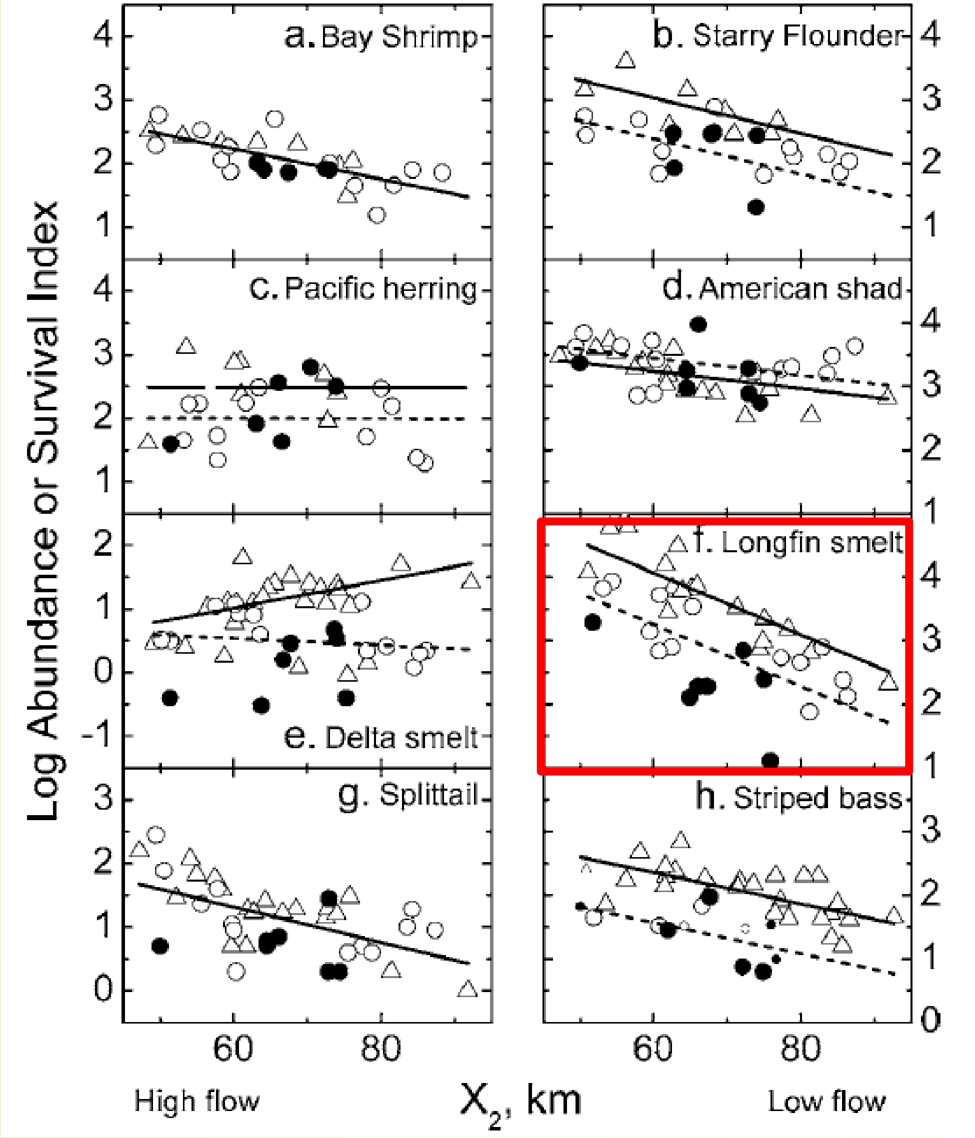
# Examining Rearing Habitat of Larval and Juvenile Longfin Smelt in the Upper San Francisco Estuary: A Case to Move to Uncharted Waters

Lenny Grimaldo (ICF), Fred Feyrer (USGS), Jillian Burns (ICF), Donna Maniscalco (ICF), Jason Hassrick (ICF), LeAnne Rojas (ICF), Dave Fullerton (MWD), and Shawn Acuña (MWD)

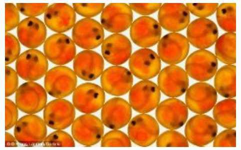
# Background


# More spring flow = more fish in the fall




Kimmerer et al. 2009

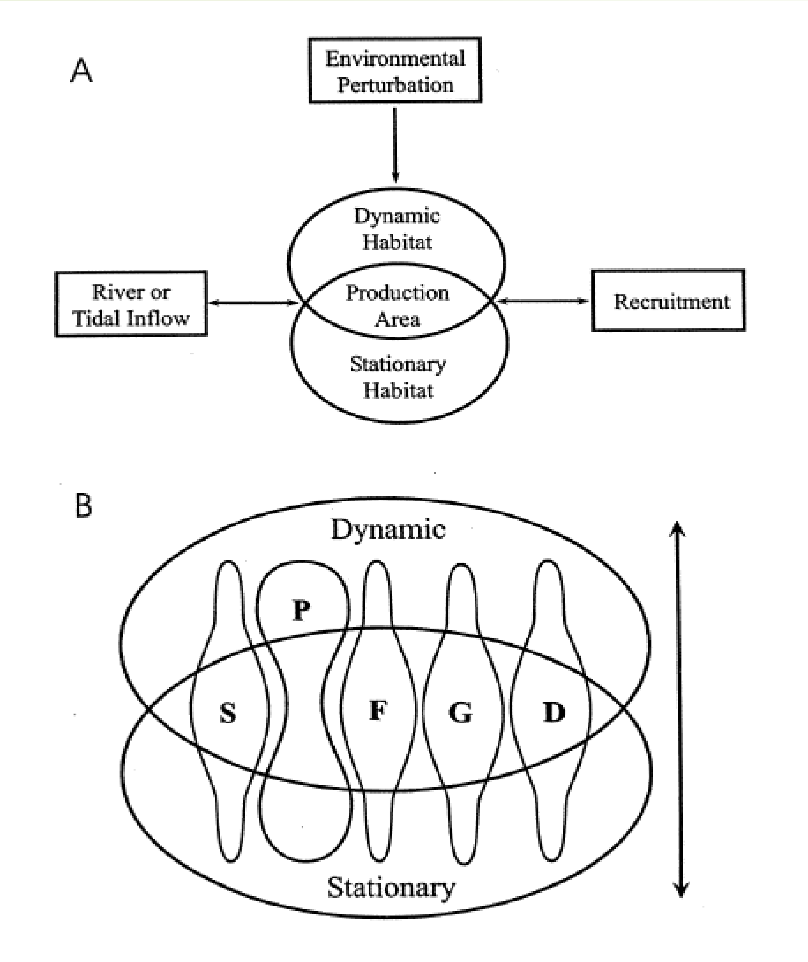
# Underlying conceptual model



Spring

Growth
Survival

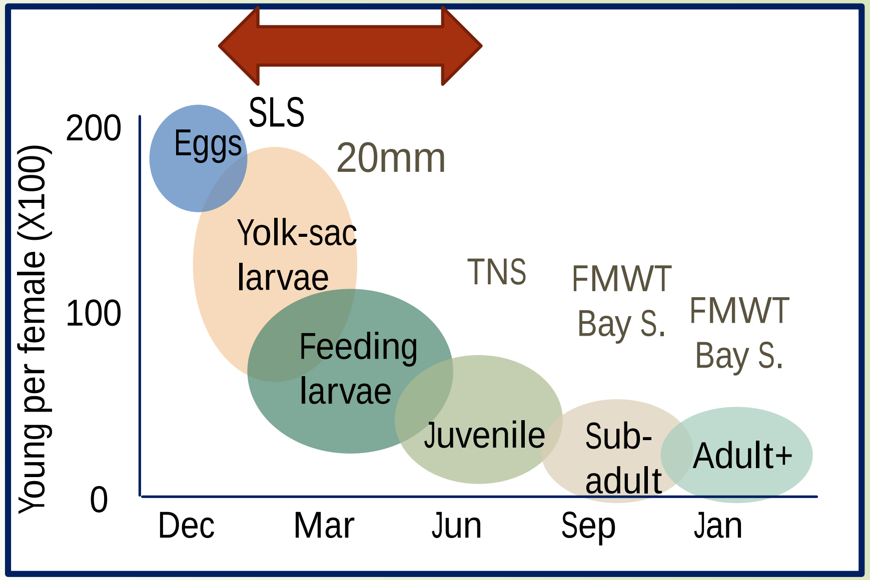
Fall




S = Survival, P = Predator, F = Foraging,
G = Growth, D = Density

Peterson 2003

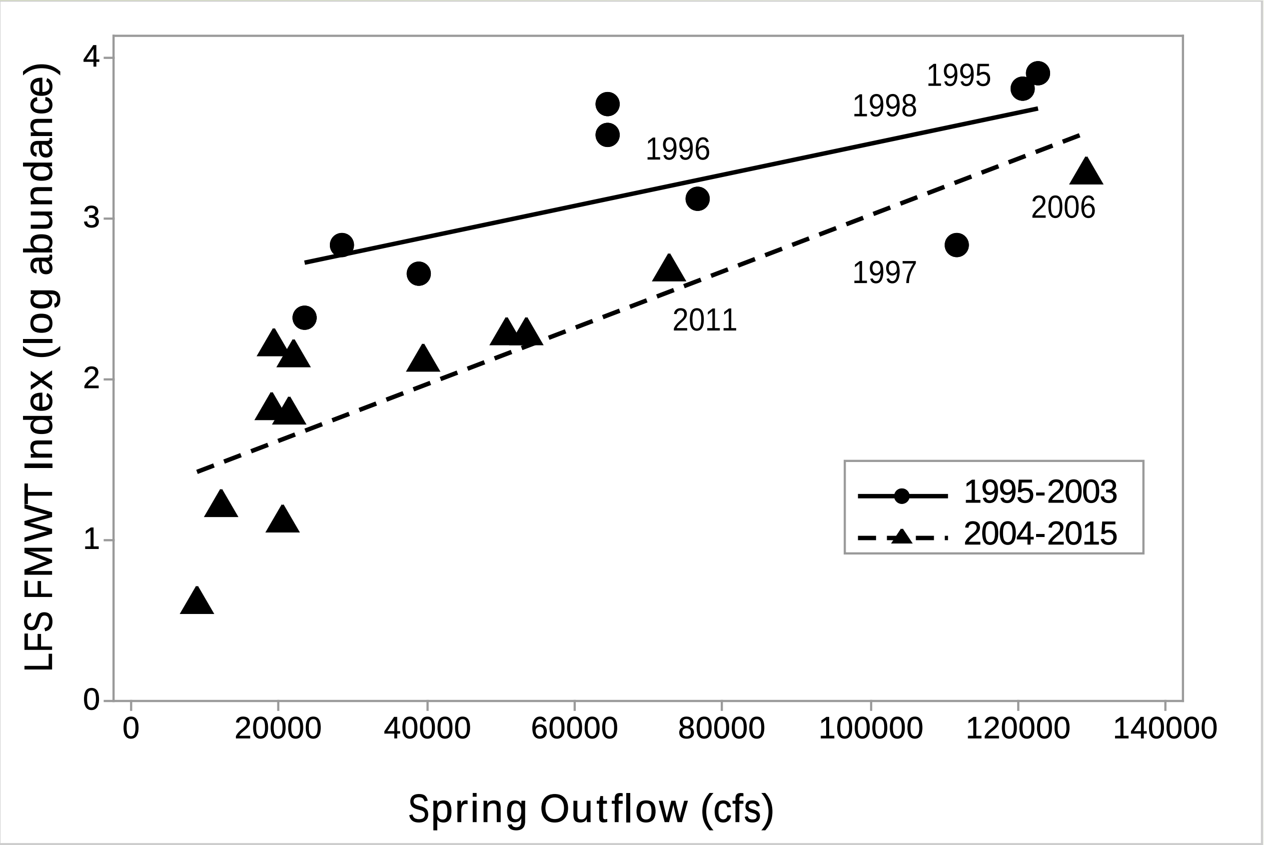
1. CDFW Monitoring Data



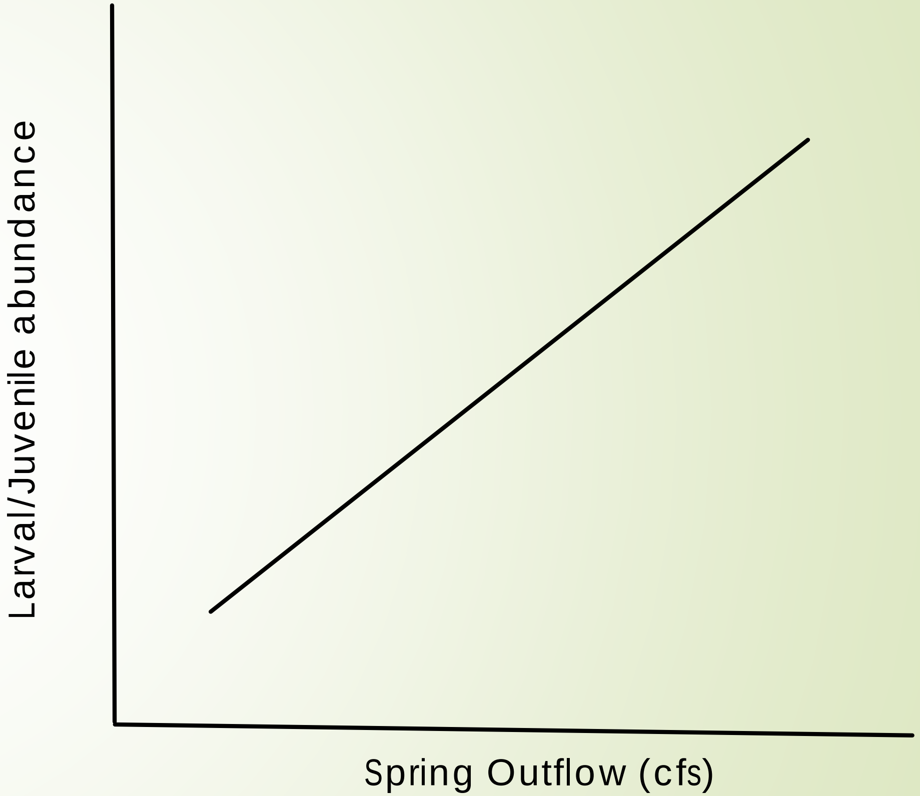

2. Tidal Marsh Study

# Relationships between flow and larval/juvenile abundance

Fall Abundance vs Spring Outflow

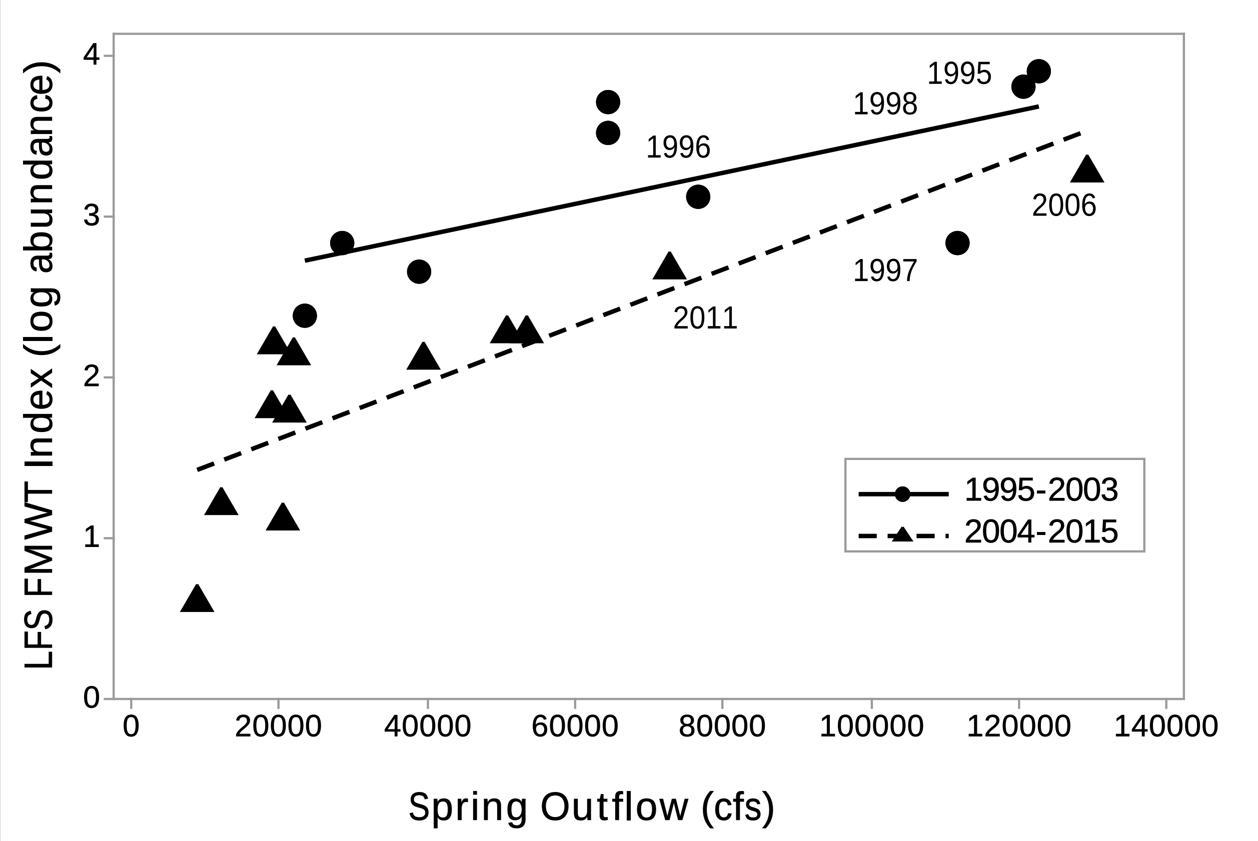



Hypothesis

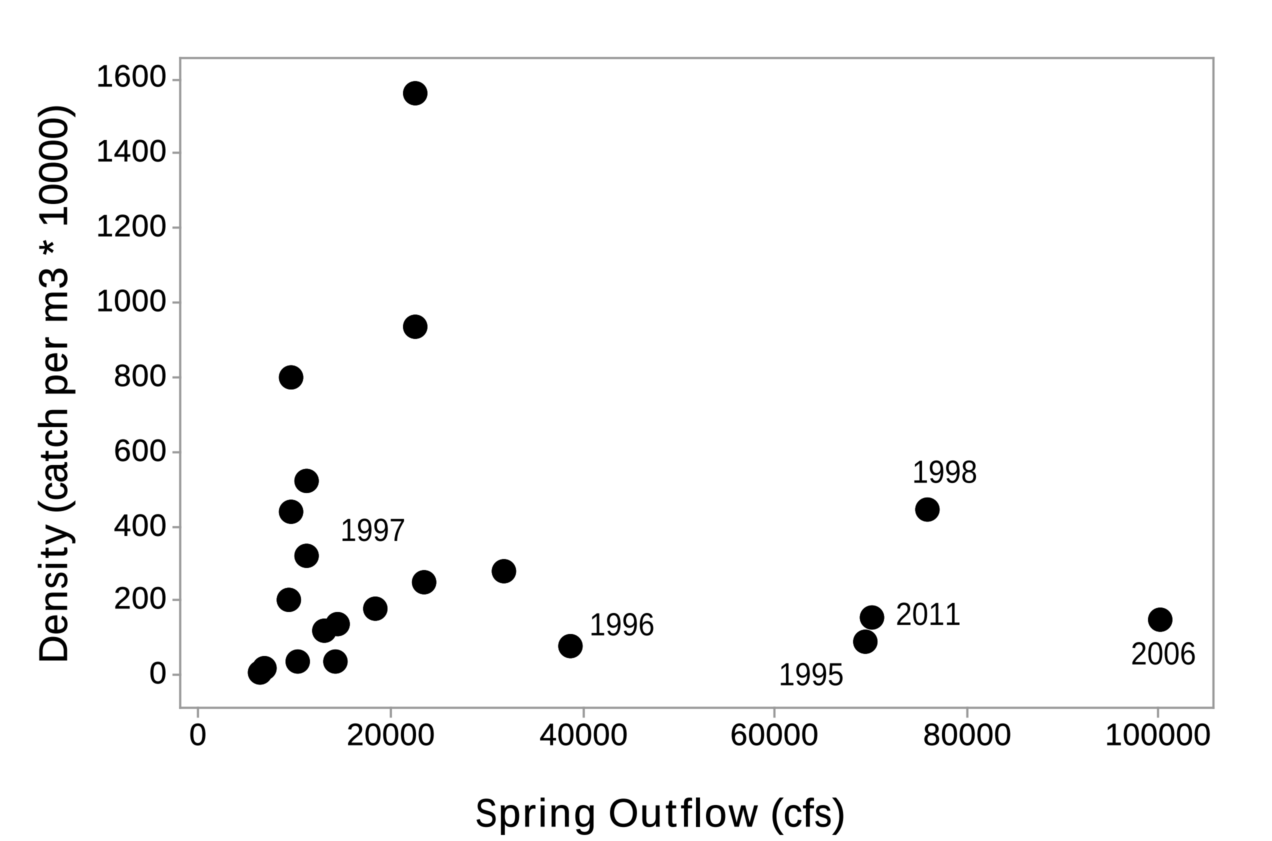


# Relationships between flow and larval/juvenile abundance

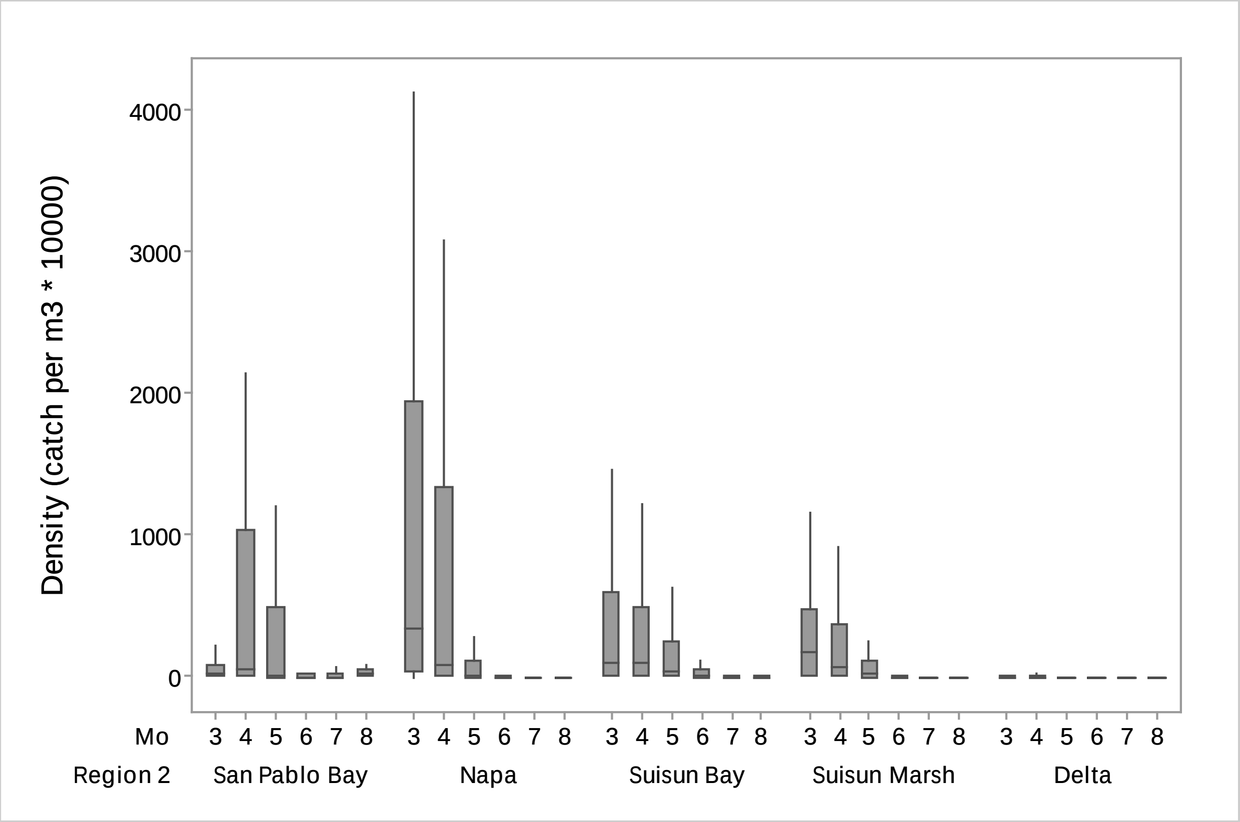
## Fall Abundance vs Spring Outflow




## Spring Abundance vs Spring Outflow



# Longfin Smelt Densities By Region
# 20 mm Survey (1995-2015)



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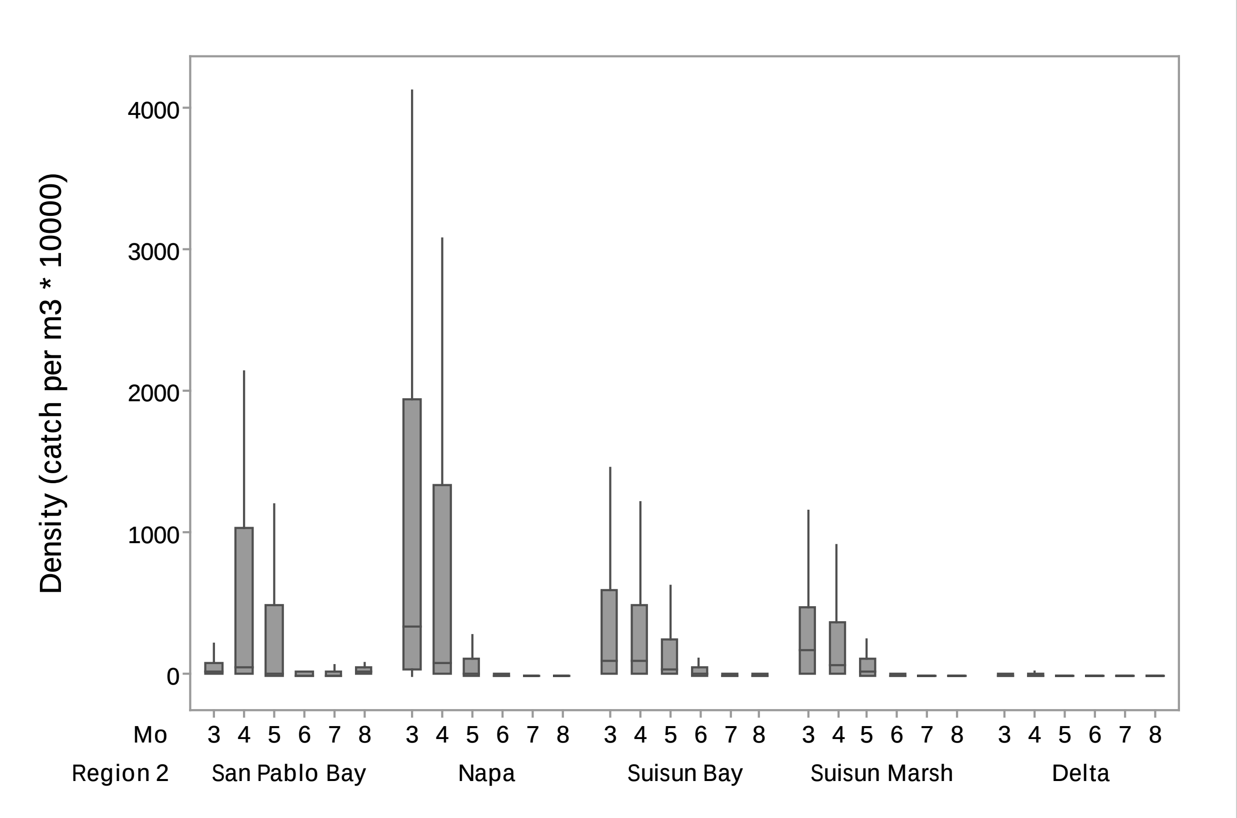
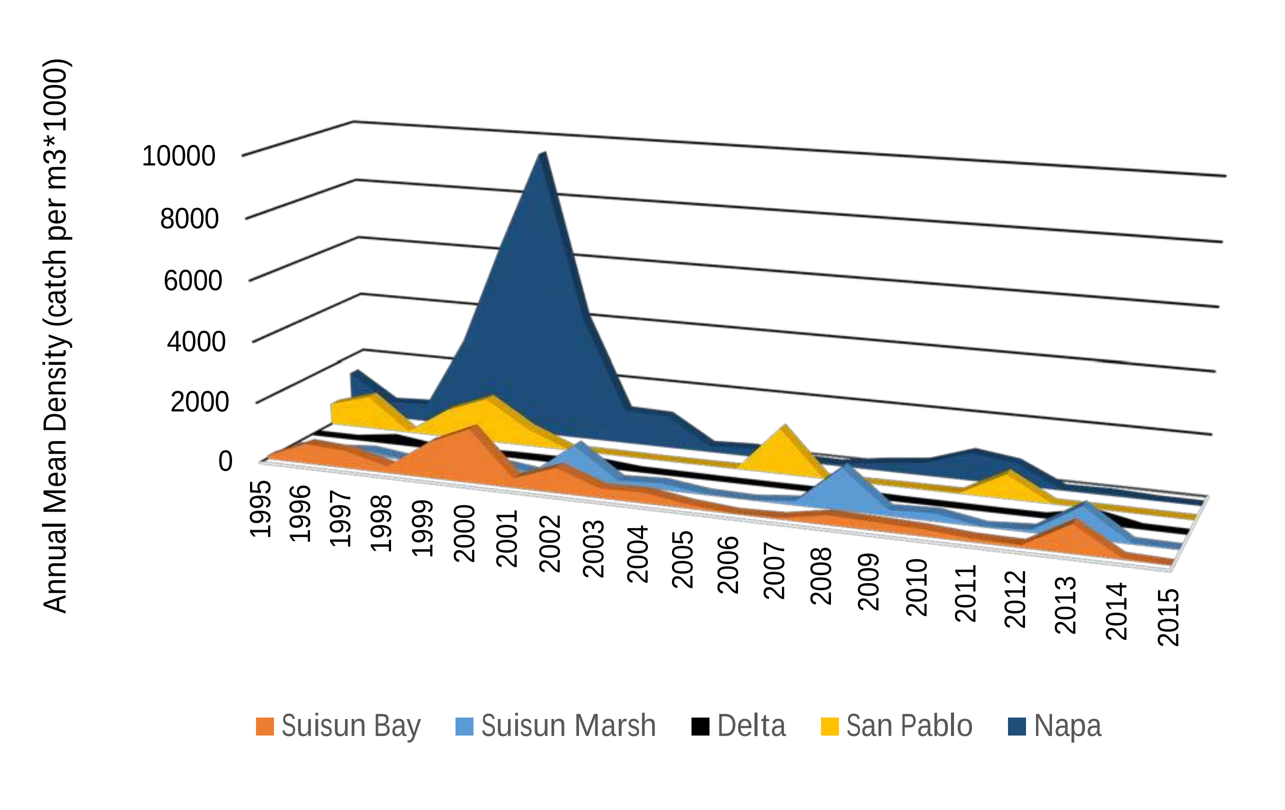
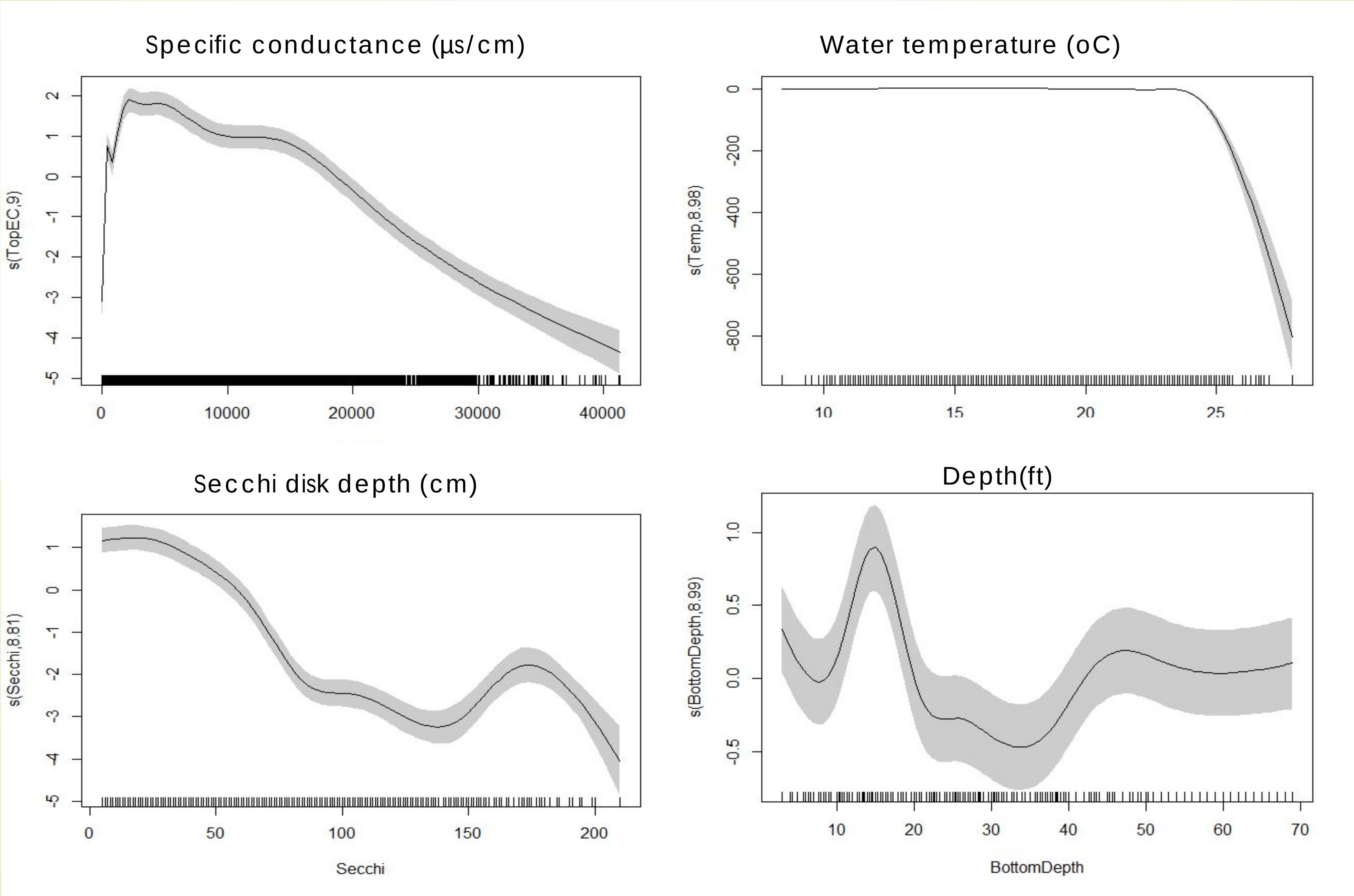


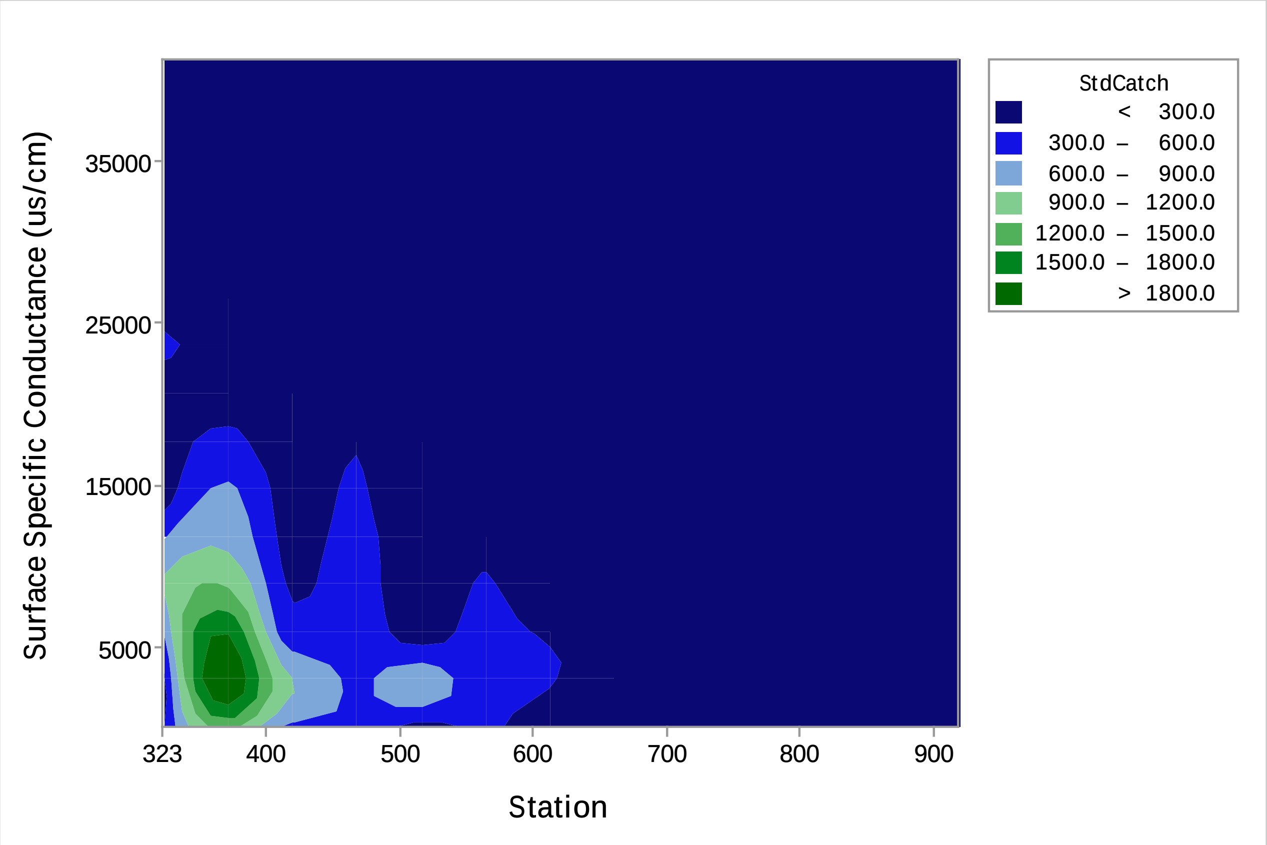



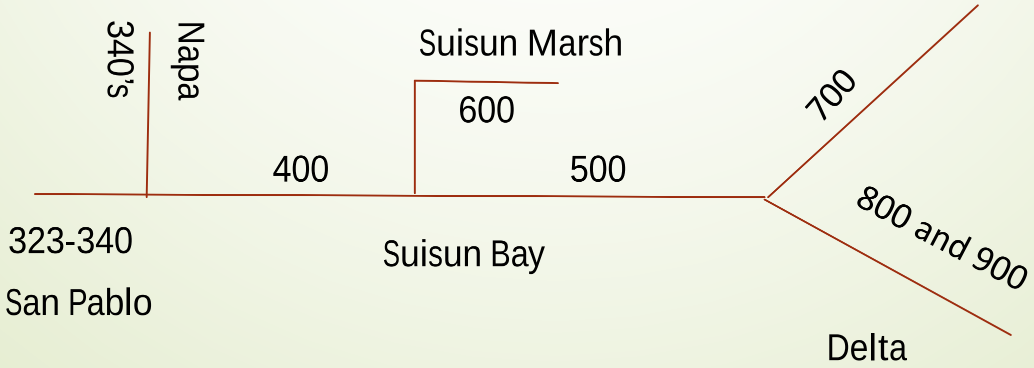
# Relationship between Longfin Smelt densities and Environmental Variables
# 20 mm data (1995-2015)




GAM = Count ~ sTemp+ Year + sSecchi,+ s(SurfaceEC)+ s(BottomDepth), offset=log(volume), family=poisson(link=log))

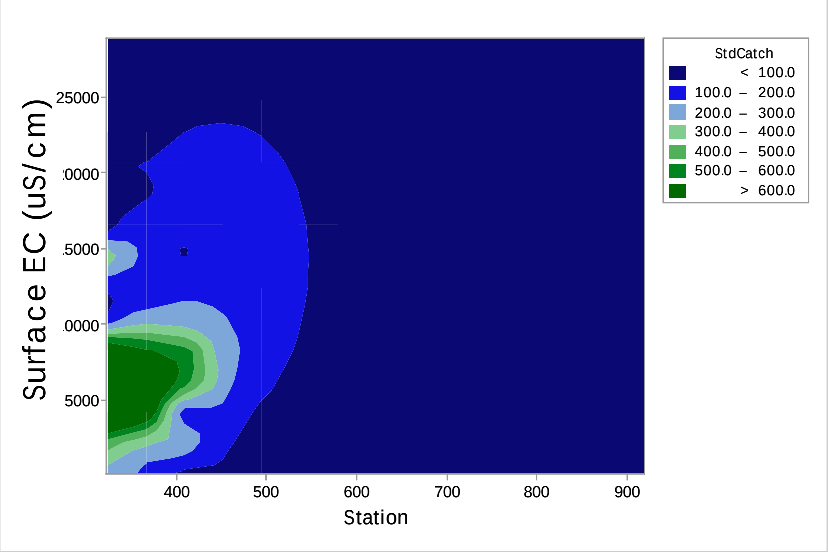
# Longfin Smelt Density by Station and Surface Specific Conductance
# 20 mm (1995-2015)



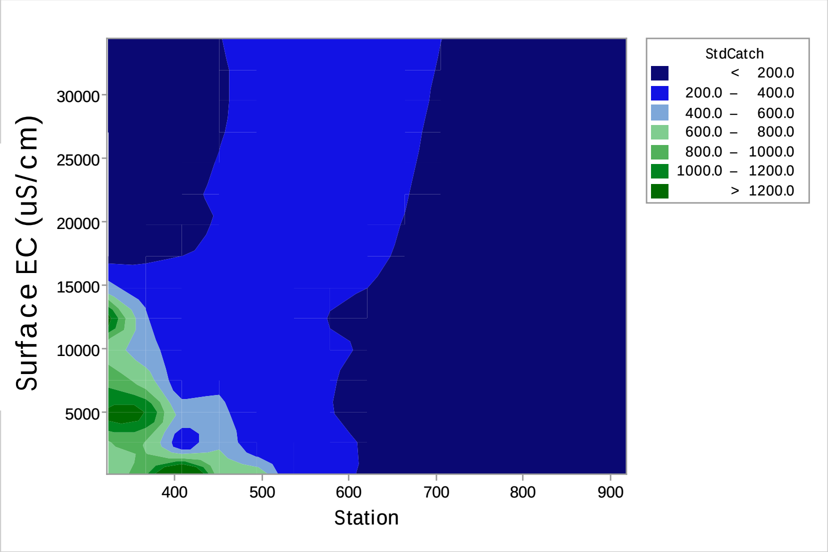



# Standardized Longfin Smelt Catch Contours by Station and EC

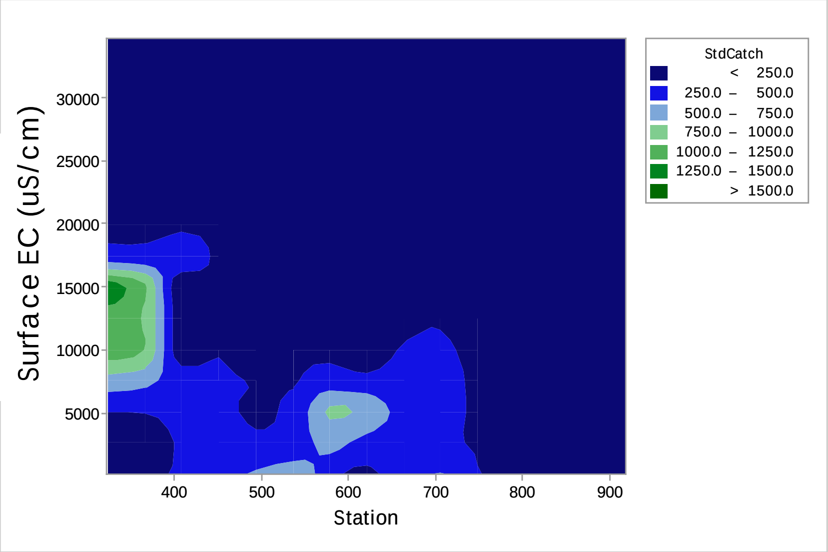
## 1995



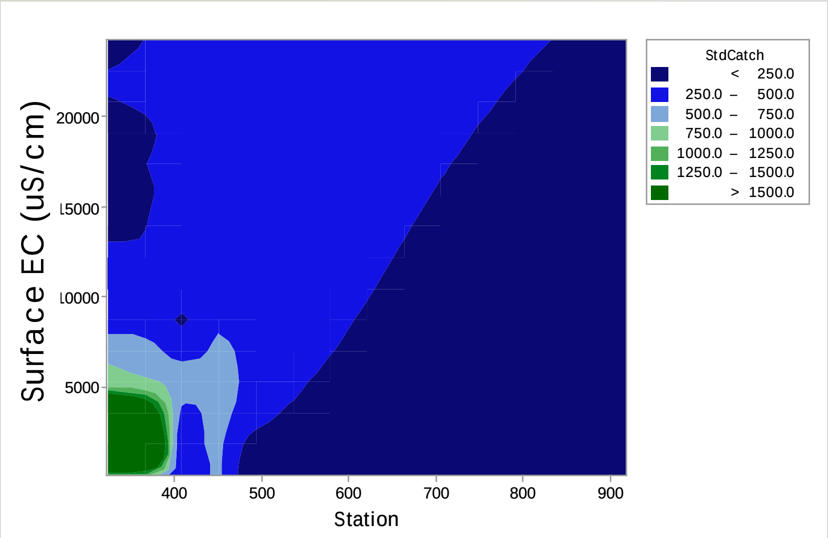

## 1996



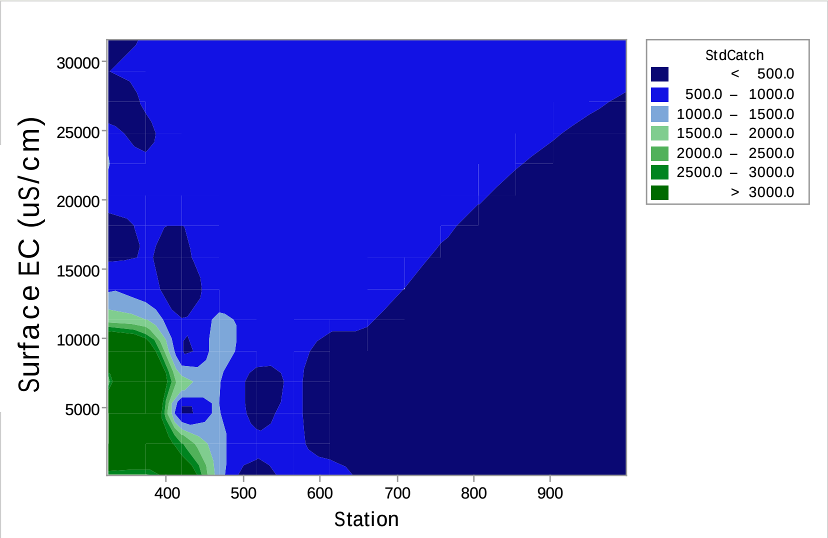

## 1997



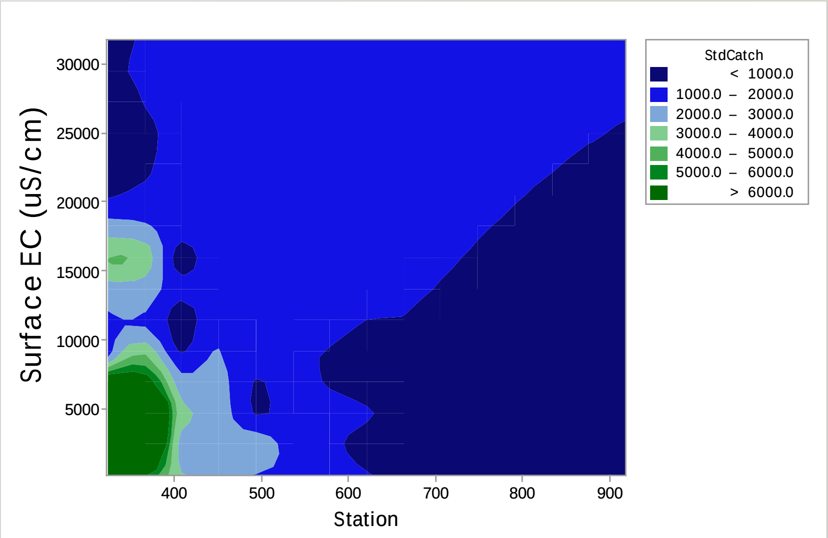

## 1998




## 1999

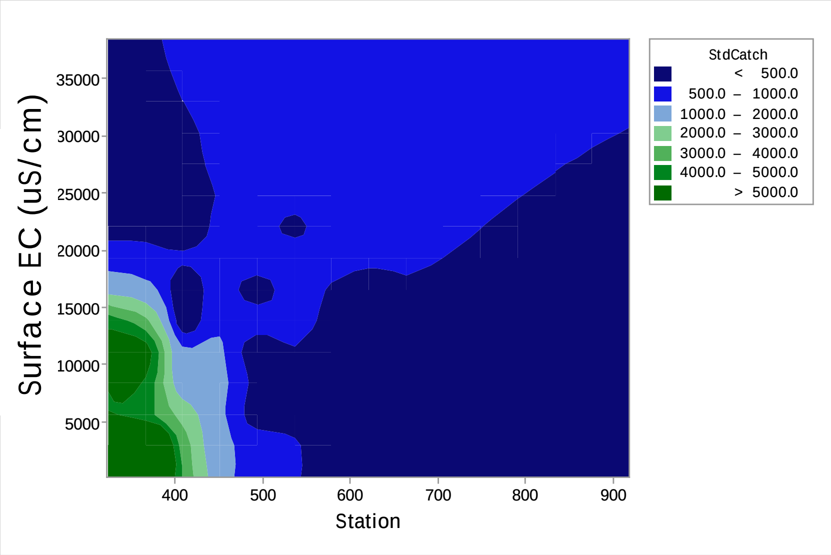



## 2000

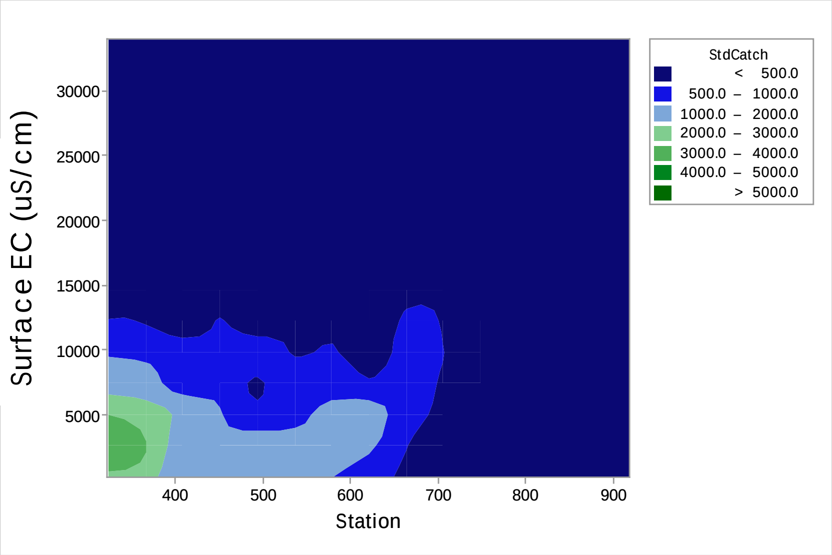


# Standardized Longfin Smelt Catch Contours by Station and EC

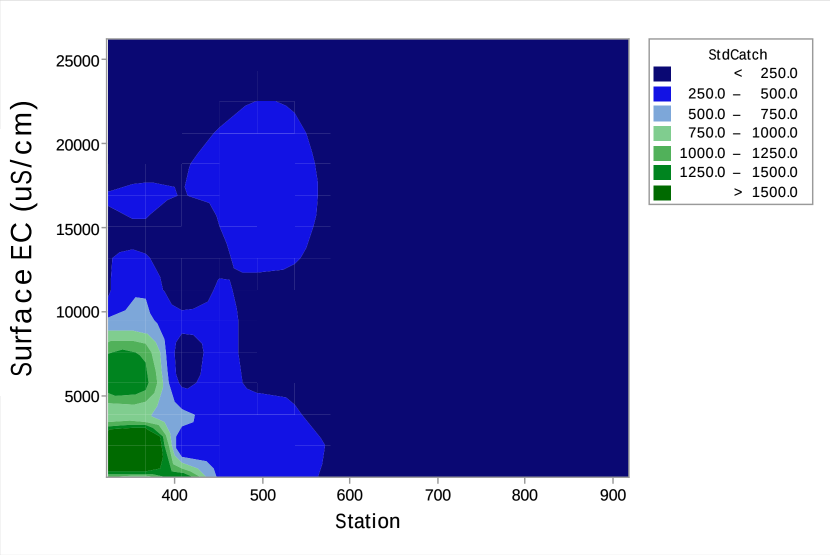
## 2001



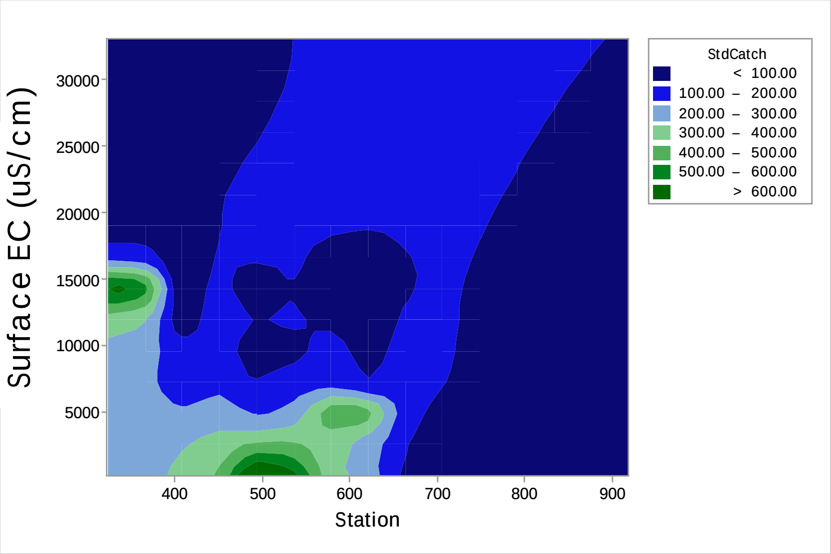

## 2002



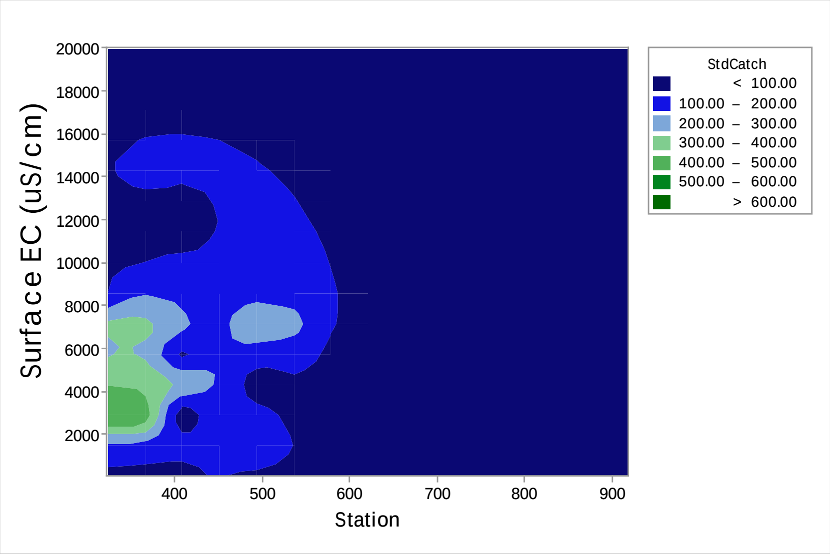

## 2003



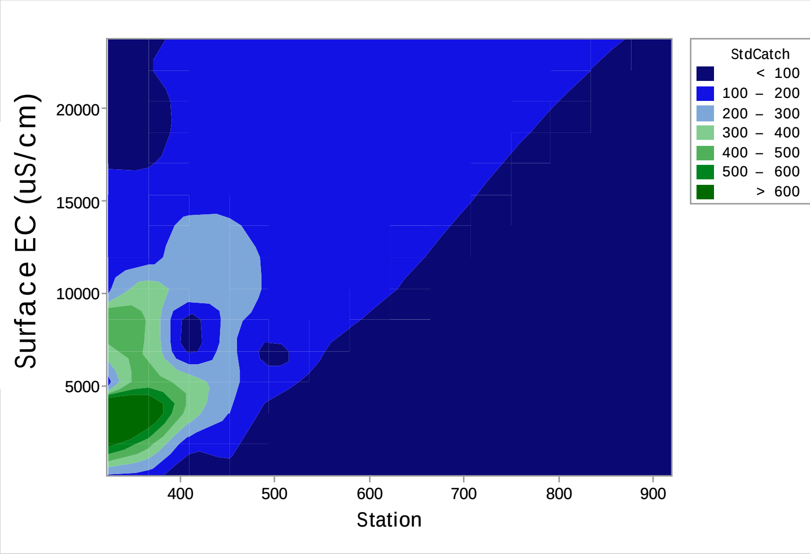

## 2004




## 2005




## 2006



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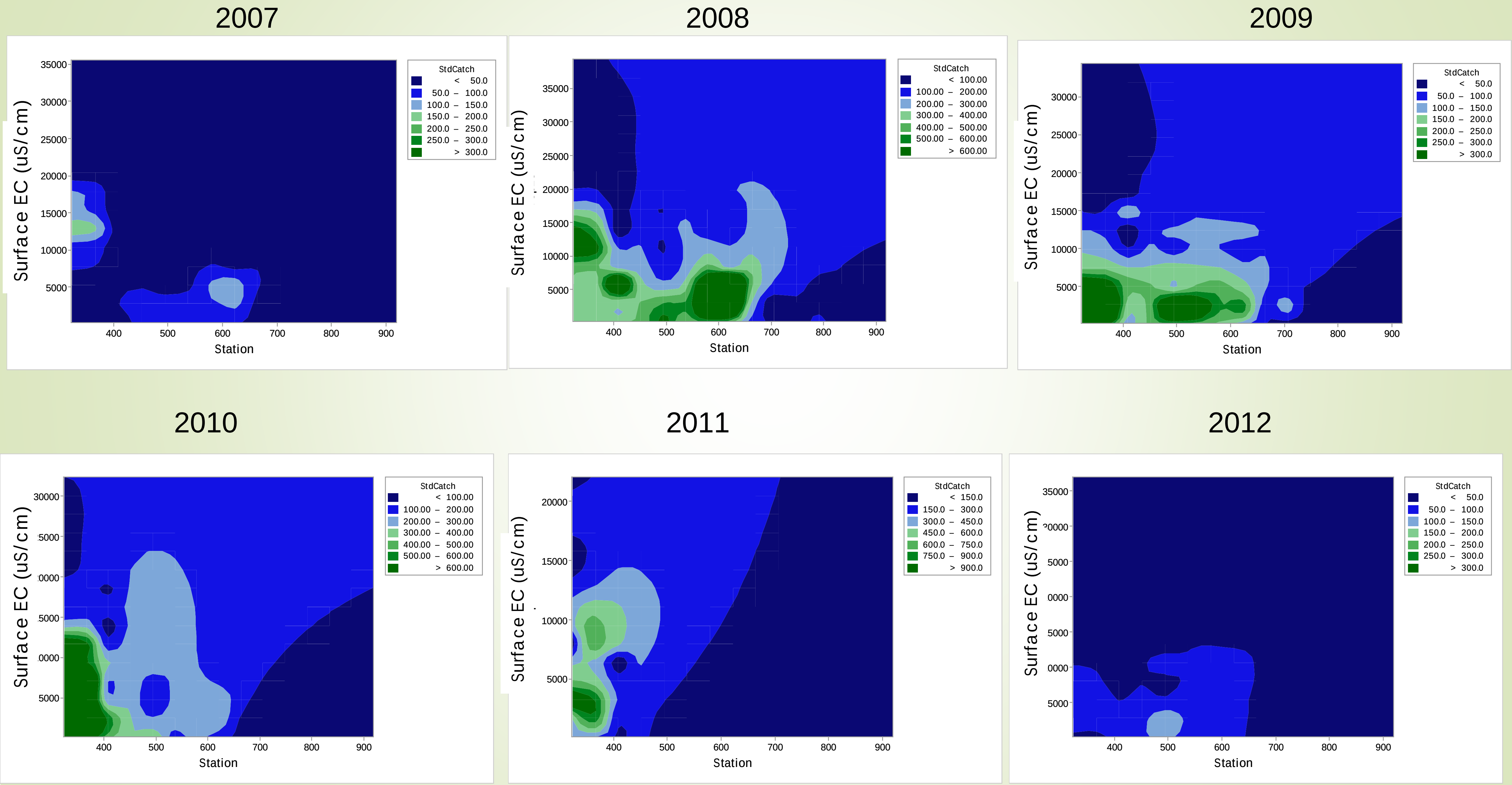
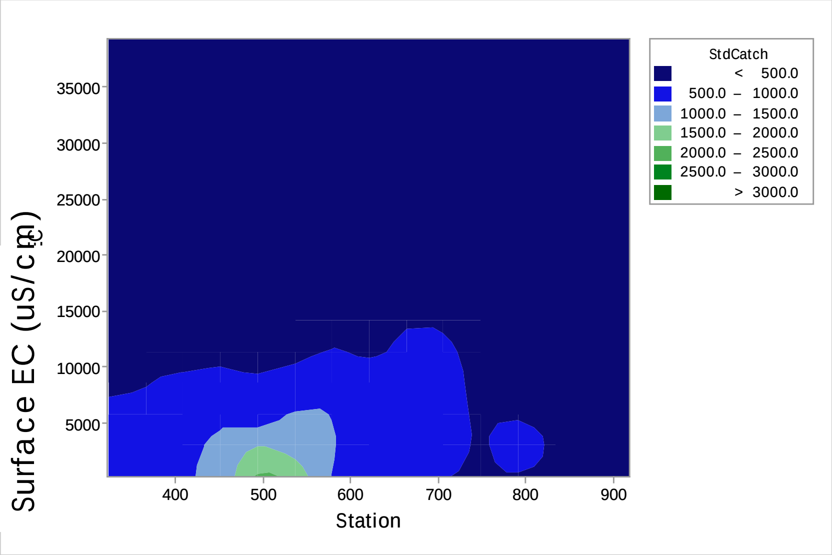
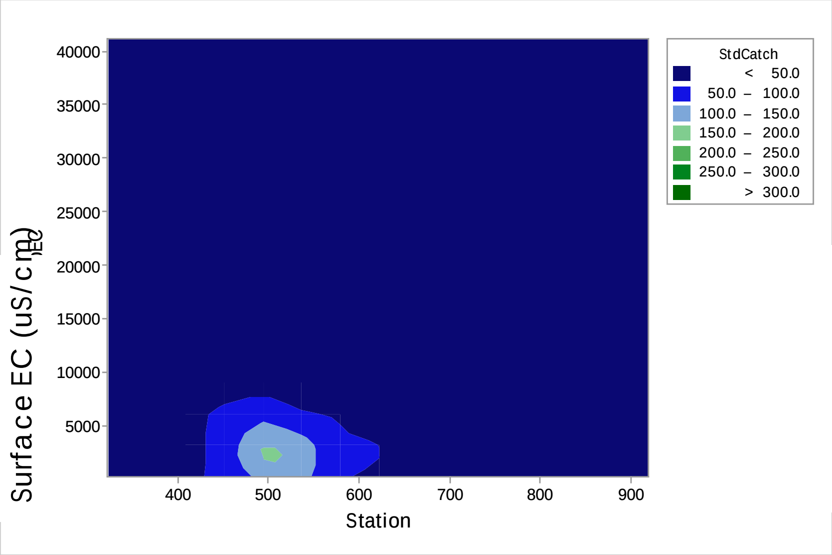


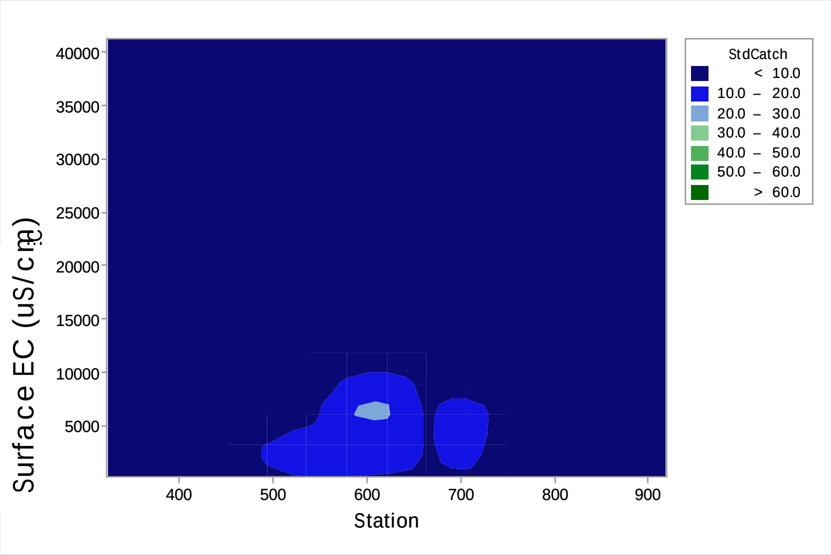
2013



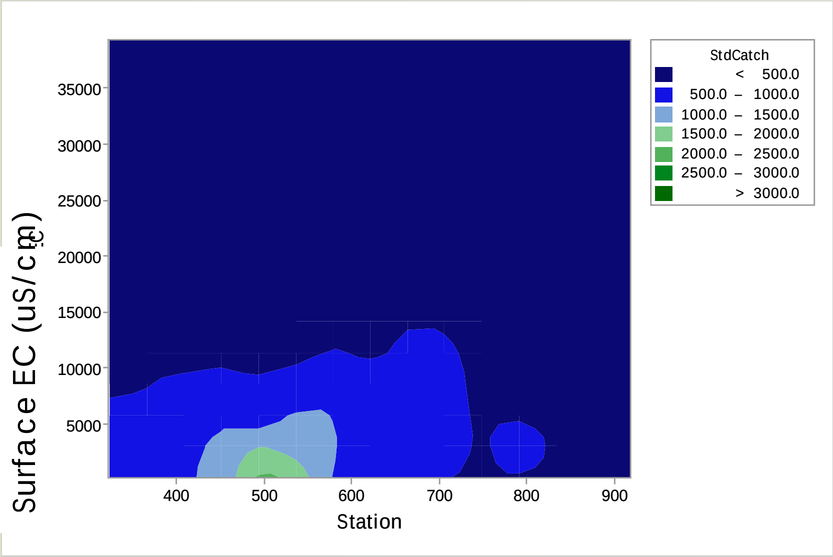

2014



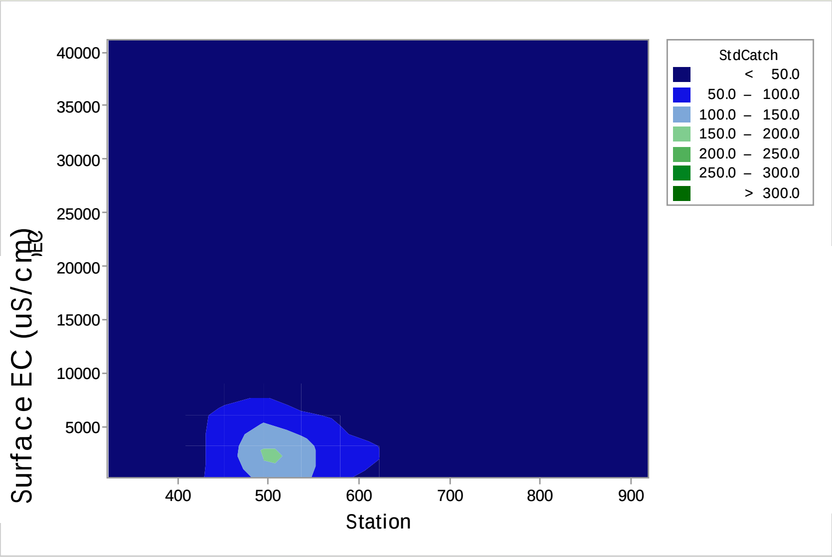

2015



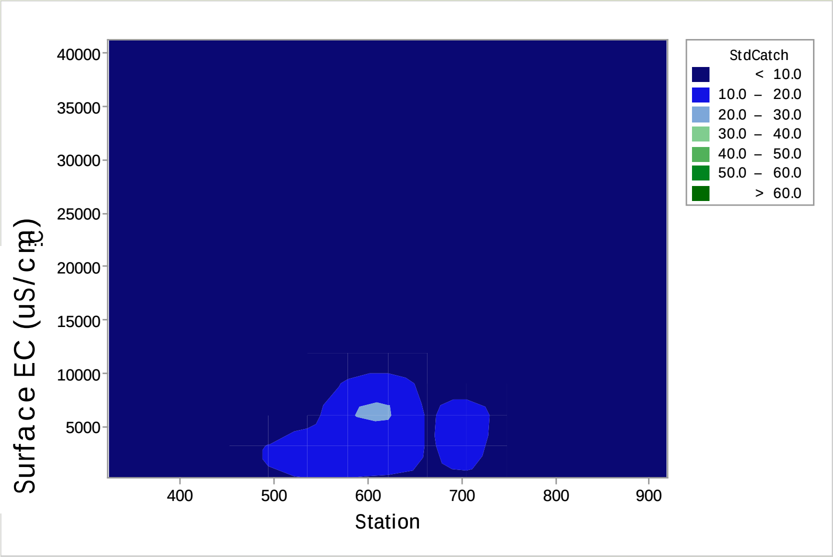
2013

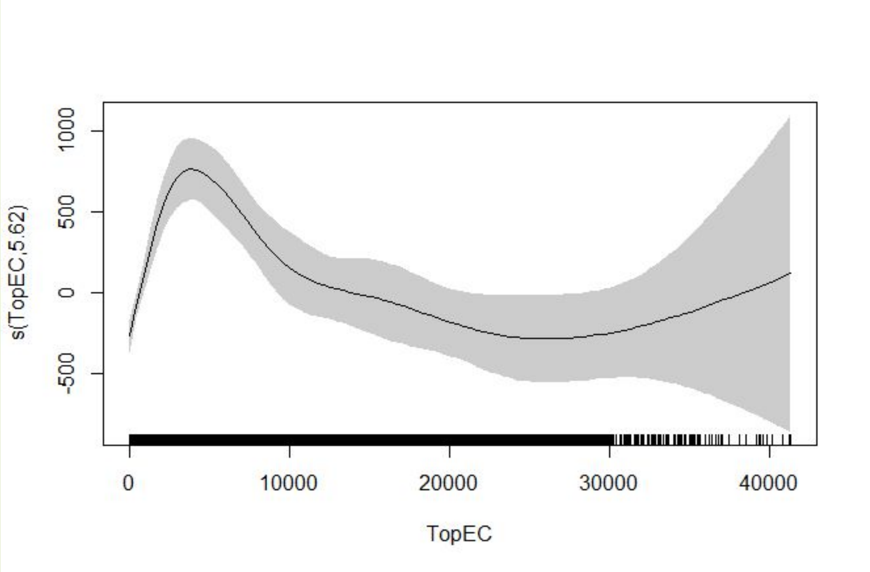



2014

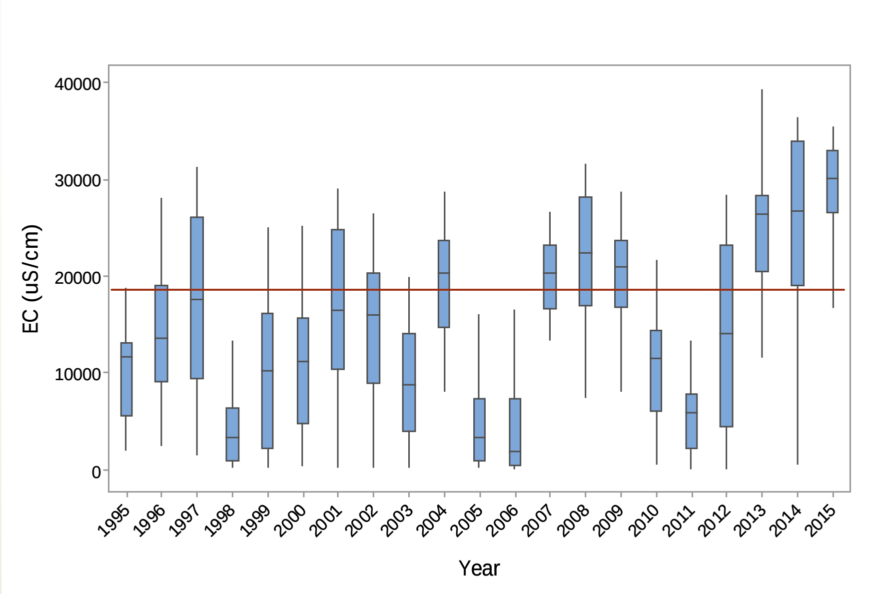



2015




Napa River Specific conductance (us/cm)



# POTENTIAL MECHANISMS

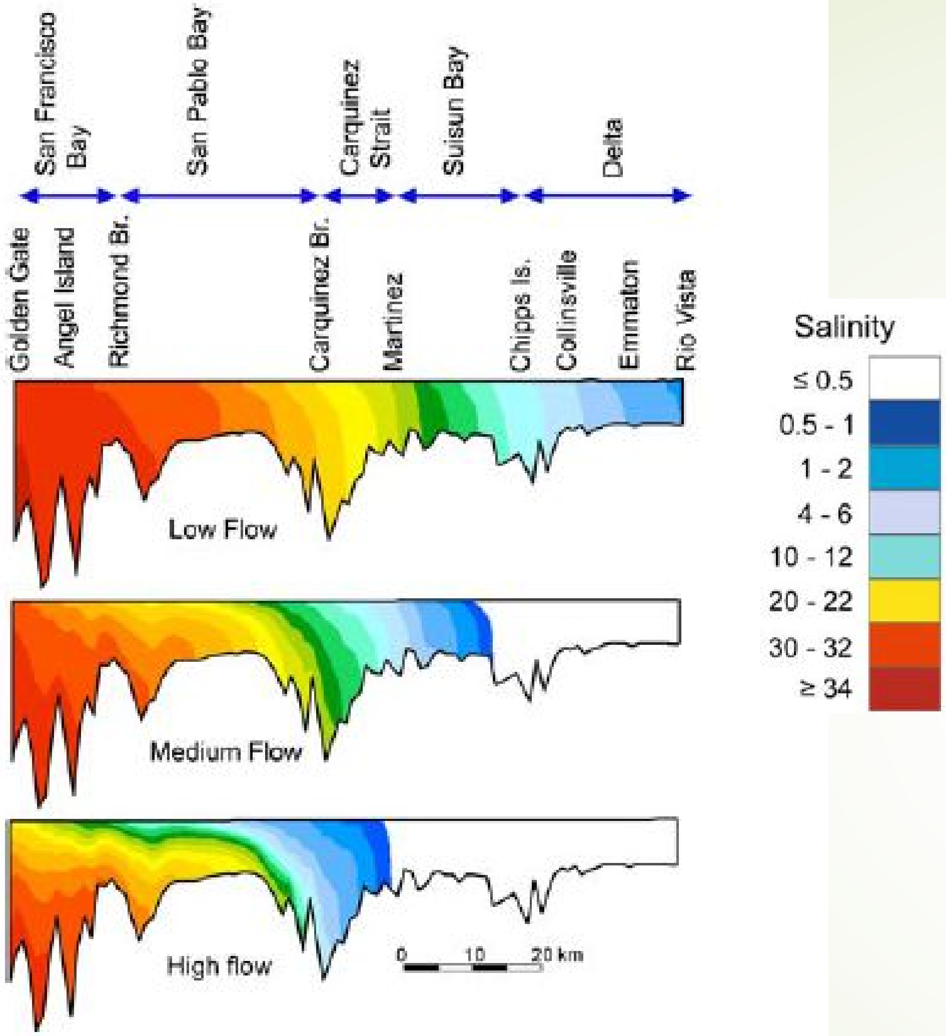
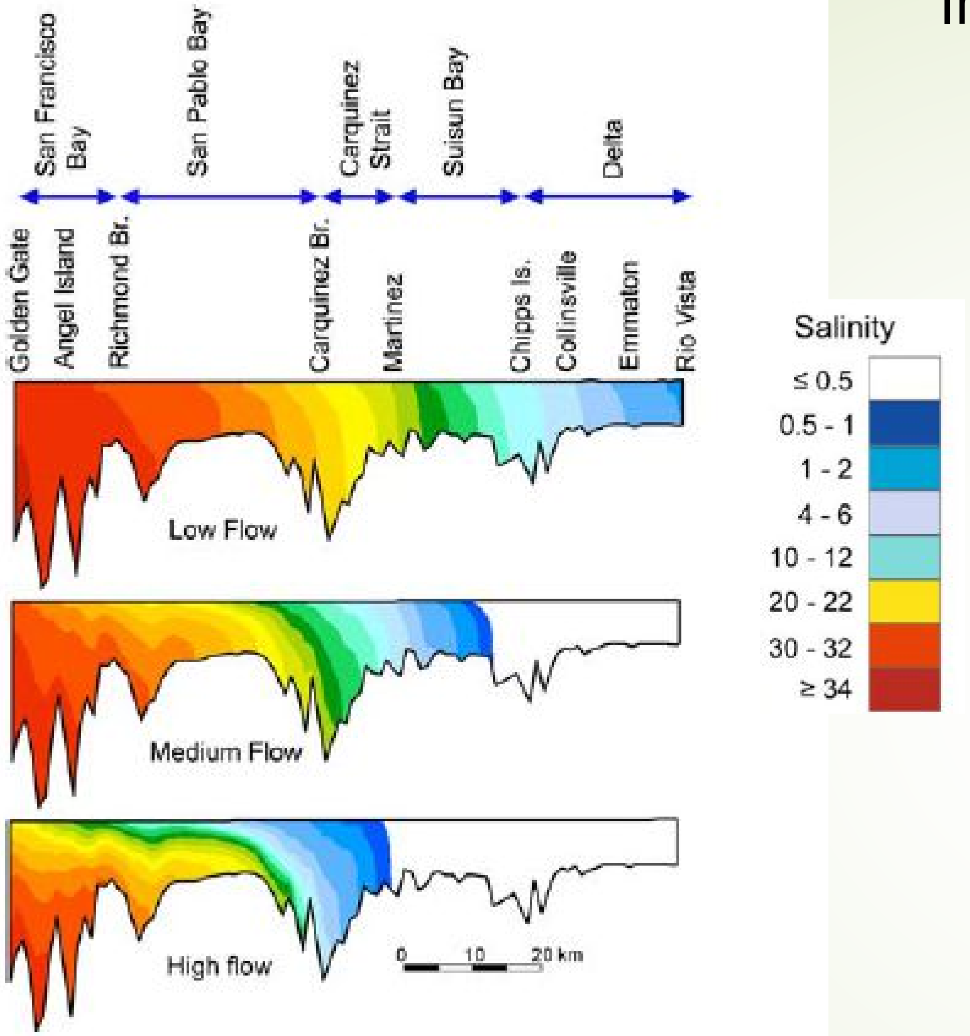



**Fig. 6** TRIM3D model output. Tidally averaged salinity along the transect of the main channel from Golden Gate to Rio Vista (river kilometer 100). Locations identified by heavy lines in Fig. 1 and estuarine basins are listed at the top. Model output is given for net Delta outflows of (*top to bottom*) 110, 630, and 2810 $m^3 s^{-1}$ (lowest, middle, and highest flow)

Kimmerer et al. 2009

# Increased spawning and rearing habitat-

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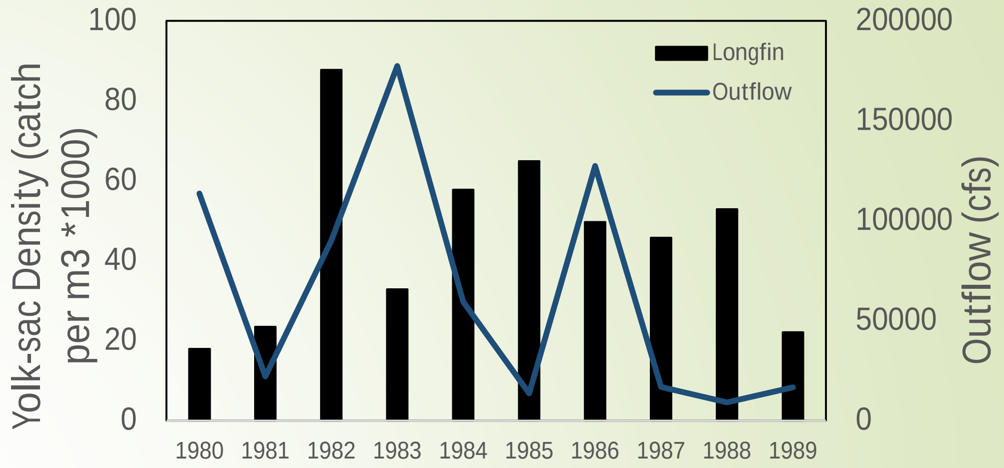
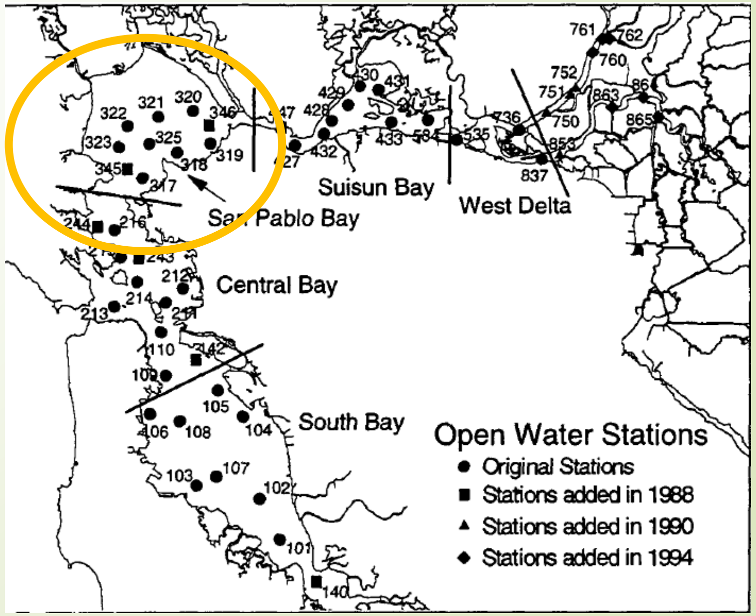
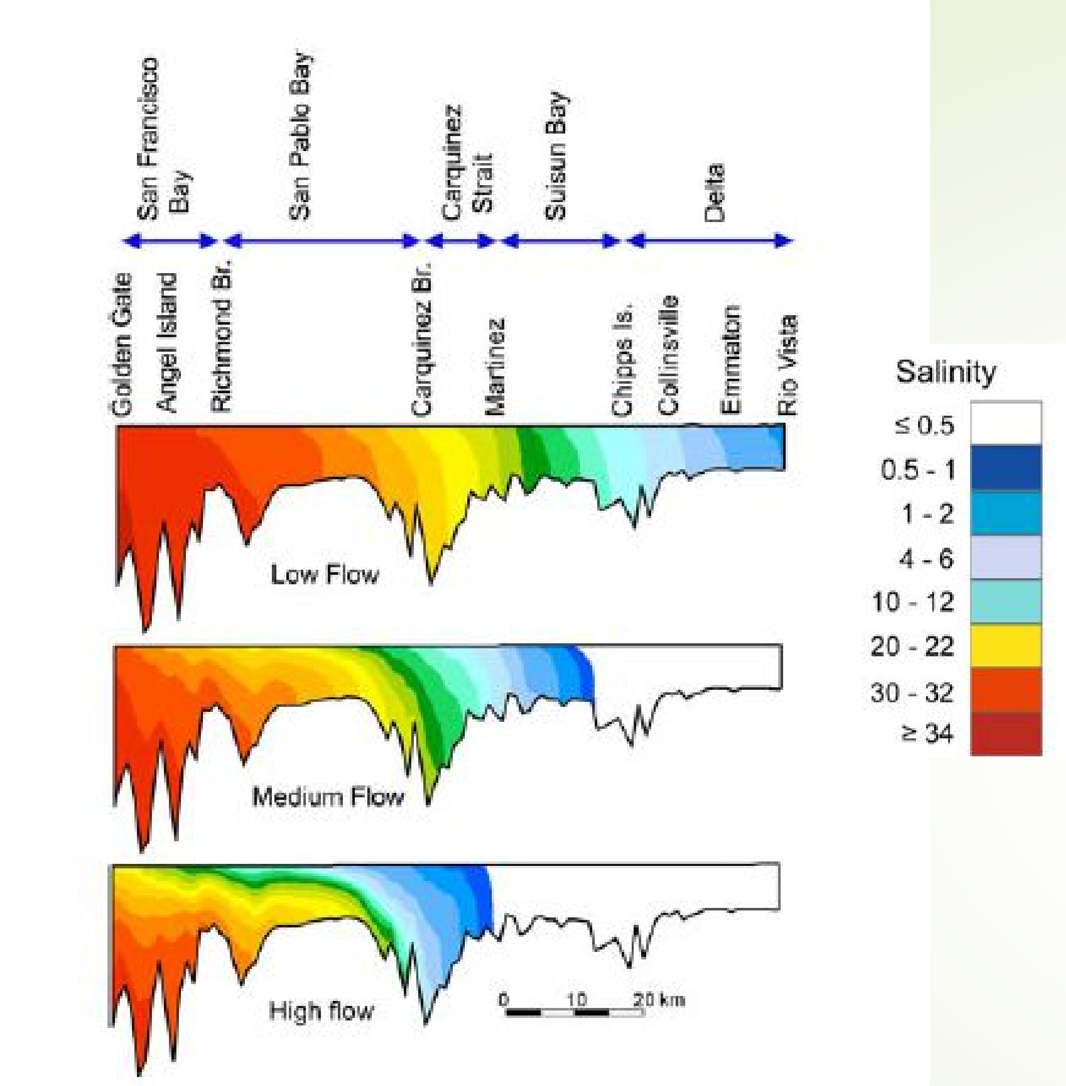
Kimmerer et al. 2009




Bay Survey E and L Data



# Food-

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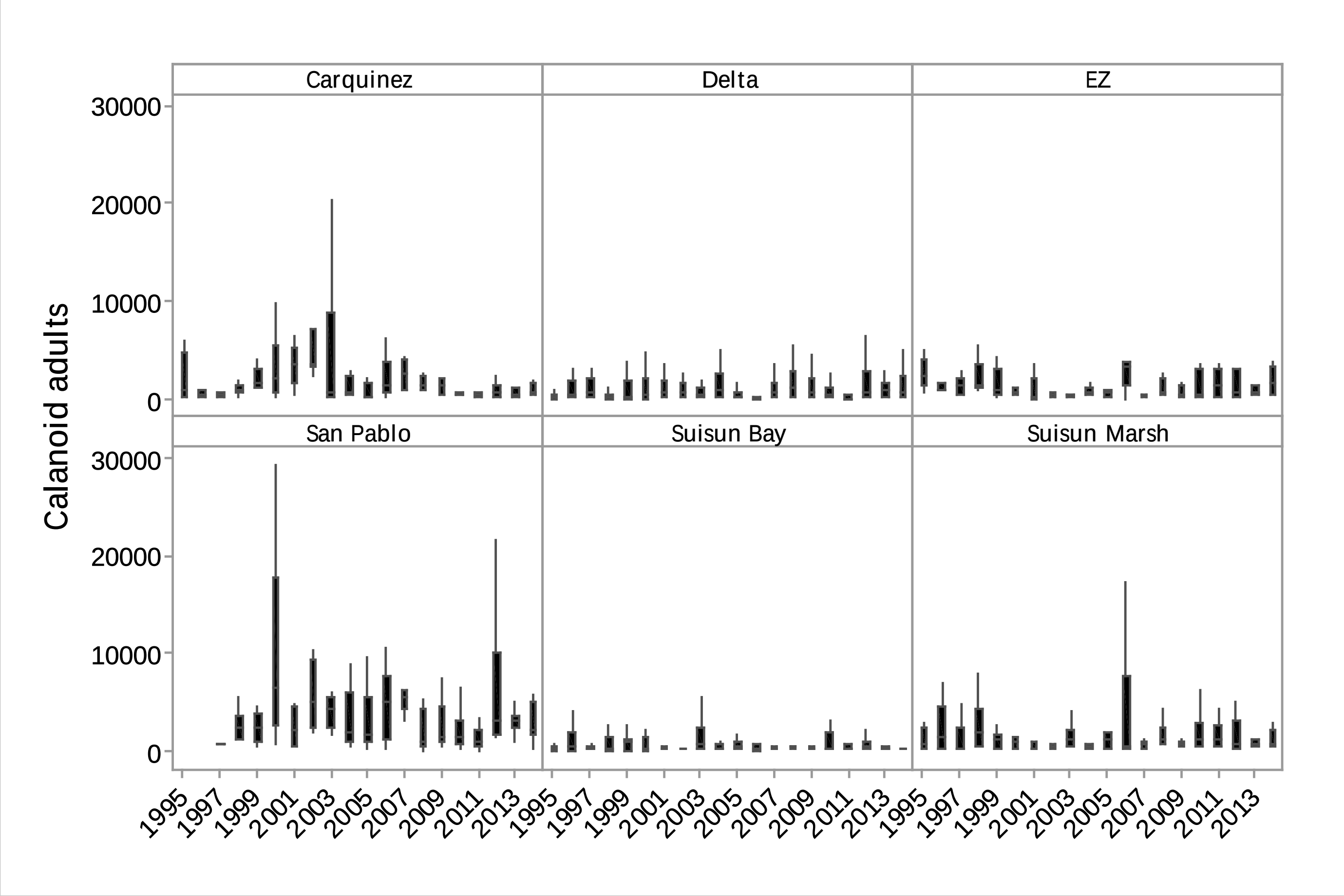
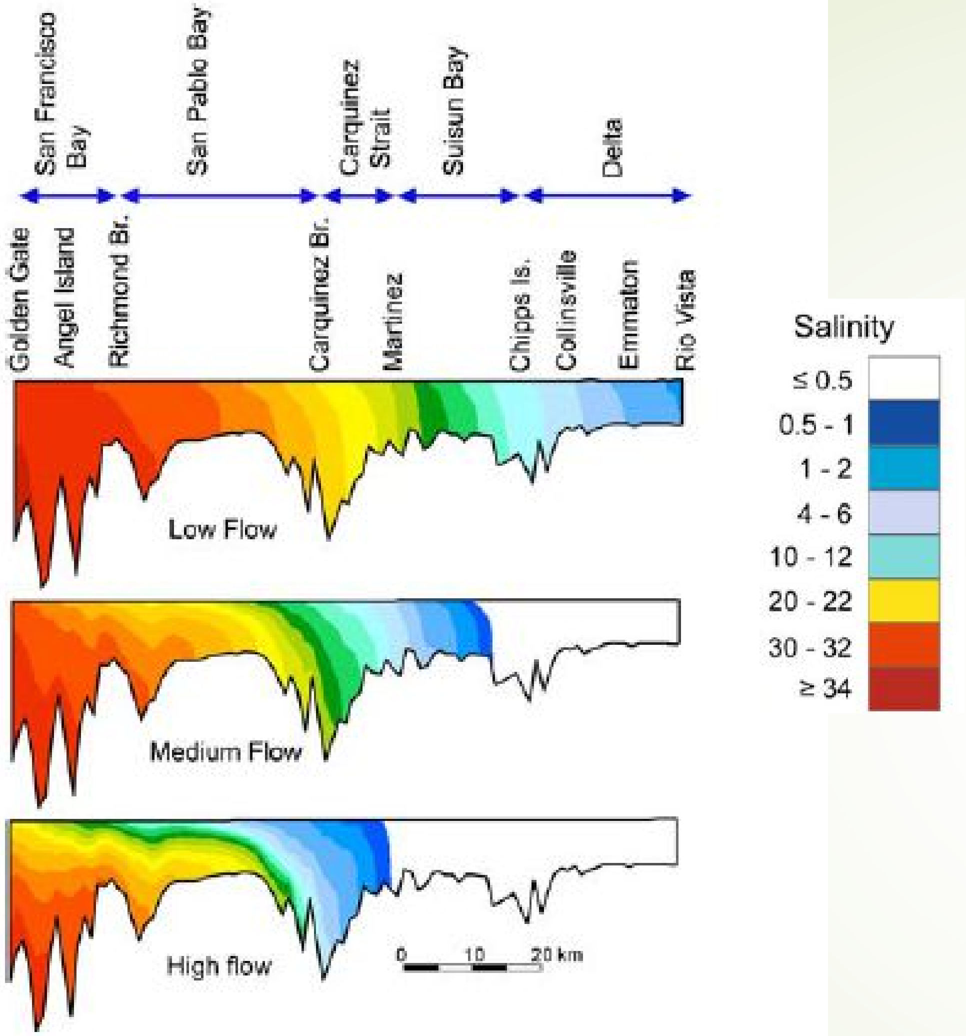
Kimmerer et al. 2009

Zooplankton abundance by region




DWR EMP-
Mar-June (1995-2014)

Food-

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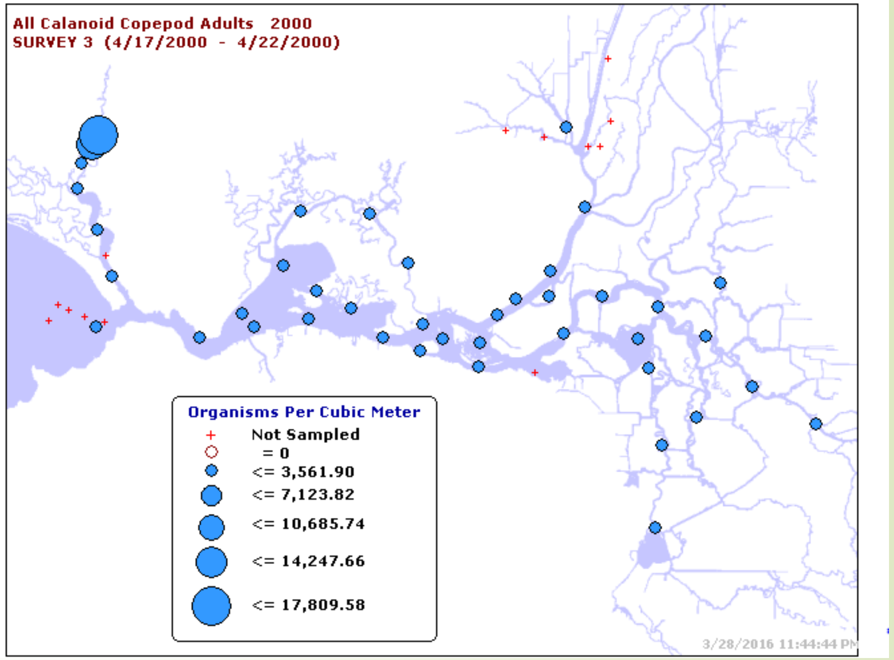
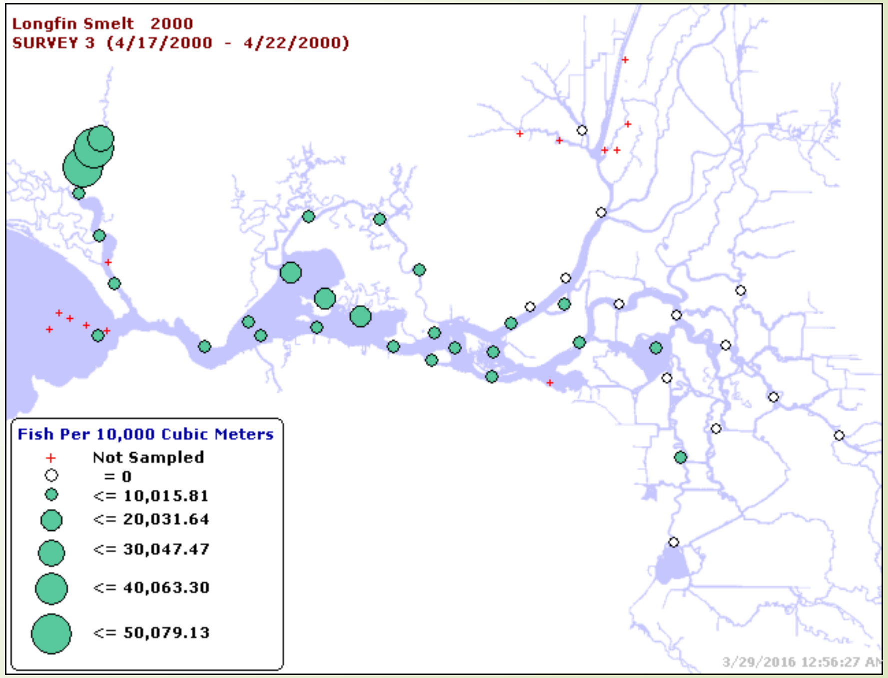
Kimmerer et al. 2009



# Tidal Marsh Study


**Study Sites**

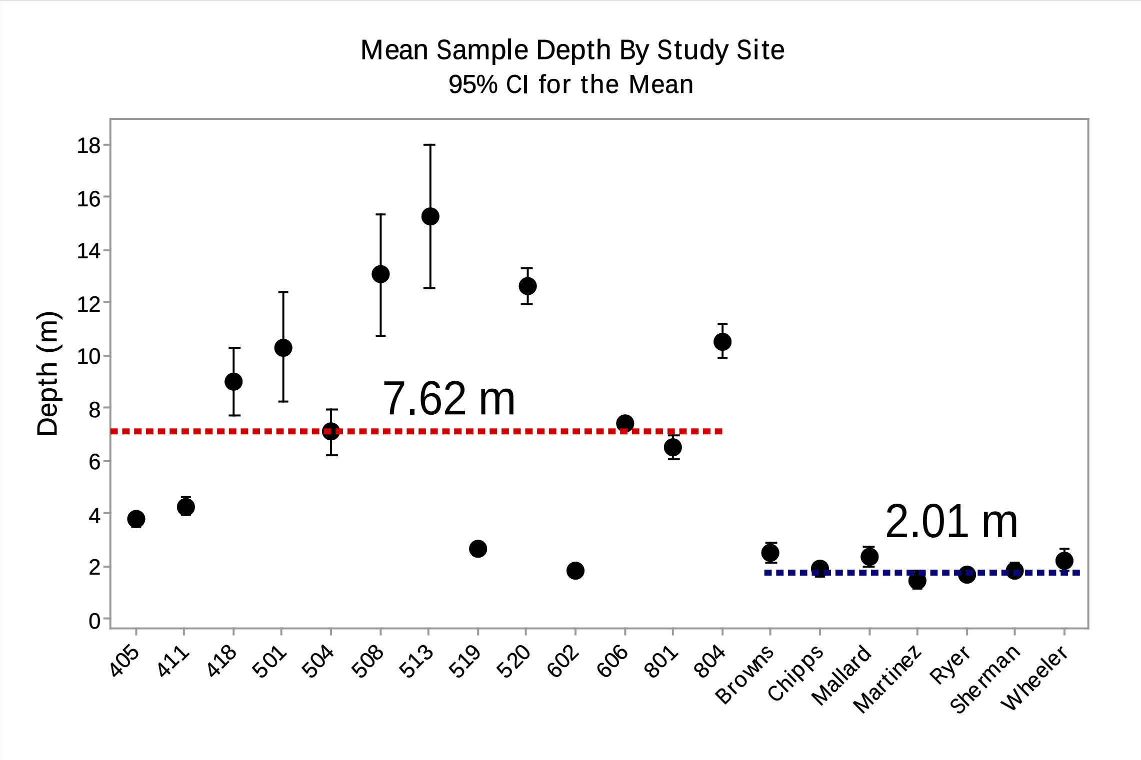
1. No name (Martinez)
2. Ryer Island
3. Wheeler Island
4. Mallard Island
5. Chipps Island
6. Browns Island
7. Sherman Island

# Conducted a tidal marsh study in actual tidal marshes

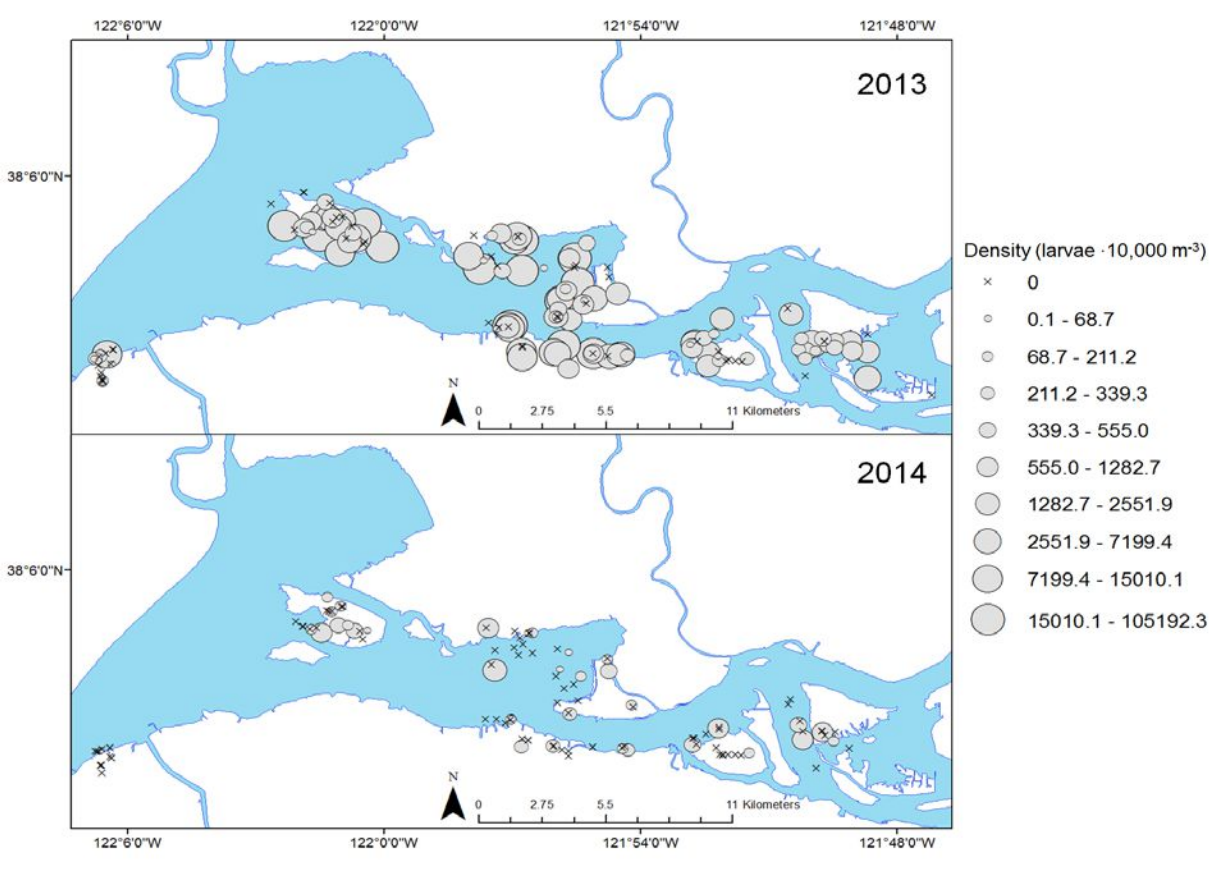
# Conducted a tidal marsh study in actual tidal marshes


Sampled all sites bimonthly;
Feb-May in 2013 and 2014

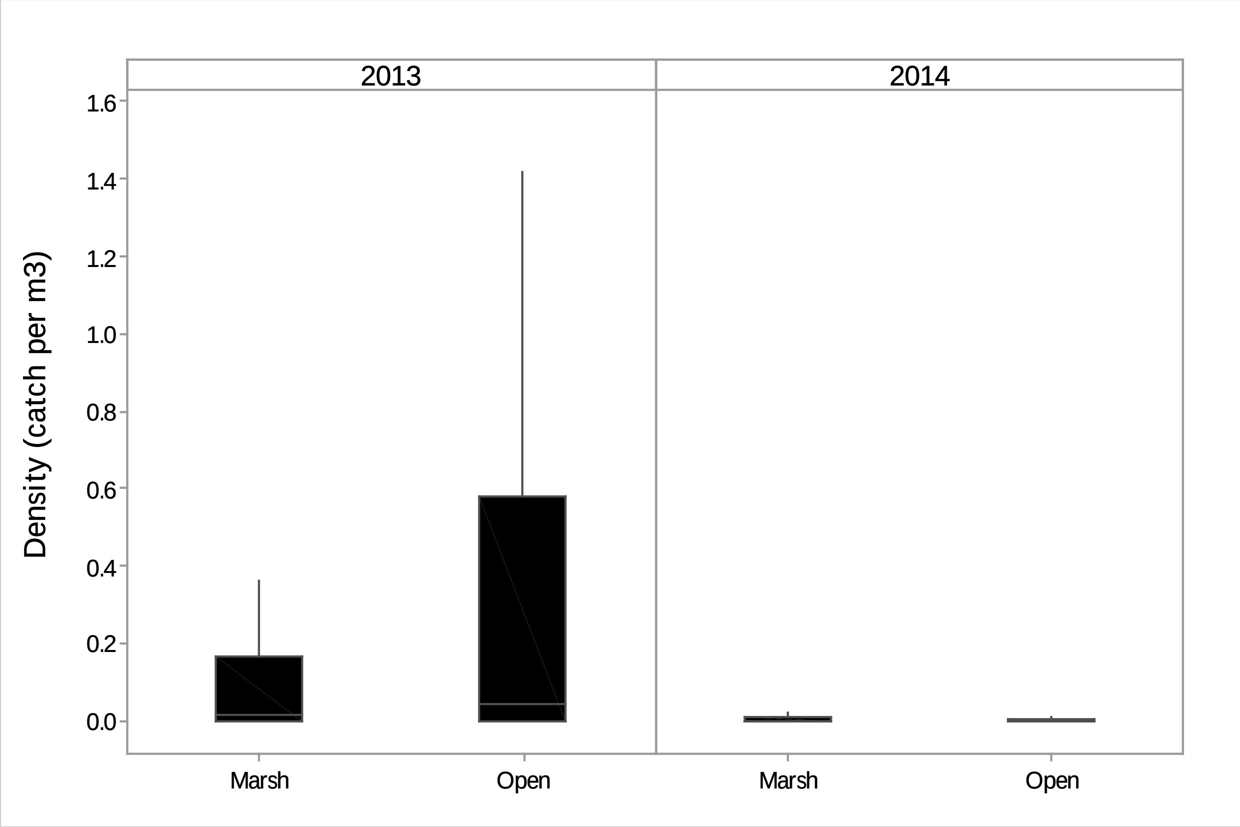
# Compared Longfin Smelt Densities between Tidal Marsh Study and CDFW Smelt Larval Survey




## More longfin smelt collected in 2013

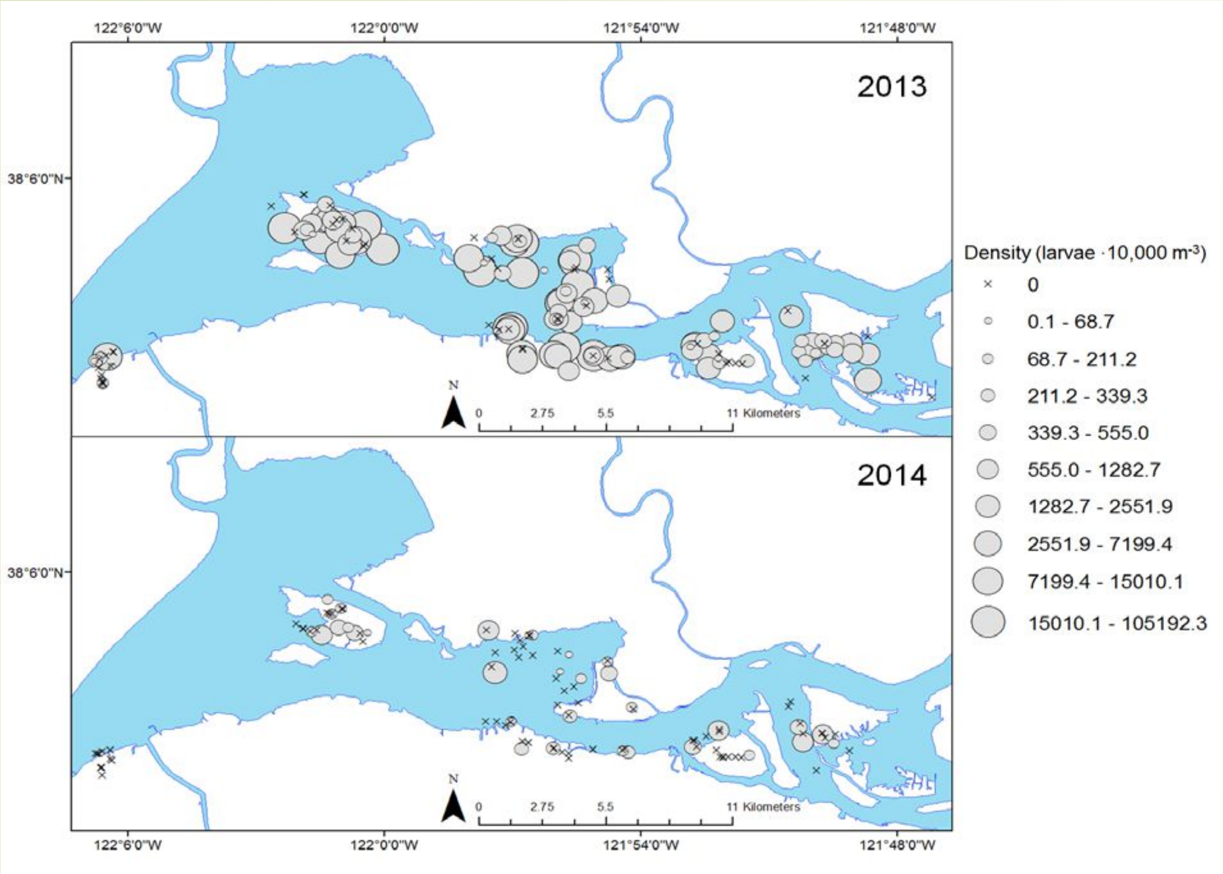



## Shallow open water areas supported higher densities of longfin smelt larvae

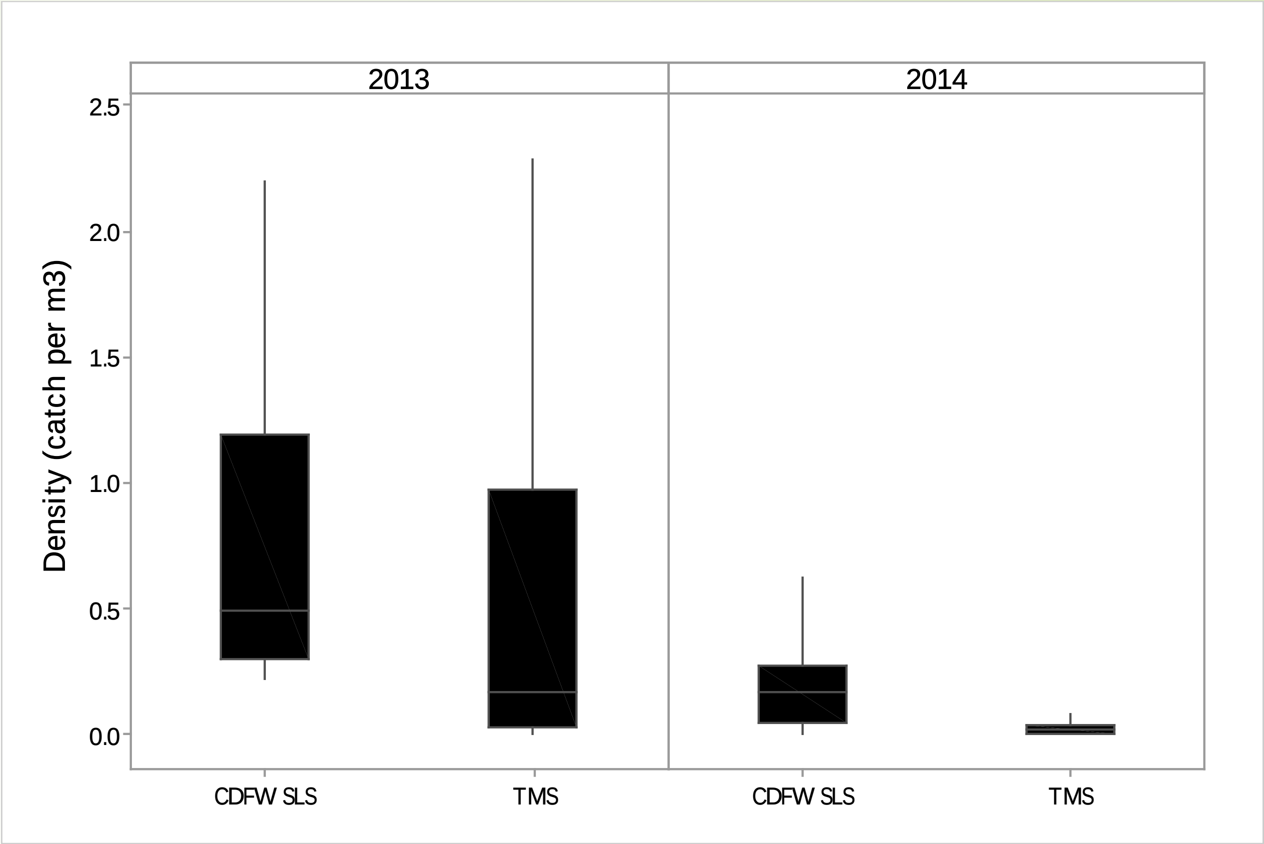



| Source | P-value |
|---|---|
| Habitat | < 0.05 |
| Year | < 0.01 |
| Month | < 0.01 |

More longfin smelt collected in 2013

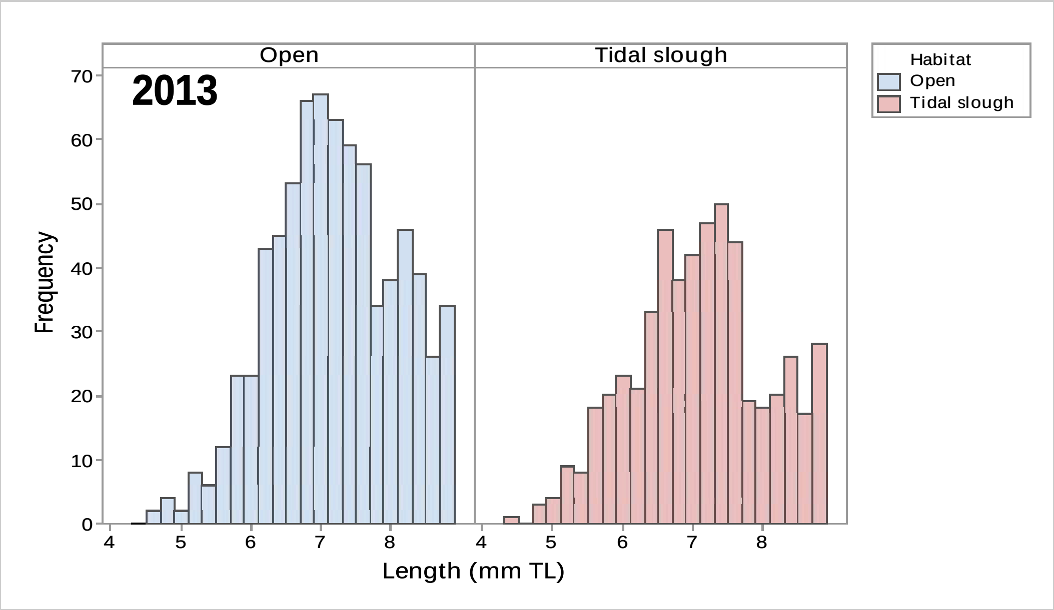


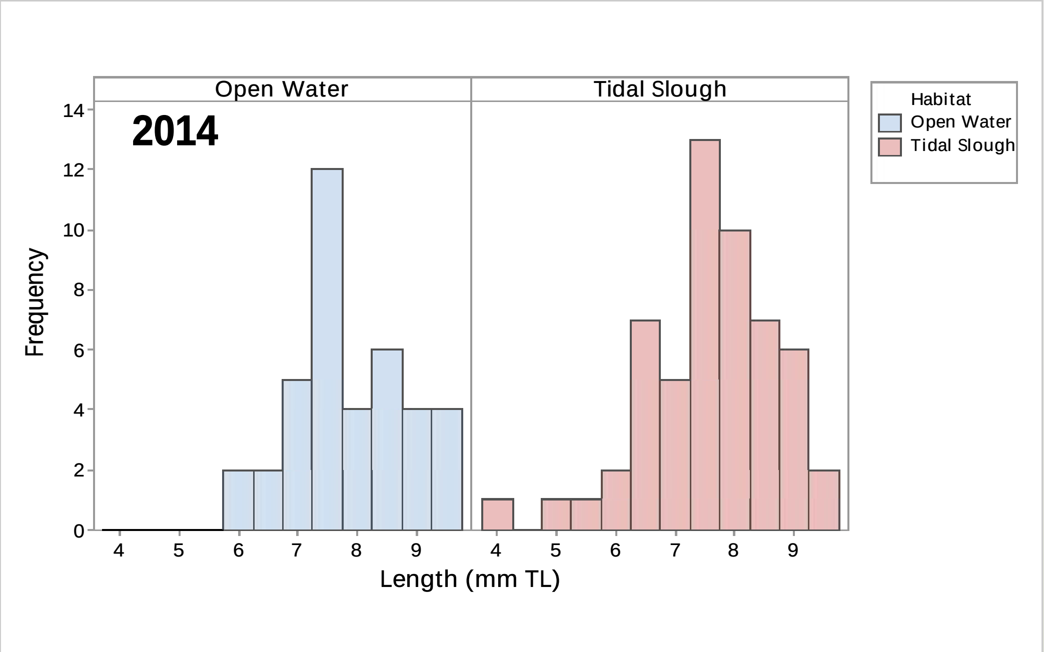

Densities not different between studies
(CDFW SLS vs Tidal Marsh Study)




| Source | P-value |
|---|---|
| Habitat | ns |
| Year | < 0.01 |
| Month | ns |

# Lot's of yolk-sac larvae were collected



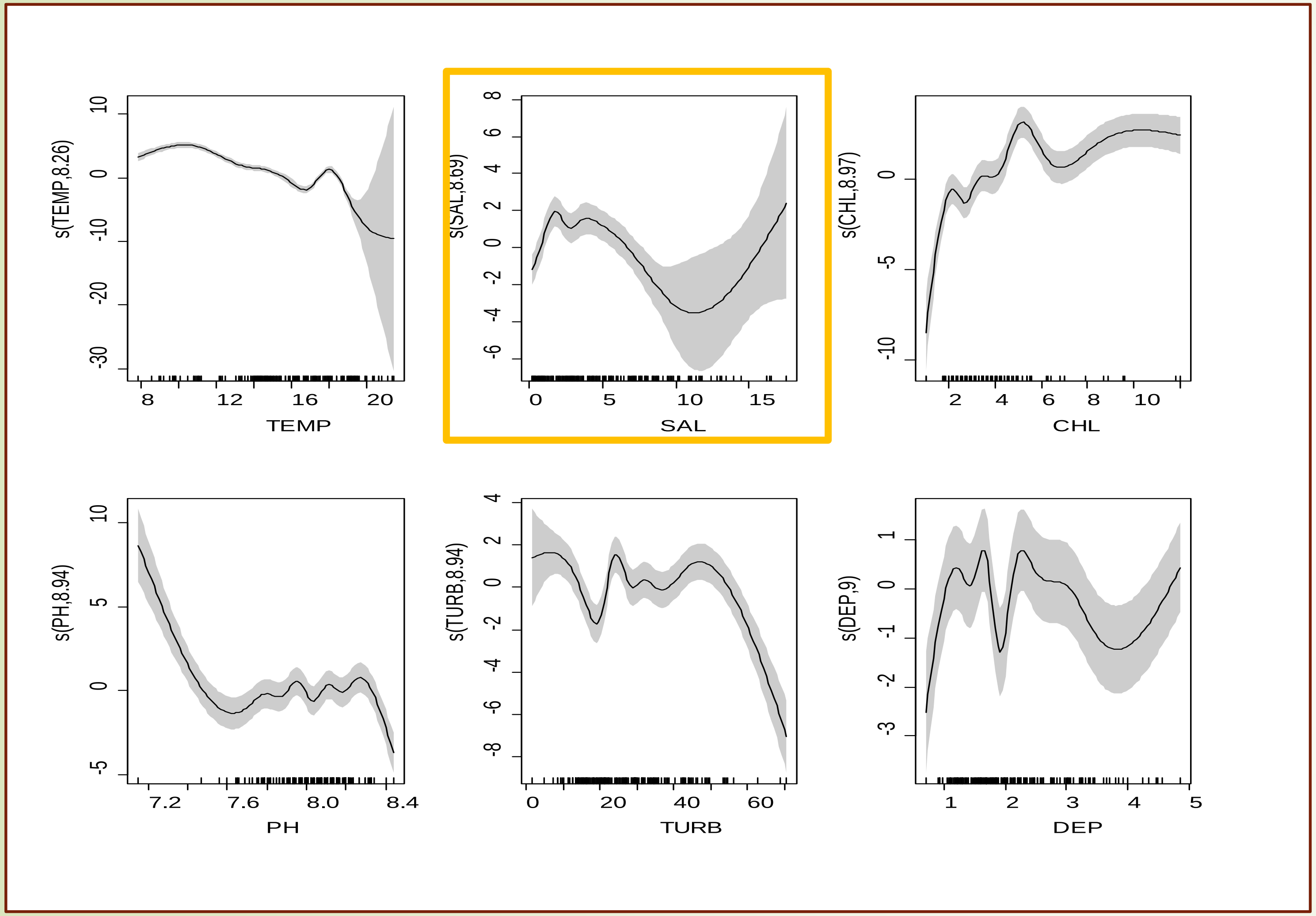

**Length at hatch 5 – 8 mm TL; Wang 2007**

2013



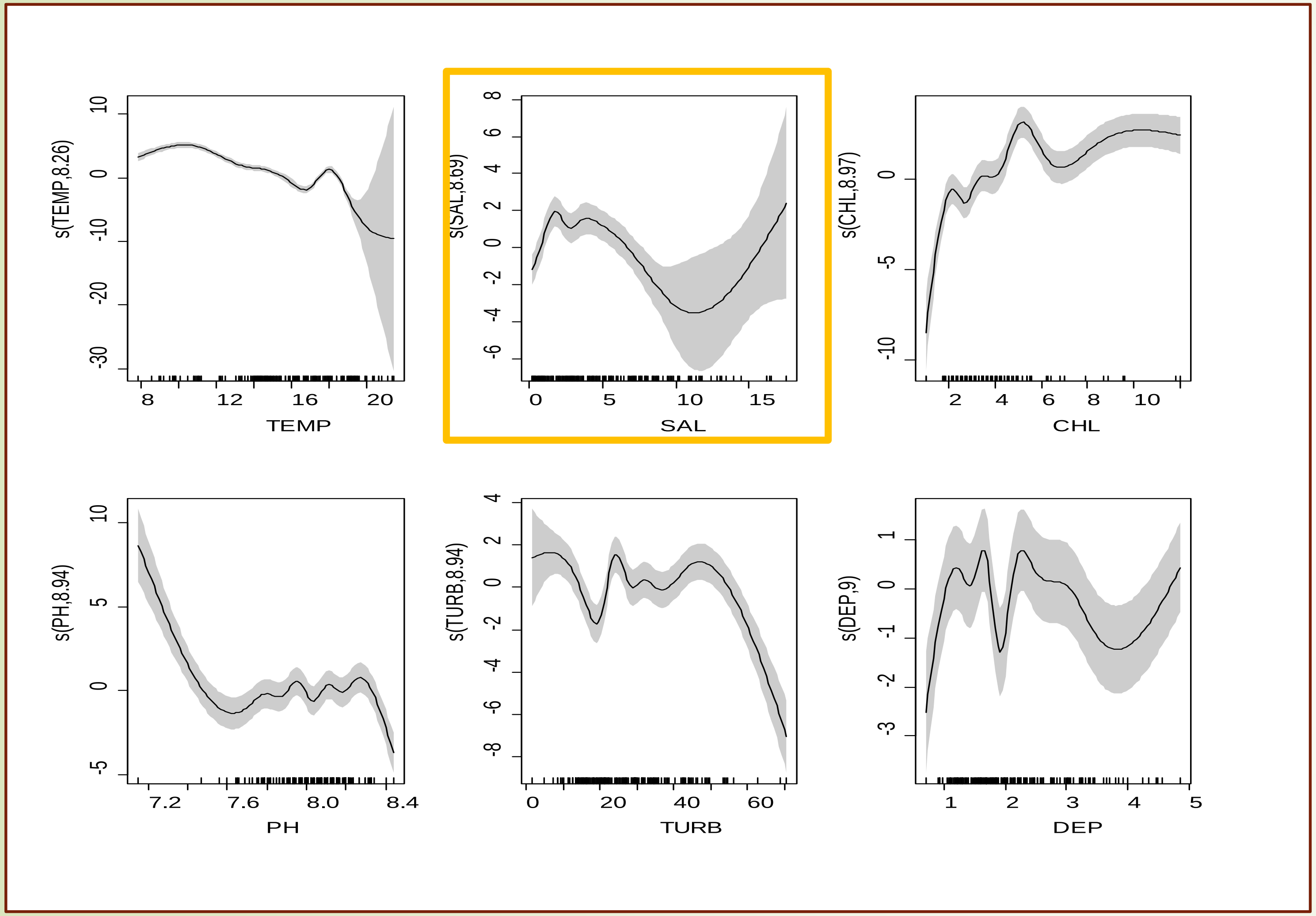

Tow position/distance recorded in Navionics

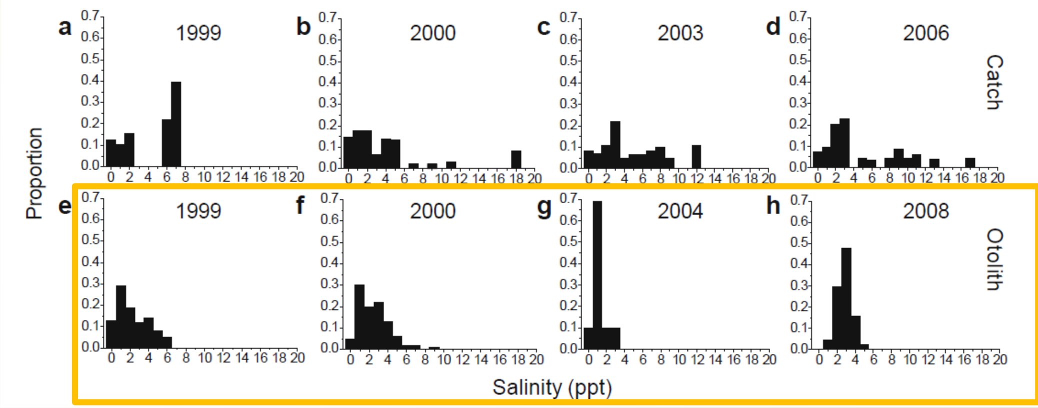
# Relationship between larval catch and environmental variables during tidal marsh survey




GAM(COUNT ~ s(TEMP')+ YEAR + s(SAL)+ s(CHL)+ s(PH)+ s(TURB) + s(DEP) + HAB, offset=log(VOL), gamma=1.4, family=poisson(link=log))

# Relationship between larval catch and environmental variables during tidal marsh survey




Hobbs et al. 2010

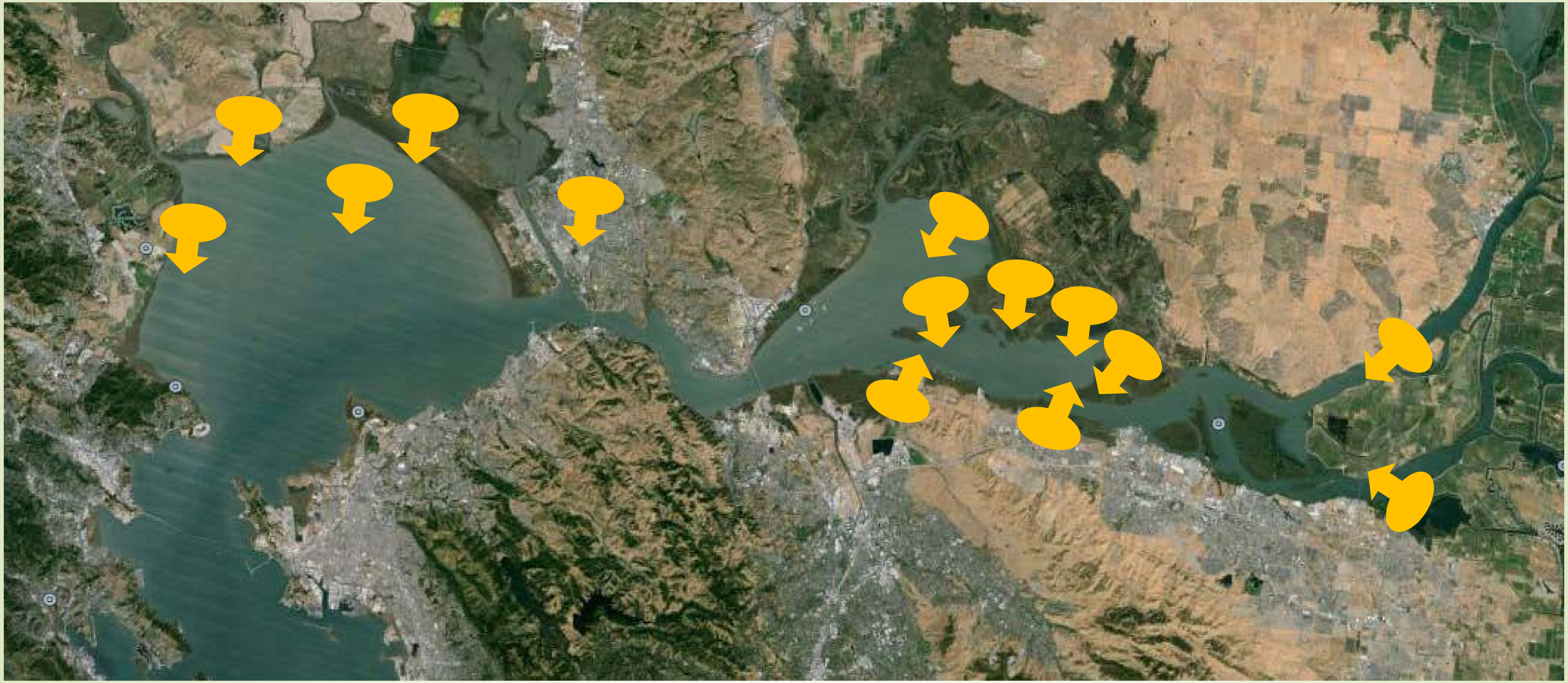
GAM(COUNT ~ s(TEMP')+ YEAR + s(SAL)+ s(CHL)+ s(PH)+ s(TURB) + s(DEP) + HAB, offset=log(VOL), gamma=1.4, family=poisson(link=log))

# Existing Paradigm-

**Longfin smelt spawn in freshwater and are transported into Suisun Bay (Rosenfield and Baxter 2007; Kimmerer et al. 2009, CDFW 2009)**

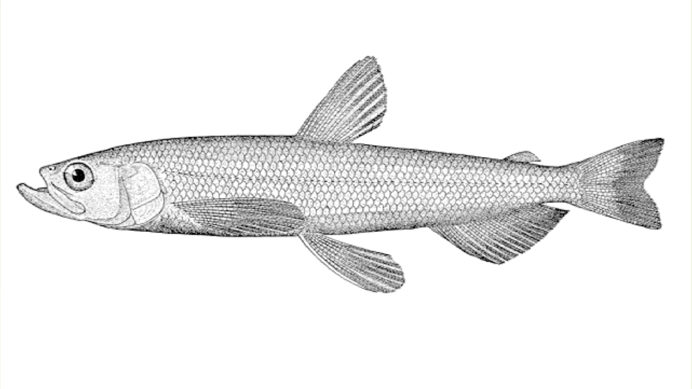
# Emerging Paradigm-

**Longfin smelt spawn in fresh water and low salinity water. Available spawning habitat increases from east to west**



# Plenty of restoration opportunities throughout the low salinity and brackish regions of the estuary

# Acknowledgments




**Funding**

2013 IEP (Management Team)

2014 MWD (David Fullerton , Shawn Acuna, and Russell Ryan)

Instrumental helpers (i.e., operators, lab assistance, fish identification, permits)

| | |
|---|---|
| Nick Sakata | Tenera Environmental |
| Nick van Ark | Colin Brennan |
| Kari Ambrosia | Dan Abbott |
| David van Rijn | Eric Sommerauer |
| Eric Santos | Carol Raifsnider |
| Jim Starr | Dave Mayer |
| Jennifer Pierre | Johnson Wang |
| Erin Gleason | Katherine Sun |

Folks who came out on boat to help but didn't work very hard

| | |
|---|---|
| Dan Riordan | Carolyn Bragg |
| Gina Benigno | Mary Lee Knecht |
| Rachel Johnson | Shelly Hattleburg |
| Marin Greenwood | Maral Kasparian |
| Leigh Bartoo | |