Drivers of Decline: Conceptual Models from the Management Analysis and Synthesis Team

Randall Baxter
Department of Fish and Wildlife
for
MAST

Delta and Longfin Smelt:
Is Extinction Inevitable?
UC Davis
March 29, 2016

Interagency Ecological Program
Cooperative Ecological Investigations Since 1970

Report Authors/Contributors

Randall Baxter, California Department of Fish and Wildlife
Larry R. Brown, U.S. Geological Survey
Gonzalo Castillo, U.S. Fish and Wildlife Service
Louise Conrad, California Department of Water Resources
Steven Culberson, U.S. Fish and Wildlife Service
Matthew Dekar, U.S. Fish and Wildlife Service
Frederick Feyrer, Reclamation, now U.S. Geological Survey
Karen Gehrts, California Department of Water Resources
Lenny Grimaldo, U.S. Bureau of Reclamation, now ICF International
Thaddeus Hunt, California State Water Resources Control Board
Joseph Kirsch, U.S. Fish and Wildlife Service
Anke Mueller-Solger, Delta Stewardship Council, now U.S. Geological Survey
Matthew Nobriga, U.S. Fish and Wildlife Service
Steven Slater, California Department of Fish and Wildlife
Ted Sommer, California Department of Water Resources
Kelly Souza, California Department of Fish and Wildlife, now Delta Stewardship Council

Outline

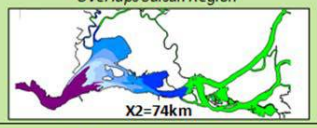
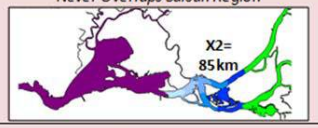
- Background for model development
- Step through Delta Smelt life cycle conceptual model

Fall Low Salinity Habitat Conceptual Model

Scientific Review Panel (and authors) concluded

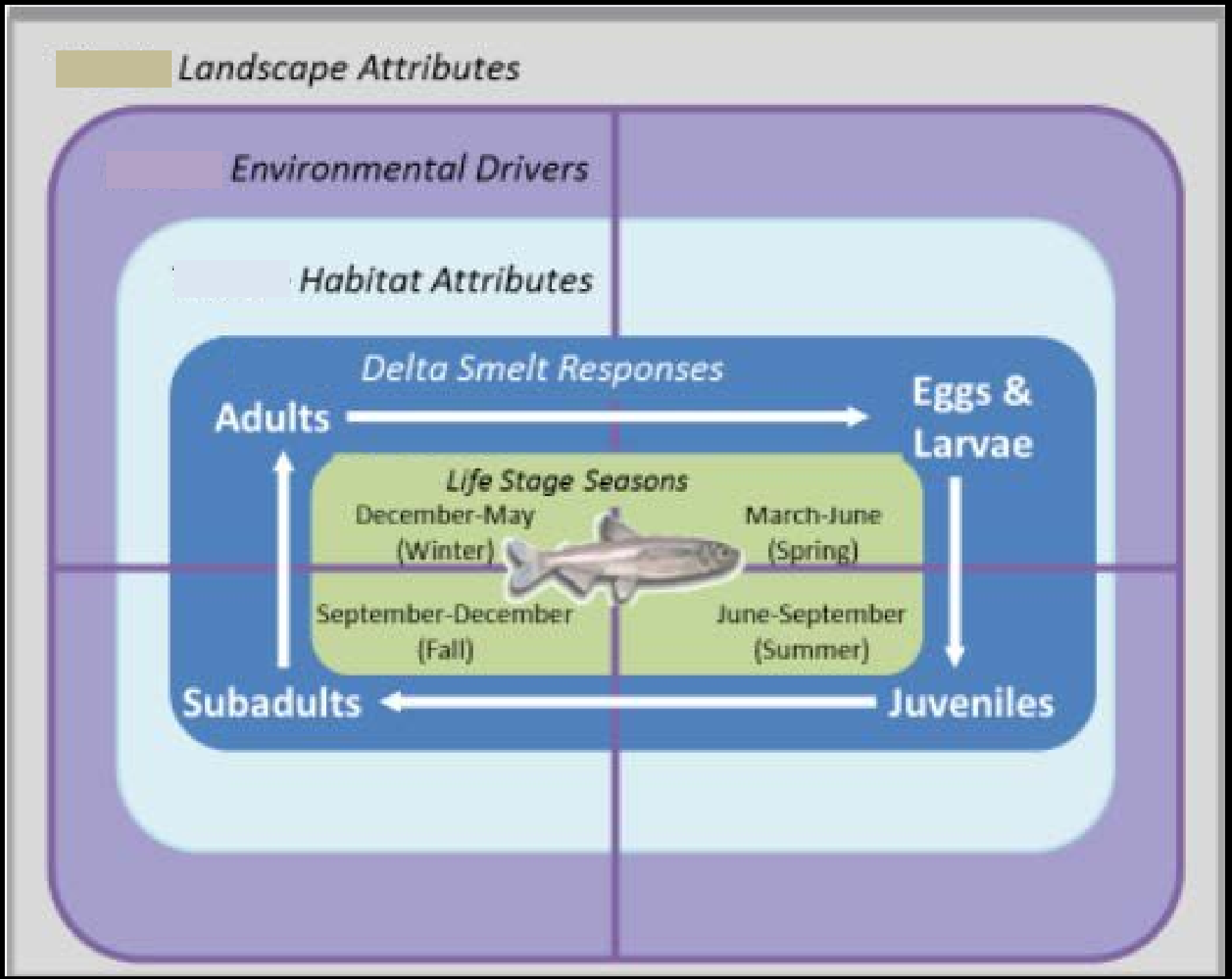
- Different visualization needed
- Seasons other than fall
- Not just LSZ

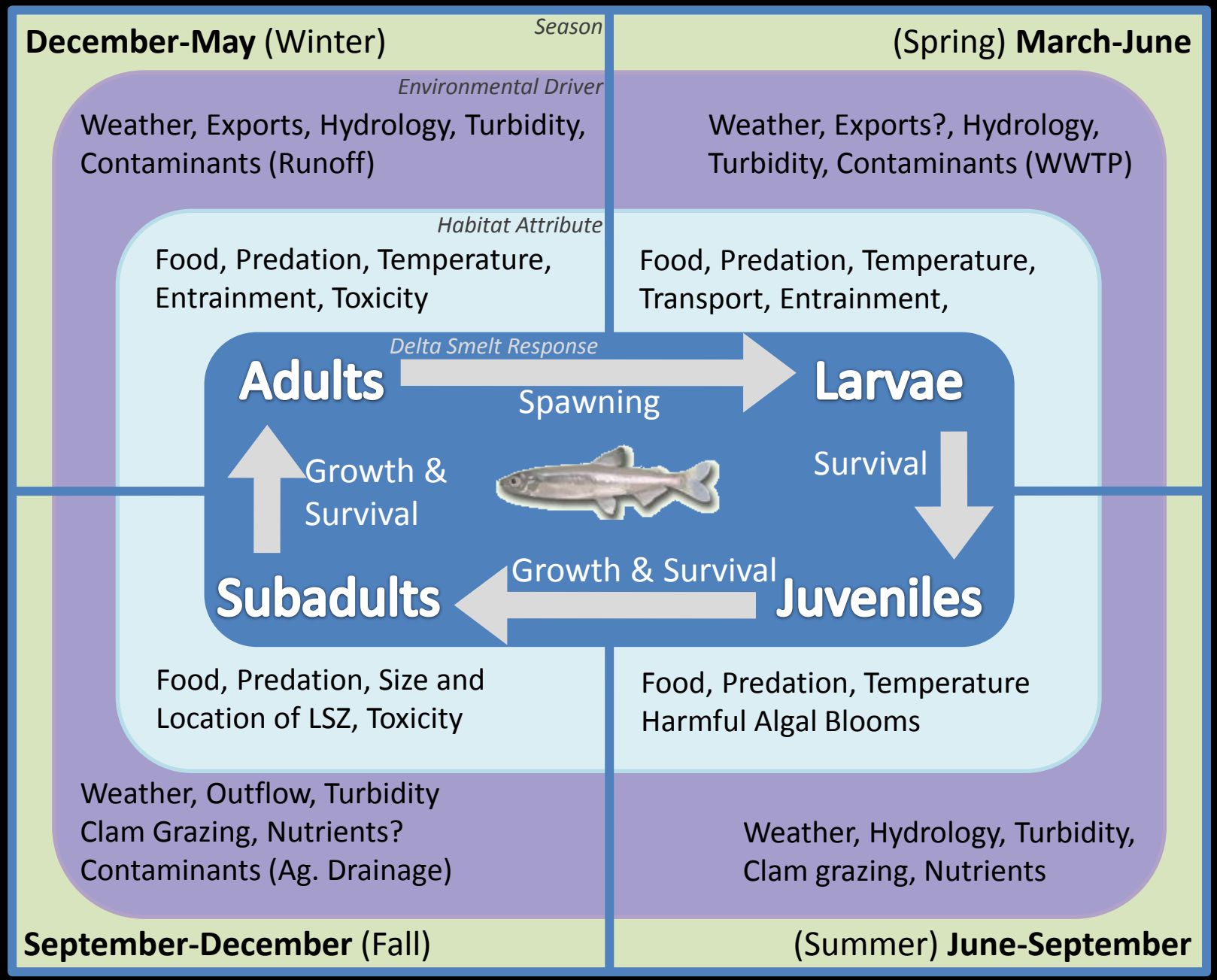
Life cycle model

Suisun Region	Stationary Abiotic Habitat Components	*River Confluence*
Higher	Bathymetric Complexity	*Lower*
Higher	Erodible Sediment Supply	*Lower*
Many in South, Fewer in North	Contaminant Sources	*Many*
Fewer	Entrainment Sites	*More*
Variable Fall Outflow Regime	**Dynamic Abiotic Habitat Components**	***Static Fall Outflow Regime***
Higher After Wet Springs	Net Total Delta Fall Outflow	*Always Low*
Higher After Wet Springs	San Joaquin River Contribution to Fall Outflow	*Always Low*
After Wet Springs, Broad Fall LSZ Overlaps Suisun Region 	Location and Extent of the Fall LSZ (1-6 psu) 	*Narrow Fall LSZ in River Channels, Never Overlaps Suisun Region* 
Higher After Wet Springs	Hydrodynamic Complexity in the Fall LSZ	*Always Lower*
Higher After Wet Springs	Wind speed in the Fall LSZ	*Always Lower*
More Variable, Higher After Wet Springs	Turbidity in the Fall LSZ	*Always Less Variable, Lower*
More Variable, Maybe Lower After Wet Springs	Contaminant Concentrations in the Fall LSZ	*Less Variable, Maybe Higher*
LSZ Overlaps Suisun Region	**Dynamic Biotic Habitat Components**	***LSZ Overlaps River Confluence***
Higher	Food Availability and Quality	*Lower*
Variable	Predator Abundance	*Higher*
LSZ Overlaps Suisun Region	**Delta Smelt Responses**	***LSZ Overlaps River Confluence***
Broad, Westward	Distribution	*Constricted, Eastward*
Higher	Growth, Survival, Fecundity	*Lower*
Better	Health and Condition	*Worse*
May be Higher	Recruitment in the next Spring	*Lower*

Conceptual Model Goal

- Develop full life cycle conceptual model
  - fully explain assumptions
- Must facilitate testing hypotheses critical to understanding


Landscape Attributes
Environmental Drivers
Habitat Attributes
Delta Smelt Responses
Adults
Eggs & Larvae
Life Stage Seasons
December-May (Winter)
March-June (Spring)
September-December (Fall)
June-September (Summer)
Subadults
Juveniles


December-May (Winter)
Season
(Spring) March-June
Environmental Driver
Weather, Exports, Hydrology, Turbidity, Contaminants (Runoff)
Weather, Exports?, Hydrology, Turbidity, Contaminants (WWTP)
Habitat Attribute
Food, Predation, Temperature, Entrainment, Toxicity
Food, Predation, Temperature, Transport, Entrainment,
Delta Smelt Response
Adults
Spawning
Larvae
Growth & Survival
Survival
Growth & Survival
Subadults
Juveniles
Food, Predation, Size and Location of LSZ, Toxicity
Food, Predation, Temperature Harmful Algal Blooms
Weather, Outflow, Turbidity Clam Grazing, Nutrients? Contaminants (Ag. Drainage)
Weather, Hydrology, Turbidity, Clam grazing, Nutrients
September-December (Fall)
(Summer) June-September

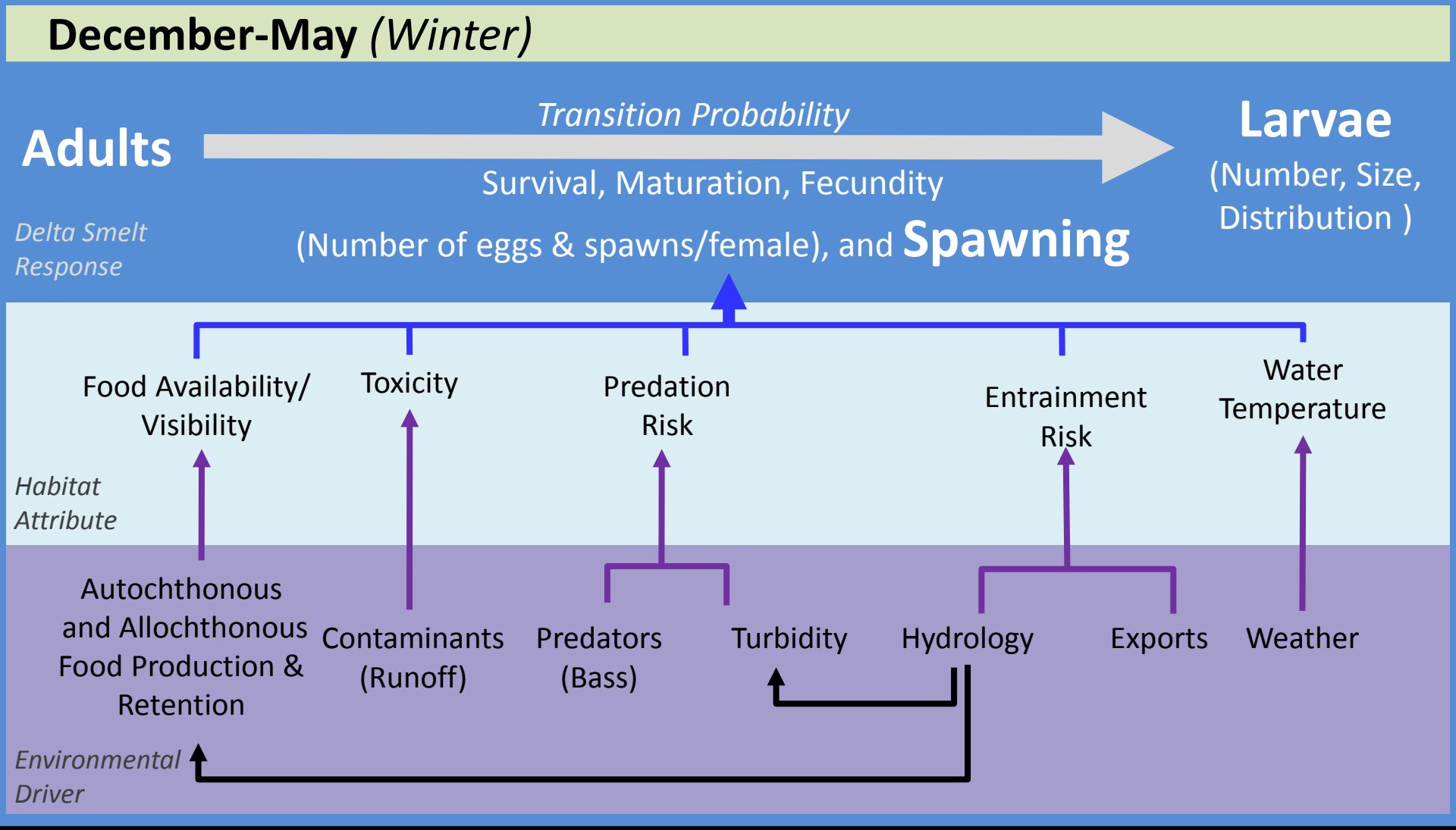
Model Description

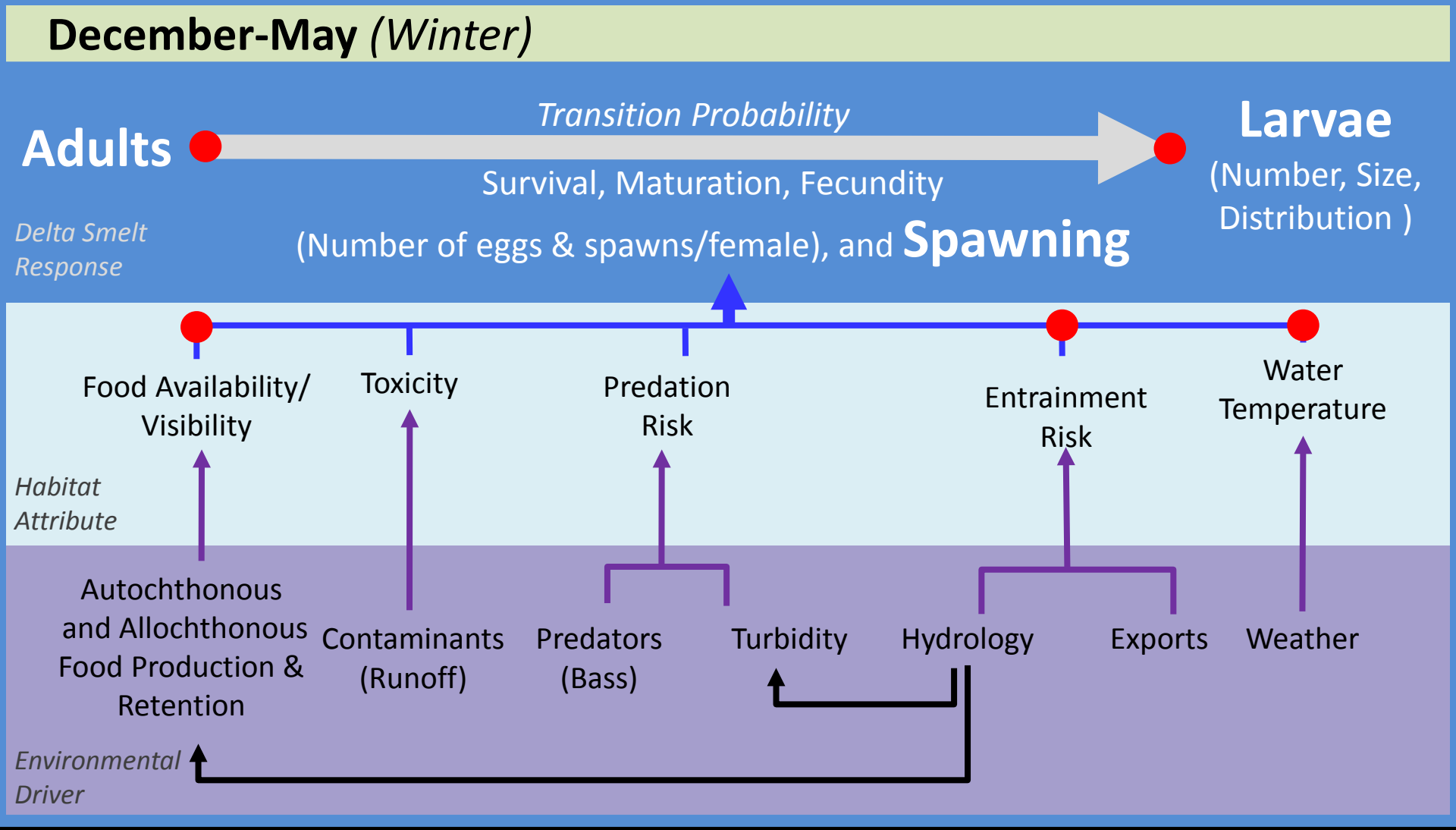
Background about how we think the Bay-Delta system works in general

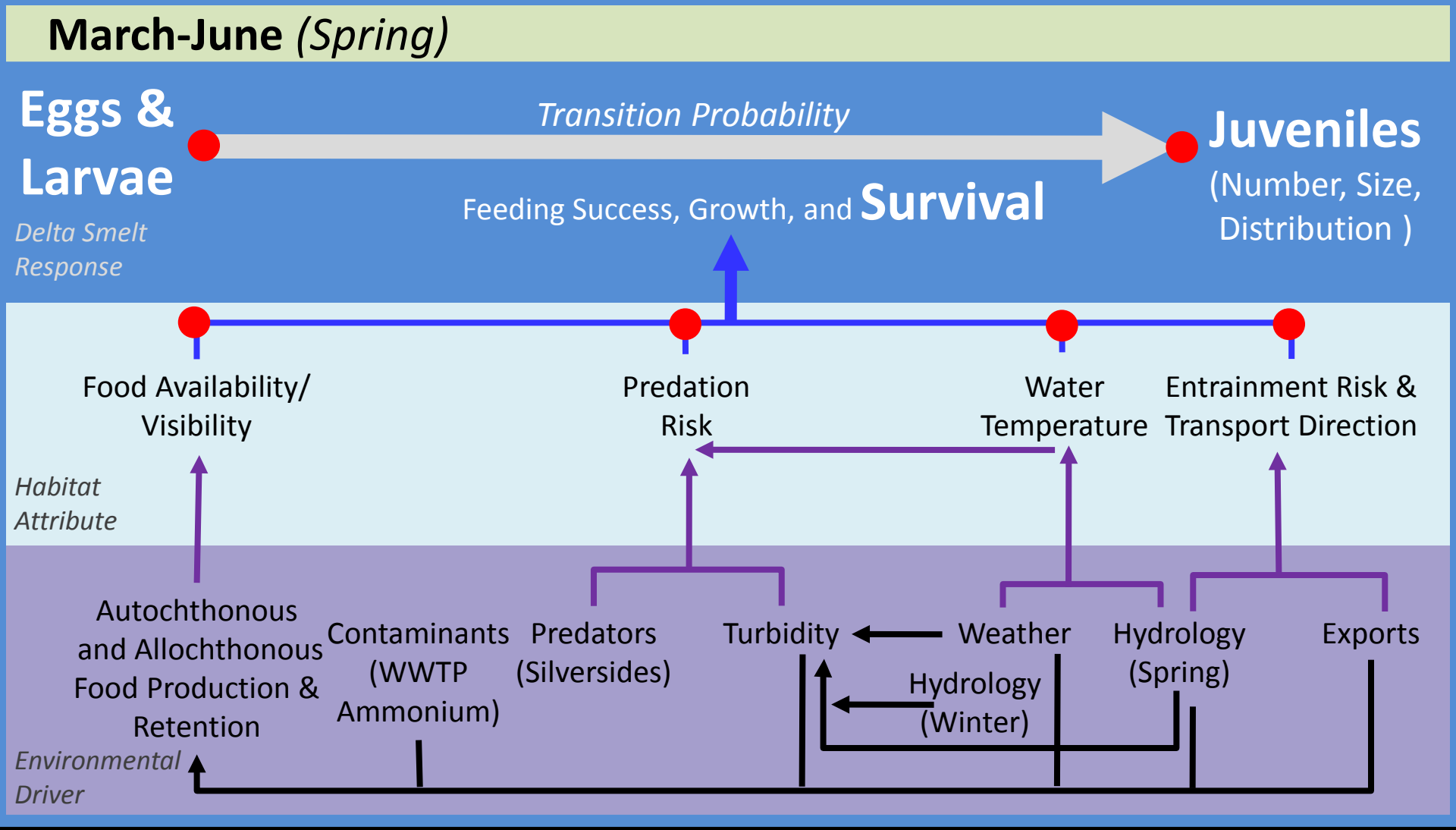
Hypotheses about how we think the Delta Smelt population responds to environmental conditions

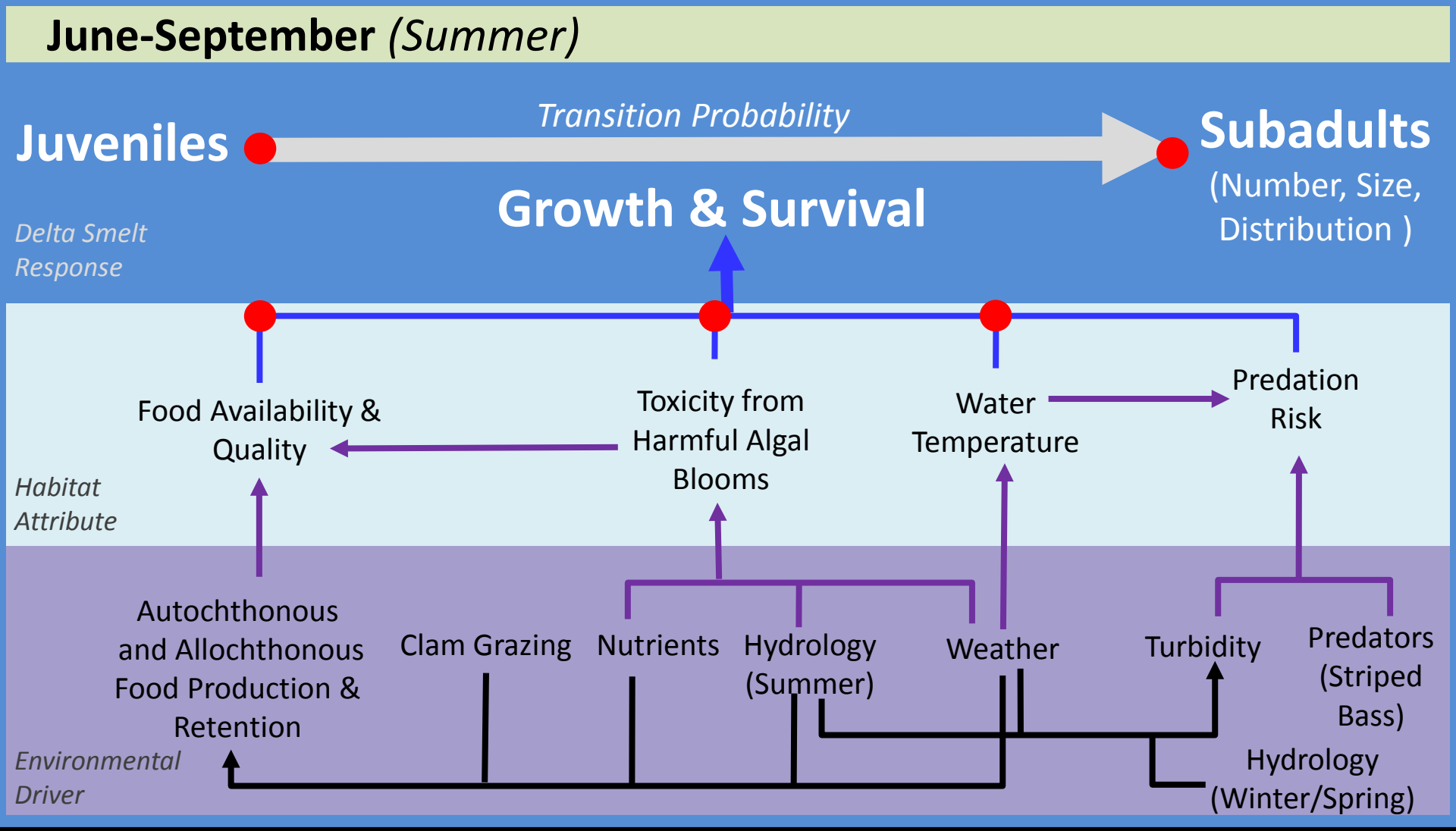
Caveats

- Connections between environmental drivers and habitat attributes not always known
  - fully explain assumptions
- Not all possible hypotheses are tested
  - not hypotheses with no data
- The same processes may not be important every year

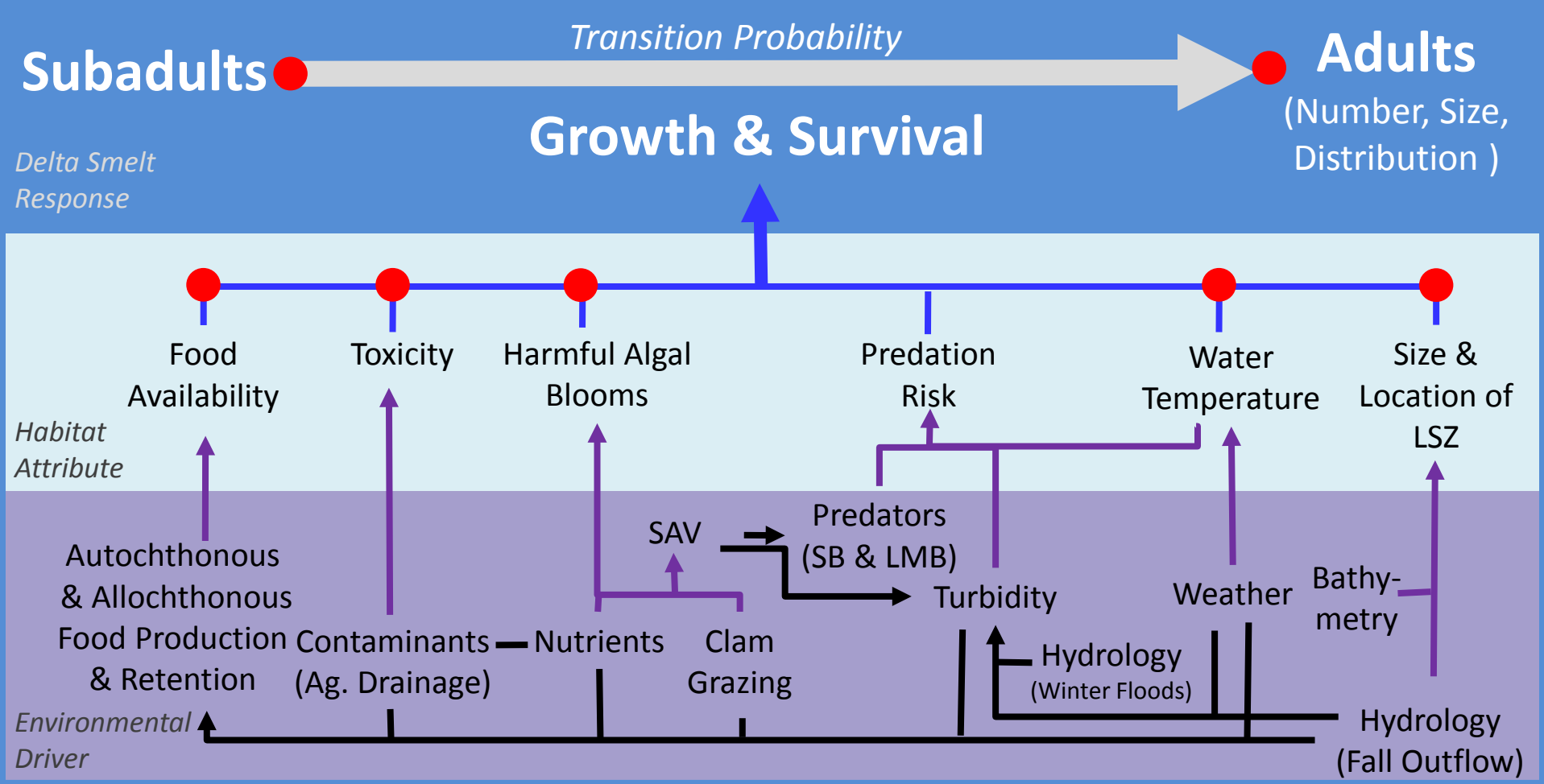

December-May (Winter)
Adults
Transition Probability
Survival, Maturation, Fecundity
(Number of eggs & spawns/female), and Spawning
Larvae
(Number, Size, Distribution)
Delta Smelt Response
Food Availability/ Visibility
Toxicity
Predation Risk
Entrainment Risk
Water Temperature
Habitat Attribute
Autochthonous and Allochthonous Food Production & Retention
Contaminants (Runoff)
Predators (Bass)
Turbidity
Hydrology
Exports
Weather
Environmental Driver


December-May (Winter)
Adults
Transition Probability
Survival, Maturation, Fecundity
(Number of eggs & spawns/female), and Spawning
Larvae
(Number, Size, Distribution)
Delta Smelt Response
Food Availability/ Visibility
Toxicity
Predation Risk
Entrainment Risk
Water Temperature
Habitat Attribute
Autochthonous and Allochthonous Food Production & Retention
Contaminants (Runoff)
Predators (Bass)
Turbidity
Hydrology
Exports
Weather
Environmental Driver


March-June (Spring)
Eggs & Larvae
Delta Smelt Response
Transition Probability
Juveniles
(Number, Size, Distribution)
Feeding Success, Growth, and Survival
Food Availability/ Visibility
Predation Risk
Water Temperature
Entrainment Risk & Transport Direction
Habitat Attribute
Autochthonous and Allochthonous Food Production & Retention
Contaminants (WWTP Ammonium)
Predators (Silversides)
Turbidity
Weather
Hydrology (Spring)
Exports
Hydrology (Winter)
Environmental Driver


June-September (Summer)
Juveniles
Transition Probability
Subadults
(Number, Size, Distribution)
Growth & Survival
Delta Smelt Response
Food Availability & Quality
Toxicity from Harmful Algal Blooms
Water Temperature
Predation Risk
Habitat Attribute
Autochthonous and Allochthonous Food Production & Retention
Clam Grazing
Nutrients
Hydrology (Summer)
Weather
Turbidity
Predators (Striped Bass)
Hydrology (Winter/Spring)
Environmental Driver

September-December *(Fall)*



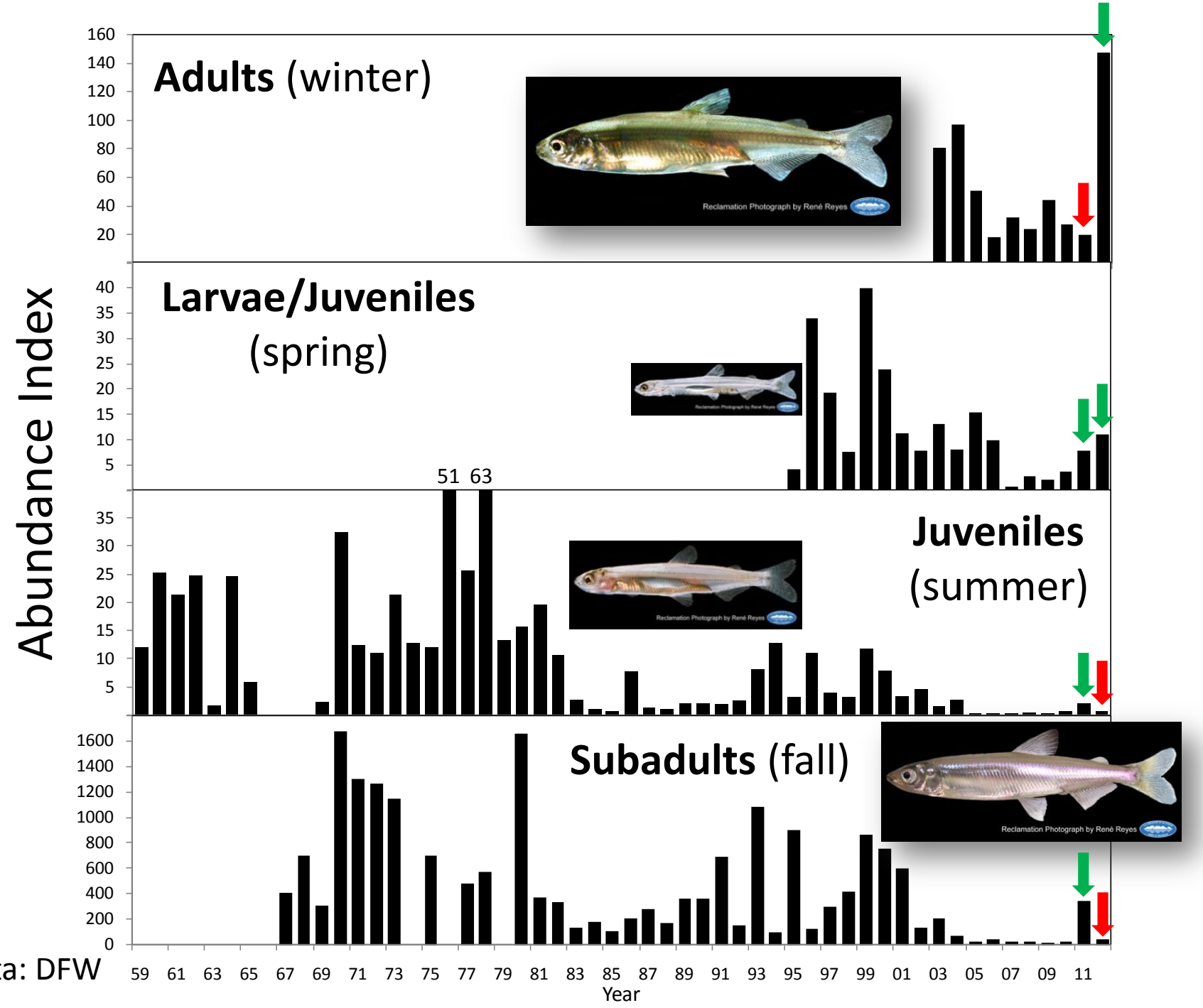
Identified data gaps

- Contaminants and toxicity effects
- Entrainment and transport
- Predation relative risk could not be evaluated in most cases
- Food incomplete information on prey densities
- Harmful Algal Blooms targeted quantitative sampling
- Quantitative life cycle model needed

The End

An Updated Conceptual Model of Delta Smelt Biology: our evolving understanding of an estuarine fish

http://www.water.ca.gov/iep/


Adults (winter)
Reclamation Photograph by René Reyes
Larvae/Juveniles
(spring)
51 63
Juveniles
(summer)
Reclamation Photograph by René Reyes
Subadults (fall)
Reclamation Photograph by René Reyes
Abundance Index
Year
Data: DFW