



Water color painting, "Cousins", with permission from biologist and artist Reife C. Reyes

CENTER FOR COASTAL OCEAN ISSUES AND DELTA SCIENCE PROGRAM SYMPOSIUM

DELTA & LONGFIN SMELT:

Is Extinction Inevitable?

March 29, 2016

Question:

Is Extinction **Inevitable** for Delta Smelt and Longfin Smelt?

Answer:

Depends on

- Time frame
- Management

Question:

Is Extinction Inevitable for Delta Smelt and Longfin Smelt?

Answer:

Time Frame: Very Long Time → YES, Extinction Almost Certain



I did **not** see that coming

Question:

Is Extinction **Inevitable** for Delta Smelt and Longfin Smelt?

Answer:

Time Frame: Very Long Time

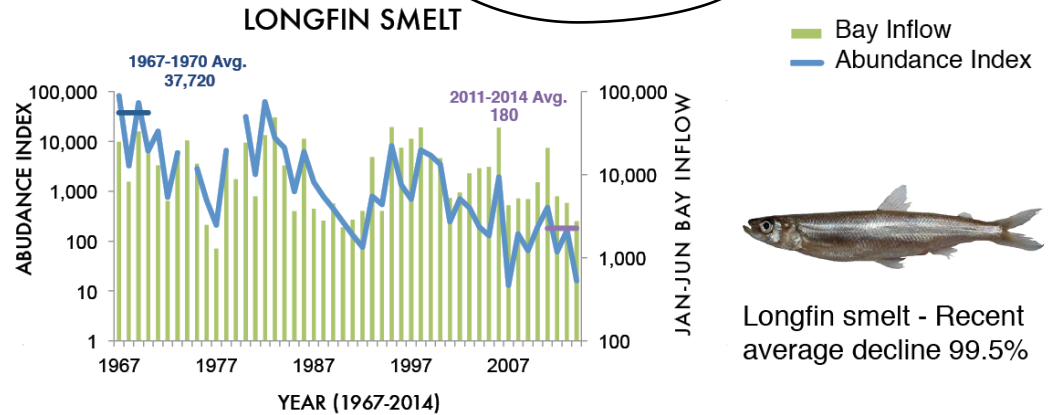
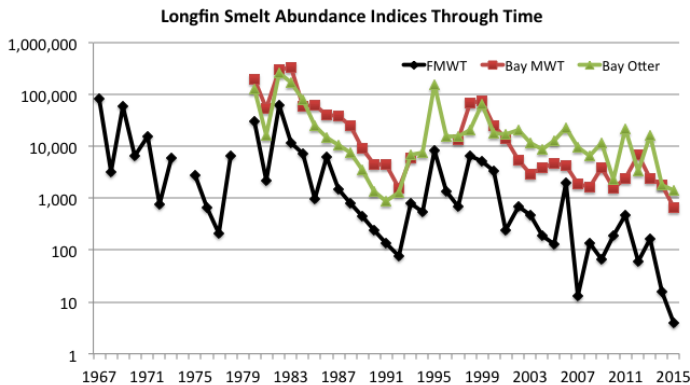
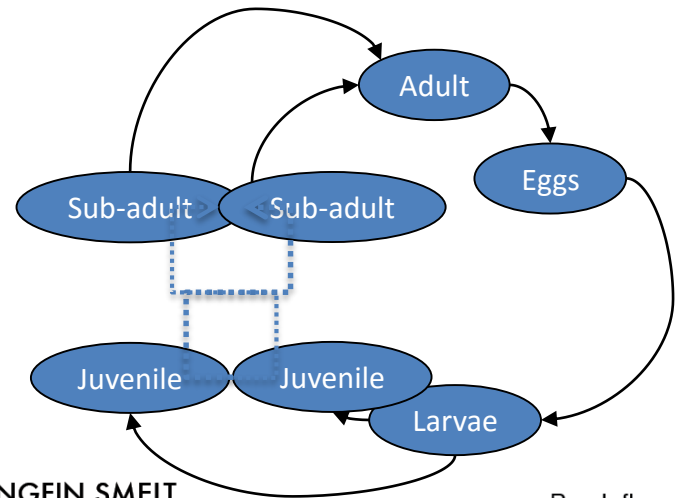
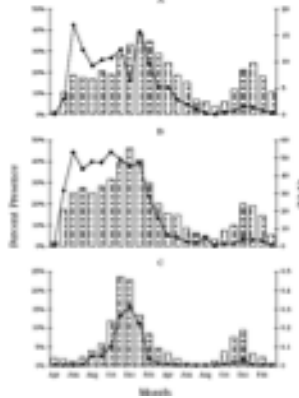
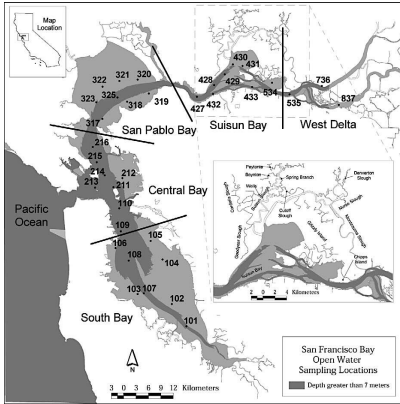
- Extinction Almost Certain

Time Frame: 1-50 years

- Irrelevant to Our Management
- Extinction is Not an Option

The Question Distracts from Our Responsibility

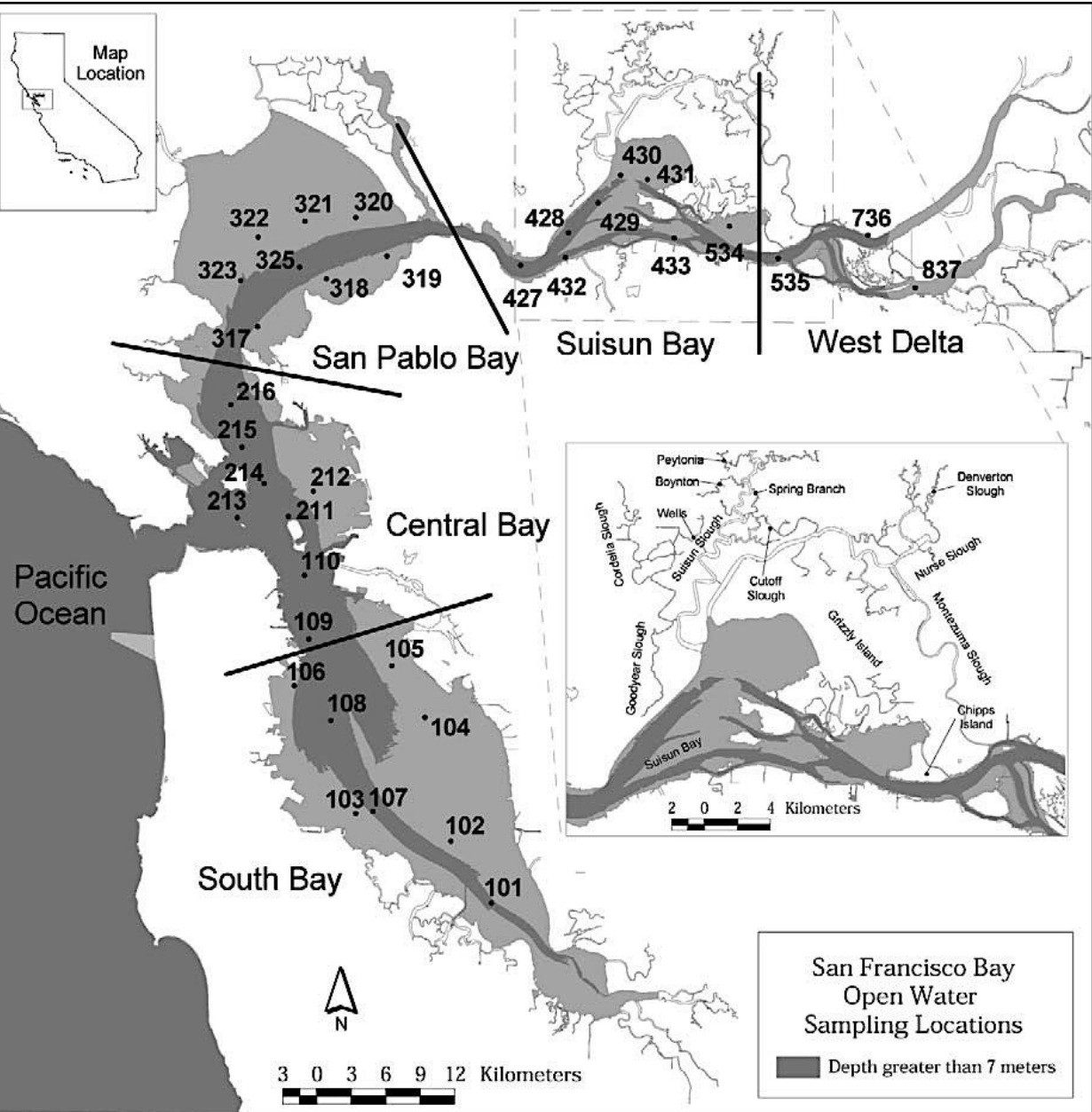
What do we know about Longfin Smelt?



Longfin smelt - Recent average decline 99.5%

Enough to Manage for Success ...

San Francisco Bay Study

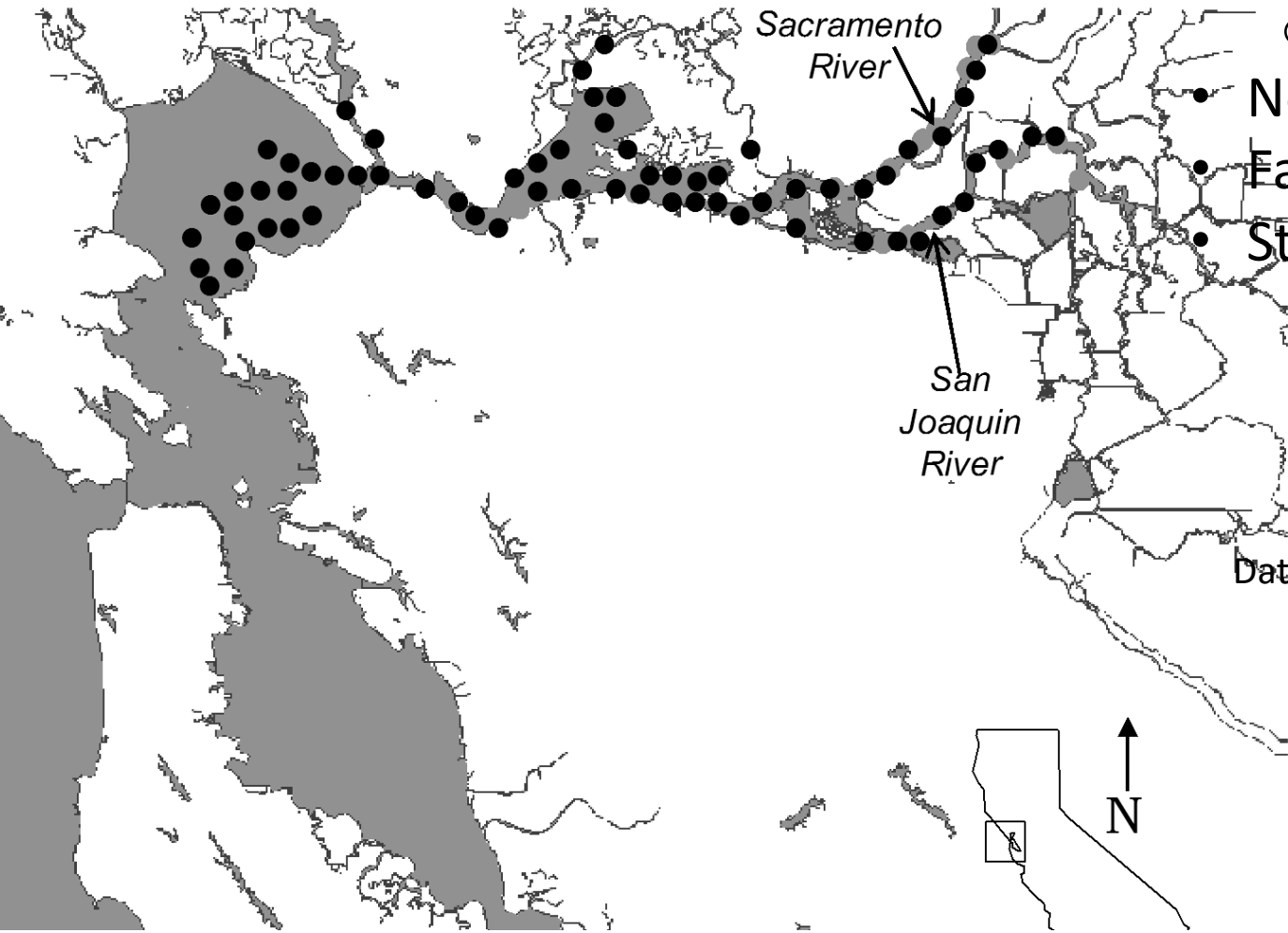


- Two Nets:
 - Otter Trawl
 - Midwater Trawl
- Throughout the Bay
- Year-round (monthly)
- Started in 1980

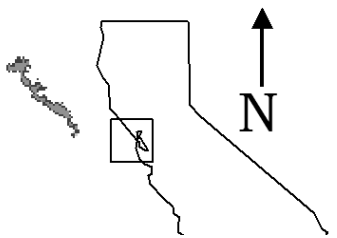
Data: Courtesy of CDFW's San Francisco Bay Study & the Interagency Ecological Program for the San Francisco Estuary

Fall Midwater Trawl

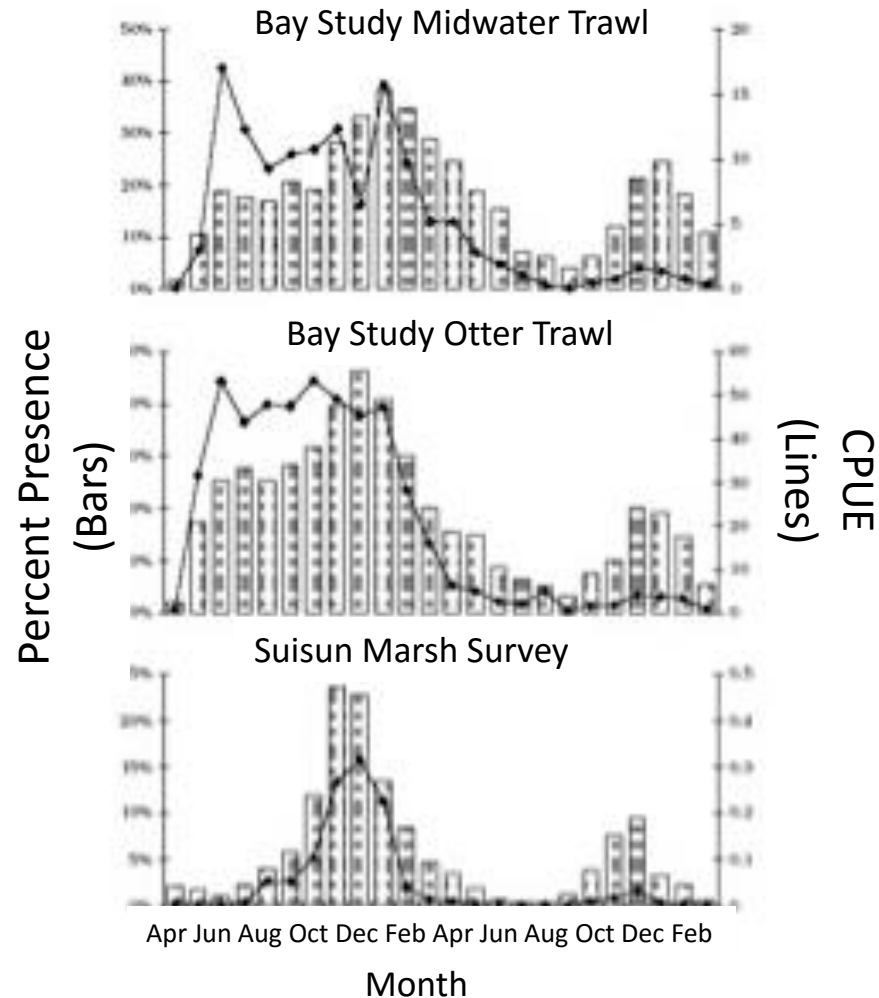
- One Net:
 - Midwater Trawl
 - Northern Estuary
 - Fall (Sep-Dec)
 - Started in 1967



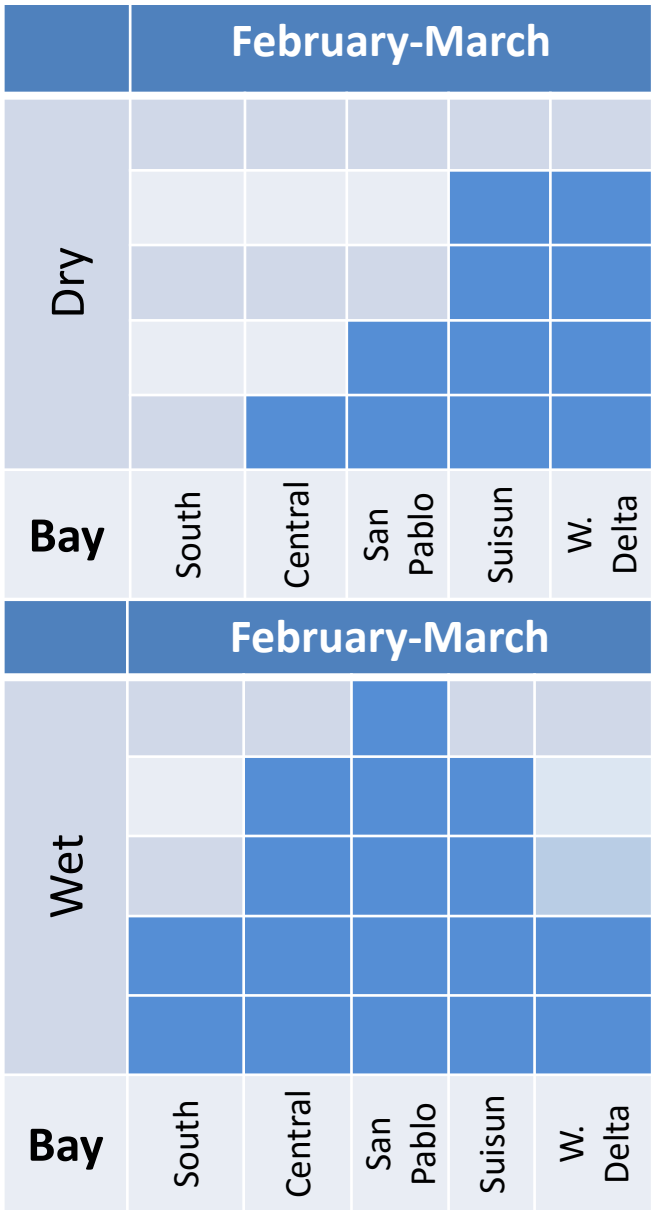
Data: Courtesy of CDFW's Fall MidWater Trawl Survey; Bay Delta Region



- Semelparous
- Two-year Life Cycle (Moulton 1974; Moyle 2002)
- Migratory, Partially Anadromous (Rosenfield and Baxter 2007)



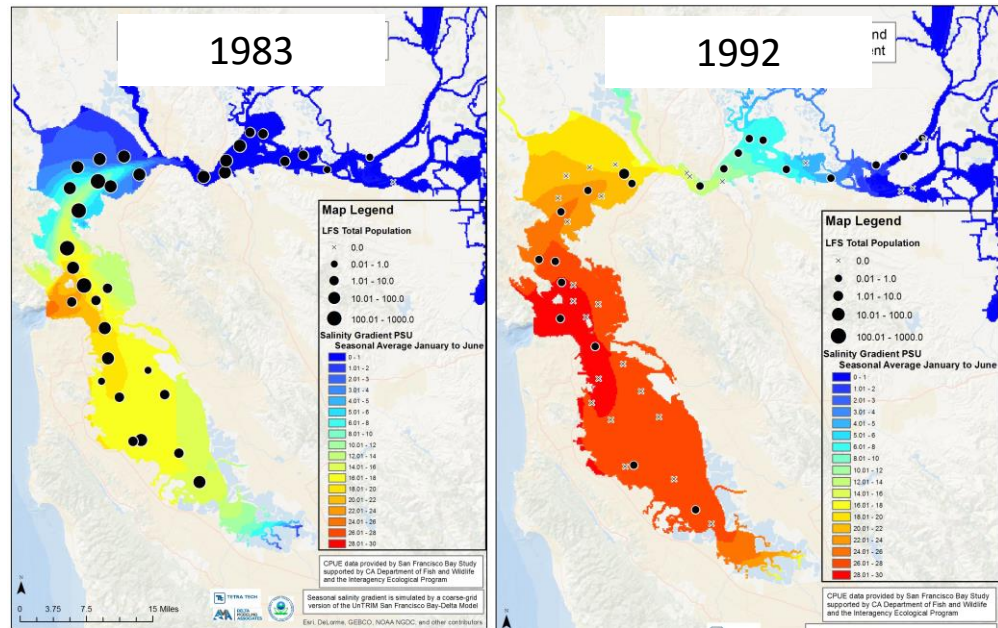
- Larvae concentrated near X_2 (Low Salinity Zone)
- Freshwater inflow to estuary affects distribution (Dege & Brown 2004; Rosenfield 2010)



- Implications of spawning and juvenile distribution

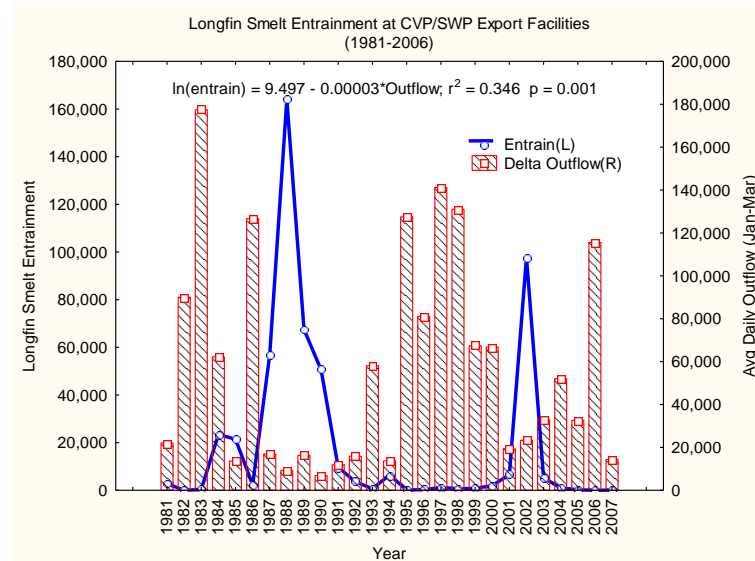
- Flow Affects Juvenile Distribution

(CDFG 2009; Rosenfield 2010; US EPA 2016)



- Spawning Distribution Affects Adult, Larval, and Juvenile Entrainment

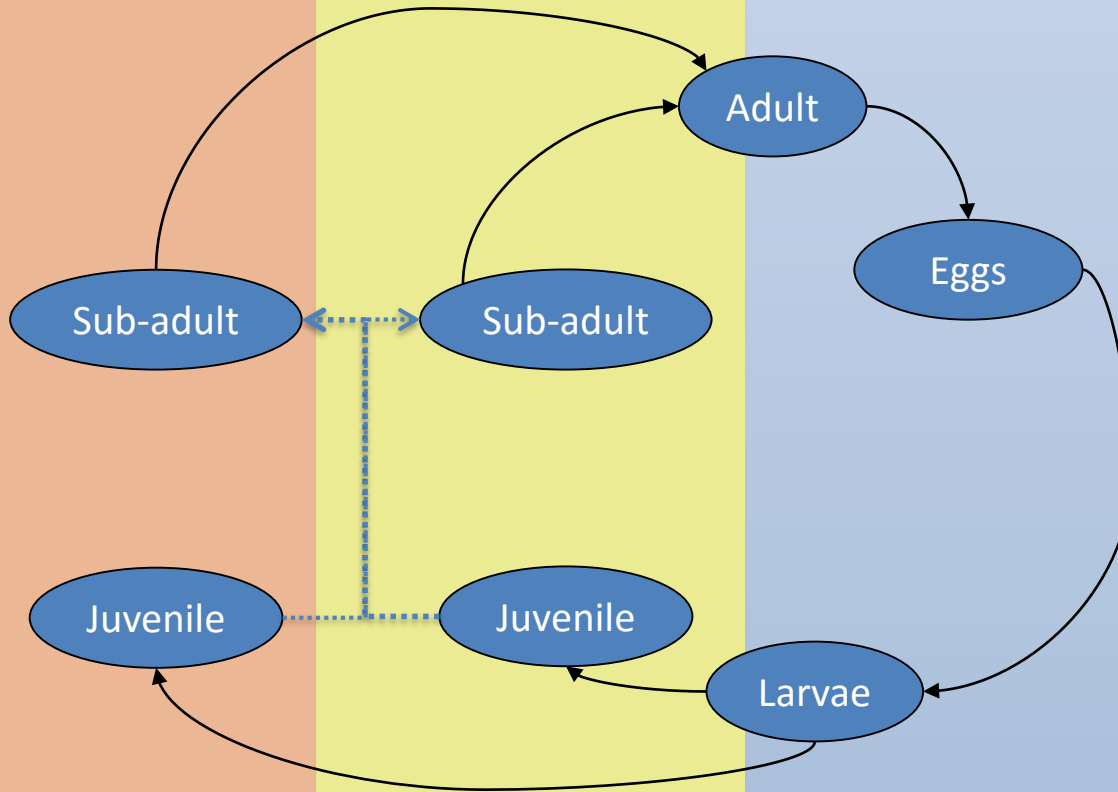
(Grimaldo et al. 2009; CDFG 2009; Rosenfield 2010)



Euhaline-to-Mixohaline
>18ppt
May-October

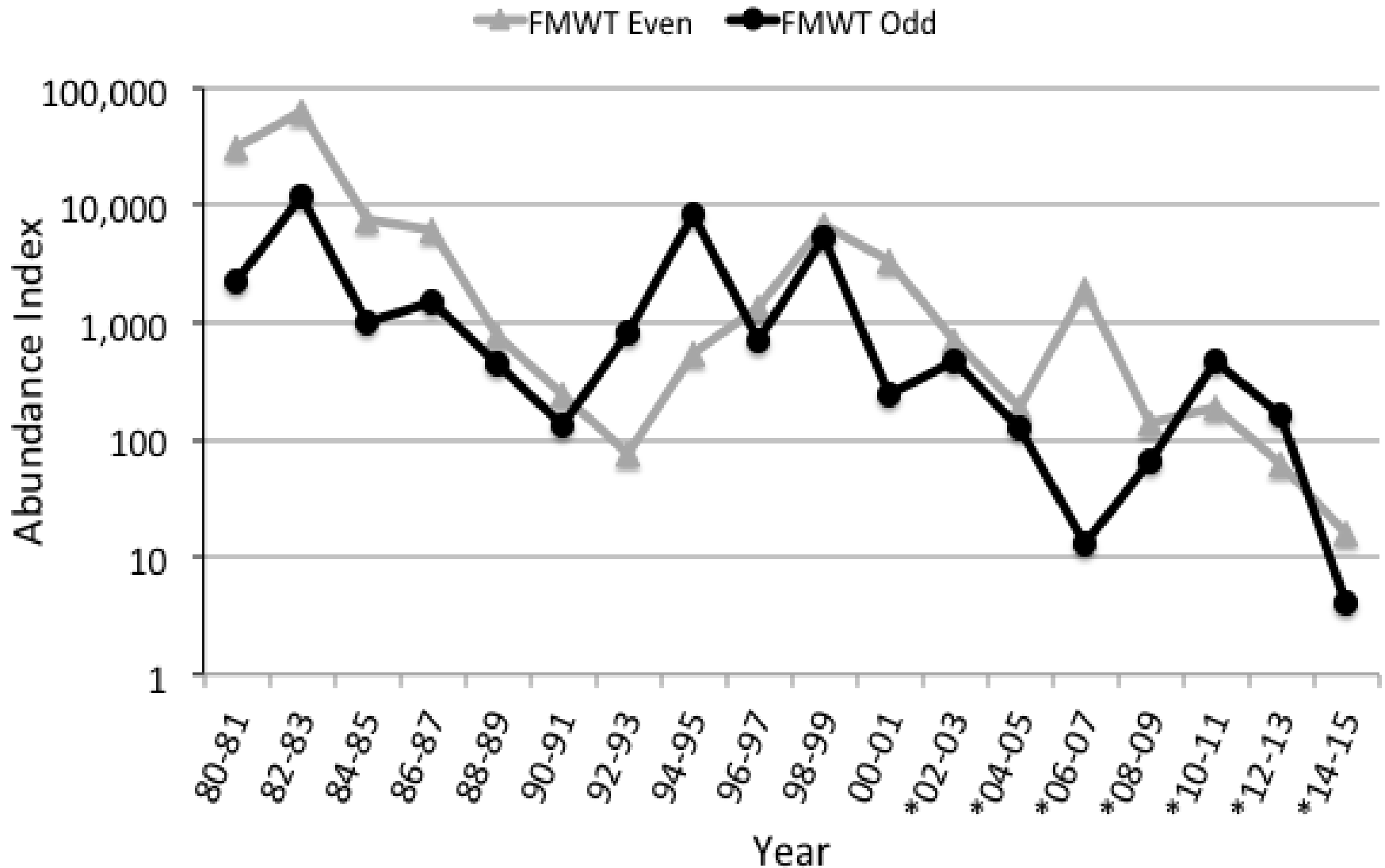
Mesohaline
5-18ppt
Year-round

Freshwater-to-Oligohaline
0-5ppt
December-April



← Marine -- Central Bay -- San Pablo Bay -- Suisun Bay -- West Delta (& Napa R. etc.) →

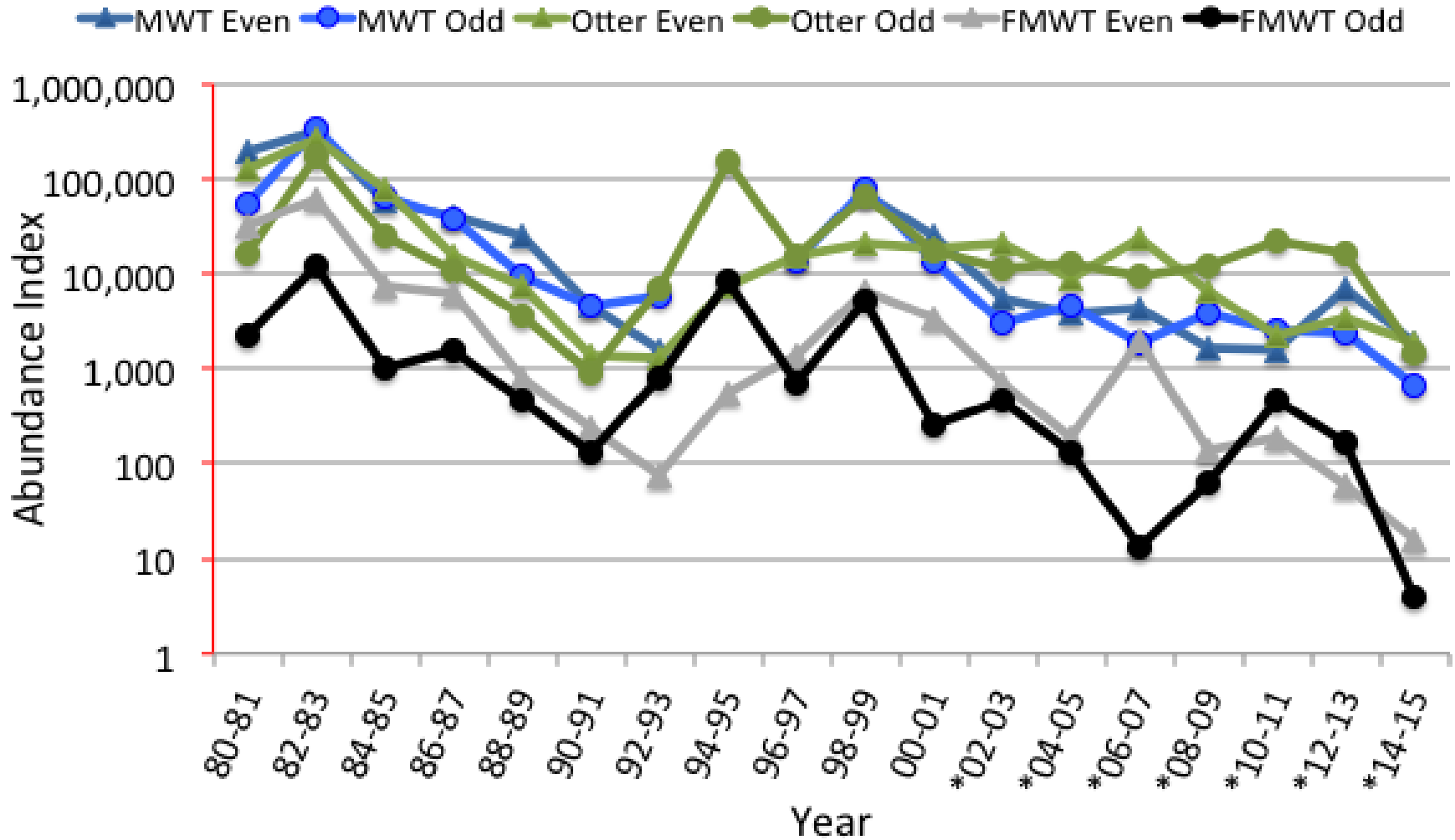
- Catastrophic Declines



FMWT

>99% decline

- Catastrophic Declines (everywhere you look)

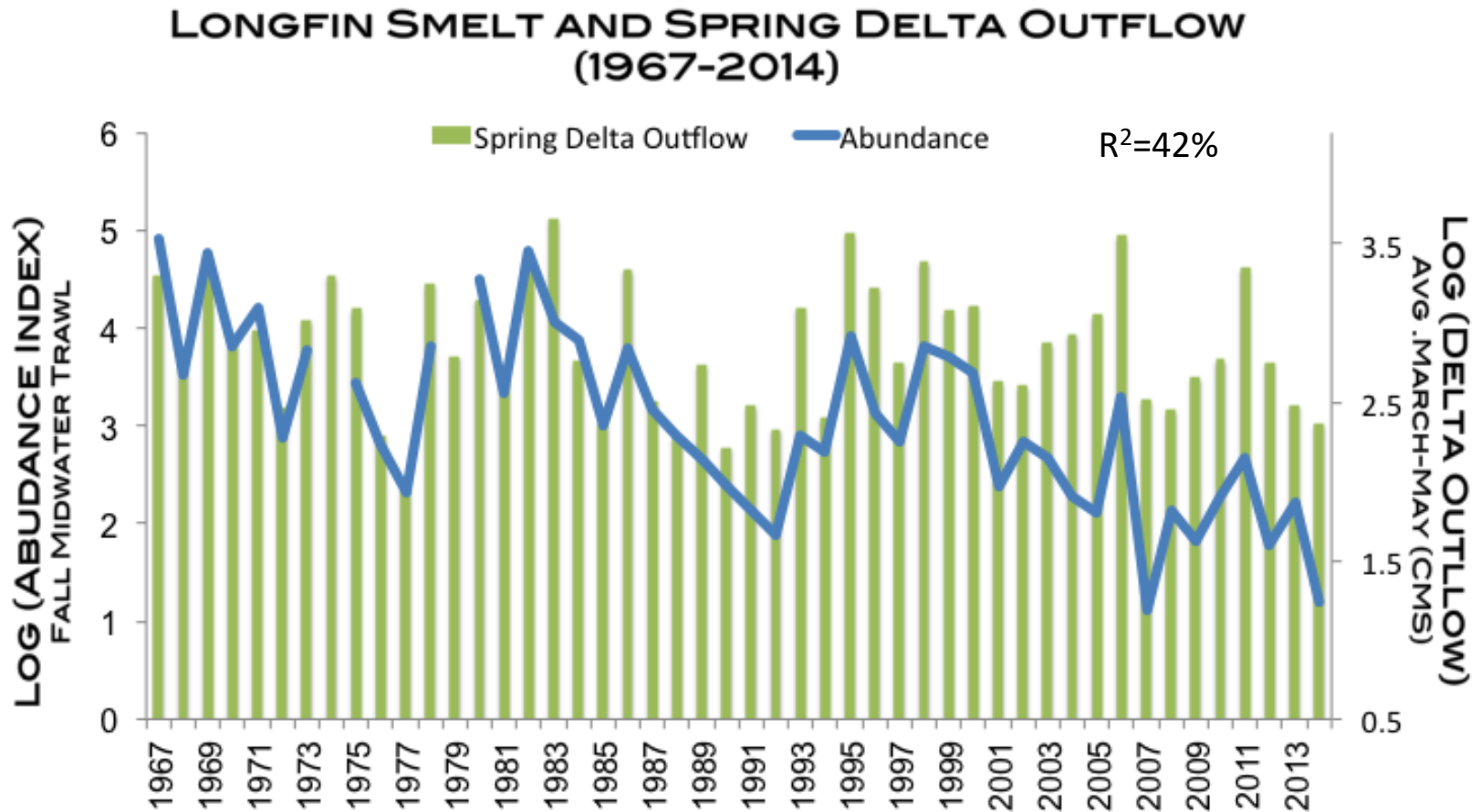


FMWT
 >99% decline

Bay Otter Trawl
 =96% decline

Bay Midwater Trawl
 =98% decline

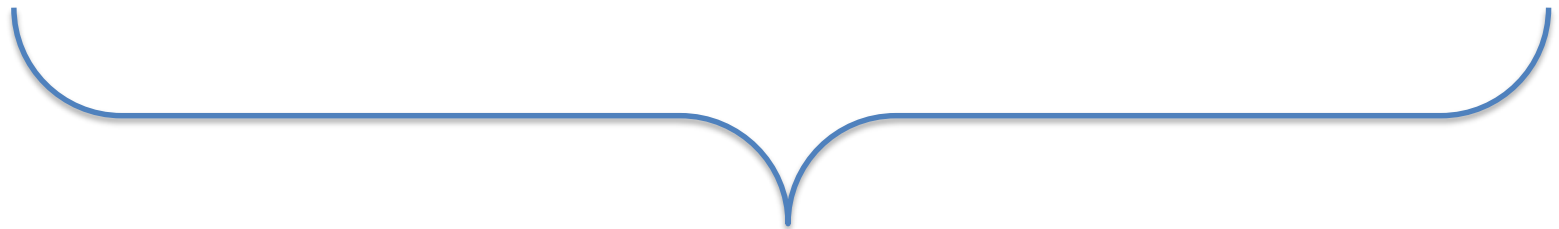
- Persistent, significant correlation with freshwater flow to the estuary during winter-spring months



Stevens and Miller 1983; Jassby et al. 1995; Kimmerer 2002; Rosenfield and Baxter 2007; Kimmerer et al. 2009; Mac Nally et al. 2010; Thomson et al. 2010; Maunder et al. 2015; Nobriga and Rosenfield 2015

What do we know about Longfin Smelt?

- 2-Year Life Cycle
- Seasonal migrations
- Egg and Larval Stages Freshwater
- Juvenile and Sub-Adult Stages → Brackish to Marine Environments
- Catastrophic Declines
- Correlation with Freshwater Flow



Are Forces Driving LFS Decline Identifiable in Different Phases of Their Life Cycle?

Disaggregating Forces Driving Decline of Longfin Smelt

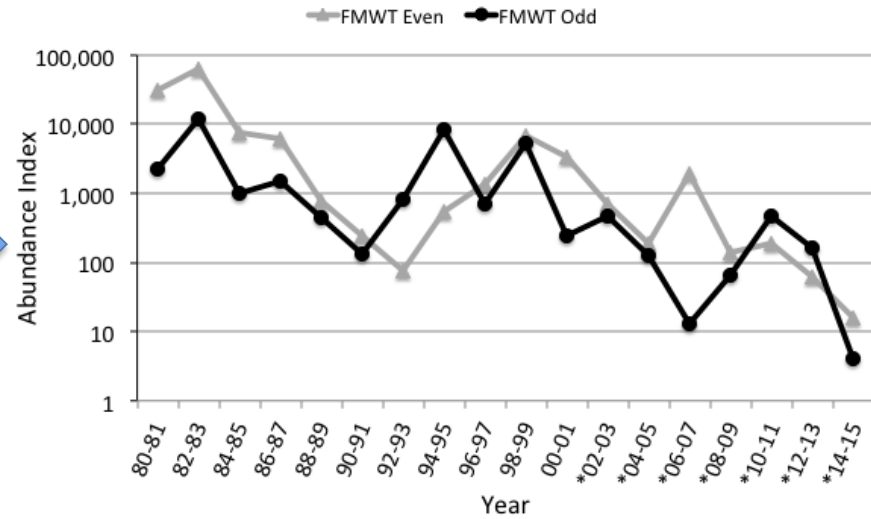
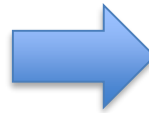
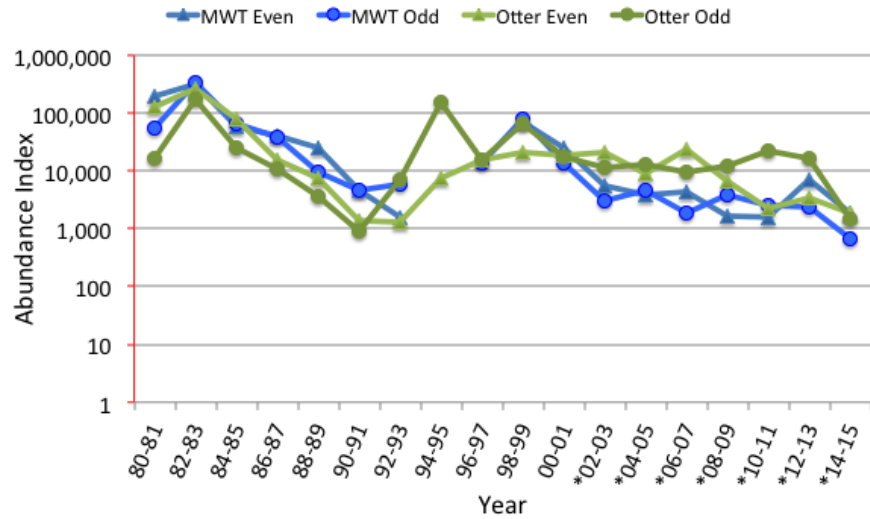
- Stock-Recruit (Ricker) Framework
- Parameterize with Bay Study (MWT + OT) → Verify against FMWT
- Two Life-stage Model
 - Age 2 → Age 0 & Age 0 → Age 2

Disaggregating Forces Driving Decline of Longfin Smelt

- Stock-Recruit (Ricker) Framework
- Parameterize with Bay Study (MWT + OT) → Verify against FMWT
- Two Life-stage Model
 - Age 2 → Age 0 & Age 0 → Age 2

Spawners (Age 2) → Recruits (Age 0 Juv)		Recruits (Age 0 Juv) → Spawners (Age 2)	
Statistic/Predictor Variables	Value	Statistic/Predictor Variables	Value
R ²	0.55	R ²	0.48
n	34	n	32
Freshwater Flow (PC)	p=6*10⁻⁷	Freshwater Flow (PC)	Dropped
Density Dependence	p<0.05	Density Dependence	p=6*10⁻⁶
Temperature (PC)	Dropped	Temperature (PC)	Dropped
Mean Temperature	Dropped	Mean Temperature	Dropped
Water Transparency (PC)	Dropped	Water Transparency (PC)	Dropped
Year (Continuous Change)	Dropped	Year (Continuous Change)	???
Step-Change (1987)	Dropped	Step-Change (1989)	???
		Step-Change (1991)	P=0.001

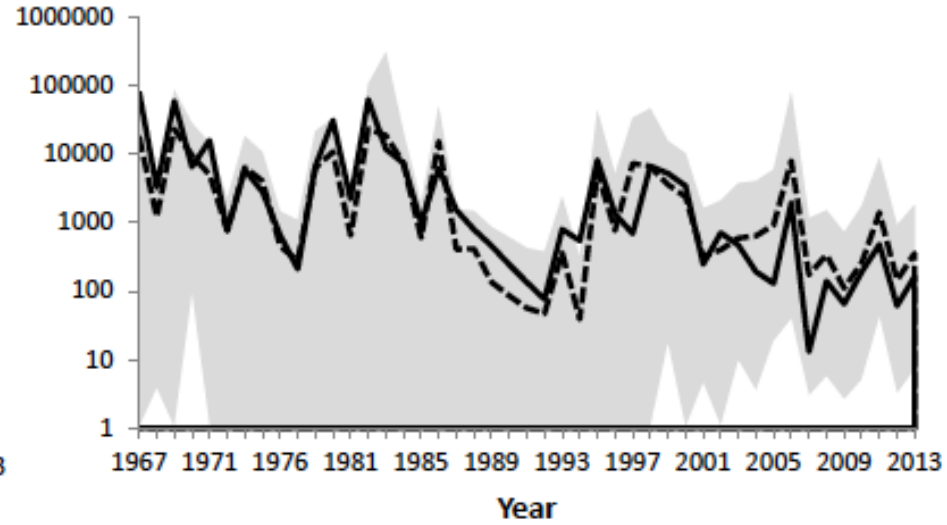
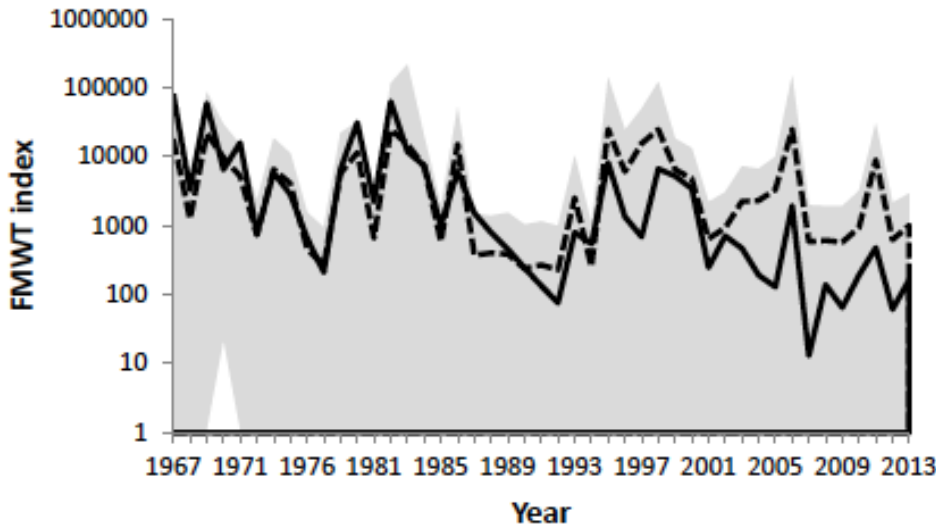
Bay Study and FMWT Tell a Consistent Story



Without Food Web Step-Change



With Food Web Step-Change



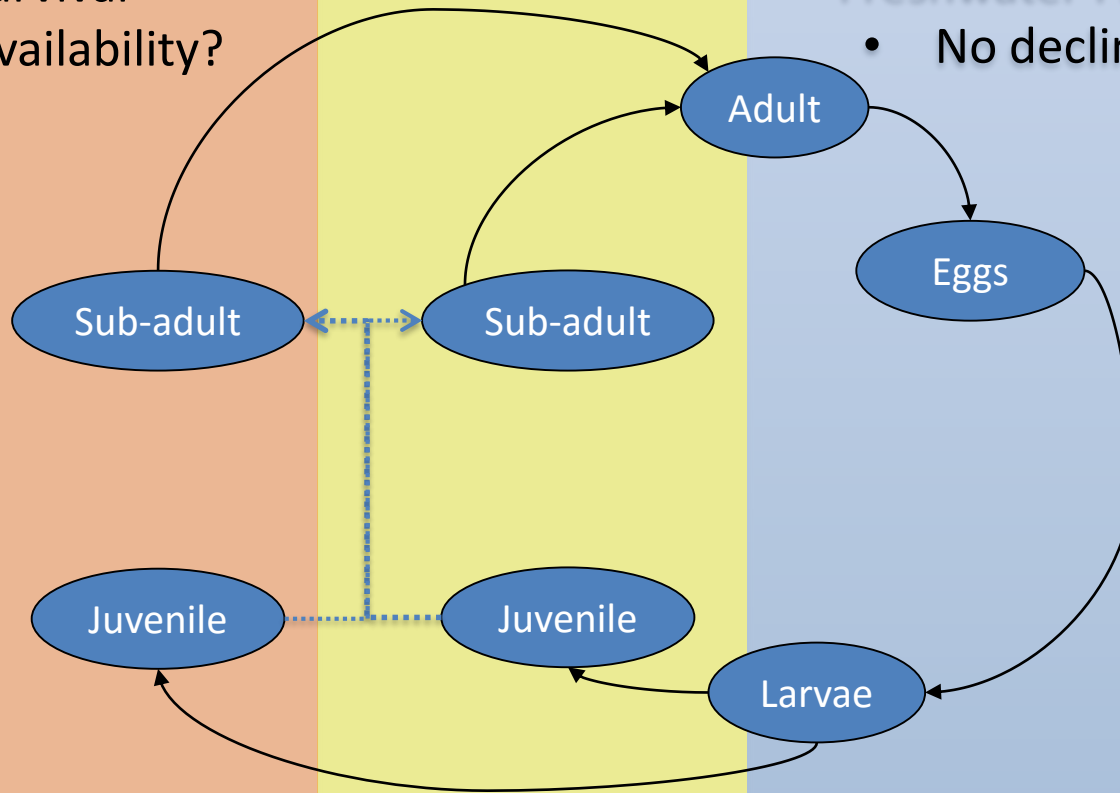
Euhaline-to-Mixohaline
May-October

Mesohaline
Year-round

Fresh-to-Oligohaline
December-April

- Juvenile Recruits
- Density Dependence
- Declining Survival
 - Food Availability?

- Spawning Stock
- Density Dependence
- Freshwater Flow
 - No decline over time



← Marine --- Central Bay -- San Pablo Bay -- Suisun Bay -- West Delta (& Napa R. etc.) →

Question:

Is Extinction Inevitable for Delta Smelt and Longfin Smelt?

- Winter-run Chinook salmon (GrandTab)

Last Drought			Following Last Drought	
Year	Escapement		Year	Escapement
1989	696		2001	8,224
1990	430		2002	7,441
1991	211		2003	8,218
1992	1,240		2004	7,869
1993	387		2005	15,839
1994	186		2006	17,296

- Longfin smelt (Bay Study MWT)

Last Drought			Following Last Drought	
Year	Index		Year	Index
1992	1,590		1998	70,213
1993	5,919		1999	77,481

Recovery is Possible – If we Manage for Recovery

Question:

Is Extinction **Inevitable** for Delta Smelt and Longfin Smelt, if we fail to use our best information to manage for success?

Answer:

Let's not try that...



Australopithecus



Homo habilis



Homo erectus



Homo sapiens neandertal



Homo sapiens



Homo politicus

I did **not** see that coming

