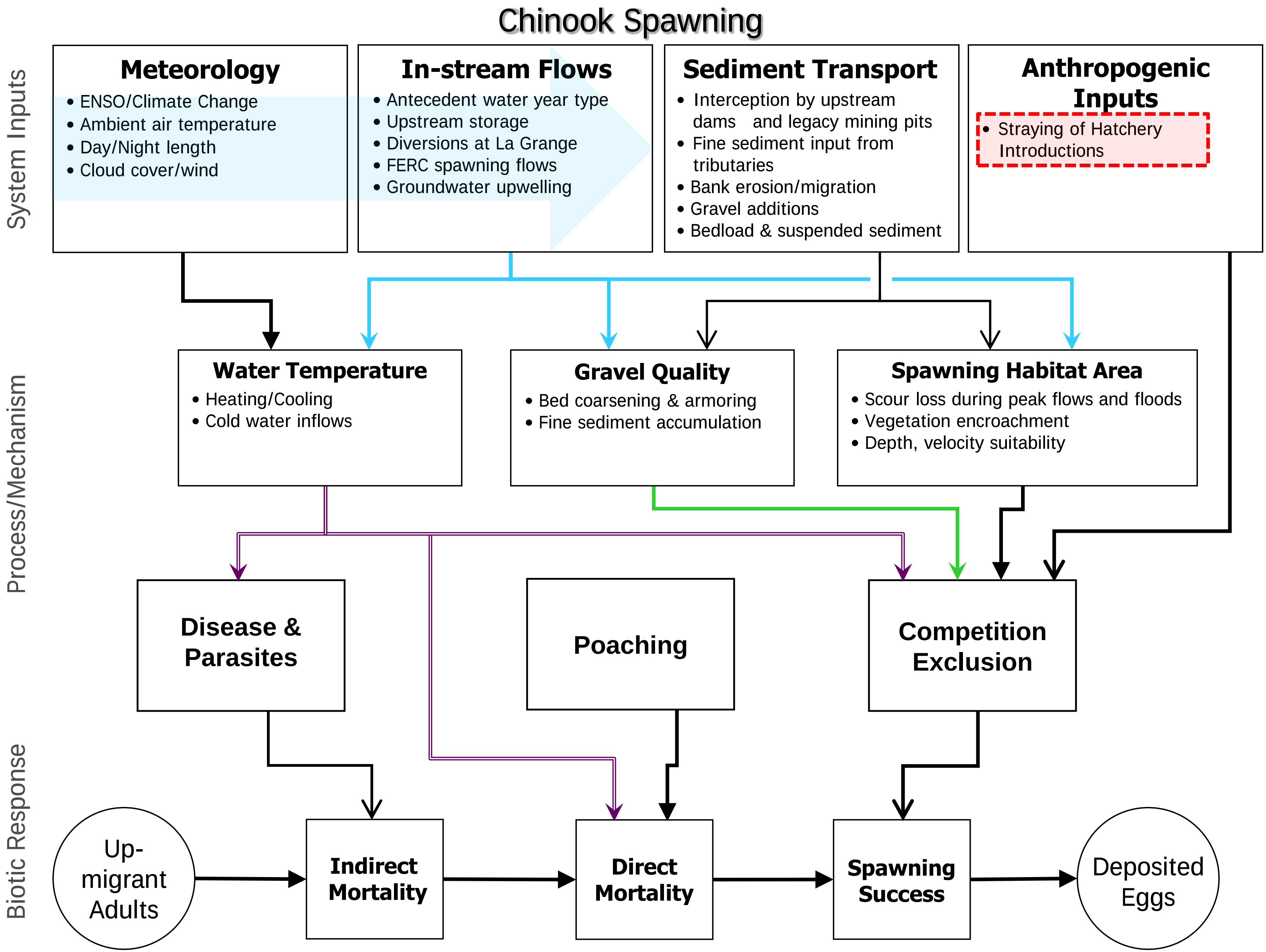
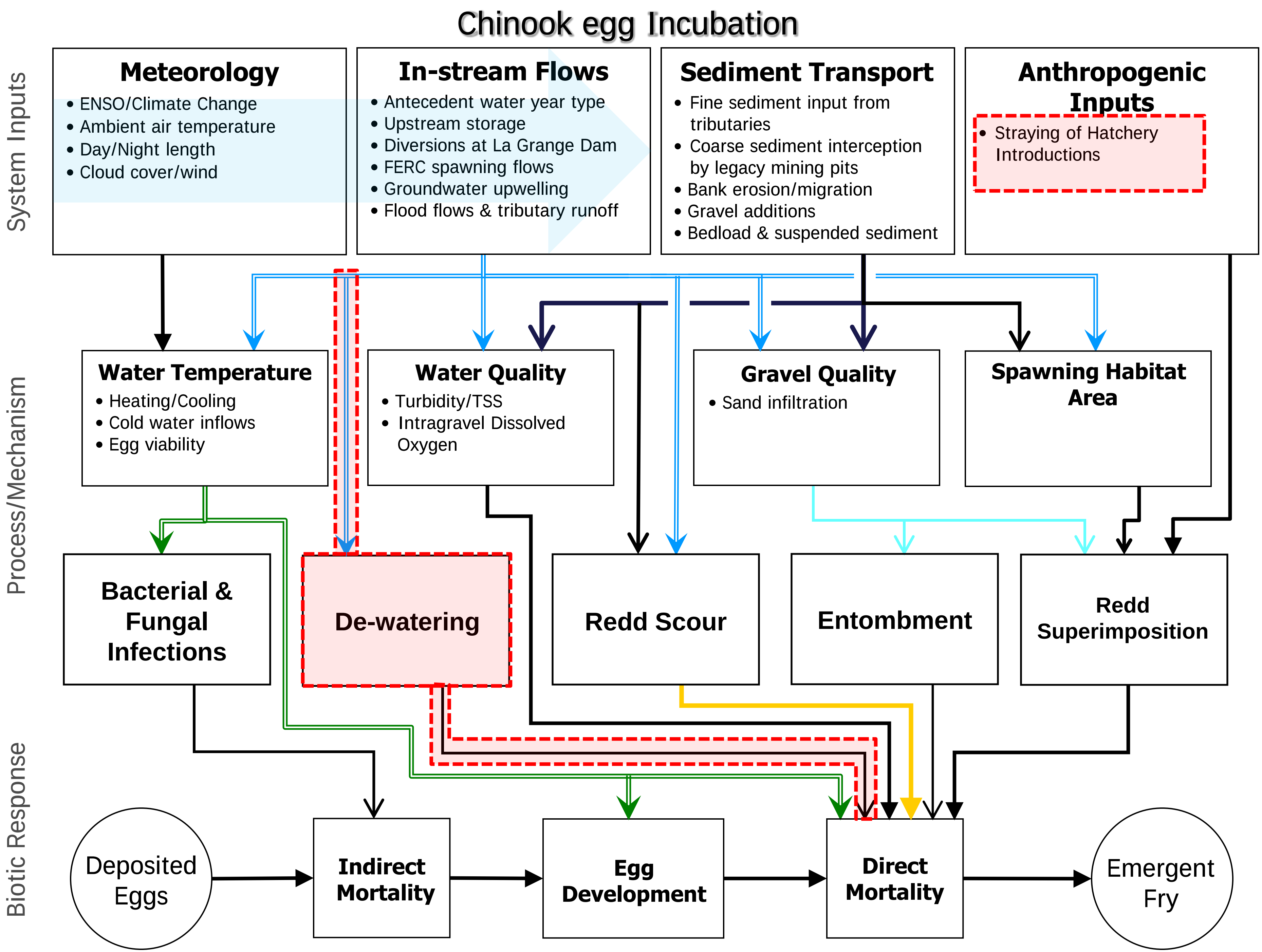
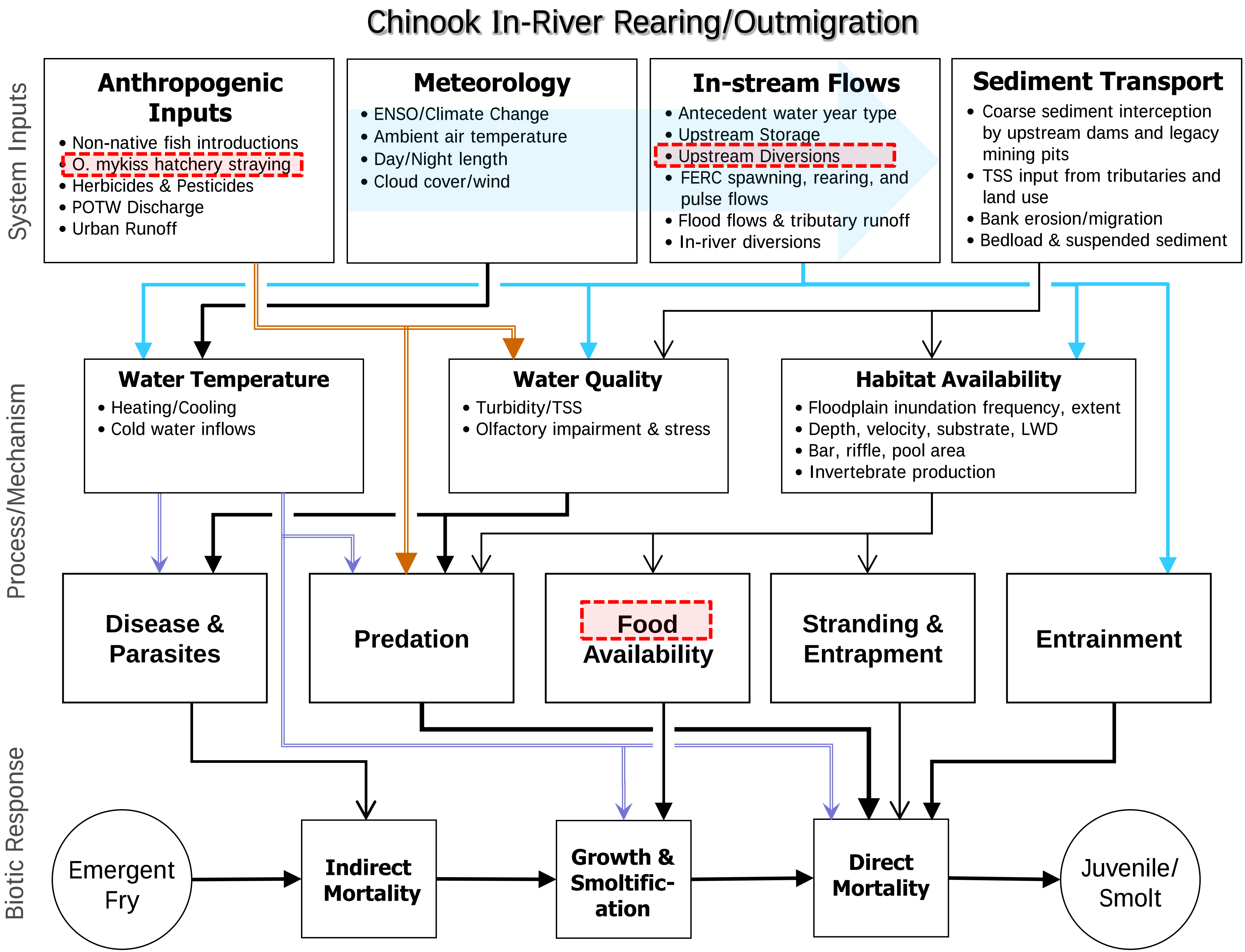
Adult Spawning												
Egg Incubation and Fry Emergence												
In-river Rearing												
Delta Juvenile Rearing												
Smolt Outmigration												

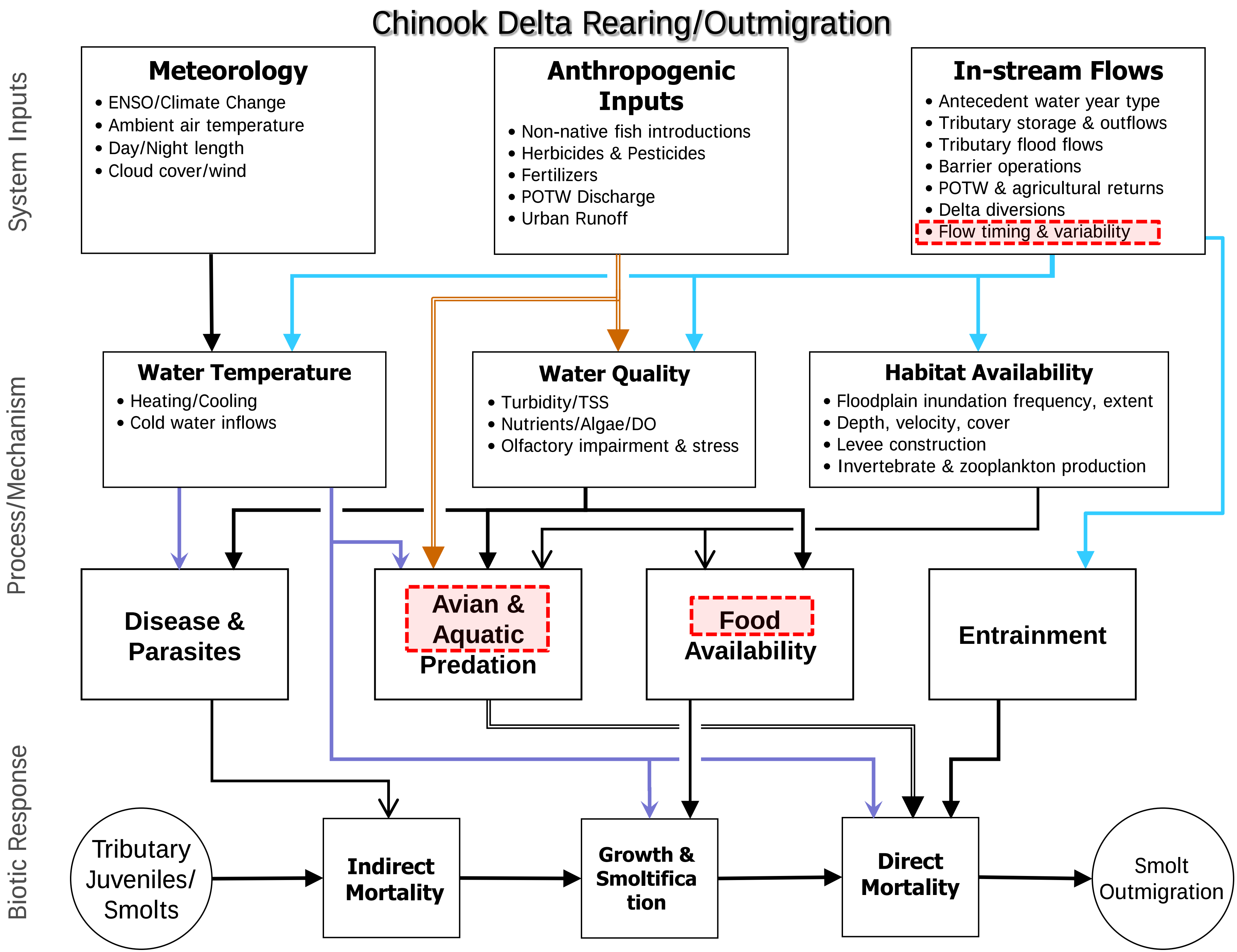

Chinook Up-migration
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Don Pedro storage/cold water pool
• FERC attraction & tributary flows
• Groundwater upwelling
• POTW & agricultural returns
• In-River & Delta diversions
• Delta Cross Channel & Barrier Operations
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Straying of Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Harvest & Poaching
Biotic Response
Ocean Adults 2-5 years
Indirect Mortality
Arrival at Spawning Grounds
Direct Mortality
Spawner Population


Chinook Spawning
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Straying of Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Poaching
Competition Exclusion
Biotic Response
Up-migrant Adults
Indirect Mortality
Direct Mortality
Spawning Success
Deposited Eggs

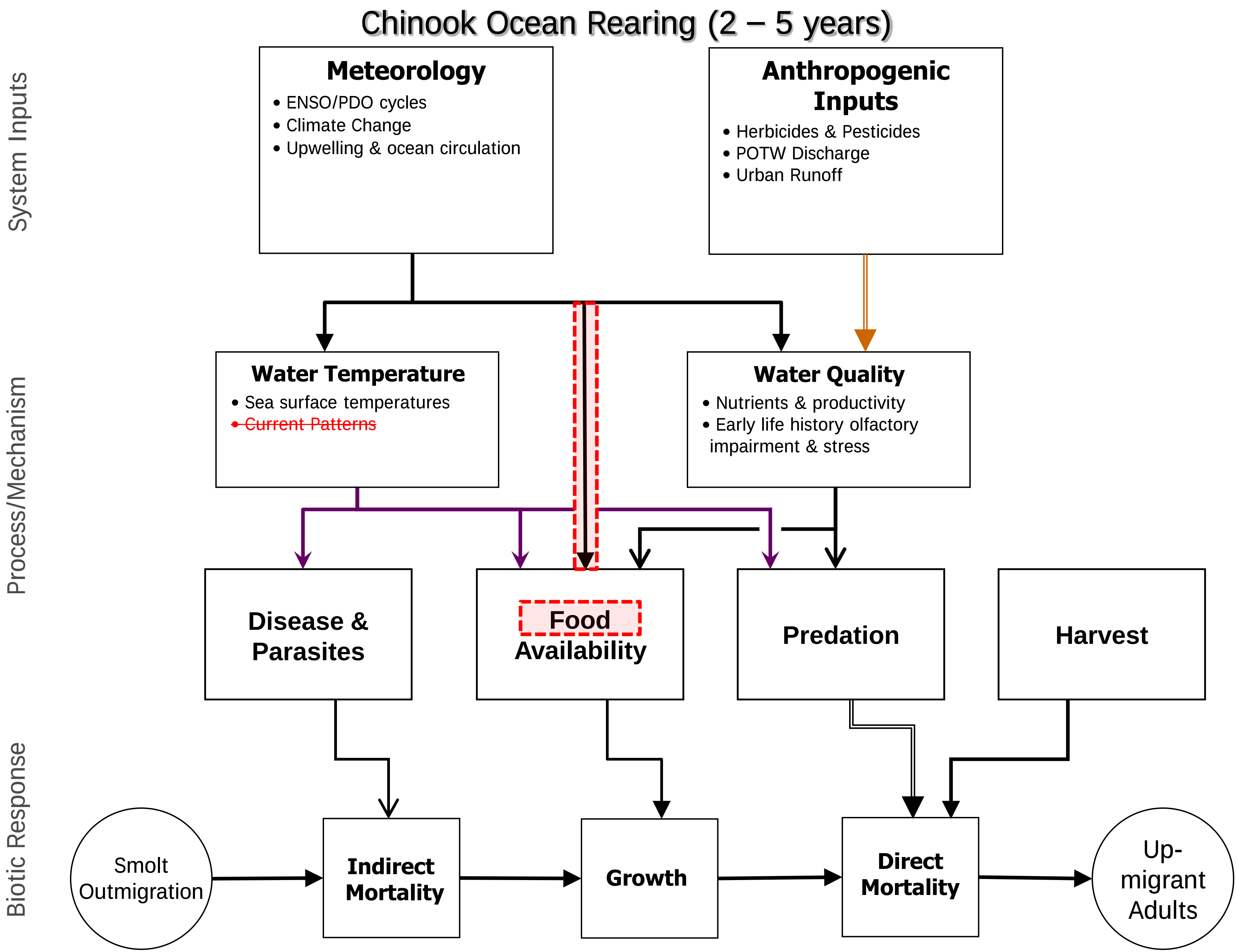


Chinook egg Incubation
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange Dam
• FERC spawning flows
• Groundwater upwelling
• Flood flows & tributary runoff
Sediment Transport
• Fine sediment input from tributaries
• Coarse sediment interception by legacy mining pits
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Straying of Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
• Egg viability
Water Quality
• Turbidity/TSS
• Intragravel Dissolved Oxygen
Gravel Quality
• Sand infiltration
Spawning Habitat Area
Bacterial & Fungal Infections
De-watering
Redd Scour
Entombment
Redd Superimposition
Biotic Response
Deposited Eggs
Indirect Mortality
Egg Development
Direct Mortality
Emergent Fry

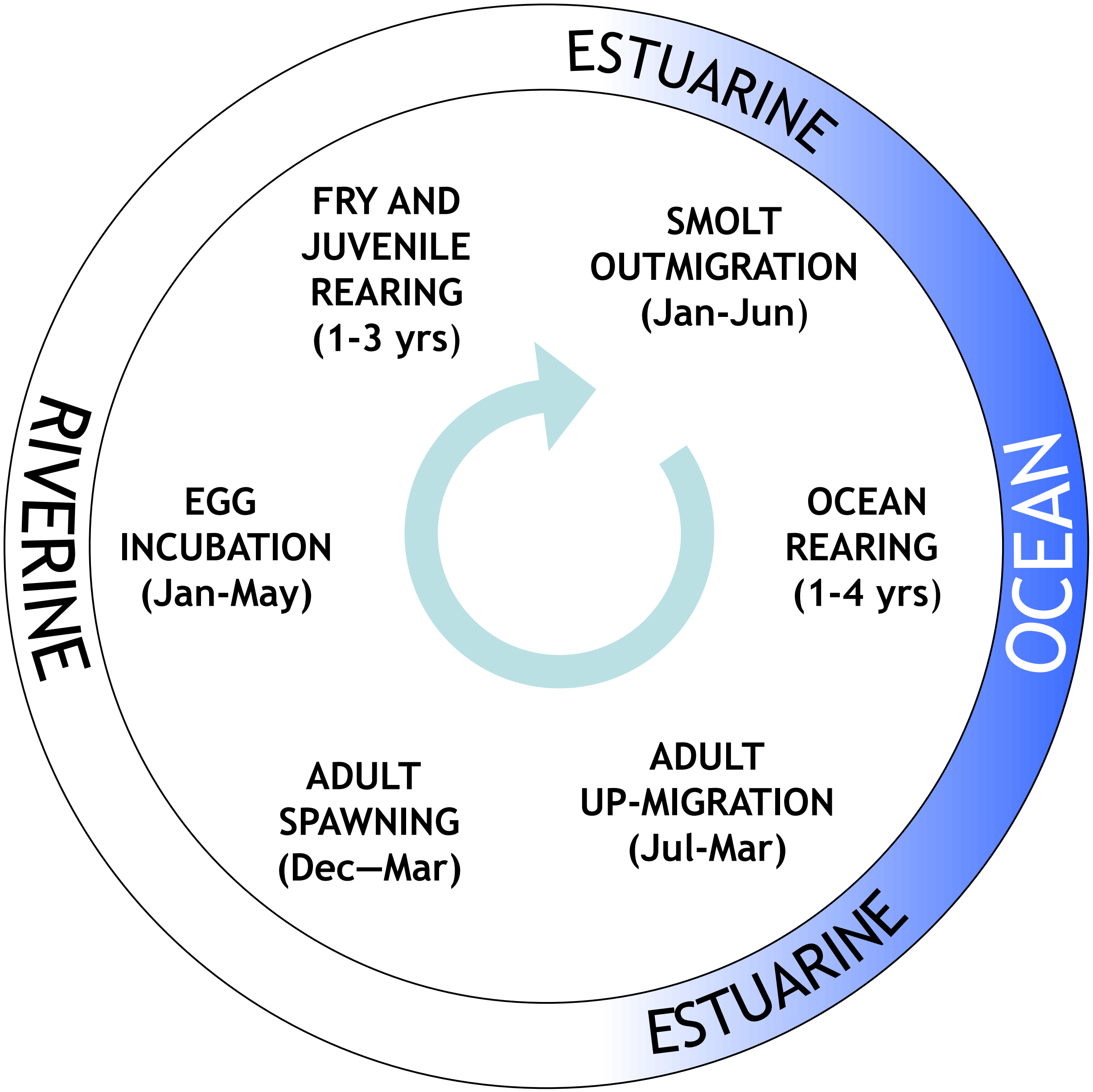

Chinook In-River Rearing/Outmigration
System Inputs
Process/Mechanism
Biotic Response
Anthropogenic Inputs
• Non-native fish introductions
• O. mykiss hatchery straying
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream Storage
• Upstream Diversions
• FERC spawning, rearing, and pulse flows
• Flood flows & tributary runoff
• In-river diversions
Sediment Transport
• Coarse sediment interception by upstream dams and legacy mining pits
• TSS input from tributaries and land use
• Bank erosion/migration
• Bedload & suspended sediment
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, substrate, LWD
• Bar, riffle, pool area
• Invertebrate production
Disease & Parasites
Predation
Food Availability
Stranding & Entrapment
Entrainment
Emergent Fry
Indirect Mortality
Growth & Smoltific-ation
Direct Mortality
Juvenile/ Smolt



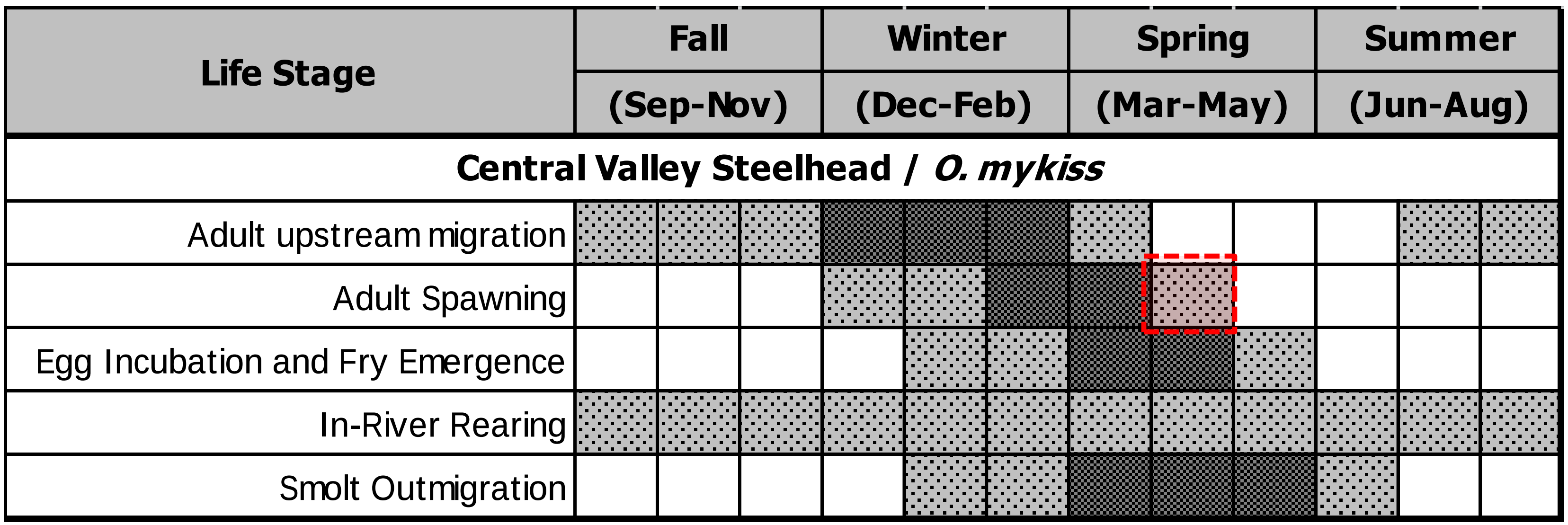
Chinook Delta Rearing/Outmigration
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
Anthropogenic Inputs
• Non-native fish introductions
• Herbicides & Pesticides
• Fertilizers
• POTW Discharge
• Urban Runoff
In-stream Flows
• Antecedent water year type
• Tributary storage & outflows
• Tributary flood flows
• Barrier operations
• POTW & agricultural returns
• Delta diversions
• Flow timing & variability
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Nutrients/Algae/DO
• Olfactory impairment & stress
Habitat Availability
• Floodplain inundation frequency, extent
• Depth, velocity, cover
• Levee construction
• Invertebrate & zooplankton production
Disease & Parasites
Avian & Aquatic Predation
Food Availability
Entrainment
Biotic Response
Tributary Juveniles/ Smolts
Indirect Mortality
Growth & Smoltification
Direct Mortality
Smolt Outmigration

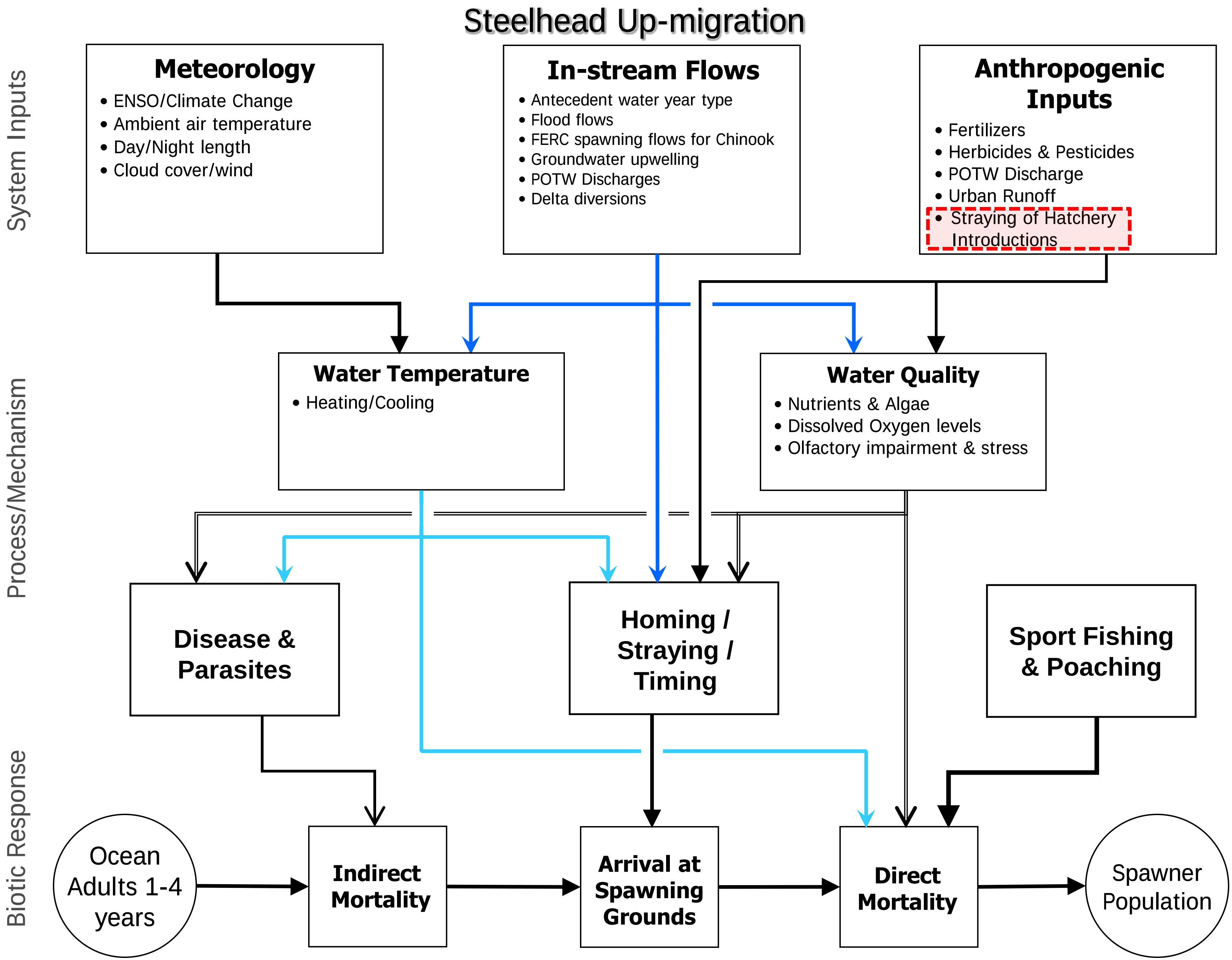

Chinook Ocean Rearing (2 – 5 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Water Temperature
• Sea surface temperatures
• ~~Current Patterns~~
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Food Availability
Predation
Harvest
Smolt Outmigration
Indirect Mortality
Growth
Direct Mortality
Up-migrant Adults

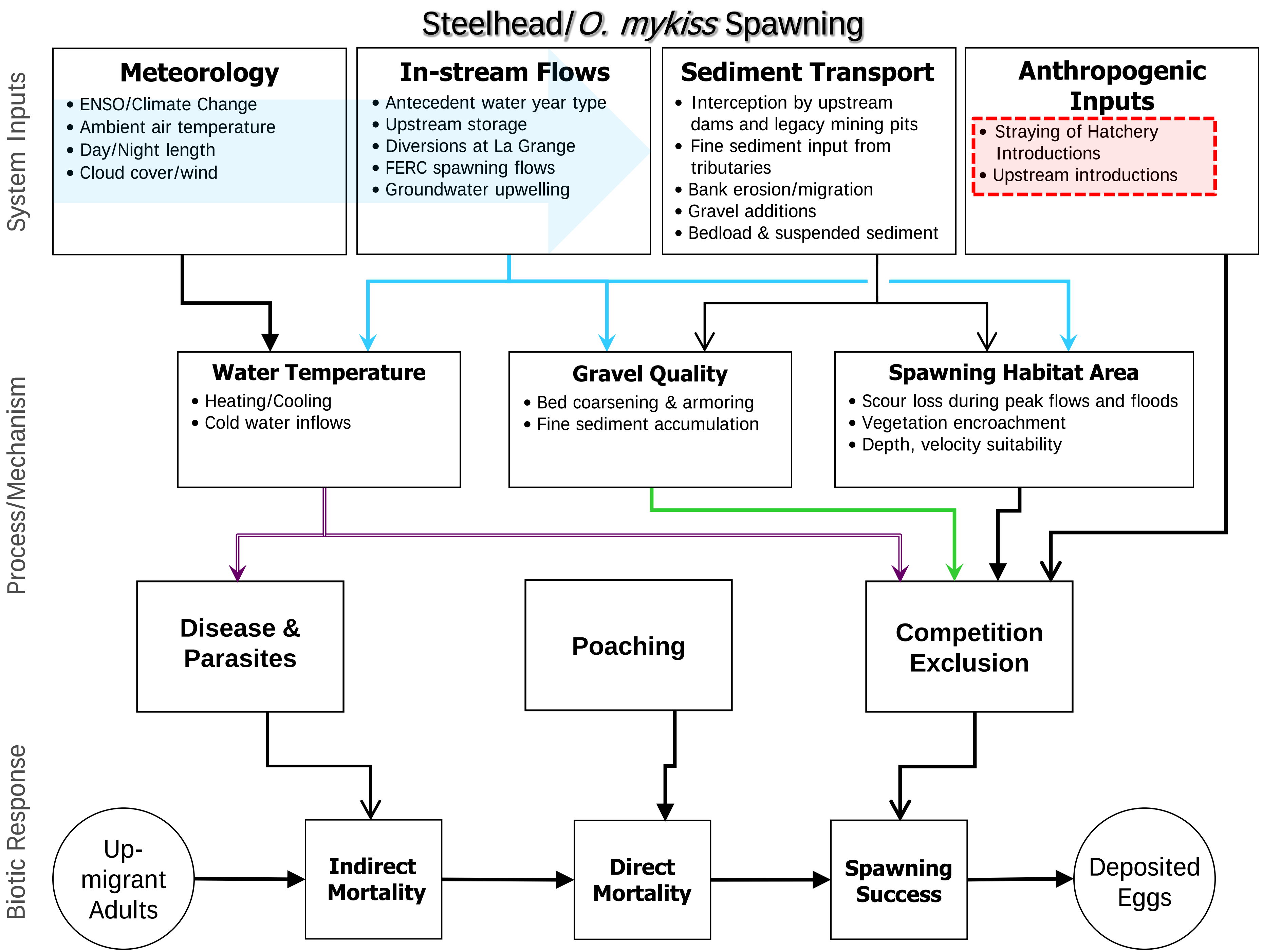
General Steelhead Life History Timing for the Tuolumne River

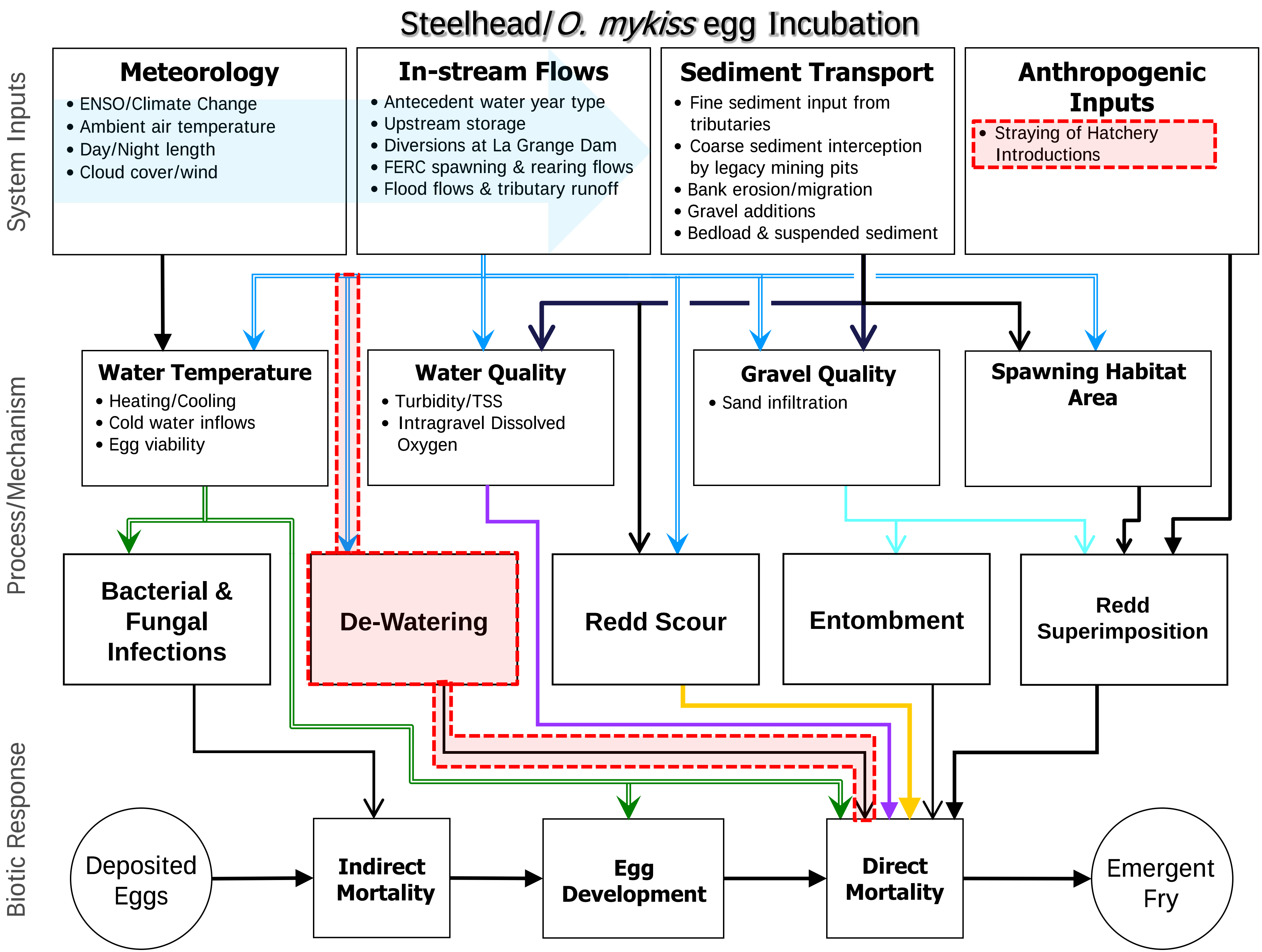


General Steelhead Life History Timing for the Tuolumne River

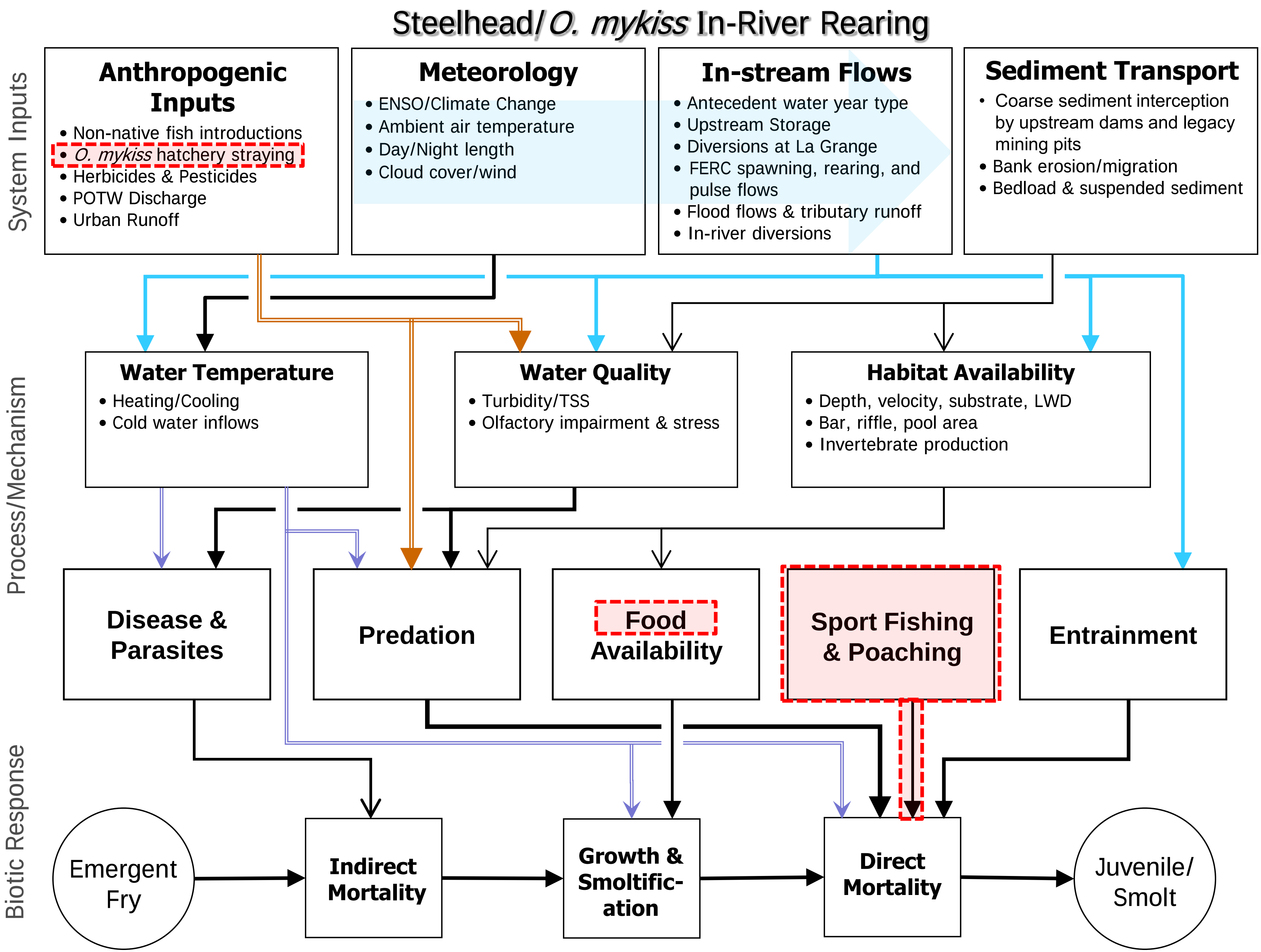



Steelhead Up-migration
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Flood flows
• FERC spawning flows for Chinook
• Groundwater upwelling
• POTW Discharges
• Delta diversions
Anthropogenic Inputs
• Fertilizers
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
• Straying of Hatchery Introductions
Water Temperature
• Heating/Cooling
Water Quality
• Nutrients & Algae
• Dissolved Oxygen levels
• Olfactory impairment & stress
Disease & Parasites
Homing / Straying / Timing
Sport Fishing & Poaching
Ocean Adults 1-4 years
Indirect Mortality
Arrival at Spawning Grounds
Direct Mortality
Spawner Population


Steelhead/ O. mykiss Spawning
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange
• FERC spawning flows
• Groundwater upwelling
Sediment Transport
• Interception by upstream dams and legacy mining pits
• Fine sediment input from tributaries
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Straying of Hatchery Introductions
• Upstream introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Gravel Quality
• Bed coarsening & armoring
• Fine sediment accumulation
Spawning Habitat Area
• Scour loss during peak flows and floods
• Vegetation encroachment
• Depth, velocity suitability
Disease & Parasites
Poaching
Competition Exclusion
Biotic Response
Up-migrant Adults
Indirect Mortality
Direct Mortality
Spawning Success
Deposited Eggs

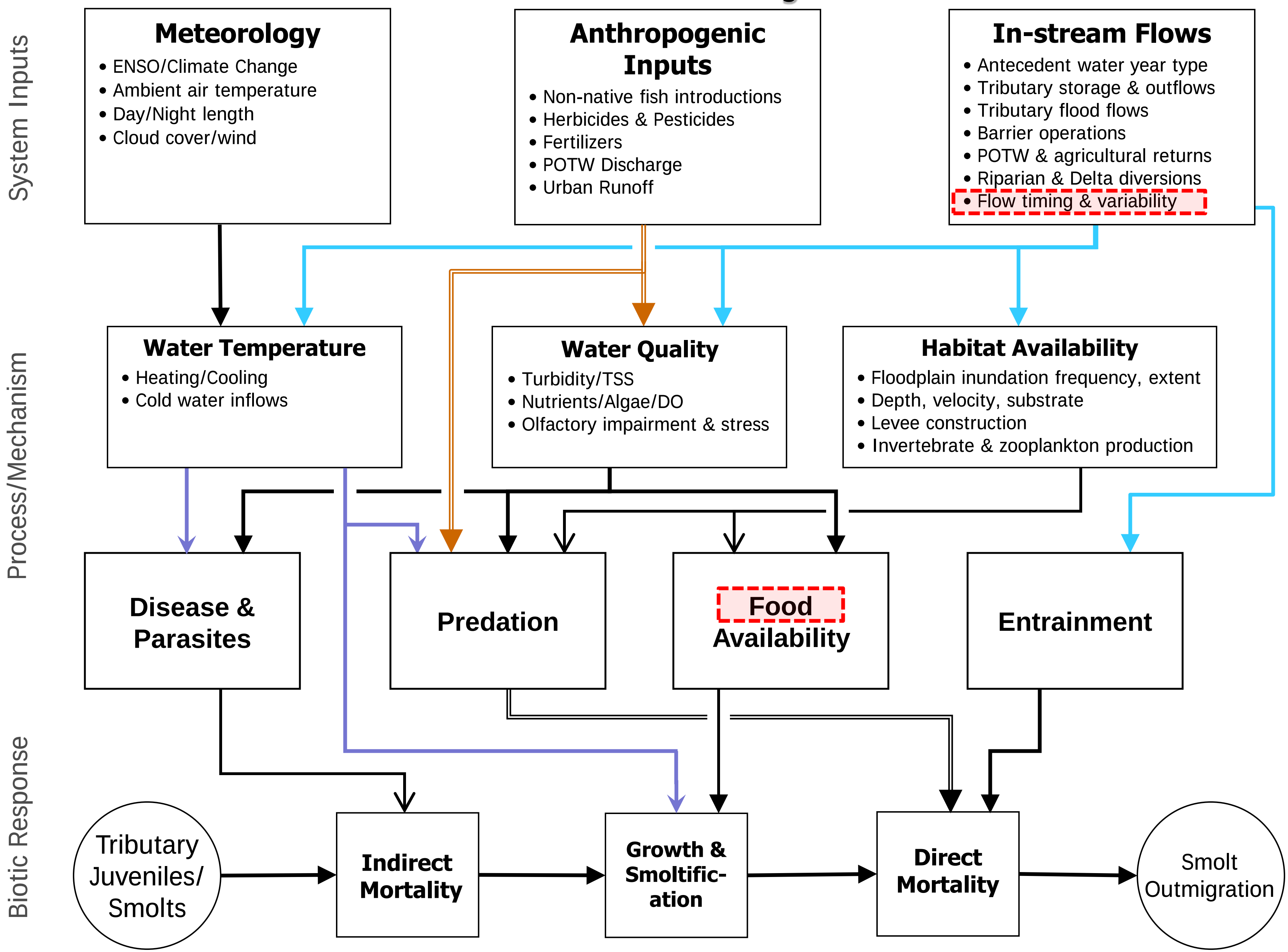


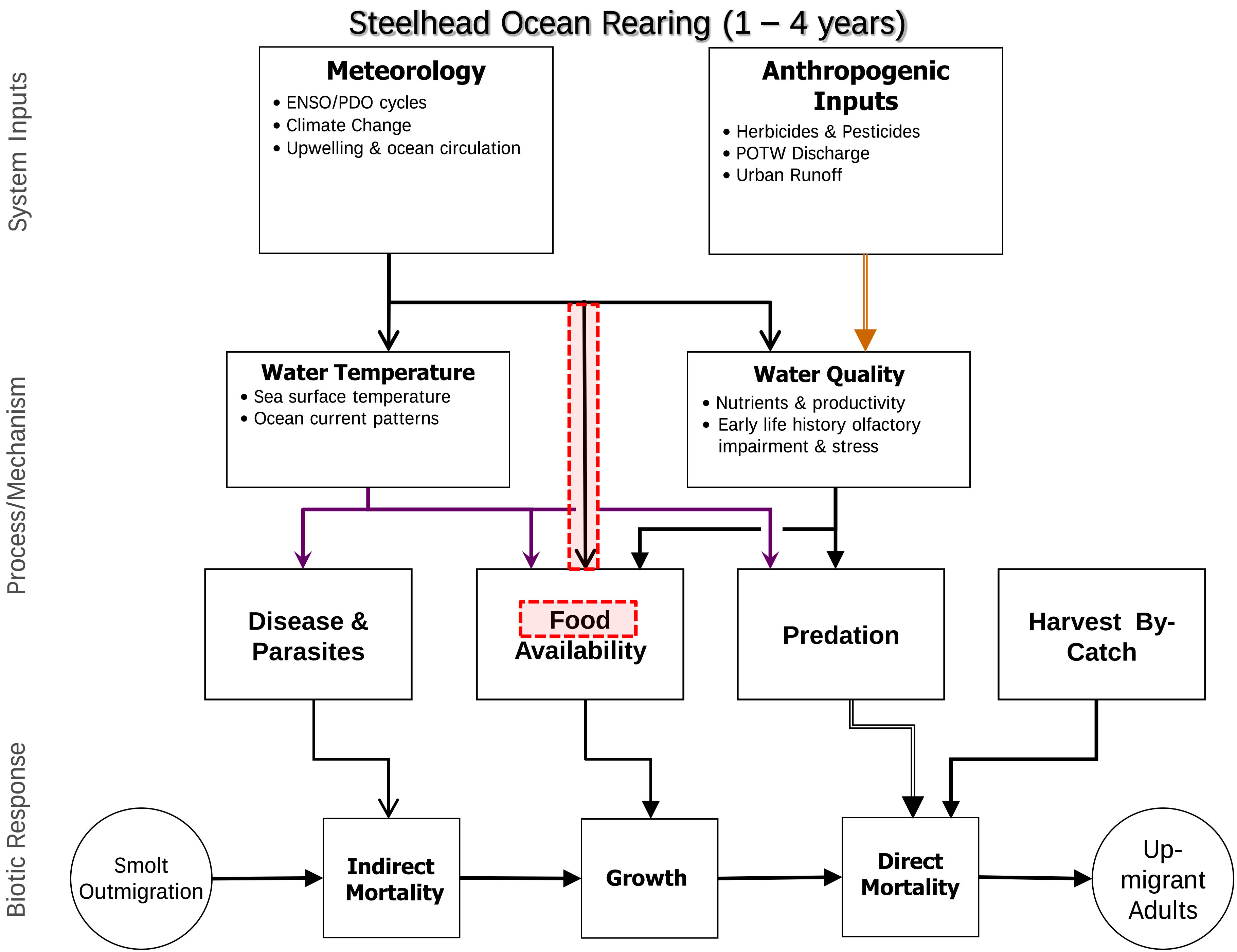
Steelhead/O. mykiss egg Incubation
System Inputs
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream storage
• Diversions at La Grange Dam
• FERC spawning & rearing flows
• Flood flows & tributary runoff
Sediment Transport
• Fine sediment input from tributaries
• Coarse sediment interception by legacy mining pits
• Bank erosion/migration
• Gravel additions
• Bedload & suspended sediment
Anthropogenic Inputs
• Straying of Hatchery Introductions
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
• Egg viability
Water Quality
• Turbidity/TSS
• Intragravel Dissolved Oxygen
Gravel Quality
• Sand infiltration
Spawning Habitat Area
Bacterial & Fungal Infections
De-Watering
Redd Scour
Entombment
Redd Superimposition
Biotic Response
Deposited Eggs
Indirect Mortality
Egg Development
Direct Mortality
Emergent Fry



Steelhead/O. mykiss In-River Rearing
System Inputs
Anthropogenic Inputs
• Non-native fish introductions
• O. mykiss hatchery straying
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Meteorology
• ENSO/Climate Change
• Ambient air temperature
• Day/Night length
• Cloud cover/wind
In-stream Flows
• Antecedent water year type
• Upstream Storage
• Diversions at La Grange
• FERC spawning, rearing, and pulse flows
• Flood flows & tributary runoff
• In-river diversions
Sediment Transport
• Coarse sediment interception by upstream dams and legacy mining pits
• Bank erosion/migration
• Bedload & suspended sediment
Process/Mechanism
Water Temperature
• Heating/Cooling
• Cold water inflows
Water Quality
• Turbidity/TSS
• Olfactory impairment & stress
Habitat Availability
• Depth, velocity, substrate, LWD
• Bar, riffle, pool area
• Invertebrate production
Disease & Parasites
Predation
Food Availability
Sport Fishing & Poaching
Entrainment
Biotic Response
Emergent Fry
Indirect Mortality
Growth & Smoltific-ation
Direct Mortality
Juvenile/ Smolt

Steelhead Delta Outmigration




Steelhead Ocean Rearing (1 – 4 years)
System Inputs
Process/Mechanism
Biotic Response
Meteorology
• ENSO/PDO cycles
• Climate Change
• Upwelling & ocean circulation
Anthropogenic Inputs
• Herbicides & Pesticides
• POTW Discharge
• Urban Runoff
Water Temperature
• Sea surface temperature
• Ocean current patterns
Water Quality
• Nutrients & productivity
• Early life history olfactory impairment & stress
Disease & Parasites
Food Availability
Predation
Harvest By-Catch
Smolt Outmigration
Indirect Mortality
Growth
Direct Mortality
Up-migrant Adults

Attachment 3:

Preliminary ranking of issues affecting

Chinook salmon and steelhead/*O. mykiss*

Preliminary ranking of issues affecting Chinook salmon population levels
W&AR-5 Salmonid Information Synthesis Workshop No. 2

Processes / Mechanisms	Time of Year	Affects salmonid population levels?	Geographic source and Notes on Supporting Information			
			Tuolumne	San Joaquin	Other	References/Notes
Adult Upmigration through Sacramento/San Joaquin River Delta and lower Tuolumne River						
1. Arrival Timing – Blockage/delay in lower San Joaquin River due to water temperature	Sep-Oct	Inconclusive	X	X		Hallock (1970) attributed salmon migration delays past Stockton to water temperature in 1964, 1965 and 1967. Stillwater Sciences (2012) shows only minor influences of fall pulse flows on water temperature near the San Joaquin River confluence and Stillwater Sciences (2003a) shows relatively consistent spawner arrival timing on a year-to-year basis. Although weir passage has been monitored since 2009 (e.g., FISHBIO 2012). No reports have been identified analyzing salmon arrival timing as a function of flow or water temperature in the Tuolumne River.
2. Arrival Timing – Blockage/delay in San Joaquin River (e.g. Stockton DWSC) due to dissolved oxygen (DO)	Sep-Oct	Inconclusive		X		Hallock (1970) attributed salmon migration delays past Stockton to low DO in 1966. Newcomb and Pierce (2010) provided a literature review of DO TMDL issues at Stockton and of an assessment of potential aeration measures. No reports have been identified analyzing salmon arrival timing (weir passage or historical spawner counts) as a function of DO in the Tuolumne River.
3. Homing/Straying – Attraction flows to improve tributary homing fidelity and spawner returns	October	Inconclusive	X	X		CWT recovery data suggests only weak relationships of straying with attraction flows. Mesick et al (2009b) found consistent year-to-year straying rates between San Joaquin tributaries and Mesick (2001) shows only weak relationships of Delta export flows and straying between Sacramento and San Joaquin River basin hatcheries. The EBMUD (2012) salmon fish attraction flow experiment on the Mokelumne involving closure of Delta Cross Channel Gates is ongoing.
Spawning in the lower Tuolumne River						
1. Spawning Area Availability	Oct-Dec	Possible at high escapement levels	X			McBain & Trush (2004) provide an assessment of gravel losses following the 1997 flood using comparisons with spawning habitat area mapping in the late 1980s (TID/MID 1992 App 6). Current studies W&AR-4 and W&AR-8 as well as the ongoing IFIM study will provide more up-to-date spawning area and habitat

						use assessments.
2. Spawning Gravel Quality	Oct-Dec	Possible at high escapement levels	X			TID/MID 2005a shows an upstream shift in spawning habitat use as compared to conditions assessed in 1988 (TID/MID 1992, App 6), which can be attributed to losses in both total spawning area as well as poor gravel quality. McBain & Trush (2000, 2004) provide an assessment of ongoing geomorphic processes affecting gravel quality, which was assessed in 1987-1988 (TID/MID 1992 App 8; TID/MID 1997, Report 1996-8) and in 1999 (Stillwater Sciences 2001). Present day gravel quality is currently being assessed as part of Study W&AR -4.
3. Pre-spawn mortality due to Water Temperature	Sep-Oct	Unlikely		X	X	Pre-spawn mortality has been documented at only low levels in the Stanislaus River (Guignard 2006) as well as in literature reviews of temperature tolerances of Central Valley salmonids (Myrick and Cech 2001). No biological data are available for the Tuolumne River to assess pre-spawn mortality.
Egg Incubation and larval development in the lower Tuolumne River						
1. Incubation rate due to Water Temperature	Oct-Jan	Inconclusive			X	Incubation rate affects emergence timing and thus size at emigration for juvenile Chinook salmon. Although no Tuolumne-specific information is available, Myrick and Cech (2001) provide relatively simple models of hatching times with water temperature.
2. Redd superimposition due to Gravel Quality and Spawning Habitat Availability	Oct-Jan	Possible at high escapement levels	X			Redd superimposition was estimated to result in a 10 to 25% egg loss in 1988 at an escapement of 4,000 spawners (TID/MID 1992, App 6). Gravel losses since 1997 seemed of have produced an increase in upstream spawning habitat use and a reduced downstream preference (TID/MID 2005a), suggesting that superimposition may now occur at escapement levels below 4,000 spawners. .
3. Entombment due to fine sediment/Gravel Quality	Oct-Jan	Unlikely	X			Past studies have attributed low salmonid survival-to-emergence rates in the lower Tuolumne River to poor spawning gravel quality TID/MID 1992, Voll II). Fine sediment intrusion into spawning gravels was assessed in 1987-1988 (TID/MID 1997, Rpt 96-8). However, entombment due to a fine sediment intrusion mechanism (Phillips et al 1975) was not documented in two separate redd excavation efforts (TID/MID 1997, Rpt 96-7, TID/MID 2007, Rpt 2006-7).
4. Redd de-watering due to changes in flow	Oct-Jan	Unlikely	X			Although FERC spawning flow requirements are designed to protect against redd-dewatering, a de-watering incident of redds found in the La Grange powerhouse tail race occurred during 2008 (TID/MID 2010, Rpt 2009-1). Maintenance and notification procedures have been modified since this event.
In-River Rearing, juvenile and smolt emigration from the lower Tuolumne River						
1. Predation – Water Temperature and habitat for Introduced Species	Feb-Jun	Yes	X			CWT smolt survival experiments (1987–2002) (TID/MID 2005b, Rpt 2004-7), direct predation assessments (TID/MID 1992, App 22; McBain & Trush and Stillwater Sciences 1999, 2006) show predation as a primary factor affecting survival of juveniles and smolts.
2. Growth – Prey/Food within	Jan-Jun	Inconclusive/	X		X	Food ration assessments (TID/MID 1992; App 28) and long-term invertebrate

available habitat area.		Unlikely				monitoring (TID/MID 1992, App 16; TID/MID 1997, Rpt 96-4; Stillwater Sciences 2003b; TID/MID 2005b, Rpt 2004-9; TID/MID 2009, Rpt 2008-7) suggest there is no limitation of food sources for fish in the Tuolumne River. Myrick and Cech (2002) and Marine and Cech (2004) examine food ration/temperature effects to allow estimation of relative feeding rates under temperature regimes at various times of year.
3. Mortality – Water Temperature	Apr-Jun	Yes, in late Spring			X	Although low levels of juvenile mortality may occur due to high water temperature in the Tuolumne River, mortality risk is based upon river water temperature as reported by Myrick and Cech (2001) as well as the current W&AR-14 Study.
4. Smoltification – Water Temperature	Mar-Jun	Unlikely		X	X	Myrick and Cech (2001) provide a temperature review including temperature thresholds for smoltification. Nichols et al 2001 as well as Rich and Loudermilk (1991) examined smolt ATPase levels at several San Joaquin basin locations, including the Tuolumne showing peak ATPase levels in May or early June. Smolt condition assessments were included in juvenile salmon studies since 1986 (e.g., TID/MID 1992; App 13; TID/MID 2011, Rpt 2010-3), but do not analyze histological effects of water temperature.
Delta Rearing and smolt emigration from the Sacramento/San Joaquin River Delta						
1. Entrainment due to instream diversions and Delta Exports	Jan-Jun	Yes		X		Brandes and McLain (2001) concluded that losses due to direct entrainment were relatively low as compared to other mortality sources (predation), but other studies examining pre-screen losses (Gingras 1997) show high mortality. OCAP BA (USBR 2008) assumes fractional pre-screen, screen, and handling/transport losses based on various sources. Moyle and White (2002) provide a literature review of entrainment effects in the Central Valley using Herren and Kawasaki (2001) inventory of water diversions and other sources.
2. Predation – Water Temperature and habitat for Introduced Species	Feb-Jun	Yes		X		The San Joaquin River Group Authority (SJRGA) Vernalis Adaptive Management Program (VAMP) Studies evaluated outmigrant survival, predation, and fish movement in response to pulse flows and barrier operations for the past decade (2000–2011) (e.g., SRGA 2011). Outmigrant survival was estimated to be zero in several years of study showing that predation in the south and Central Delta is a primary factor affecting smolt emigration.
3. Mortality – Water Temperature	Apr-Jun	Yes, in late Spring		X		Baker et al (1995) found that variations in CWT smolt survival studies in the Delta are largely explained by variations in water temperature and were consistent with laboratory assessments of fish mortality. Myrick and Cech (2001) provide a temperature review including survival thresholds and acclimatization effects.
4. Smoltification – Water Temperature	Mar-Jun	Unlikely		X	X	Myrick and Cech (2001) provide a temperature review including temperature thresholds for smoltification. Nichols et al 2001 as well as Rich and Loudermilk (1991) examined smolt ATPase levels at several San Joaquin basin locations, including the Tuolumne showing peak levels in May or early June. Smolt

						condition is assessed by size at various trawl (Chipps by FWS and Mossdale by DFG) and salvage locations, but do not examine temperature effects.
5. Growth – Prey/Food within available habitat area.	Jan-Jun	Inconclusive/ possible			X	MacFarlane and Norton (2002) show low growth rates in the Delta as compared to the 1st month following Ocean entry. Although Sommer et al (2001) does not examine long-term trends in growth rates, Jassby et al (2002) shows long-term trends in Chl-a since the 1980s and reviews mechanisms explaining declines in common zooplankton typically used by salmonids.
Ocean Rearing						
1. Food availability – meteorology/ocean conditions	Year-round	Episodic depending on Ocean Conditions			X	Chavez et al (2002) and MacFarlane et al (2005) examine El Niño and Pacific Decadal oscillation effects on upwelling and juvenile growth and Lindley et al (2009) attributed the salmon fisheries collapse of the early 2000s to changes in ocean productivity. Wells et al (2007) relate growth rates, size at age, and fecundity to ocean upwelling and other meteorological conditions.
2. Harvest – numbers of fish entering	Apr-Oct	Episodic depending on Ocean conditions		X	X	The Central Valley Harvest Index is tracked in various reports of the Pacific Marine Fisheries Council (e.g., PFMC 2011), showing relative changes in harvest and escapement for Central Valley rivers. Lindley et al (2009) concluded that harvest may affect changes in year class strength in some years.
3. Predation – marine mammals, etc	Apr-Oct	Episodic depending on Ocean conditions			X	Scordino (2010) reviews monitoring of pinniped predation on Pacific coast salmonids, but does not assess population level impacts. Predation usually associated with feeding of salmon on troll lines and other gear types.

Preliminary ranking of issues affecting steelhead/*O. mykiss* population levels
W&AR-5 Salmonid Information Synthesis Workshop No. 2

Processes / Mechanisms	Time of Year	Affects salmonid population levels?	Geographic source and Notes on Supporting Information			
			Tuolumne	San Joaquin	Other	References/Notes
Adult Upmigration through Sacramento/San Joaquin River Delta and lower Tuolumne River						
1. Homing/Straying – Instream flows	Sep-Feb	Unlikely			X	Williams (2006) reviews available studies of straying, principally related to hatchery planting practices. Although no studies were identified examining the effectiveness of attraction flows on homing fidelity, olfactory cues appear to influence homing in Pacific salmonids (Dittman and Quinn 1996).
2. Water temperature blockage (late summer)	Sep-Oct	Unlikely	X	X	X	Although WDOE (2002) shows the potential for temperature blockage in Washington State rivers, Stillwater Sciences (2012) shows only minor influences of fall pulse flows on water temperature near the San Joaquin River confluence and most Upmigration is expected to occur later in the Fall. Weir passage has been monitored since 2009 (e.g., FISHBIO 2012) and few upmigrant *O. mykiss* arrived during October or late summer periods corresponding to high water temperatures in the San Joaquin River.
3. Delta/In-river sport-fishing/Poaching	Sep-Oct	Unlikely	X	X		Annual fishing report cards (e.g,. Jackson 2007) are insufficient to quantitatively assess hooking mortality, poaching or other Sportfishing impacts.
Spawning in the lower Tuolumne River						
1. Spawning Area Availability	Dec-Mar	Possible	X			Although no steelhead/*O. mykiss* spawning activity has been documented in the Lower Tuolumne River, McBain & Trush (2004) suggests gravel patches suitable for *O. mykiss* spawning occur. Current studies W&AR-4 and W&AR-8 as well as the ongoing IFIM study will provide estimates of spawnable area and any documented spawning activity.
2. Spawning Gravel Quality	Dec-Mar	Possible	X			Although no steelhead/*O. mykiss* spawning activity has been documented in the Lower Tuolumne River, McBain & Trush (2004) suggests gravel patches suitable

						for *O. mykiss* spawning occur. Current studies W&AR-4 and W&AR-8 will provide estimates of spawning gravel quality for steelhead and any documented spawning activity.
3. Water Temperature Suitability	Dec-Mar	Unlikely			X	Myrick and Cech (2001) and the current W&AR-14 study provides a review of temperature suitability for steelhead spawning.
Egg Incubation and larval development in the lower Tuolumne River						
1. Temperature/incubation rates	Jan-May	Unlikely			X	Although no Tuolumne-specific information is available, Myrick and Cech (2001) provide relatively simple models of of hatching times with water temperature.
2. Temperature related egg mortality from early/late spawners	Jan-May	Unlikely			X	Myrick and Cech (2001) and the current W&AR-14 study provides a review of temperature thresholds for steelhead embryo survival. Study W&AR-8 is also currently documenting locations of any Steelhead/*O. mykiss* spawning, which will allow assessment of temperature exposure of developing embryos.
3. Redd de-watering due to changes in flow	Jan-May	Unlikely	X			FERC spawning flow requirements are designed to protect against redd-dewatering through June 1 of each year. Although maintenance and notification procedures are intended to minimize the potential for redd dewatering, dewatering may occur following flow reductions after flood control releases. Study W&AR-8 is currently documenting locations of any Steelhead/*O. mykiss* spawning, which will allow assessment of any redd dewatering.
4. Entombment due to fine sediment	Jan-May	Unlikely	X			Fine sediment intrusion into spawning gravels was assessed in 1987-1988 (TID/MID 1997, Rpt 96-8). However, no *O. mykiss* spawning redds have been documented to assess this mechanism on the Tuolumne.
In-River Rearing, juvenile and smolt emigration from the lower Tuolumne River						
1. Food availability and growth rate – water temperature	Year-round	Possible with increasing temperature in summer	X		X	Long-term invertebrate monitoring (TID/MID 1992, App 16; TID/MID 1997, Rpt 96-4; Stillwater Sciences 2003; TID/MID 2005, Rpt 2004-9; TID/MID 2009, Rpt 2008-7) suggest there is no limitation of food sources for fish in the Tuolumne River. Myrick (1998) assesses ration and temperature effects to allow estimation of relative feeding rates under temperature regimes at various times of year.
2. Age 0+ Predation – water temperature/suitability	Year-round	Likely	X		X	Although no predation studies have examined predation on *O. mykiss* juveniles on the Tuolumne River, Counihan et al (2012) assess predation on juvenile *O. mykiss* by predator species found in the Tuolumne River. The current W&AR-7 study will assess potential predator populations affecting *O. mykiss.*
3. Age 0-3 – water temperature mortality	Apr-Oct	Yes, in late Spring and Summer			X	Low levels of mortality may occur due to high water temperature in the Tuolumne River. Mortality risk is based upon river water temperature data and reviews by Myrick and Cech (2001). Mortality thresholds are being examined by the current W&AR-14 Study.
4. Smoltification – Water	Mar-Jun	Unlikely			X	Myrick and Cech (2001) provide a temperature review including temperature

Temperature						thresholds for smoltification.
Delta Rearing and smolt emigration from the Sacramento/San Joaquin River Delta						
1. Entrainment due to instream diversions and Delta Exports	Jan-Jun	Likely			X	OCAP BA (USBR 2008) and Clark et al (2009) assess steelhead/*O. mykiss* pre-screen loss at the SVP/SWP. Moyle and White (2002) provide a literature review of entrainment effects in the Central Valley using Herren and Kawasaki (2001) inventory of water diversions and other sources.
2. Predation – Water Temperature and habitat for Introduced Species	Jan-Jun	Likely			X	Clark et al (2009) assess steelhead/*O. mykiss* pre-screen loss at the CVP/SWP
3. Mortality – Water Temperature	Apr-Jun	Yes, in late Spring			X	Myrick and Cech (2001) provide a temperature review including survival thresholds and acclimatization effects.
4. Smoltification – Water Temperature	Jan-Jun	Unlikely			X	Myrick and Cech (2001) provide a temperature review including temperature thresholds for smoltification
Ocean Rearing						
1. Food availability – meteorology/ocean conditions	Year-round	Episodic depending on Ocean Conditions			X	Mantua et al (1997) examine the effects of El Niño and Pacific Decadal oscillation effects on upwelling and juvenile salmonid growth. Quinn et al (2012) provides reviews marine ecology of steelhead.
2. Predation – marine mammals, etc.	Apr-Oct	Unlikely			X	Scordino (2010) reviews monitoring of pinniped predation on Pacific coast salmonids, but does not assess steelhead impacts.
3. Harvest (Bycatch) – numbers of fish entering	Apr-Oct	Unlikely			X	No Information could be identified examining potential impacts of gill net fisheries on Central Valley steelhead populations

Attachment 4:

Supplemental references provided in Workshop No. 2 notes and ranking of salmonid issues

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Attachment C
California Dept. of Fish and Game comments on Turlock Irrigation District and Modesto Irrigation District Salmonid Population Information Integration and Synthesis Study Plan

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Subject: Comments on Turlock Irrigation District and Modesto Irrigation District Salmonid Population Information Integration and Synthesis Study Plan, Don Pedro Hydroelectric Project (No. 2299-075), Tuolumne River, California

Dear Secretary Bose and Messrs. Nees and Dias:

The California Department of Fish and Game (Department) respectfully submits the following comments in response to the June 15, 2012 “Filling on behalf of the Turlock Irrigation District and Modesto Irrigation District’s Don Pedro Project” concerning “Final Meeting Notes and Relicensing Participants Comments on the April 10, 2012 Salmonid Information Synthesis Workshop No. 1” and to the Draft Meeting Notes the Department received on July 25, 2012 concerning the Don Pedro Relicensing Salmonid Population Information Synthesis Workshop held on June 26, 2012.

On June 26, 2012, the Turlock Irrigation District and Modesto Irrigation District (collectively, the Districts) conducted a second workshop for the Salmonid Population Information Synthesis to discuss the development of the Districts’ preliminary conceptual population models for Chinook salmon and *O. mykiss*. The Districts have presented their materials and the June 26, 2012 workshop as first steps in the effort to summarize relevant and available information regarding in-river and out-of-basin factors affecting Chinook salmon and *O. mykiss* population in the Tuolumne River. According to the Salmonid Populations Information Integration and Synthesis Study Plan

(Synthesis Study Plan), the primary goal of this effort is “to help readers make sense of a wide and complex set of studies through a focused examination of the available literature.” (Synthesis Study Plan at p. 3). The Synthesis Study Plan also states that “[t]he review and synthesis of available data will provide the context for rejecting, accepting, or refining hypotheses and will improve understanding of key uncertainties affecting any conclusions drawn from th[e] [Synthesis Study Plan].” (*Id*. at p. 4).

The Department has reviewed the June 15, 2012 filling on behalf of the Districts and the June 26, 2012 Draft Meeting Notes and other related materials and provides the following comments regarding the information presented by the Districts.

June 15, 2012 Filing on Behalf of Districts

In the June 15, 2012 filing submitted to the Federal Energy Regulatory Commission (Commission or FERC), the Districts state that they “do not agree with the [Department’s] characterizations regarding ‘declining’ salmonid populations” (Filing on Behalf of Districts at p. 3). The Districts’ response to data sources and other information the Department has submitted to the Commission and relicensing participants highlights a concern the Department has previously expressed; namely the Districts’ proposed Salmonid Populations Information Integration and Synthesis is inherently a subjective exercise.

Moreover, in the filing on behalf of the Districts, the Districts fail to articulate any rationale for characterizing the Department’s information and conclusions as having “limitations.” (*See* id. at p. 3). To oppose the Department’s conclusions, the Districts paraphrase a statement in the April 12, 2012 FERC Order Clarifying Proceeding on Interim Conditions (139 FERC ¶ 61,045). (*Id*.) However, the Districts do not provide the full context of the Commission statement and they do not cite any data sources to support their disagreement with the current role inadequate instream flows have in the degradation of aquatic habitat and water temperatures in the Tuolumne River.

The Department reiterates that impaired instream flows and water temperatures are key drivers in the long term decline of the Tuolumne River fall-run Chinook salmon population and notes that it has provided numerous sources in support of this conclusion. To date, the Synthesis Study Plan exercise appears to be largely guided by the Districts’ goals and objectives. As such, the Department believes that the end product should be characterized as a compilation prepared on behalf of the Districts.

June 26, 2012 Workshop and July 25, 2012 Draft Meeting Notes

Two representatives from the Department participated in the June 26, 2012 workshop: Ms. Gretchen Murphey (in person) and Ms. Annie Manji (by phone). Please note in the meeting notes Ms. Murphey's last name is misspelled. Based on that participation and upon review of the related filings, the Department has the following comments.

<u>Conceptual Model Information Sources</u>

One purpose of the workshop was to identify and begin to rank key impacts on salmonid populations based on a review of relevant sources of information. However, the Department notes that the basis for ranking various sources of information was vague and not adequately discussed during the workshop. Without specific evaluation criteria and the opportunity to collaboratively review and assess references, the Department believes that the classification of hypotheses as unlikely, inconclusive, or sound should be clearly labeled as the Districts' perspective.

The Department notes that sources that establish the significance of instream flow and water temperature were given less weight by the Districts, without discussion of the merits of the information or other efforts to seek consensus. During the workshop, the Districts appeared to briefly raise the following concerns: 1) several Department-recommended references were literature reviews and already had a degree of synthesis; 2) without specific page numbers it is difficult to evaluate extensive references; and 3) references without numeric data are less meaningful for purposes of building a model. To assist in understanding the science underlying the key role of flow and water temperature on salmon populations in the lower Tuolumne River, the Department resubmits the following excerpts along with specific pages and numeric data from the cited sources.

- **Mr. Timothy Heyne's testimony**[1]

In Timothy Heyne's testimony to the Administrative Law Judge proceeding on interim conditions pending relicensing, the Department wishes to highlight the following four concepts that should be considered in the Synthesis Study Plan:

[1] (Mr. Heyne is a Senior Environmental Scientist employed by the California Department of Fish and Game)

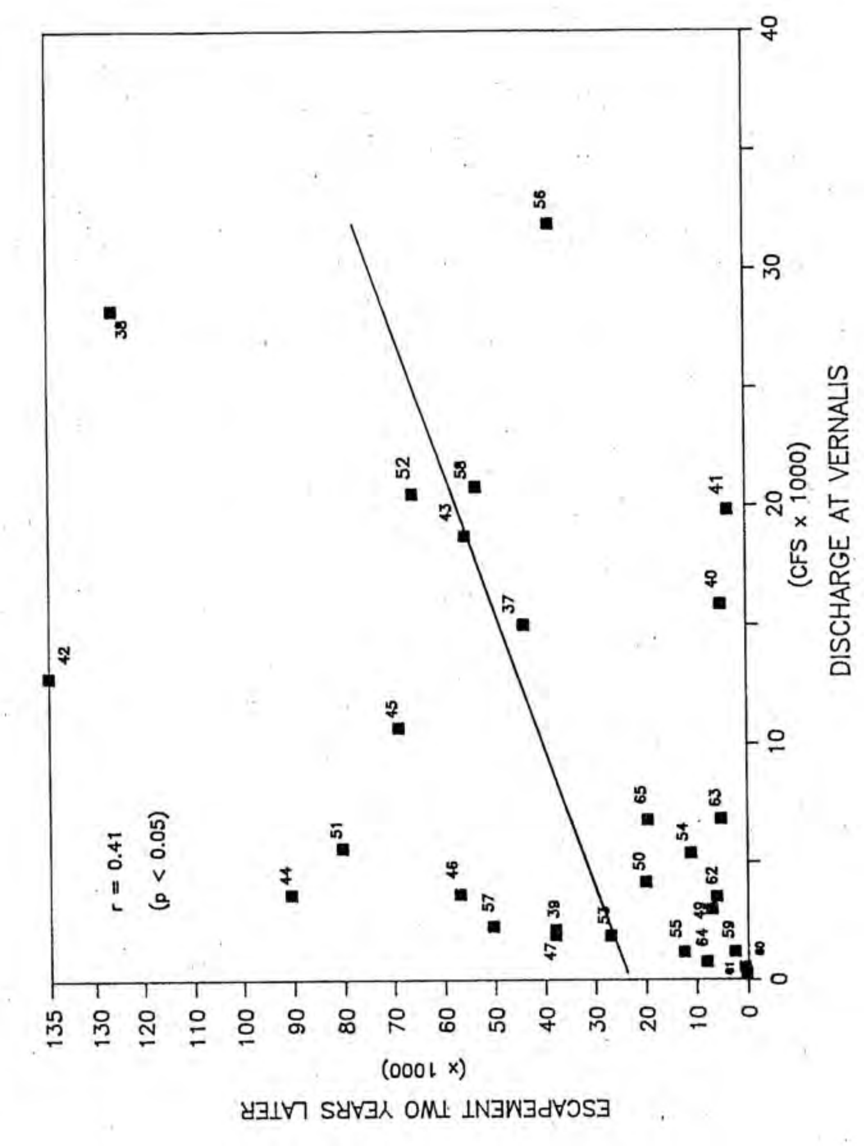
- “Current flow releases to the lower Tuolumne River required under Article 37 of the Project license are insufficient to conserve fall-run Chinook salmon and steelhead.” (Exhibit DFG-2, at p. 2).

- “The single most important impact of Project operations affecting anadromous fish populations is the manipulation of flows in the Tuolumne River.” (Id. at p. 4).

- “Providing more flow to the river at specific times of the year will improve habitat and water temperature for fall-run Chinook and steelhead.” (Id. at p. 7).

- Inadequate spring flows “have been identified repeatedly as the principle limiting factor on fall-run Chinook salmon populations in the Tuolumne River.” (Id. at p. 14).

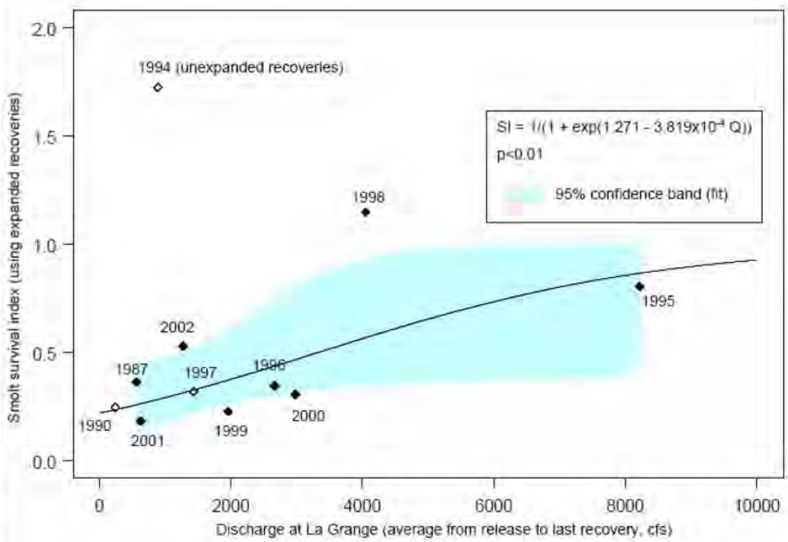
Mr. Heyne’s testimony includes several sources of information and analyses that support his interpretation of the positive relationship between flows and the fall-run Chinook salmon populations in the Tuolumne River as well as other major San Joaquin tributaries. First, Mr. Heyne’s testimony includes a table from the 1987 Department report to the State Water Resources Control Board (SWRCB) entitled: “The Status of San Joaquin Drainage Chinook Salmon Stocks, Habitat Conditions and Natural Production Factors.” In the original document this table is labeled Figure 13 and appears on page two of the Errata sheet of the above-referenced document. In his testimony, Mr. Heyne noted that this data, as shown in the graph below, was provided to the SWRCB to illustrate the relationship between the spring time flows in the San Joaquin tributaries (as measured at Vernalis) and the number of returning adults.


r = 0.41
(p < 0.05)
ESCAPEMENT TWO YEARS LATER
(x 1000)
DISCHARGE AT VERNALIS
(CFS x 1000)

As indicated in the above graph, as flows at Vernalis increase, the number of Chinook salmon that return to spawn in San Joaquin tributaries two years later also increases.

Second, and more specific to the Tuolumne River, Mr. Heyne's testimony also provides information from the Districts' 2005 Ten Year Summary Report to the Commission to illustrate the relationship between flow and smolt survival. The original graph and discussion can be found at page 3-119 of the Districts 2005 report. The graph is labeled Figure 4 Tuolumne River Smolt Survival Relationship in Mr. Heyne's testimony and shows a statistically significant increase in smolt survival with increasing discharges from La Grange Dam.

Figure 4. Tuolumne River Smolt Survival Relationship



Figures 3 and 4 illustrate the benefits increased spring time flows can provide for the fall-run Chinook salmon population. However, the spring stream flow levels provided by the Project are grossly deficient (in terms of flow magnitude, flow duration, and elevated flow frequency) and do not produce an adequate supply of smolts to conserve the fall-run Chinook salmon population. The artificially low flows cause the juveniles to stop migrating and also cause excessive warming of water as flow level recedes. Low flows during the spring out-migration also impact smolts moving through the Delta where predation and water quality are significant sources of mortality. The losses of smolts associated with current Project releases in the spring are a significant impact on the fishery and have been correlated with fewer

Third, Mr. Heyne's testimony illustrates the relationship of spring flows to salmon populations by compiling data from rotary screw traps. These traps have been operated for almost two decades with the most recent years' results available on the Tuolumne River Technical Advisory Committee website. The following pages from Mr. Heyne's testimony evaluate the correlation between outmigrant success and spring flow utilizing spawning females as a basis for estimating egg production. Again, as flows increase so does production of outmigrant smolts.

Additional data supporting the conclusion that current spring flows are insufficient come from analyses of smolts collected in rotary screw traps, seines, and trawls in the lower Tuolumne and Delta. These smolt production evaluations have been performed since the early 1980s, with the rotary screw trap estimates beginning in mid 1990s. Observed trends in smolt number, size, and river mile have been correlated with spring flow conditions as well as water temperature. Data from all of these long term evaluations demonstrate that fish production is heavily dependent on river flows. To maximize smolt production, spring flows must be elevated during the smolt out-migration season, which, as demonstrated by the licensees' juvenile monitoring, occurs from about mid-March to mid-June. Elevated flows (defined as increased flow magnitude, flow duration, and flow level frequency) during this spring time would maximize smolt survival and reduce water temperature, both of which would substantially enhance likelihood of smolt survival out of the Tuolumne River.

The licensees raised a concern on the smolt survival evaluations about the use of hatchery fish. Due to the concerns regarding how well hatchery fish represent wild fish and a desire to understand the migration and abundance of wild fall-run Chinook salmon smolts, DFG had already begun (1995) a program of using a capture device called a rotary screwtrap at the mouth of the Tuolumne to document the numbers of fish leaving the Tuolumne River. This program, too, was operated in conjunction with the licensees. The result of screw trapping is an estimate of the number of juvenile fall-run Chinook salmon leaving the river each year. These estimated number of outmigrants are presented in the table below (Table1) with the estimated number of eggs that produced those outmigrants. The egg estimates are produced by DFG each year after they perform adult spawning surveys. When you divide the outmigrants by the eggs produced and then multiply by 5,000 you have an estimate of the number of outmigrants that make it out of the river per average female. By comparing the "high" production years and low production years to streamflow it is clear that streamflow has a large impact on production, affecting the number of outmigrants/female making out of the river.

Table 1. Evaluation of Production of Outmigrant Juveniles per Spawning Female Compared Spring Flows in the Tuolumne River.

Outmigration Year	Potential Eggs	RST Outmigrants	% Leaving River	Outmigrants / Avg. Female	Spring Flow Apr-Jun
1998	21,520,864.77	1,615,673	7.507%	375	3931
1999	22,640,987.17	1,073,669	4.742%	237	1381
2000	18,842,659.42	132,017	0.701%	35	1029
2001	68,954,846.59	111,644	0.162%	8	467
2002	30,833,259.73	14,540	0.047%	2	388
2003	23,220,487.01	7,261	0.031%	2	453
2004	7,939,399.75	13,134	0.165%	8	503
2005	5,227,439.49	74,471	1.425%	71	4426
2006	2,813,709.71	178,034	6.327%	316	6703
2007	1,802,677.00	937	0.052%	3	338
2008	543,200.66	3,283	0.604%	30	448

I submit that after three major and substantially independent evaluation programs, all reaching the same conclusion, it is time to act on the information available. Current spring flows are inadequate and need to increase to keep the fall-run Chinook salmon populations from declining to zero (extinction).

- **Mesick et al., 2008. Limiting factor analyses & recommended studies for fall-run Chinook salmon and rainbow trout in the Tuolumne River.**

Rotary screw trap surveys and coded-wire tag smolt survival studies also inform the limiting factor analyses prepared by Mesick et al. (2008) which is cited in the testimony of both Mr. Heyne and Dr. Andrew Gordus. Mesick et al. finds that spring flows are highly correlated with Chinook salmon recruitment. The following excerpt from the Mesick et al. study details the relationship between salmon abundance and instream flow.

Salmon Abundance and Flow

The intent of the 1996 FERC Settlement Agreement[iii] (FSA) and subsequent modified FERC License No. 2299 (License) Articles 37 and 58 was to improve minimum flow levels from the New Don Pedro Project, implement an adaptive management research program, and restore critical habitat to help recover the fall-run Chinook salmon population in the Tuolumne River. However, the number of adult Tuolumne River fall-run Chinook salmon produced at a given spring flow has significantly declined by about 50% since the FSA was implemented (Figure 3). The statistical test of significance was based on a permutation test conducted by Dr. Allan Hubbard[1] to avoid violations of assumptions for correlation tests resulting from potential autocorrelations in population trend analyses. His analysis indicates that the intercepts of the regressions between the two data sets shown in Figure 3 are significantly different ($P = 0.01$).

[1] Dr. Allan Hubbard, Assistant Professor of Biostatistics (Division of Biostatistics, School of Public Health, University of California, 101 Haviland Hall, MC 7358, Berkeley, CA 94720

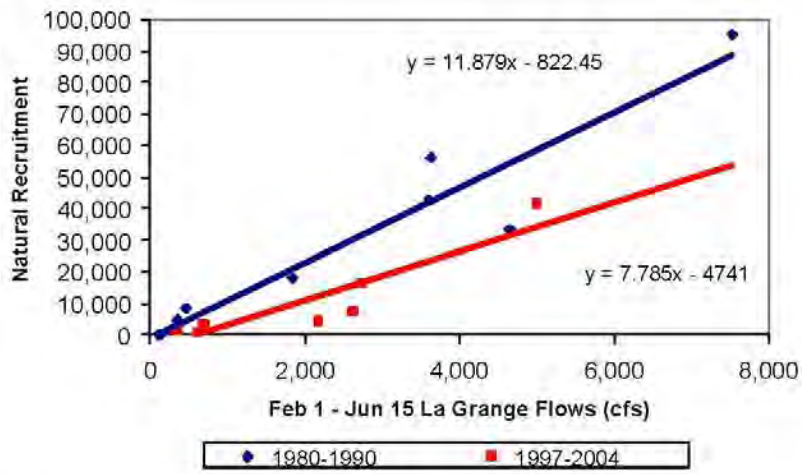


Figure 3. Tuolumne River natural fall-run Chinook salmon recruitment plotted with mean flow in the San Joaquin River at Vernalis during February 1 through June 15 during two periods: 1980 to 1990 (pre-FSA) and from 1997 to 2004 (post-FSA). Recruitment is the number of adults in the escapement and ocean harvest (including shaker mortality) that belong to individual cohorts of same-aged fish (Mesick et al. 2007). Estimates were excluded for which spawner abundance was less than 650 Age 3 equivalent fish to minimize the effect of spawner abundance on the relationship between flow and recruitment.

Prior trend analysis suggests that the number of naturally produced and hatchery adult salmon that return to the lower Tuolumne River is strongly correlated with spring time flow (e.g. April and May) when the fish migrated to the ocean as juveniles (as summarized in Mesick and Marston 2007). The most recent evaluation by Mesick and Marston (2007) indicates that the mean spring flow in the San Joaquin River near Vernalis between March 1 and June 15 explains about 92% of the variation (adjusted R-squared) in total (natural and hatchery) adult recruitment to the Tuolumne River between 1980 and 2003 (Figure 4). Instream flow releases in the Tuolumne River as gauged at La Grange are almost as important as they explain about 82% of the variation in Tuolumne River recruitment. Adding stock abundance and a categorical variable to account for the population change that occurred sometime between 1987 and 1994, increases the amount of variation explained by the Vernalis flow model to about 95%. Other factors, such as *Microcystis* blooms, pyrethroid insecticides, water quality in the Stockton Deep-Water Ship Channel, CVP and SWP Delta export rates, Delta Cross Channel Gate operations, and ocean productivity (e.g., upwelling and Pacific Interdecadal Oscillation) explain relatively little variation in adult recruitment to the Tuolumne, Stanislaus, and Merced rivers (Mesick and Marston 2007).

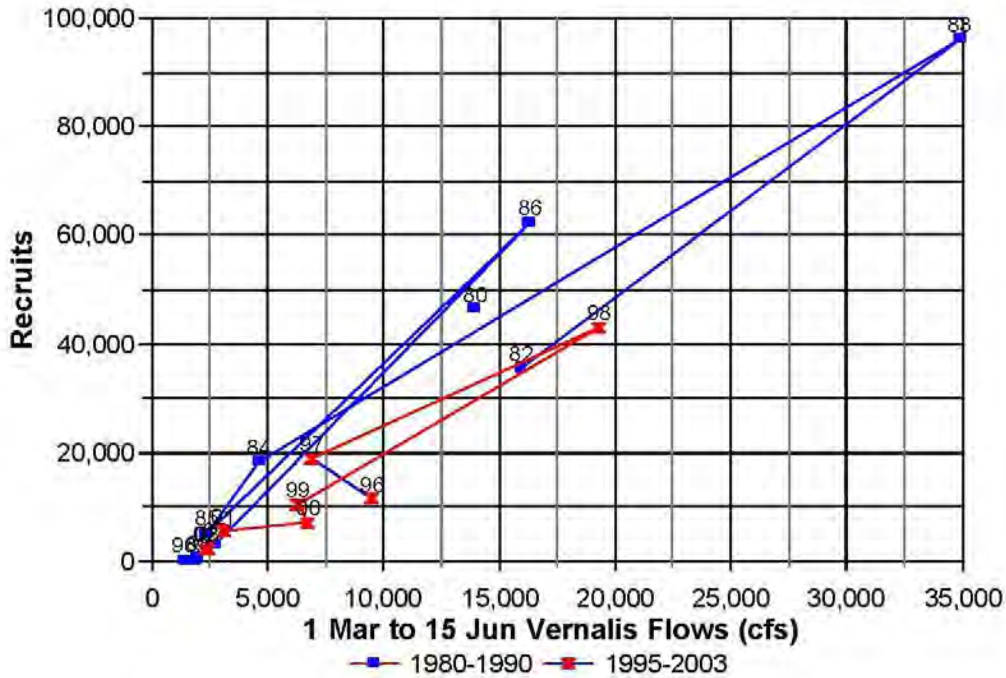


Figure 4. Number of fall-run Chinook salmon recruits to the Tuolumne River plotted with flows in the San Joaquin River at Vernalis from March 1 to June 15 from 1980 to 2003. This analysis excludes recruitment estimates that were affected by a low number of s pawners (< 500 Age 3 equivalent fish) to better illustrate the relationship with flow. The recruitment estimates are labeled according to the year when the fish outmigrated as smolts.

Spring flow affects juvenile survival in the Tuolumne River as well as the Delta based on rotary screw trap surveys in the Tuolumne and Stanislaus rivers and coded-wire-tag smolt survival studies in the Tuolumne River and Delta[iv]. Preliminary analyses of rotary screw trap data from the Tuolumne River near Grayson (RM 5.2) suggest that spring flow releases at La Grange from March 1 to June 15 are highly correlated (adj-R^2 = 0.82, P = 0.0005) with the number of Tuolumne River smolt outmigrants passing the Grayson traps at rivermile 5 (Figure 5)[v] and the number of Tuolumne River smolt outmigrants is highly correlated (adj-R^2 = 0.96, P = 0.0004) with the number of Tuolumne River adult recruits (Figure 6).

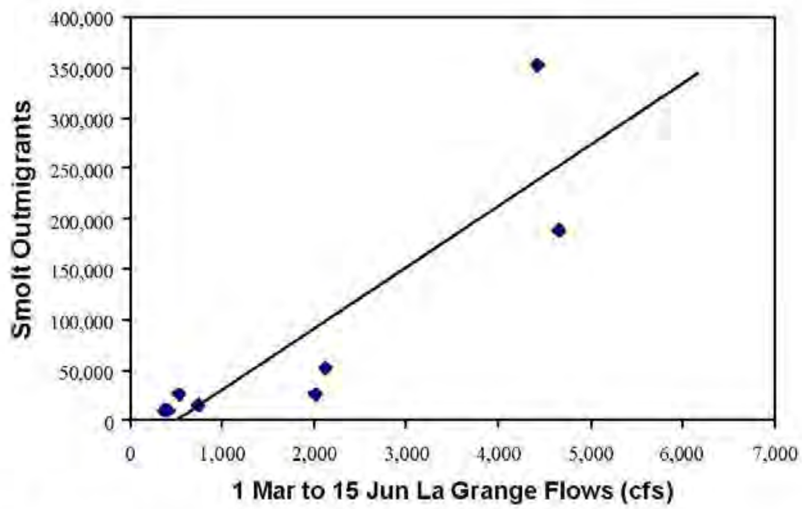


Figure 5. The Number of smolt-sized Chinook salmon outmigrants (FL > 70 mm) passing the Grayson rotary screw trap site (RM 5) plotted with flows at La Grange between March 1 and June 15 in the Tuolumne River from 1998 to 2005. The regression model has an adj-R2 of 0.73 and a probability level of 0.0004.

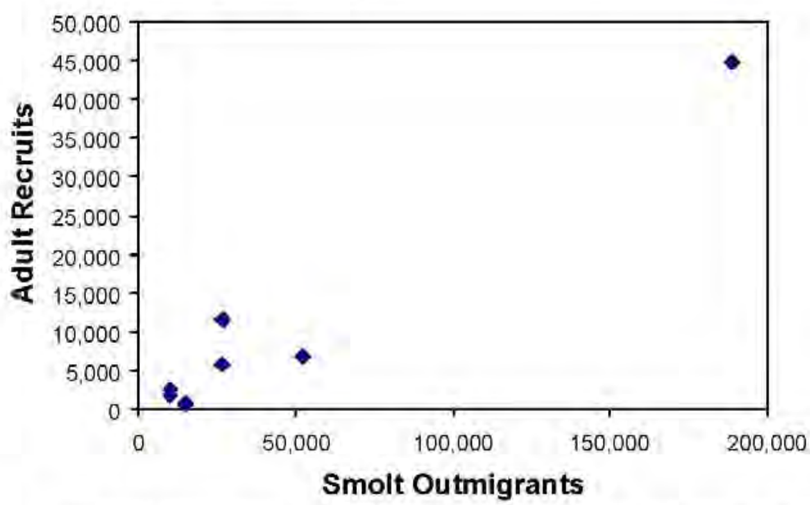


Figure 6. The number of smolt-sized Chinook salmon outmigrants (FL $\geq$ 70 mm) measured at the Grayson rotary screw trap site (RM 5) regressed with the number of adult recruits in the Tuolumne River from 1998 to 2003. The regression model has an adj-R^2 of 0.95 and a probability level of 0.0001.

- **Dr. Andrew Gordus' testimony**[2]

While Mr. Heyne's testimony addressed the relationship of flow and salmon populations, Dr. Andrew Gordus' testimony focused specifically on the mechanism of water temperature. In his testimony to the Administrative Law Judge proceeding on interim conditions pending relicensing, Dr. Gordus concluded as follows:

> "Elevated water temperatures contribute to the ongoing decline [of] fall-run Chinook salmon in the Tuolumne River by: 1) inducing adult mortality as adults migrate into the San Joaquin River and adjacent tributaries to spawn (i.e. pre-spawn mortality); 2) reducing egg viability for eggs deposited in stream gravels; 3) increasing stress levels, thereby reducing survival of juveniles within the tributary nursery habitats; and 4) reducing salmon smolt out-migration survival as smolts leave the nursery habitats within the tributaries to migrate down the San Joaquin River to Vernalis and through the south Delta" (Exhibit DFG-4, at p. 12).

In support of this conclusion, Dr. Gordus cited findings from both the United States Environmental Protection Agency (EPA) and the SWRCB that water temperature is impaired on the lower Tuolumne River. The June 15, 2012 filing on behalf of the District notes the Department's references on water temperature but emphasizes that only primary data sources will be used for assessing temperature impacts (Filing on Behalf of Districts at p. 3). The Districts also imply that the proposed Temperature Criteria Assessment for Chinook Salmon and *O. mykiss* Study will have a role in identifying appropriate regional water temperature standards using historical data. (*Id*.) To clarify the Department's perspective on water temperature, we strongly recommend the use of the EPA temperature criteria to evaluate project impacts. The Commission has reaffirmed this perspective in the December 2011 Study Plan Determination:

> "CDFG and NMFS reference several documents that support use of EPA (2003) temperature criteria for all life stages of salmonids in the lower Tuolumne River. We have reviewed these documents and have determined that the existing information concerning the effects of water temperature on

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[2] (Dr. Gordus is a Water Quality Biologist employed by the California Department of Fish and Game)

> specific life-stages of salmonids is sufficient (study criterion 4)." (Study Plan Determination for the Don Pedro Hydroelectric Project at p. 55).

Given the lack of proposed studies to quantify the mechanisms of water temperature impacts on the lower Tuolumne River, the Department does not understand how the Districts' proposed Temperature Criteria Assessment Study Plan will inform the ongoing synthesis.

Conceptual Model Flow Charts

Another purpose of the June 26, 2012 workshop was to present conceptual salmon and steelhead population models as a prelude to developing actual modeling tools. During the workshop two frequently cited proximate mechanisms, prey availability and disease/parasites, were characterized as not being well documented but also unlikely to be a significant problem. We note that two studies the Department recommended earlier in the relicensing process were specifically recommended to better understand these proximate causes; namely the bioenergetics and fish health/disease studies. However, the Districts opted not to pursue these lines of investigation.

Moreover, the Department is also concerned that the Districts' proposed salmon modeling emphasizes mortality (as opposed to survival) and lacks a clear nexus with subsequent life stages. The Department notes that all of the Districts' flow chart processes and mechanisms ultimately feed into direct mortality. It is not clear how the abundance of survivors (i.e., those that avoid the direct mortality outcome) will feed into the next life stage. This linkage is missing in the Districts' current schematics. The Department has raised these concerns previously. In fact, in comments on the Districts' proposed study plan submitted to the Commission and Districts on October 24, 2011, the Department stated that:

> "As a first stage review, the proposal lacks: i) the key component of non-fry juveniles to adult recruitment; ii) an acknowledgment of the nexus of fry abundance to parr/smolt abundance; iii) an acknowledgment of the importance of both winter and spring flow level to fry abundance thence both parr and smolt abundance; iv) an acknowledgment of the statistically significant relationship between flow in the lower Tuolumne River and smolt survival; and v) any accounting for the relationship between juvenile

> out-migration (fry, parr, and smolt) patterns and adult recruitment." (Revised Study Requests and Comments, at pp. 20-21)

Finally, the Districts' proposed modeling hierarchy conveys implicit priorities. The Department is concerned that factors of high importance from our perspective (such as flow magnitude, frequency and duration and water temperature) are relegated to less prominent positions within the model structure based on preliminary District assessments. The proposed structure appears to assign, by default, a less important role to factors such as water temperature and habitat quality and quantity as they do not appear in the bottom tier proximate to biotic responses.

The Department submits the following comments to illustrate alternative modeling concepts and linkages.

- Except during rare spill events, the Don Pedro Project directly controls flow releases to the lower Tuolumne River. With over 2 million acre feet storage capacity, the Project controls the timing, magnitude and duration of instream flows in the lower Tuolumne River most of the time. However no portion of the instream flow regime is classified as an anthropogenic input. Instead Project controlled flow releases and storage are included in the same category as water year type, groundwater upwelling and tributary inflow. The Department recommends Project operations involving water management be separated from unimpaired instream flow contributions into a distinct controllable system input.

- Hatchery introductions are specifically listed as an anthropogenic input in several life stages (sometimes the only such input). As there is no Chinook salmon hatchery on the Tuolumne River, the presence of hatchery Chinook in the lower Tuolumne River is actually an indirect impact, more correctly characterized as straying. (The Department notes that the draft meeting notes have replaced hatchery introduction with straying of hatchery fish in the relevant flow charts and agrees this is more accurate.)

- Lack of passage to historic spawning habitat is not included in the spawning flow chart, based on the rationale that existing structures are baseline and not relevant to a forward looking modeling exercise. Meanwhile in both the in-river and Delta rearing flow charts, non-native introductions are listed as the first anthropogenic input. There has been no formal introduction of non-native fish into the lower Tuolumne or San Joaquin River watersheds for over a decade.

Non-native fishes are a legacy of past actions and would seem to constitute a "baseline" similar to the lack of passage facilities. A more appropriate current anthropogenic input involving non-native fishes would be angler regulation and/or harvest.

- The proposal to treat predation as a proximate mechanism leading to direct mortality requires clarification. Predation is an essential part of a functioning aquatic ecosystem and not a classic impact such as impaired water temperature or reduced quality/quantity of rearing habitat. Even in pristine systems, predation is a common outcome for juvenile salmonids and a mechanism for removal of less fit individuals from a population. Predation is also a more likely outcome for juveniles experiencing stressors such as the high water temperatures and lack of cover habitat in the lower Tuolumne River. Therefore, the Department agrees predation may be a likely "biotic response" in a degraded environment; however, predation is not necessarily a key mechanism for declining trends in populations. A more appropriate concept would be analogous to the food (prey) abundance mechanism where the distribution and abundance of predators is the mechanism of interest.

- Similar to predation, competitive exclusion during spawning and redd superimposition during incubation are actually consequences of limited high quality spawning habitat and/or altered run timing. The mechanisms of interest would be factors that reduce habitat quality or constrain habitat quantity such as impaired water temperatures and passage barriers.

- The in-river flow chart does not include the temporal aspect of smolt out migration which is strongly linked to survival rates. Simply put, out-migration transit times are reduced and survival rates improved by increased flow. Also missing in the Districts' proposed modeling hierarchy is the duration of floodplain rearing habitat, with longer periods of inundation linked to improved prey availability and reduced predation. To address this issue, the Department recommends inserting a flow timing and availability box as a first tier mechanism in the in-river rearing and out-migration chart. This mechanism should have system inputs from meteorology, unimpaired flow and anthropogenic water management operations. The flow timing and availability mechanism in turns impacts water temperature, water quality, habitat availability, predator and food distribution and abundance, disease and straying.

- In the Draft Meeting Notes, the Delta rearing and out migration flow chart now includes the flow elements of timing and variability added as a bullet at the bottom of the instream flow box. This bullet should also include at a minimum, the magnitude and duration of flow. Given the large role of flow elements, the Department recommends adoption of the same structure of a distinct flow timing and availability mechanism as described previously for the in-river flow chart. The Department does not support lumping flow elements into a catch-all of system inputs far removed from actual mechanisms and processes of interest.

- The water temperature component should have various mechanisms identified and treated as distinct processes/inputs. At a minimum the elements of: 1) snow melt (or conversely the interruption of snow melt); 2) groundwater seepage (or conversely lack of seepage due to overdraft); 3) riparian vegetation shading (or conversely loss of shading); and 4) tail water (heat sink) returns should be explicitly inserted into the appropriate flow charts. The Department also notes the importance of the relationship between thermal mass and shifts in downstream temperature which is dependant on Project storage practices and release volumes. This relationship is missing in the Districts' current schematics.

- Both the in-river and Delta rearing charts should include metabolic processes as a distinct mechanism with input from water temperature and food availability and directly impacting disease and growth. In addition, the prey abundance mechanism should be broadened to food abundance. (The Department notes that the Draft Meeting Notes include revised flow charts with prey replaced by food and appreciate the refinement. Along this line, instead of "availability", the distribution and abundance characterization recommended for predators would also be appropriate for food).

- Both in-river and Delta rearing flow charts should also include migration as a distinct process on the same tier as entrainment and disease. Migration is impacted by flow availability and duration, habitat availability, metabolic processes, and water temperature and quality. The duration and timing of migration behaviors, in turn, impacts survival (or indirect mortality as presented in the conceptual flow chart).

- As appropriate mechanisms are added, the in-river rearing/out-migration flow chart becomes quite complex. The Department recommends splitting this critical phase into two distinct life stages: in-river rearing and smolt out-migration. These are in fact different life stages (fry versus smolt) with different stressors.

Classification of various factors as anthropogenic or not, or mechanisms versus inputs may seem to be a matter of semantics; however, when identifying controllable factors under the Commission's jurisdiction, such distinctions become important. The Department notes that the December 22, 2011 Commission Study Plan Determination required that the Synthesis Study Plan effort and the related modeling studies specifically identify project related impacts:

> "The objective for the quantitative models is to identify critical in-river life stages affected by the project and then allow an evaluation of appropriate PM&E's to inform license conditions. The model objective is not to predict the precise population size of any particular life-stage, as in a life-cycle model, but rather identify all in-river life stages affected by the project and then allow an evaluation of appropriate PM&E's." (Study Plan Determination for the Don Pedro Hydroelectric Project, at p. 38).

The Department believes the modifications recommended above will result in a better understanding and assist parties in developing and evaluating protection, mitigation, and enhancement (PM&E) measures.

<u>Preliminary Ranking of Issues Affecting Chinook Salmon Population Levels</u>

The Department laments that the Districts' preliminary ranking table was not clearly articulated until after the workshop with the distribution of the July 25, 2012 Draft Meeting Notes. Our review of the Draft Meeting Notes' preliminary ranking table revealed that flow is not considered an issue (of any rank) affecting Chinook salmon population levels. Flow (timing, magnitude, duration and availability) does not meet the criteria of a process or mechanism in this summary presentation. The only processes/mechanisms affecting populations and consistently having the support of conclusive evidence appear to be redd superimposition, predation, and entrainment. In contrast, most process and mechanisms involving water temperature impacts are categorized as "unlikely" or "inconclusive."

In some cases, the notes section cites a lack of biological data specific to the Tuolumne River. *In situ* sampling of delicate/widely distributed life stages (such as those needed for egg viability, fry metabolism and floodplain juvenile mortality studies) is notoriously difficult. However, this should not translate into a lack of impacts. While predators and redds may be more amenable to tracking and quantification, this convenience should not override relationships based on laboratory studies or scientific research in comparable ecosystems. Finally, as noted previously, water temperature criteria developed through the Districts' proposed Temperature Criteria Assessment Study Plan to assist in assessing risk of mortality is not an appropriate substitute for the EPA temperature criteria.

For the reasons explained above, the Department does not concur with the Districts' preliminary set of issues nor the proposed ranking. The Department recommends the following life history components be addressed by any Tuolumne River salmon population model. (The chart below is organized by highest to lowest priority, first by life stage and secondarily by component.)

#1 Smolt out migration		
Flow is the primary determinant of smolt survival, and ultimately, the contribution to adult recruitment in Tuolumne River.		
Process/Mechanism	**Season**	**Notes**
a) Water quality (temp, contaminants, DO)	Apr-Jun	Increased flow improves water quality and reduces mortality causal factors of disease, contaminants, starvation
b) Smoltification and out migrant transit time	Apr-Jun	Increased flow reduces duration of vulnerable stages
c) Predation	Apr-Jun	Increased flow reduces predation by reducing temperature, improving water quality, increasing velocity, increasing flood-related turbidity
d) Entrainment	Apr-Jun	Minor factor
#2 In-river rearing		
Flow is the primary determinant of number of juvenile salmon that survive to smolt size, and ultimately, the contribution to adult recruitment in Tuolumne River.		
Process/Mechanism	**Season**	**Notes**
a) Habitat quantity and quality (floodplain)	Feb-May	Increased flows increases floodplain habitat

Process/Mechanism	**Season**	**Notes**
b) Food availability	Feb-May	Increased flow inundates floodplain and increases food availability
c) Water quality (temp, contaminants, DO)	Feb-May	Increased flows reduce temperature, improve water quality, reduce mortality from other stressors (disease, contaminants, starvation)
d) Predation	Feb-May	Increased flow reduces predation
#3 Delta rearing		
Spring flows (Feb-May) improve the number of fry and parr that survive migration through Tuolumne River and San Joaquin River and Delta, but provide minor contributions to adult recruitment compared to the number of smolts produced in the Tuolumne River. (This is a consequence of many stressors severely reducing the quality of Delta and estuary rearing habitats.)		
#4 Adult up-migration and spawning		
Fall flows (Sep-Oct) improve egg viability, reduce egg mortality from redd superimposition and minimize straying of early arriving adult salmon. Fall attraction flow releases were implemented starting in the mid 1990s, but based on documented responses to date; these flows appear to have a relatively minor effect on adult recruitment.		
#5 Egg survival to emergence		
The incubation period (Oct - Jan) is not considered a major bottleneck, given the current poor survival of fry and smolts. If higher winter and spring flows were provided to improve juvenile survival, then improving spawning habitat (e.g. restoration of spawning gravel quality and fluvial processes) would increase in importance.		
#6 Ocean Rearing		
Ocean mortality is generally small compared to factors affecting juvenile survival in Tuolumne River and Delta.		

For greater detail on how to utilize these factors in a conceptual Chinook salmon population model, please refer to the 2008 limiting factor paper by Mesick et al. (specifically pages 45 through 48)

Future Consultation

The Department appreciates the amount of effort involved in building a population model while simultaneously seeking input from other parties. In fact, the Department biologists and environmental specialists with expertise in issues involving salmonid populations of the Tuolumne River have been working on a salmon population model for the San Joaquin and its major tributaries (including the Tuolumne River) for over seven years. The development of the Department's model has included several rounds of peer review.

Unfortunately, the Districts have dismissed utilizing the framework of the Department's San Joaquin River Salmon Population Model for this relicensing by noting that not all concerns raised during the first two rounds of peer review had been resolved (TID/MID, 2011, page 314). The Districts have incorrectly concluded that because the Department has yet to address a few remaining peer review concerns, the model is not functional and should not be considered.

Despite the Districts' conclusions, the Department continues to believe that the San Joaquin Salmon Population Model is worth the significant amount of resources invested in its development, peer review and refinement. Furthermore, the Department notes that its staff, with the expertise to develop the Tuolumne River salmon population model, are already fully committed to providing a credible and informative tool to assist the respective regulatory agencies in managing San Joaquin River Watershed resources. Consequently, this Department staff are unable to commit to an additional modeling effort, even one with limited scope and compressed development phase such as proposed in the Tuolumne River Chinook Salmon Population Model Study Plan.

While the Department will continue to actively consult and participate on study plan development for those studies the Department has requested, due to the pre-existing high priority commitments of the Department's modeling experts, this particular information synthesis and conceptual modeling effort is one in which our participation will, unfortunately, be minimal at best. The Department brings this to the attention of the relicensing parties due to the decision of the Commission not to require peer review of this modeling effort. In particular, the Department is concerned with the following excerpt from the Commission's December 22, 2011 Study Plan Determination:

> "However, we agree with the Districts that establishment of a scientific review panel and any associated cost is not necessary, as participation by experienced biologists from NMFS, FWS, CDFG, the Conservation Groups, and Commission staff would ensure a rigorous scientific review (study criterion 7)." (Study Plan Determination for the Don Pedro Hydroelectric Project, at p. 39).

Based on the concerns and the recommendations set forth above, the Department strongly recommends the Districts reconsider the decision not to obtain an independent review of their proposed model to ensure their investment of time and effort results in a credible and useable product. The Department notes that the Delta Science Panel is a pre-existing body of respected, knowledgeable and independent experts who could inject a valuable degree of scientific rigor and credibility into this process.

The Department appreciates the opportunity to comment on the above-reference filing and workshop meeting notes and other related materials the Districts have provided as a prelude to the development of a salmon population model. If you have any questions regarding these comments please contact Ms. Annie Manji, Staff Environmental Scientist, at (530) 225-2315, or Mr. Dean Marston, Environmental Program Manager, at (559) 243-4014, extension 241.

Sincerely,

Jeffrey R. Single, Ph.D.
Regional Manager, Central Region

cc: Mr. Peter Barnes
Water Quality Certification Program
State Water Resources Control Board
Post Office Box 100
Sacramento, California 95812-0100

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Document Content(s)

Attachment D
Tuolumne River Trust and California Sportfishing Protection Alliance comments on W&AR-5 Salmonid Information Synthesis Workshop No. 2-Draft Meeting Notes

Tuolumne River Trust

August 24, 2012

Robert Nees
Turlock Irrigation District
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Greg Dias
Modesto Irrigation District
PO Box 4060
Modesto, CA 95352

RE: Don Pedro Project (FERC Project P-2299) Comments on W&AR-5 Salmonid Information Synthesis Workshop No. 2-Draft Meeting Notes.

Dear Messrs. Nees and Dias:

Tuolumne River Trust (TRT) and California Sportfishing Protection Alliance (CSPA) submit these comments on the W&AR-5 Salmonid Information Synthesis Workshop No. 2-Draft Meeting Notes.

Background

On June 26, 2012, the Turlock Irrigation District and Modesto Irrigation District (collectively the Districts) conducted the second workshop for the Salmonid Information Integration and Synthesis Study and the related Chinook Salmon Population Model and *O mykiss* Population Model. The workshop was conducted in accordance with the study plans prepared for these three studies and approved by the Federal Energy Regulatory Commission (FERC) in its December 22, 2011 Study Plan Determination (SPD). Section 7.0, Schedule, of the W&AR-5 Study Plan contained a task to conduct a second workshop to present, discuss, and review the conceptual models for salmonids. This second workshop followed FERC's directive related to ongoing consultation processes contained in Appendix B, page 1, of the FERC SPD.

The purpose of this workshop was to continue the discussion of relevant information, studies, and data and to present, review, and discuss preliminary conceptual models under development by the Districts.

Comments

TRT and CSPA have reviewed the meeting notes and other related materials and have the following comments regarding the information presented.

1. The meeting notes give the impression that the Districts' preliminary ranking of issues affecting Chinook salmon and O mykiss (Attachment 3) was discussed and developed collaboratively within the meeting. We request that the record accurately reflect that this is not the case and

that the presentation of the preliminary ranking of issues within these meeting notes is, in fact, the first time that any ranking, preliminary or otherwise, has been disclosed. While no specific ranking of factors was discussed or proposed by any party, what were discussed were the various factors and studies, data, and other information that could be used to inform the relative importance of each of these factors. We request that a future workshop be dedicated specifically to discussing the preliminary ranking of factors. Included in this workshop should be a discussion of the criteria for weighting the various factors. If the group is to come to a consensus as to why Factor A has a greater influence on any given life stage than Factor B, the criteria by which that determination is based should be clear.

2. As these draft meeting notes represent the first presentation of the preliminary rankings, our comments on the preliminary ranking are brief and incomplete. We anticipate that we will provide more complete comments during a future workshop in which the rankings are discussed.
3. Of great concern to TRT and CSPA as this modeling exercise proceeds is the process and criteria by which the various factors will be weighted and ranked. While the Districts have worked diligently to identify studies, articles, and data to provide information about the various factors that may potentially affect Chinook salmon and *O mykiss* populations, in general the information does not provide a comparison of the relative importance of the various factors in any quantifiable manner, forcing the Districts to use subjective judgment in ranking the factors.
4. An additional limitation to this exercise is that the various factors are evaluated in isolation, whereas any given factor may compound or diminish the influence of other factors. To the extent possible, a discussion of how each factor may be related to other factors should be included with the conceptual models.

<u>Salmon Ranking</u>

5. *Spawning*
   - A row should be added for inability of spawning fish to locate suitable spawning habitat.
6. *Egg incubation*
   - A row should be added for reduced egg viability due to water temperature effects on adult up-migrants.
   - The study referenced for red superimposition (TID/MID, 1992) cited estimates of egg losses in 1988. There is no recent evidence of effects from redd superimposition.
7. *In-river rearing, juvenile and smolt emigration from the lower Tuolumne River*
   - Predation should be linked not only to habitat for predators but also to habitat conditions for fry and smolts. Effects are both from predation and from flow and channel conditions that set the table for a gauntlet of predation. The interaction between salmonid habitat and predation is central to understanding predation.
   - Slow growth is a likely cause of unsuccessful smolting and outmigration. We recognize that there is limited evidence but believe that this information would have been developed through a bioenergetics study, as requested by agencies and conservation groups.
   - See Mesick, 2009, *The High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Tuolumne River due to Insufficient Instream Flow Releases*, and Mesick 2010, *The High Risk of Extinction for the Natural Fall-Run Chinook Salmon Population in the Lower Merced River due to Insufficient Instream Flow Releases* for discussion of effects of water temperature and lack of rapid growth due to lack of floodplain inundation.
8. *Delta Rearing and smolt emigration from the Sacramento/San Joaquin River Delta*

- Predation should include presence of predation hotspots caused by hydrodynamics and incipient entrainment of juvenile salmonids due to export operations combined with low San Joaquin River outflow.
- A row should be added for impaired water quality as cause of losses, including but not only low DO in Stockton Deepwater Ship Channel.

9. *Ocean Rearing*
    - Harvest should be changed to "Harvest Management."

<u>Steelhead Ranking</u>

10. *Spawning*
    - A row should be added for inability of spawning fish to find suitable spawning habitat.
11. *In-River Rearing, juvenile and smolt emigration from the lower Tuolumne River*
    - Predation should be linked not only to habitat for predators but also to habitat conditions for juveniles. Effects are both from predation and from flow and channel conditions that set the table for a gauntlet of predation. The interaction between salmonid habitat and predation is central to understanding predation.
    - In row on temperature, slow growth should be cited as a problem as well as mortality. Mortality should not be characterized as occurring at "low levels" in the absence of evidence. We suggest simply saying "mortality."
    - A row should be added for low flows as a cause of lack of smoltification.
12. *Delta Rearing and smolt emigration from the Sacramento/San Joaquin River Delta*
    - Predation should include presence of predation hotspots caused by hydrodynamics and incipient entrainment of juvenile salmonids due to export operations combined with low San Joaquin River outflow.
    - A row should be added for impaired water quality as cause of losses, including but not only low DO in Stockton Deepwater Ship Channel.

13. In the December 22, 2011 FERC Study Plan Determination, Commission staff recommended that, except for a peer review panel, the Districts adopt guidelines similar to the June 2011 Salmonid Integrated Life Cycle Model Workshop. We are concerned that these guidelines are not being entirely adhered to. For example, no standard glossary has been developed to date. Also, specific questions have not yet been articulated for which the model is formulated to answer. Finally, the strategy for using data to calibrate and validate the model has not been developed.
14. In the FERC Study Plan Determination, Commission staff recommended that the Districts include an agreement describing how interested participants and the Districts would achieve consensus on all issues. This recommendation differs from the workshop protocol to which the Districts are adhering for W&AR5. In the Districts' workshop protocol, the Districts simply note the areas of disagreement rather than strive to reach consensus.
15. The Districts include 47 pages of information as Attachment 1 – Meeting Materials, including Meeting Agenda, General Chinook salmon and *O mykiss* Life History Timing, and Preliminary Conceptual Models for the various life stages of Chinook salmon and *O mykiss*, all of which were handed out during the meeting as the packet of meeting materials. The Districts have also included several pages of information titled Preliminary Information Factors Review (6/26/12) in Attachment 1. For the sake of an accurate record, these pages were not amongst the Meeting Materials handed out during the meeting, but rather these pages reflect information needed and other notes that were identified during the meeting. As such, they should be included with the section of the meeting notes that summarizes the discussion of the conceptual models.

We request that the Districts respond to these specific requests in their filing with FERC on revised meeting notes.

TRT and CSPA appreciate the Districts' consideration of our comments. If there are any questions, they can be directed to Patrick Koepele, Tuolumne River Trust, 209-588-8636 or patrick@tuolumne.org.

Sincerely,

Patrick Koepele

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Tuolumne River Trust

Chris Shutes

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CALIFORNIA SPORTFISHING PROTECTION ALLIANCE CSPA * Since 1983 *

Attachment E
U.S. Fish and Wildlife Service comments on Workshop No.2 for Study
W&AR-5 – Salmonid Populations Information Integration and Synthesis;
W&AR-6 – Chinook Salmon Population Model;
W&AR-10 – O. mykiss Population Study; and on the
W&AR-20 – O. mykiss Scale Collection and Age Determination Study Plan

United States Department of the Interior

FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825-1846

In Reply Refer To:

AUG 24 2012

Turlock Irrigation District and
Modesto Irrigation District
Robert Nees
Director of Water Resources and TID/MID
333 East Canal Drive
Post Office Box 949
Turlock California 95380

Subject: U.S. Fish and Wildlife Service Comments on Workshop No. 2 for *Study W&AR-5 Salmonid Populations Information Integration and Synthesis*, *W&AR-6 Chinook Salmon Population Model, and W&AR-10 O. mykiss Population Studies* and on *W&AR 20 – Oncorhynchus mykiss Scale Collection and Age Determination Study Plan* for the Don Pedro Hydroelectric Project, Federal Energy Regulatory Commission Project 2299, on the Tuolumne River, Tuolumne and Stanislaus Counties, California

Dear Mr. Nees:

On December 22, 2011, the Director of Energy Projects for the Federal Energy Regulatory Commission (Commission or FERC) issued a Study Plan Determination for the Turlock Irrigation District and the Modesto Irrigation District's (Districts or Applicants) application for New License for the Don Pedro Hydroelectric Project 2299 (Project). The Determination required, among other things, that the Districts develop and file with FERC a Workshop Consultation Process for Studies W&AR 2, 3, 5, 6, 10, and 16 for the Don Pedro Hydroelectric Project. The Determination also required the Districts to consult with the U.S. Fish and Wildlife Service (Service), the National Marine Fisheries Service (NMFS), California Department of Fish and Game (CDFG), and the California State Water Resources Control Board (SWRCB) regarding at least parts of the aforementioned studies, providing them 30 days to review the draft Study plan modifications, workshop materials and notes, and incorporate or address any resource agency comments into the final plan filed with FERC. Moreover, the Determination required that, if the Districts do not adopt a recommendation from a consulted entity, then the Districts must include their reasons for not adopting the recommendation in their filing with the Commission of the final study plan.

The Districts hosted a workshop on June 26, 2012 and presented information and materials for *Study W&AR-5 – Salmonid Populations Information Integration and Synthesis, W&AR-6 Chinook Salmon Population Model, and W&AR-10 O. mykiss Population Studies*. The draft meeting notes, conceptual model narratives for salmonids, and preliminary ranking of key issues affecting salmonid life stages were provided to the Relicensing Participants on July 25, 2012 with a request that all comments be provided no later than August 24, 2012.

The following constitute the Service's comments on the proposed modifications to the above Study Plans. The Service submits these comments and recommendations under the Endangered Species Act (ESA) of 1973, as amended (16 U.S.C. § 1531 *et seq.*), the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. § 661 *et seq.*), and the Federal Power Act (FPA) (16 U.S.C. § 791a, *et seq.*).

Comments on Draft Meeting Notes

Page 4, item D: The Service provided suggestions regarding factors that may be impacting the age structure of the Chinook salmon and steelhead populations (e.g., year-class strength, ocean growth rate) and provided a manuscript (Wells et al. 2007). Specifically, the Service suggested that year-class strength has the largest effect on age structure of the Tuolumne River salmonid populations because recruitment is much higher in wet years than during normal and dry years based on the numbers of subsequent adult returns. For example, we might expect that 30,000 adult Chinook salmon return from juveniles that out-migrated during wet year flood flow releases and there would be 7,500 age-2 adult returns, followed by 16,500 age-3 fish in the following year, and 6,000 age-4 fish the year after. If the year following the wet year with flood flow releases is a dry year, we would only expect 3,000 adults to return from the juveniles produced during that year and the returns by age would be low too. Another factor that is likely to influence the age structure of the Chinook salmon population is the rate of growth of individuals in the ocean. Wells et al. (2007) found that the faster Chinook salmon grow in the ocean, the more likely they are to return at age-two. Further, San Joaquin River basin salmon appear to return at age-two at about double the rate as Sacramento River basin salmon, suggesting that San Joaquin salmon exhibit some differences in behavior in the ocean

Page 4, item F: The Service provided a report showing an increase in adult migration in the Mokelumne River following increased flow releases (Del Real and Saldate 2011). This report provides information suggesting that river flow combined with management actions (e.g., pulse flows; Delta Cross Channel closure) were followed by peaks in daily passage of adult Chinook salmon and contributed to high adult returns. These results also support observations of increases in daily upstream adult Chinook salmon passage at the Tuolumne River Weir in relation to daily average flows. The efficacy of releasing pulses of water in the fall to attract adult Chinook salmon could be further evaluated (USFWS 1995; USFWS 2001). However, sufficient data exist to support continuation of managing water operations in a way that includes substantial (i.e., >500 cfs), short-term (i.e., <5 day) increases in river discharge.

Page 4, item G: The Service clarifies that CDFG is initiating an adult tracking study of up-migrant Chinook salmon in the San Joaquin River near Mossdale. The objectives of this study are to: 1) track movement patterns through the Sacramento-San Joaquin Delta and in the San Joaquin River basin in response to environmental variability; 2) record external water temperature that tagged fish experience while migrating through the study area; and 3) track egg viability of the adults that migrate into the Merced River Hatchery as a function of water temperatures experienced. This study also addresses the Anadromous Fish Restoration Program Final Restoration Plan Evaluation 4 for the Tuolumne River (USFWS 2001), to evaluate fall pulse flows for attraction and passage benefits to Chinook salmon and steelhead.

Page 5, item B: The Service provided a reference to a manuscript discussing egg predation by salmonids and other species (Johnson et al. 2009). This reference was provided because the introduction of this paper includes many references to other studies that reported predation on Pacific salmon eggs. Several studies have documented the consumption of salmon eggs by sculpins and salmonids including coho salmon, steelhead, brook trout, and brown trout (Greeley 1932; Idyll 1942; Reed 1967; Stauffer 1971; Johnson and Ringler 1981; Johnson 1981; Foote and Brown 1998). Due to anthropogenic changes in the Tuolumne River (e.g., impaired flows, mining operations), suitable spawning habitat area may be limited in some years which may result in redd superimposition and increased egg predation by a variety of native and nonnative species.

Page 5, item D: The Service provided a manuscript (Nobriga et al. 2004) and provided contact details for further information regarding entrainment rates of various screen types.

Page 10, item E: The Service provided a report showing an increase in adult Chinook salmon migration following increased flow releases (Del Real and Saldate 2011). The Anadromous Fish Restoration Program Final Restoration Plan Evaluation 4 for the Tuolumne River (USFWS 2001) identifies the need to evaluate fall pulse flows for attraction and passage benefits for both Chinook salmon and steelhead. Information on steelhead adult fish migration from the Yuba River, American River, Stanislaus River, and/or the Tuolumne River fish counting weir should be used to make this evaluation.

Page 11, Egg Incubation item B: McCullough et al. (2001) discusses the role temperature plays on the physiology of various salmonid species and within the stages of their life history. Water temperature in the Tuolumne River may exceed EPA's temperature criteria during critical salmonid life stages, including egg incubation. In lieu of studies that evaluate temperature impacts on incubating eggs, CDFG thermograph data from the spawning reach of the Tuolumne River should be evaluated in comparison to EPA's temperature criteria. Following that evaluation, the importance of temperature impacting recruitment at various life stages can be incorporated into the model.

Comments on Conceptual Model Narratives for Salmonids

The Service had an opportunity to comment on and work with other relicensing participants to refine the draft conceptual models for Chinook salmon and steelhead. We concur with the current model and have no further comment at this time.

Comments on Preliminary Ranking of Key Issues Affecting Salmonid Life Stages

The Service had an opportunity to comment on and work with other relicensing participants to rank key issues or limiting factors affecting Chinook salmon and steelhead. We concur with the current rankings and have no further comment at this time.

Comments on Study Plan Determination Modifications

On July 25, 2012, the Commission issued its Review of New and Modified Studies for the Don Pedro Hydroelectric Project. As part of this determination, the Commission approved W&AR 20 (*Oncorhynchus mykiss* Scale Collection and Age Determination Study Plan).

The Service previously submitted detailed justification for more robust scale collections to accurately describe the age structure and growth characteristics of *O. mykiss* in the lower Tuolumne River. The Commission makes the following statement in its discussion of this study: "...Districts propose to age scale samples from a wide range of fish sizes, and relate that information to a much larger data base of length distribution data through regression analysis, sampling scales from 400 *O. mykiss*, as the FWS recommends, is not necessary for the purposes of this study."

The Service disagrees with the Commission's view that 75 samples are sufficient. The fact that the Districts propose to relate growth information to a much larger dataset of lengths does not negate the need for a larger sample size, but rather makes a larger sampling essential. It is highly likely that problems will arise with the current recommended sampling framework. For example, within the suggested sampling framework the 15 fish from the 150-250 mm size-group could all be between 240-250 mm, then the ages (and thus growth rates) assigned to the larger data base of length distribution data will be biased because the smaller fish in the size group will not be represented and are likely age-two (e.g., 150-160 mm fish). To illustrate this point, if 10 of those fish are age-three, and 5 are age-four, then 67% of 150-250 mm fish from the lengths-only dataset will be assigned an age of three and the remaining 33% will be assigned an age of four, and none will be assigned an age of two even though the size category likely contains age-two individuals. Thus, to avoid this bias, the common scientific practice is to sample at least 5 fish per centimeter-length-group for management purposes and at least 10 fish per centimeter-length-group for research projects (Quist et al. 2009). This simple and realistic example illustrates the need for a reasonable and defensible sampling methodology; the Service is available to discuss this guideline and illustrate further examples.

Conclusion

The Service has attended both *W&AR-5 – Salmonid Populations Information Integration and Synthesis* workshops and has worked closely with other resource agencies and the Applicant to provide the best available information that will help inform the development of Project license conditions as required by CFR 18 § 5.11 (b)-(e). The Service has worked with the Applicants in seeking solutions to Study Plan deficiencies and we appreciate the collaborative discussions in which all participants have engaged.

If you have any questions regarding this response, please contact Deborah Giglio at (916) 414-6600.

Sincerely,

Daniel Welsh
Assistant Field Supervisor

Enclosures

cc:
FERC #2299 Service List, Don Pedro River Hydroelectric Project

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BEFORE THE
UNITED STATES OF AMERICA
FEDERAL ENERGY REGULATORY COMMISSION

CERTIFICATE OF SERVICE

I hereby certify that U.S. Fish and Wildlife Service Comments on Workshop No. 2 for *Study W&AR-5 Salmonid Populations Information Integration and Synthesis, W&AR-6 Chinook Salmon Population Model, and W&AR-10 O. mykiss Population Studies* and on *W&AR 20 – Oncorhynchus mykiss Scale Collection and Age Determination Study Plan* for the Don Pedro Hydroelectric Project, Federal Energy Regulatory Commission Project 2299, on the Tuolumne River; Tuolumne and Stanislaus Counties, California has this day been electronically filed with the Federal Energy Regulatory Commission and electronically served on Parties indicating a willingness to receive electronic service and served, via deposit in U.S. mail, first-class postage paid, upon each other person designated on the service list for Project #2299 compiled by the Commission Secretary.

Dated at Sacramento, California, this 24th of August, 2012.

Name:
Heeja Seto Heeja Seto
U.S. Fish and Wildlife Service
2800 Cottage Way, Rm. W-2605
Sacramento, CA 95825
(916) 414-6600

that sample sizes are equal among time periods or populations, variances are equal among populations or time periods, samples are collected completely at random (i.e., samples are completely independent), and data are normally distributed. Numerous scenarios can be envisioned where variance changes among time periods, sample size varies among time periods, or paired or fixed sites are sampled through time. In addition, many fisheries data are not normally distributed (e.g., Hubert and Fabrizio 2007). Gerow (2007) recently developed a sample-size estimator to help address some of these concerns:

$$n = \frac{C\left(t_\alpha + t_\beta\right)^2\left(\lambda_0^2 + \lambda_1^2 - 2r\lambda_0\lambda_1\right)}{\left(\lambda_0 - \lambda_1\right)^2},$$

where n is the estimated sample size, C is a variance inflation constant (standard deviation of the mean/mean) that accounts for a non-Poisson distribution, t_α is the t-distribution deviate for a one-tailed test given α, t_β is the t-distribution deviate for a one-tailed test for the given level of statistical power, λ_0 is the mean at time 0, λ_1 is the mean at time 1, and r is the correlation among samples between two time periods ($r = 0$ if samples are not paired). The equation allows estimation of the number of samples (i.e., equal or unequal samples sizes) necessary for detecting an increase or decrease in a mean value and allows for the incorporation of paired- or fixed-site sampling designs (see Gerow 2007 for a detailed description and Quist et al. 2006 for an application). Although the estimator is relatively complex, a spreadsheet that allows for simple application of the equation is available online (www.statsalive.com).

Many standard sampling protocols use a stratified sampling design to allocate effort among different strata (e.g., littoral and pelagic habitat in lakes; pools, riffles, and runs in streams). Although sample-size estimators for such designs may be highly complex, a relatively simple estimator is provided by Scheaffer et al. (1996):

$$n = \frac{\sum\left(\frac{N_i^2 \times \sigma_i^2}{w_i}\right)}{\left(N^2 \times D\right) + \sum\left(N_i \times \sigma_i^2\right)}$$

where n is the estimated number of samples (across all strata), N_i is the number of samples in stratum i, σ_i^2 is the estimated variance from stratum i, w_i is the allocation fraction (i.e., allocation fraction of the final design), N is the total sample size, and D is equal to $B^2/4$ (B is the desired number of measurements units from the sample mean; see Box 11.1 for an example). Alternative forms of this sample-size estimator are available in Scheaffer et al. (1996), as are various methods for allocating samples (e.g., proportional allocation, allocation based on cost, allocation based on variance).

11.3.4 Resampling Methods

Thus far, we have focused on sample-size estimators used to detect a change in the mean (e.g., mean CPUE) between time periods or populations. While such questions will

Box 11.1 Example of estimating sample size using a "moderately complex" estimator and allocating samples among strata.

Suppose that a biologist has pre-existing sampling data for a fish species sampled from three different strata in a river system and wants to estimate the number of samples required to estimate catch per unit effort (CPUE) within 5% of the mean CPUE. A total of 50 samples (i.e., $N_1 = 10$, $N_2 = 15$, $N_3 = 25$) resulted in a mean CPUE estimate of 25 fish/net-night and strata variances as follows: $\sigma_1{}^2 = 25$, $\sigma_2{}^2 = 5$, and $\sigma_3{}^2 = 50$. In this example, D would be $B^2/4 \left[\frac{(0.05 \times 25)^2}{4} = 0.39\right]$. Also, assume that the biologist wants to allocate the sampling effort proportional to the variance: stratum 1 = 31% of the samples, stratum 2 = 6%, and stratum 3 = 63%. Sample size would then be estimated as

$$n = \frac{\sum\left(\frac{N_i^2 \times \sigma_i^2}{w_i}\right)}{\left(N^2 \times D\right) + \sum\left(N_i \times \sigma_i^2\right)}$$

$$n = \frac{\left(\frac{10^2 \times 25}{0.31}\right) + \left(\frac{15^2 \times 5}{0.06}\right) + \left(\frac{25^2 \times 50}{0.63}\right)}{\left(50^2 \times 0.39\right) + \left[(10 \times 25) + (15 \times 5) + (25 \times 30)\right]}$$

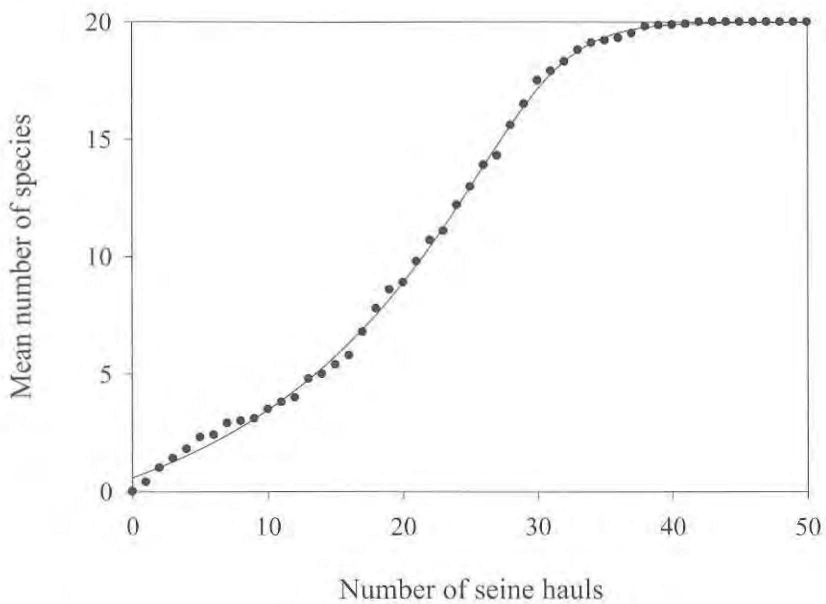
$$n = \frac{76,418}{2,550} = 30$$

Thus, 30 samples would be required and would be allocated as $N_1 = 30 \times 0.31 = 9$; $N_2 = 30 \times 0.06 = 2$; and $N_3 = 30 \times 0.63 = 19$. This example illustrates the value of preliminary sampling, which can provide investigators with an idea of the variance they will encounter and allow an appropriate sample allocation.

remain important in fisheries management and research, other sample-size questions are common. In particular, biologists are often interested in the number of samples required to capture some proportion of the species present in a system with some level of confidence (e.g., Lyons 1992; Angermeier and Smogor 1995; Walsh et al. 2002). Questions such as these do not conform to standard sample-size equations. The most common technique for estimating sample size in these situations is to use a resampling simulation (e.g., Colwell and Coddington 1994). Resampling procedures are conceptually straightforward, but require a relatively high level of programming skill. Because resampling methods are often tailored to specific sample-size questions and standard formulae are not used, an example is provided in Box 11.2 to illustrate how a resampling procedure might be used to estimate sample-size requirements. Although the example is specific to species richness, it provides a framework that can be used to answer a number of questions common to sampling fish populations (i.e., questions focused on CPUE, length structure, condition, or other parameters). MacKenzie et al. (2002) introduced the use of site occupancy models to estimate species richness, a

Box 11.2 Example of using a resampling method for estimating species richness.

Suppose a biologist is interested in estimating the number of seine hauls needed to capture all of the species present in a river segment (e.g., Lyons 1992; Patton et al. 2000; Walsh et al. 2002). Using pre-existing data (e.g., 50 seine hauls from the system), replicate random samples (e.g., 500 replicate samples or iterations) are drawn with varying numbers of seine hauls (e.g., 1, 2, 3, 4...50 seine hauls). For a sample size of one, one seine haul is randomly sampled 500 times and the metric of interest (e.g., species richness) is estimated from each iteration. For a sample size of two, two seine hauls are randomly sampled (without replacement) 500 times and species richness is estimated from each iteration (i.e., total number of species across all transects), and so forth up to 50 seine hauls. Thus, for each number of seine hauls there are 500 random samples, each with some number of collected fish species. One method for estimating the required sample size is to develop a species "accumulation curve" by plotting the cumulative number of species (e.g., minimum, mean, median, or maximum number of species across the 500 iterations) against the number of seine hauls. The resulting curve will likely reach an asymptote and provide an estimate of the required sample size. Other methods for developing species accumulation curves are provided in Kwak and Peterson (2007) and applications are provided in Lyons (1992), Angermeier and Smogor (1995), and Walsh et al. (2002).

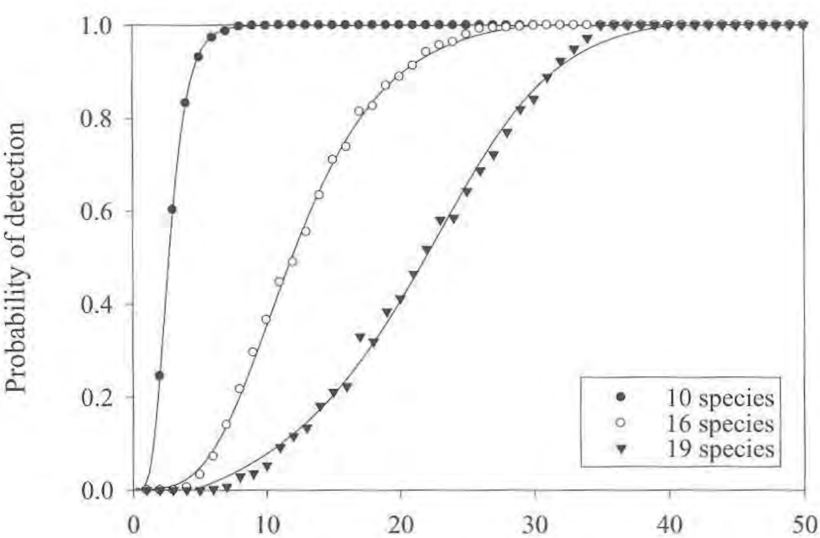


Relationship between mean species richness (i.e., mean of 500 random samples for each number of seine hauls) and the number of seine hauls. Based on this relationship, around 40 seine hauls should be sufficient to sample most of the species present.

(Box continues)

Box 11.2 (continued)

An alternative method is to estimate the probability of sampling a specified proportion of species. For example, if a total of 20 fish species is sampled in the 50 seine hauls, a biologist may be interested in the number of samples required to capture 50% (i.e., 10 species), 80% (i.e., 16 species), or 95% (i.e., 19 species) of the species present in the study area. The probability of sampling 50% of the species can be estimated for each sample size (i.e., number of seine hauls) by tallying the number of times out of 500 that 10 or more species were sampled, and then dividing that tally by 500. The probabilities can then be plotted against the number of seine hauls and a regression model (e.g., logistic regression model) can be fit to the probabilities. Fitting a regression model helps "smooth" the relationship and allows one to estimate the probability of detecting a defined percentage of the species present (e.g., how many samples are needed to have a 95% probability of sampling 50% of the species; see Bailey and Gerow 2005 for a detailed example).



Relationship between the probability of sampling a specified number of species and the number of seine hauls.

method which has been used for estimating animal abundance and has gained popularity in wildlife studies. Some software packages are available online that will conduct portions of statistical simulations. One example of such software is EstimateS that can be used to derive species accumulation curves (http://viceroy.eeb.uconn.edu/EstimateS; see Walsh et al. 2002 for an application). Another straightforward package for conducting resampling methods is PopTools (www.cse.csiro.au/poptools), which is a free add-in to Microsoft (MS) Excel (Microsoft Corporation, Redmond, Washington).

11.3.5 Monitoring Spatial and Temporal Trends

The purpose of standardized sampling is to monitor whether the magnitude of some quantity (e.g., fish density, diversity, body condition, mortality) is increasing or decreasing through time or space. While examining trends is critical for effective management and conservation, changes in a quantity over short temporal and spatial scales can lead to erroneous conclusions because these changes may be due to natural variation rather than representation of a true trend. Consequently, investigating changes between a few sampling events often requires more samples than for investigating a trend over long time periods (e.g., Larsen et al. 2004). Sections 11.3.1 through 11.3.4 largely focus on sample-size requirements associated with detecting changes in two points in time or space. Sample-size questions focused on long-term trends are somewhat different than those related to a comparing two values, but progress has been made in the development of monitoring designs that allow scientists to maximize statistical power by allocating samples over time and space based on the variance structure of initial samples. A detailed description of these techniques is beyond the scope of this chapter but can be found in the published literature (e.g., Gerrodette 1987; Gibbs et al. 1998; Urquhart et al. 1998; Larsen et al. 2004).

A number of software programs have been developed to assist scientists with sample-size calculations. These programs generally focus on allocating samples in time and space while maintaining a specified level of statistical power. A useful characteristic of these programs is that they allow the user to evaluate the benefits and limitations of different designs by simulating a variety of sampling scenarios. Popular programs include MONITOR (available from the Illinois Natural History Survey, Clearinghouse for Ecology Software, Champaign; http://nhsbig.inhs.uiuc.edu/wes/populations.html) and TRENDS (available from NOAA Fisheries Service, Southwest Fisheries Science Center; http://swfsc.noaa.gov).

11.4 DATA MANAGEMENT

According to the Data Management Association, data management refers to the "development and execution of architectures, policies, and procedures that properly manage the full data lifecycle of an enterprise." For our purposes, data management can be defined as the mechanism by which data are handled, which involves the acquisition, storage, and retrieval of information for later use by an individual or group of individuals. As we develop standardized sampling methods, we are essentially predicting what assessments will be important in the future, and that, in turn, influences which data and how data are collected (Schnute and Richards 1994). The same logic applies to data management, in that how data are stored places constraints on how data can be retrieved and used in the future.

A database is simply a collection of related data or a data repository. Fisheries scientists have been using databases since the first datum was recorded on a datasheet and placed in a filing cabinet. Currently, data are stored in a variety of locations and formats, from paper records that are only accessible at the local or regional level to electronic data that are accessible by a user across a large geographic area. Most fisheries sampling data collected over long temporal and large spatial scales are stored in relational databases. Although many biologists continue to store data in flat file formats, (i.e., where data are stored in single, nonrelational tables or layers), such as MS Excel, this format is disadvantageous for large data sets because file space is quickly consumed by redundant data. Data stored in flat files can also be cumbersome to update, particularly if data are distributed in multiple worksheets. Relational databases were first developed in 1970 and are simply data stored in multiple tables that are linked or related by their content (Codd 1970). Therefore, a large database stored in a single table in MS Excel can be separated into several related tables that reduce data redundancy, data entry errors, and time spent entering data while, at the same time, improving the ease of maintaining the database and increasing the efficiency of data retrieval. For instance, if time or effort was incorrectly entered into the database depicted in Figure 11.1, many rows of data would need to be corrected in the flat file structure (table on left) versus one line in the relational database structure (top right table). The probability of making an error is reduced and database maintenance is more efficient if databases are organized in a relational structure.

In 1998, the first National Freshwater Fisheries Database Summit was held in San Diego, California. Representatives from state, federal, and private organizations met to discuss issues related to the management and sharing of fisheries information (Loftus 1998). Additional summits were organized in 2002 (Loftus and Faibisch 2003) and 2006. Some of the data issues presented at these database summits are addressed here, particularly those related to data standards and sharing.

11.4.1 Data Standards

Although some data are unique to a region or state, much of the information collected on fisheries resources is common among agencies and geographic locations. These include date and time notations, taxonomic information, geographic data, weather data (e.g., wind speed, temperature), habitat data (e.g., aquatic vegetation type, substrate composition), and biological data (e.g., fish length and weight). To facilitate sharing of information and standardization of data management procedures, agencies must adopt data standards (Loftus 1998). Many standards have been created and adopted by federal agencies, including the U.S. Fish and Wildlife Service (www.fws.gov/stand) and the U.S. Environmental Protection Agency (www.epa.gov/edr). The creation of common species, habitat, and geographic "look-up tables" and standard reporting forms increases the ability of integrating and sharing information across jurisdictional boundaries (Beard et al. 1998). Furthermore, the adoption of other data standards, including defined measurement units and sampling techniques, can facilitate data sharing (Loftus 1998). Due to their broad scope, many federal data standards (Table 11.2) have been adopted by state and local agencies. Other data standards, such as measurement units, precision standards, and equipment codes, have only been standardized at the state level. Even if standards

Date	Time	Gear	Effort	Species	TL
1/2/06	1000	EFF	600	LMB	200
1/2/06	1000	EFF	600	LMB	150
1/2/06	1000	EFF	600	LMB	516
1/5/06	915	EFF	600	LMB	240
1/5/06	915	EFF	600	LMB	180
1/5/06	915	EFF	600	LMB	265
1/5/06	915	EFF	600	LMB	300
1/5/06	915	EFF	600	LMB	452
1/5/06	915	EFF	600	LMB	314

Event	Date	Time	Gear	Effort
1	1/2/06	1000	EFF	600
2	1/5/06	915	EFF	600

Event	Species	TL
1	LMB	200
1	LMB	150
1	LMB	516
2	LMB	240
2	LMB	180
2	LMB	265
2	LMB	300
2	LMB	452
2	LMB	314

Figure 11.1 Example of data stored in a flat file format (e.g., MS Excel spreadsheet; left table) and the same data stored in a relational format (e.g., MS Access; right tables).

Table 11.2 Common data standards established by federal agencies that, if used by all levels, could facilitate the sharing of fisheries information among agencies.

Data type	Standard code	Source	Web site
Taxonomic identifiers	Taxonomic serial numbers (TSN)	Integrated Taxonomic Information System	www.itis.gov
Geographic identifiers	Geographic Names Information System (GNIS)	U.S. Board on Geographic Names	geonames.usgs.gov
	Reach codes from EPA's Reach File Version 3 (RF3)	National Hydrography Dataset (NHD)	nhd.usgs.gov
Wetland and deepwater habitat classifications	National Wetlands Inventory Inventory (NWI) code lists	U.S. Fish and Wildlife Service	www.fws.gov/nwi
Drainage basins	Hydrologic unit code (HUC)	U.S. Geological Survey	water.usgs.gov/GIS/huc.html
National vegetation classifications	National Vegetation and Information Standard (NVCS) code lists	Federal Geographic Data Committee	http://bology.usgs.gov/npsveg/nvcs.html

are specific to a state agency, these standards should be clearly documented to facilitate potential data sharing in the future.

11.4.2 Data Sharing

Most fisheries management issues are not restricted to a single system or species. With the onset of ecosystem-based management and activities that involve cooperative efforts among local, state, and federal agencies, it is important that databases are constructed in a manner that facilitates sharing of information (Hamm 1993; Schnute and Richards 1994; Beard et al. 1998). Data stored on individual hard drives or in filing cabinets are no longer sufficient to meet the needs of the public. For example, the Multistate Aquatic Resources Information System (MARIS) was developed in 1994 and represents a collaborative effort between multiple state and federal natural resource agencies (Beard et al. 1998; see Box 11.3). This project is focused on providing access of state-collected freshwater fisheries data obtained using various methodologies and stored in multiple formats via a single online location (Beard et al. 1998).

Most fisheries data collected by state agencies are available to the public as defined by the Freedom of Information Act. However, many professionals are concerned that data can be misused or incorrectly analyzed and then used to argue inappropriately for opposing views. Although states are obligated to make these data available to the public, introducing a time lag in the data availability, creating readily accessible summary reports, or providing a mechanism by which raw data are requested can be used to limit the release of sensitive data and monitor where information is distributed. For example, the Western Pacific Fishery Information Network (WPACFIN) warehouses data collected by multiple fishery agencies of Samoa, Hawaii, Guam, and the Northern Mariana Islands (Hamm 1993). Requests for confidential or raw data from WPACFIN are submitted to the donor agency and must be approved by that agency before being distributed. However, summary and nonconfidential data are available without restriction (Hamm 1993). Undoubtedly, some data will be used incorrectly, but fisheries professionals should be open to different interpretations of their data, including interpretations by members of the public (Schnute and Richards 1994). Furthermore, providing information in a widely used interface, such as through online sources, may enhance communication with the public, and can be used as an educational tool and as a mechanism for increasing support of management programs (Loftus 1998).

A primary component associated with sharing data is documentation and availability of metadata. Metadata are data about the data or information describing a particular data set, and they can include information such as location, species, methodology, precision, accuracy, and measured variables included in the database (Loftus 1998). Metadata can be used to determine whether data are appropriate to meet a particular objective and to identify potential constraints associated with a data set (Loftus 1998). Because the individual collecting and entering data is rarely the same individual who conducts the data analysis, proper and consistent documentation of metadata is critical (Gray et al. 2005). Furthermore, metadata

Box 11.3 The Multistate Aquatic Resource Information System (MARIS): sharing data across agency boundaries (Andrew J. Loftus and T. Douglas Beard, Jr.).

The Multistate Aquatic Resources Information System (MARIS) was initiated in the 1990s to facilitate data sharing across political boundaries. The initial goals of MARIS were to reduce the duplication of data collection efforts, promote sharing of technical expertise among member agencies, and better utilize the millions of dollars worth of existing information annually collected by states (Beard et al. 1998).

The focus of MARIS is to allow agencies to share information related to the status and trends of aquatic resources. Utilizing a single Web interface, users access data from multiple fisheries management jurisdictions (currently 10 states) via a common query structure. MARIS is designed to provide select elements that the contributing agencies determine will serve the intended goal of the information system (currently, status and trends information). The information provided in MARIS is not raw data, but rather first- or second-order synthesis of data collected as part of fisheries sampling events. MARIS is designed to serve data at the water body level but is flexible enough to allow analysis of such data at larger geographic scales. Quantitative data elements reflecting status and trends currently in the system include population estimates and catch per unit effort.

MARIS is designed as a distributed transactional information system. Agencies that contribute data to the system house the subset of data that they will provide to MARIS on their own internal agencies' servers. The MARIS server periodically queries each agency server to obtain the most current data available and creates a centralized cache of data for increased efficiency and accessibility. Thus, agencies that collect the data retain ultimate control over them, updates to the data can be conducted automatically by the agency, and the most current available data in the state can be made available to MARIS. This approach also allows states to maintain control over the availability of sensitive data such as the location of threatened and endangered species.

An important feature shaping MARIS development is the adoption of existing data standards to facilitate data sharing. While many states have developed their own internal data standards, MARIS does not require them to change those standards. A series of lookup tables will convert their data to the MARIS standard system. To the extent possible, MARIS is using existing standards, such as the integrated Taxonomic Information System for species coding.

MARIS is an example of a current system that offers a mechanism through which nearly any type of fisheries information can be shared. Fisheries professionals who desire to exchange data between jurisdictions on a continuing basis should strongly consider working with an existing effort, such as MARIS, to meet their information sharing needs. The ability to integrate data across borders and to use these data for multiple purposes increases the value of every data point collected.

allow agencies to inventory their data (e.g., by location) and provide guidance on the proper interpretation of data by other parties (Loftus 1998).

11.4.3 Database Platform

Ultimately, the primary focus of any fisheries database is the end user. Depending on the nature and scope of the data, desktop applications such as MS Access can be used, but in more complex situations (e.g., when multiple users must access the database from remote locations), a full enterprise product such as MS SQL Server or Oracle (Oracle Corporation, Redwood Shores, California) is more appropriate. In most cases, the end user is unaware of the database structure or program used; rather, they just need it to work for their needs. Therefore, the database designer and manager are responsible for ensuring that the database structure and application optimize performance while catering to the needs of end users. Unfortunately, database personnel often lack the biological expertise or background information about the data to make decisions on their own. Creating and maintaining an open channel of communication with end users, or persons familiar with the data and the needs of end users, is vital to the success of any database because objectives can be clearly identified and pertinent applications can be developed. For instance, questions such as what kinds of data are or will be collected, how the data will be used, who will need access to the data, what kinds of reports will need to be generated, and what queries are most useful are all important for ensuring that the database meets the needs of end users. In some situations, appointing a liaison between the database developers and end users may be necessary. The liaison would be responsible for reviewing the database during its development and ensuring that important questions are adequately addressed so that the needs of the end users are met.

In addition to sound database design, the structure and layout of the user interface should also be considered because the ease at which data can be entered and retrieved will have a large impact on the future use of the database. If the interface is cumbersome, the database will not be used and biologists will return to the "old way of doing things." For example, when entering fish lengths and weights from a standard sampling survey, biologists would rather not type or select from a drop-down menu the species name or code for each measurement (Figure 11.2; top panel). Instead, a more time efficient solution is to create a single drop-down menu for a species, under which multiple length and weight records can be entered (Figure 11.2; bottom panel). The user interface can further be optimized by standardizing the layout, such as creating standard navigation tools, presentation of prompts and forms, and output reports.

After the database and associated applications have been designed, database personnel must maintain and improve the database based on its performance and feedback from end users. As part of this process, quality-control procedures and processes should be established to maintain the integrity of the data. If water temperature was entered as 83°C for a natural Florida lake, a quality-control procedure (e.g., an acceptable range of 0–40 for the temperature field) could alert the user that a data-entry error occurred. Many

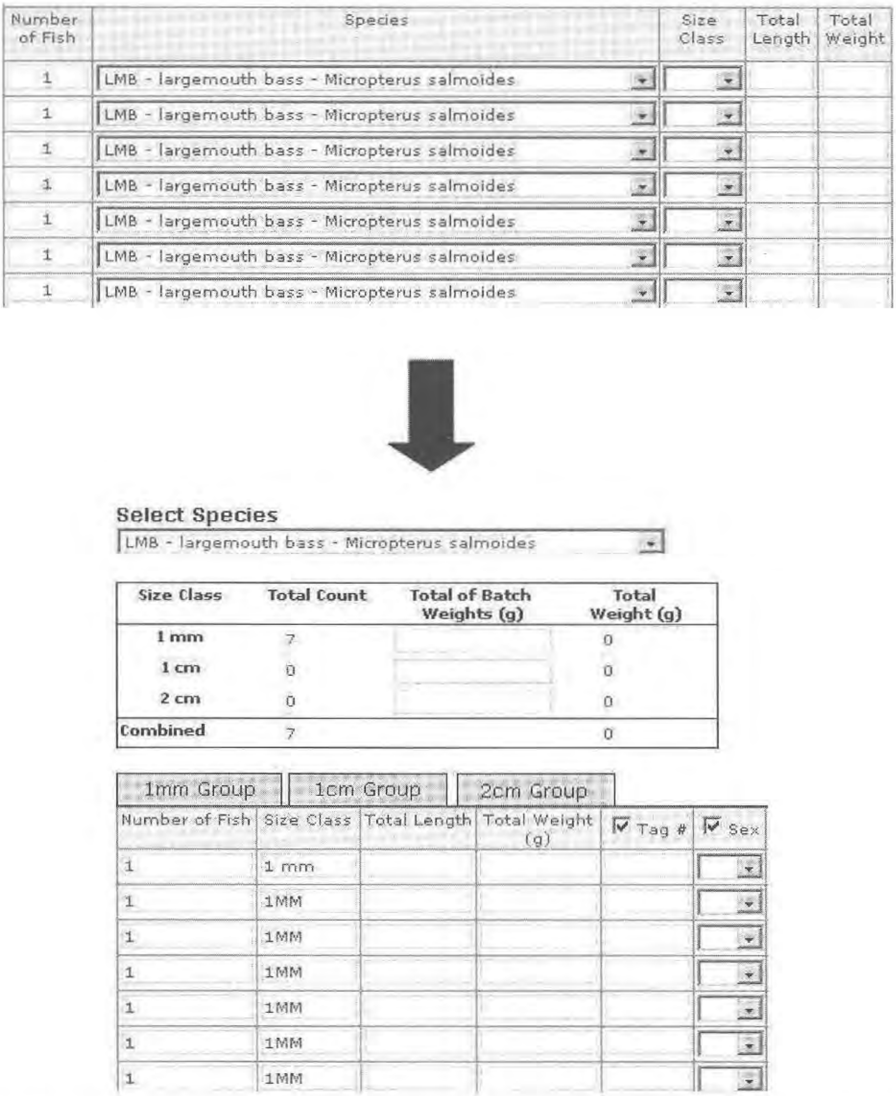


Figure 11.2 Design of a user interface that minimizes time associated with data entry.

quality-control parameters cannot be defined by database personnel, but rather by those knowledgeable about the data. Therefore, communication between database personnel and end users is critical throughout the postdevelopment period. Open dialogue is also helpful when creating a user's manual or troubleshooting guide that addresses common database issues encountered by end users.

With this book and similar initiatives, the fisheries profession is becoming increasingly integrated. Federal and state agencies are beginning to work together to create common standards and to provide a centralized online location where data can be accessed, such as MARIS (see Box 11.3). The Internet has increased the accessibility of fisheries data to end users, who are often located over large geographic areas. Even so, security and database accessibility are problematic, and these issues should be considered when using this type of interface. As technology and access issues are addressed, agencies will continue the process of integrating data over larger and larger areas. A single online location where fisheries data can be accessed for any state or federal agency is not only possible, but is quickly becoming reality. Such efforts should greatly increase collaboration among agencies and will enable biologists to address management problems that occur over large spatial and temporal scales.

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Attachment F
State Water Resources Control Board comments on W&AR-5 Salmonid Information Synthesis Workshop No. 2-Draft Meeting Notes

From: Barnes, Peter@Waterboards [mailto:Peter.Barnes@waterboards.ca.gov]
Sent: Friday, August 31, 2012 4:22 PM
To: Staples, Rose; Devine, John
Subject: Salmonid Population Information Integration and Synthesis Study Plan, Workshop No. 2 Comments

Rose,

State Water Resources Control Board (State Water Board) staff attended the workshop hosted by Turlock and Modesto Irrigation Districts (Districts) on June 26, 2012, as part of the Water and Aquatic Resources Study Plan (W&AR 5), Salmonid Population Information Integration and Synthesis, for the Don Pedro Hydroelectric Project, Federal Energy Regulatory Commission (FERC) Project No. 2299 (Project). Staff has reviewed the draft meeting notes prepared by the Districts and provides the following comments:

General Comments

State Water Board staff appreciates the collaborative efforts of the Districts and believes the workshops to be a valuable tool in study plan development. We also understand that planning meetings for such a large number of groups can be difficult. When planning meetings that are months into the future, we agree that it is more efficient to choose a date and allow Relicensing Participants to plan accordingly. However, if a meeting is to be planned on shorter notice, we believe that it is necessary for the Districts to consult with the Relicensing Participants and choose a date which would allow the most parties to attend. The extra effort from the Districts will help ensure that the workshop process is as collaborative as possible.

Additionally, State Water Board staff would like to recognize the expertise of the Department of Fish and Game (DFG), U.S. Fish and Wildlife Service (USFWS), and National Marine Fisheries Service (NMFS) as it pertains directly to this study plan. These agencies are responsible for the protection and preservation of fishery resources and therefore, their opinions and comments on this material is important in developing an adequate study plan.

Comments on Conceptual Model Narratives for Salmonids

In general, State Water Board staff agrees with the conceptual model narratives and the comments hope to provide clarification and continuity throughout the models. In a few of the narratives, Sport Fishing and Poaching are included as Process/Mechanism related to the Biotic Response of Direct Mortality. We believe that Sport Fishing and/or Poaching, a direct result of human actions, should be included within the System Input of Anthropogenic Inputs. The Anthropogenic Inputs box is then connected to Predation which results in Direct Mortality.

Since the conceptual model narratives are intended to illustrate the impacts to salmonids during different life stages, it is important that consistent terms and structure are utilized. For example, in the *O. mykiss* In-River Rearing conceptual model narrative, the “Diversions at La Grange Bullet” is still located under In-stream Flows while it was renamed to “Upstream Diversions” in the Chinook In-River Rearing model. Different terms should only be used if they are intended to represent different factors.

Overall, State Water Board staff agrees with the concept and structure of the conceptual model narratives. We acknowledge that these are minor comments and suggestions, but wanted to stress the importance of clarity and continuity between the models as we move forward. These models are being developed to inform the decision making of the Relicensing Participants and Districts during the relicensing process. Therefore it is important to be consistent when developing the models in order to allow comparison and identify the issues that have the greatest influence upon fishery resources.

Comments on the Preliminary Rankings of Issues Affecting Salmonids

State Water Board staff generally agrees with the information provided within the Preliminary Rankings. However, we believe that further discussions among the Relicensing Participants and Districts are necessary in order to identify the Processes/Mechanisms truly limiting salmonid populations. Many Processes/Mechanisms are currently listed as “Unlikely”, “Possible”, or “Inconclusive” in the column titled “Affects salmonid population levels”. It is important that the Processes/Mechanisms affecting the salmonid populations are identified so they can be taken into consideration when developing license conditions.

The State Water Board appreciates the opportunity to comment on the meeting and workshop notes. If you have any questions please feel free to contact me.

Sincerely,

Peter Barnes
Engineering Geologist
Water Quality Certification Unit 1
Division of Water Rights
State Water Resources Control Board
Phone: (916) 445-9989
Email: PBarnes@waterboards.ca.gov

Attachment G

Draft Glossary

Salmonid Information Integration and Synthesis Study (W&AR-5)

Salmonid Information Integration and Synthesis Study (W&AR-5)
Draft Glossary

Terms	Definitions
Adipose fin	A small fleshy fin with no rays, located between the dorsal and caudal fins. Clipping of adipose fins is used to identify hatchery-raised salmonids.
Age	The number of years of life completed, here indicated by an arabic numeral, followed by a plus sign if there is any possibility of ambiguity (e.g., age 1, age 1+).
Age composition	Proportion of individuals of different ages in a stock or in the catches.
Age-class	A group of individuals of a certain species that have the same age.
Alevin	Newly hatched salmon or steelhead that have not completely absorbed their yolk sacs and usually have not yet emerged from the gravel.
Alluvial	Originating from the transport and deposition of sediment by running water.
Anadromous	Fish such as salmon and steelhead trout that migrate up rivers from the sea to spawn in fresh water.
Caudal fin	The tail fin.
Coded-wire tag (CWT)	A small (0.25mm diameter x 1 mm length) wire etched with a distinctive binary code and implanted in the snout of salmon or steelhead, which, when retrieved, allows for the identification of the origin of the fish bearing the tag.
Cohort	Members of a life-stage that were spawned in the same year.
Density-dependent	Factors affecting the population that are dependent on the population size, such as spawning habitat area or juvenile rearing area at higher population sizes.
Density Independence	Factors affecting the population regardless of population size, such as temperature, disease, or stranding.
Delta	An alluvial landform composed of sediment at a river mouth that is shaped by river discharge, sediment load, tidal energy, land subsidence, and sea-level changes. The Sacramento and San Joaquin River Delta is formed at the western edge of the Central Valley by the confluence of these rivers and refers to a complex network of

	channels east of where the rivers enter Suisun Bay (an upper arm of San Francisco Bay).
Escapement	The number of sexually mature adult salmon or steelhead that successfully pass through an ocean fishery to reach the spawning grounds. This amount reflects losses resulting from harvest, and does not reflect natural mortality, typically partitioned between enroute and pre-spawning mortality. Thus, escaped fish do not necessarily spawn successfully.
El Niño	A climactic event that begins as a warming episode in the tropical Pacific zone that can result in large scale intrusions of anomalously warm marine water northward along the Pacific coastline of North America.
Estuary	A region where salt water from the ocean is mixed with fresh water from a river or stream (also see Delta).
Floodplain	The part of a river valley composed of unconsolidated river deposits that periodically floods. Sediment is deposited on the floodplain during floods and through the lateral migration of the river channel across the floodplain.
Fry	Salmonid life stage between the alevin and parr stages.
Homing	The ability of a salmon or steelhead to correctly identify and return to their natal stream, following maturation at sea.
Hydroelectric	Generation of electricity by conversion of the energy of running water into electric power.
Irrigation	To application of water to land by means of pumps, pipes, and ditches in order to help crops grow.
Kelts	A spent or exhausted salmon or steelhead after spawning. All species of Pacific salmon, except some steelhead and sea-run cutthroat, die at this stage.
Life history	The events that make up the life cycle of an animal including migration, spawning, incubation, and rearing. There is typically a diversity of life history patterns both within and between populations. Life history can refer to one such pattern, or collectively refer to a stylized description of the 'typical' life history of a population.
Life-stage	Temporal stages (or intervals) of a fish’s life that have distinct anatomical, physiological, and/or functional characteristics that contribute to potential differences in use of the environment.
Macroinvertebrate	Invertebrates visible to the naked eye, such as insect larvae and crayfish.

Osmoregulation	Refers to the physical changes that take place in salmonids as their gills and kidneys adjust from fresh water to salt water as they enter the ocean, and from salt water to fresh water upon their return.
Parr	Life stage of salmon or steelhead between the fry and smolt stages. At this stage, juvenile fish have distinctive vertical parr marks and are actively feeding in fresh water.
Predator	An animal which feeds on other living animals.
Production	Output from a stock-production model at a particular life-step.
Recruitment	Addition of new fish to a defined life history stage by growth from among smaller size categories. Often used in context of management, where the stage is the point where individuals become vulnerable to fishing gear.
Redd	A nest of fish eggs consisting of gravel, typically formed by digging motion performed by an adult female salmon or steelhead trout.
Riffle	A shallow gravel area of a stream that is characterized by increased velocities and gradients, and is the predominant stream area used by salmonids for spawning.
Riparian	Referring to the transition area between aquatic and terrestrial ecosystems. The riparian zone includes the channel migration zone and the vegetation directly adjacent to the water body that influence channel habitat through alteration of microclimate or input of LWD.
River mile	A statute mile measured along the center line of a river. River mile measurements start at the stream mouth (RM 0.0).
Riverine	Referring to the entire river network, including tributaries, side channels, sloughs, intermittent streams, etc.
Smolt	Salmonid life stage between the parr and adult stages. At this stage, juvenile salmon and steelhead undergo physical changes and migrate to the ocean.
Smoltification	Refers to the changes that take place in salmonids as they prepare to enter the ocean. These changes include the development of the silver color of adults and a tolerance for salt water.
Spawn	The act of producing a new generation of fish. The female digs a redd in the river bottom and deposits her eggs into it. The male then covers the eggs with milt to fertilize them.
Spawning grounds	Areas where fish spawn.

Straying	A natural phenomena of adult spawners not returning to their natal stream, but entering and spawning in some other stream.
Stock	Input value required by the stock-production models. It is the first required value entered into the population dynamics model spreadsheets; for example, stock would be the number of fry, for a fry-to-juvenile step.
Wild	Salmon or steelhead produced by natural spawning in fish habitat from parents that were spawned and reared in fish habitat.
Woody debris	Logs, branches, or sticks that fall or hang into rivers. This debris gives salmonids places to hide and provides food for insects and plants which these fish feed upon.
Yolk sac	A small sac connected to alevin which provides them with protein, sugar, minerals, and vitamins. Alevin live on the yolk sac for a month or so before emerging from the gravel and beginning to hunt food for themselves.