Agenda Item H.2.b
Supplemental WGR PowerPoint
April 2009

What Caused the Sacramento River Fall Chinook Stock Collapse?

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and
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What's the Problem/Why Was the Working Group Formed?

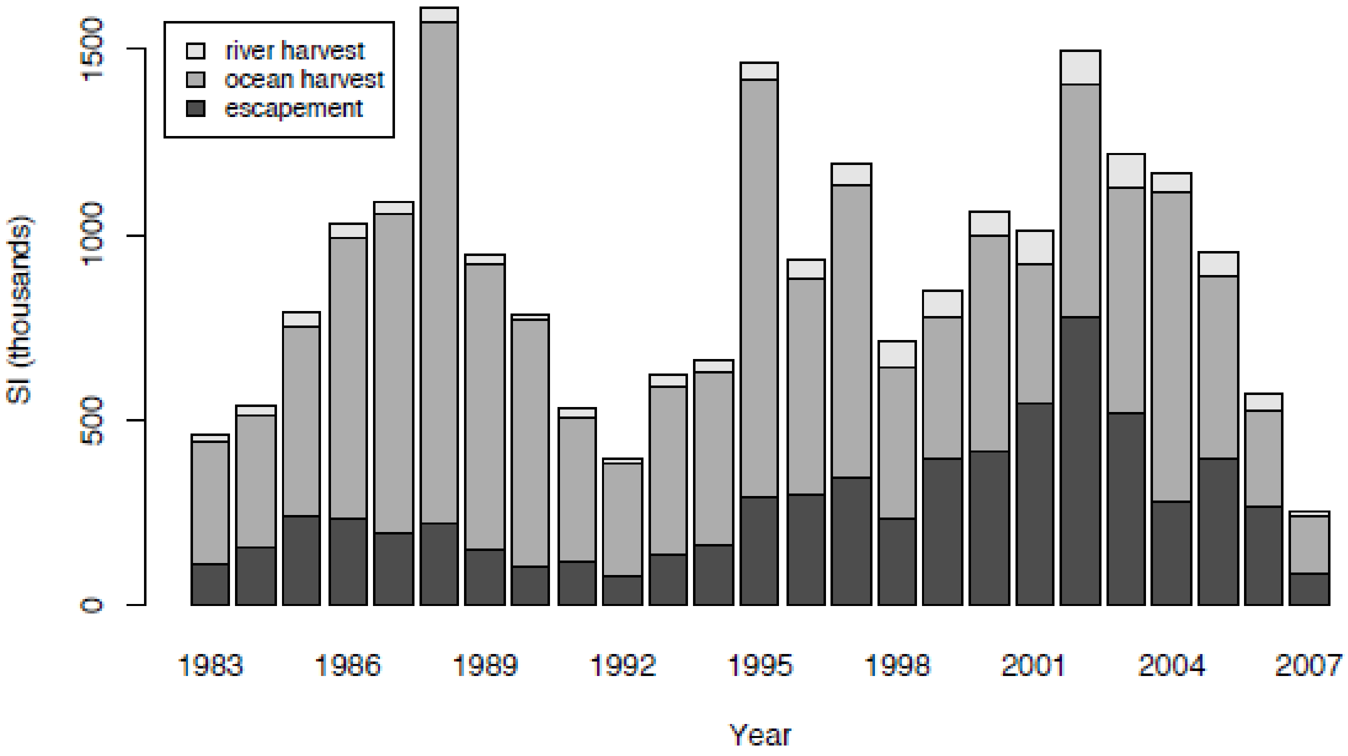


Figure 1: Sacramento River fall Chinook escapement, ocean harvest, and river harvest, 1983–2007. The sum of these components is the Sacramento Index (SI). From O'Farrell et al. (2009).

Composition of the Scientific Working Group

- Co-chairs– Churchill Grimes (SWFSC) and John Stein (NWFSC)
- NOAA members – Daniel Bottom (NWFSC), John Ferguson (NWFSC) , Peter Lawson (NWFSC), Steven Lindley (SWFSC), Bruce McFarland (SWFSC), William Peterson (NWFSC), Carlos Garza (SWFSC), Michael Mohr (SWFSC), Brian Wells (SWFSC), Robert Kope (NWFSC), Robin Webb (OAR, ESRL), Tracy Collier (NWFSC), and Frank Schwing (SWFSC)
- PFMC – Chuck Tracy
- CDFG – Alice Low, Melodie Palmer-Zwahlen, and Allen Grover
- ODFW –Kelly Moore
- WDFW – Craig Busak
- USFWS-CA – James Smith
- Academia – Loo Botsford, UC Davis, David Hankin, Humboldt State University, and James Anderson, University of Washington.

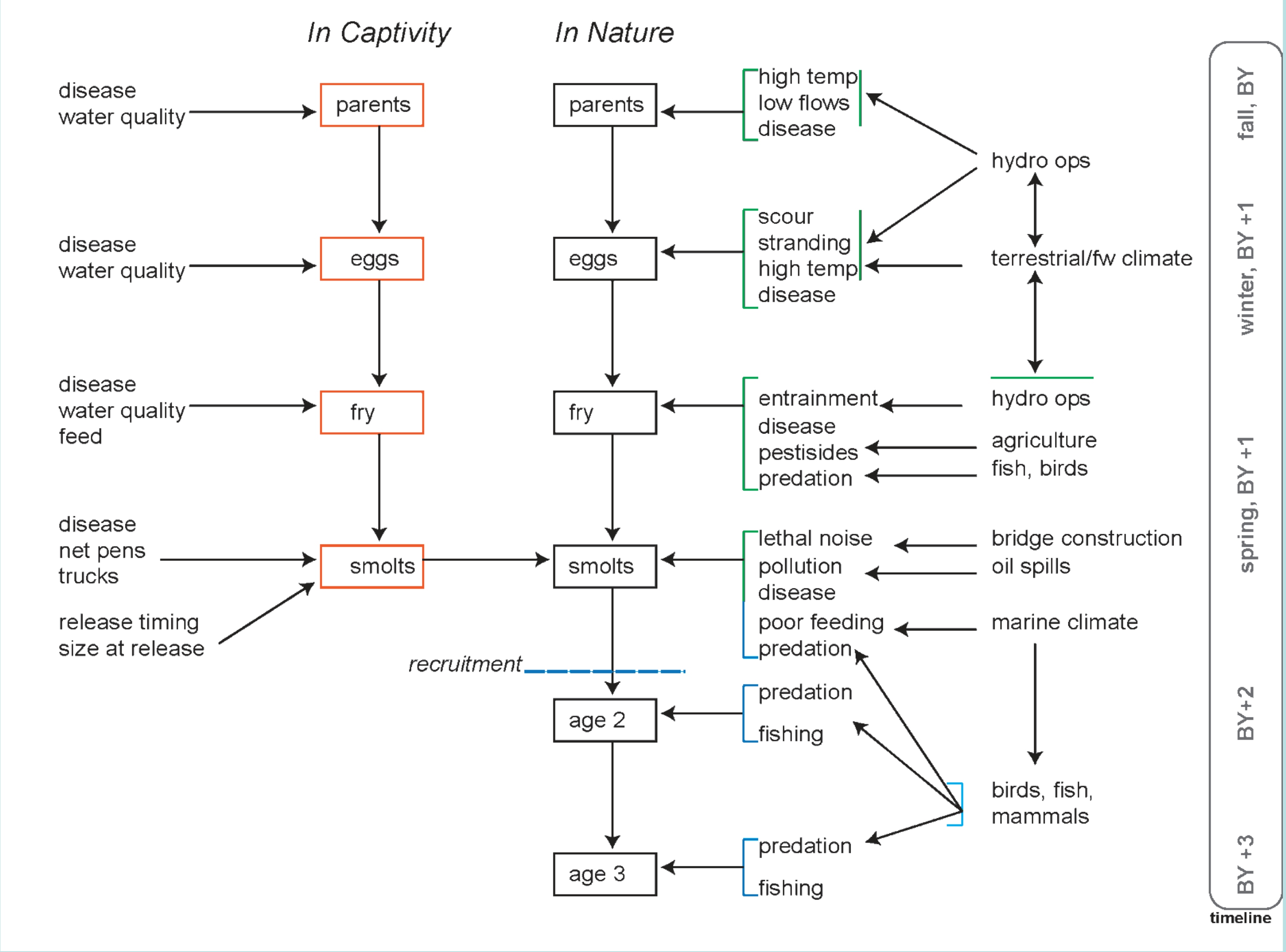
Charge to the Working Group

- Consider potential causes of the recent collapse of SRFC, and what may be a broader depression of salmon productivity for stocks involved in west coast fisheries from the Sacramento River north to Puget Sound.
- Specifically examine potential factors provided in a PFMC list that could have contributed to the low survival of the 2004 and 2005 brood years in the attempt to identify possible causative factors.
- Assess whether the performance of current stock predictors can be improved by incorporating ocean environmental information.
- Develop research and monitoring recommendations for improving the understanding of causes of decline and stock forecasts.
- Produce an interim and final report to PFMC and submit a paper for publication in a peer reviewed journal.

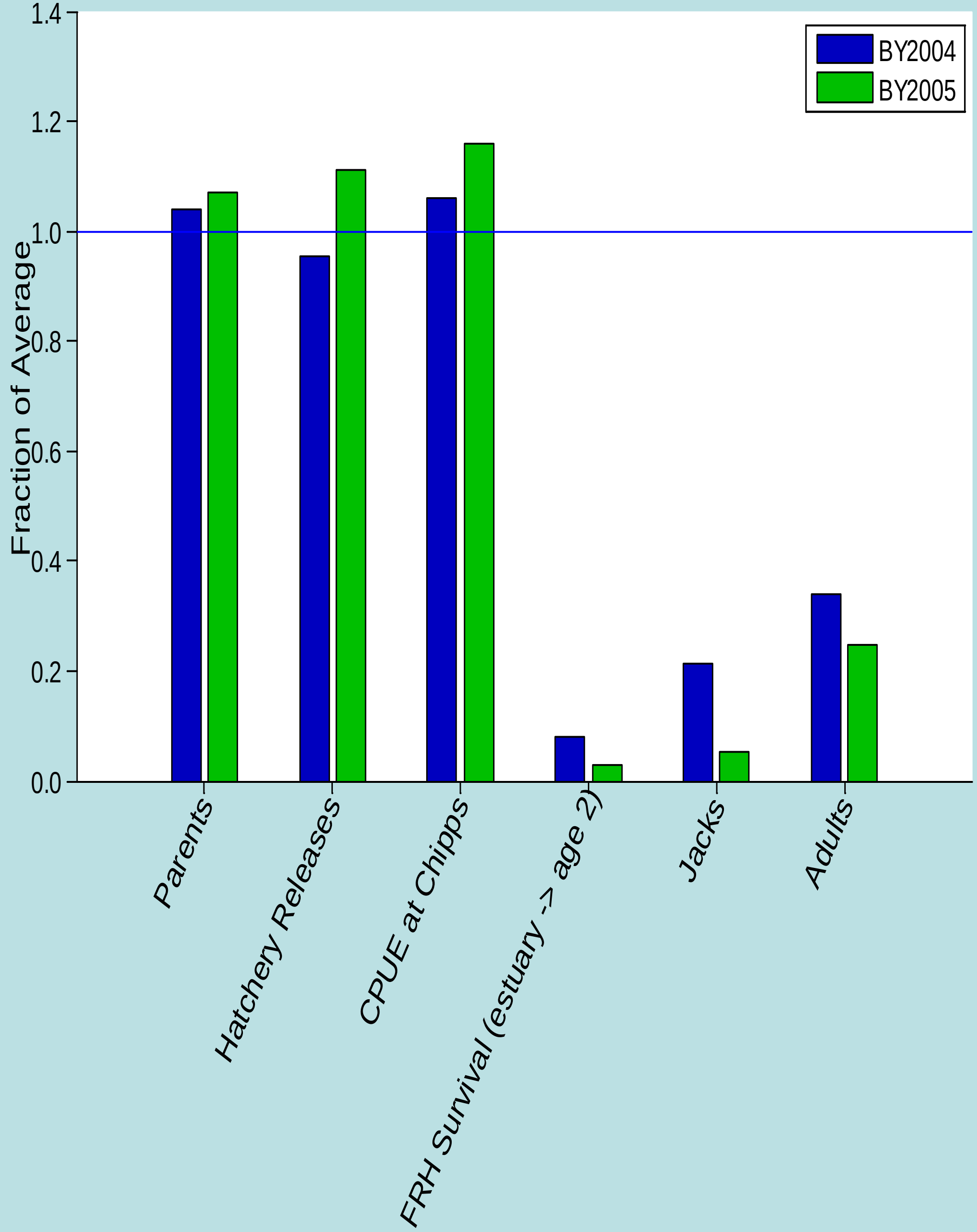
Workgroup Process

- Meeting #1 (July 28-29): present relevant data, address 40+ questions, outline report, writing assignments
- Public meeting (Aug 29): gather information from stakeholders and co-managers
- Meeting #2 (Nov 7): review written submissions, revise outline
- Meeting #3 (Mar 4): review draft report, compose recommendations
- Submit preliminary report to PFMC on Mar 18
- Next steps: revise and publish (NOAA Tech Memo)

Conceptual Approach



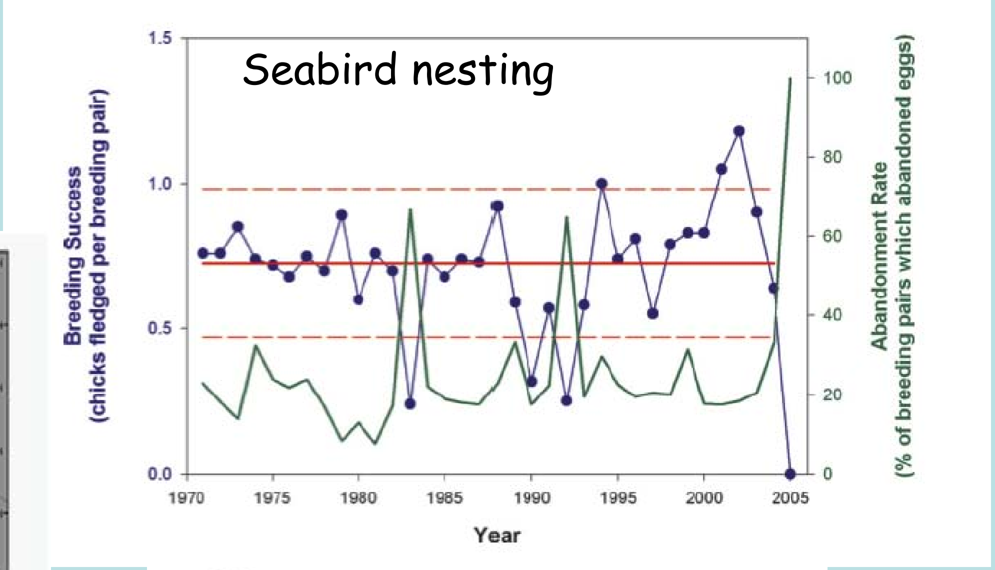
Things went wrong between entering the bay and recruitment to the fishery at age 2

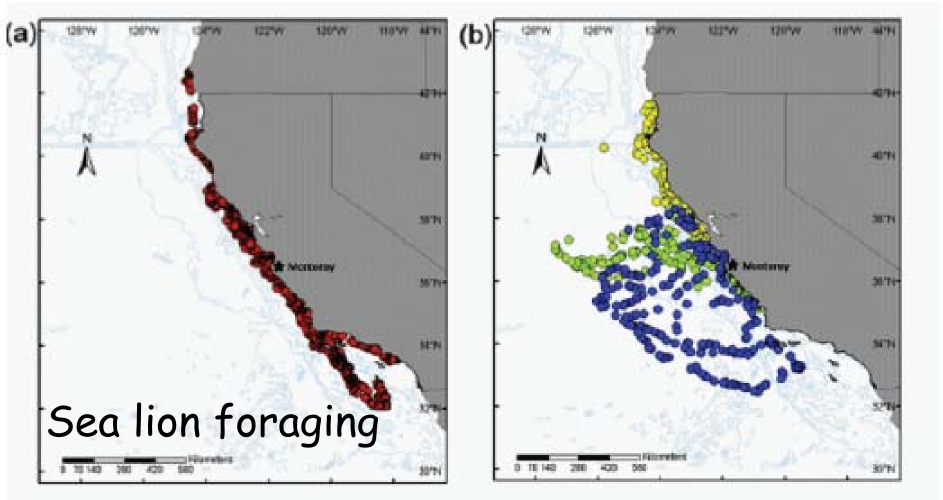


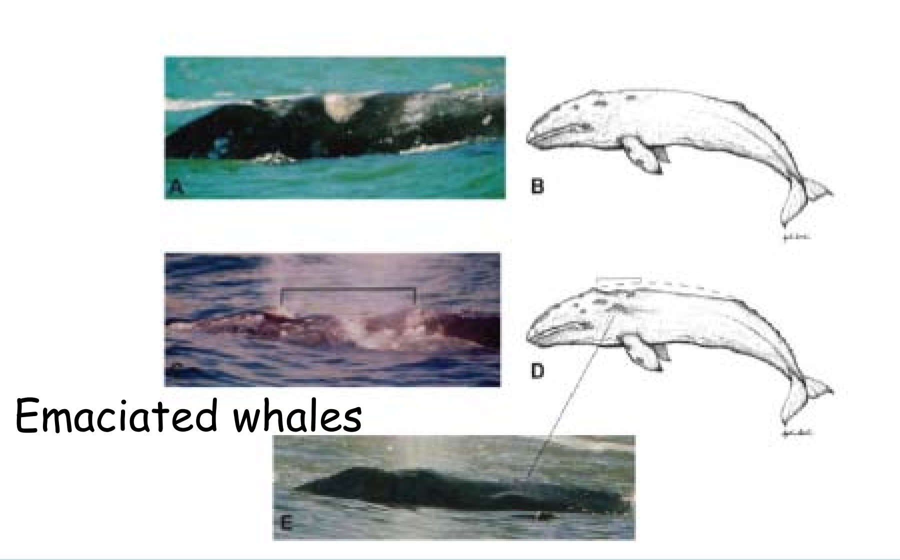
Avg. Calculation

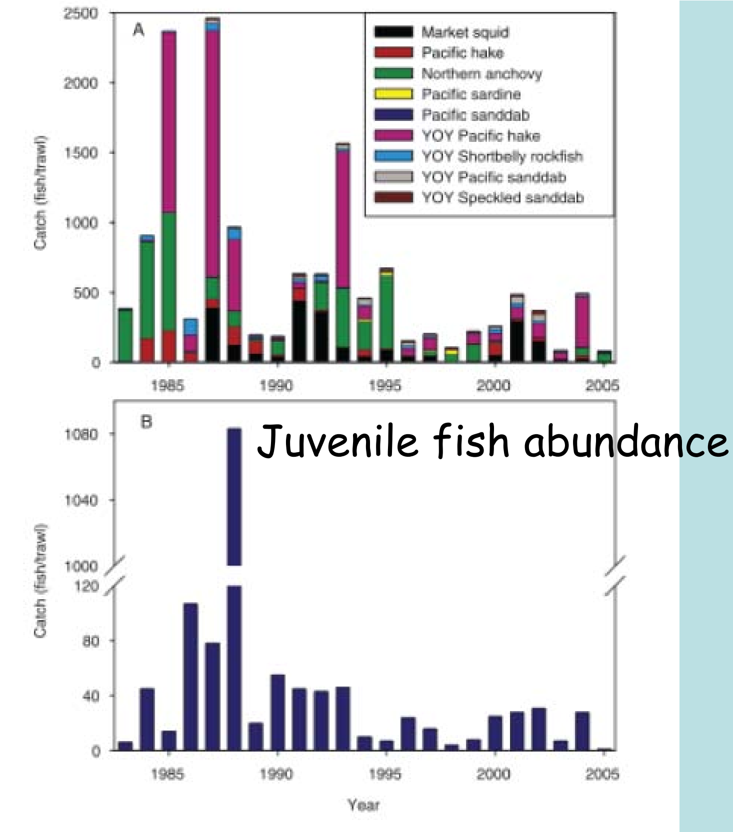
- Parents = '70-'07
- jacks = '70-'07
- Adults = '70-'07
- Chipps I. = '76-'07
- Hatchery = '90-'07
- FRH = fract. of '00 BY

CA Current was unusual in 2005

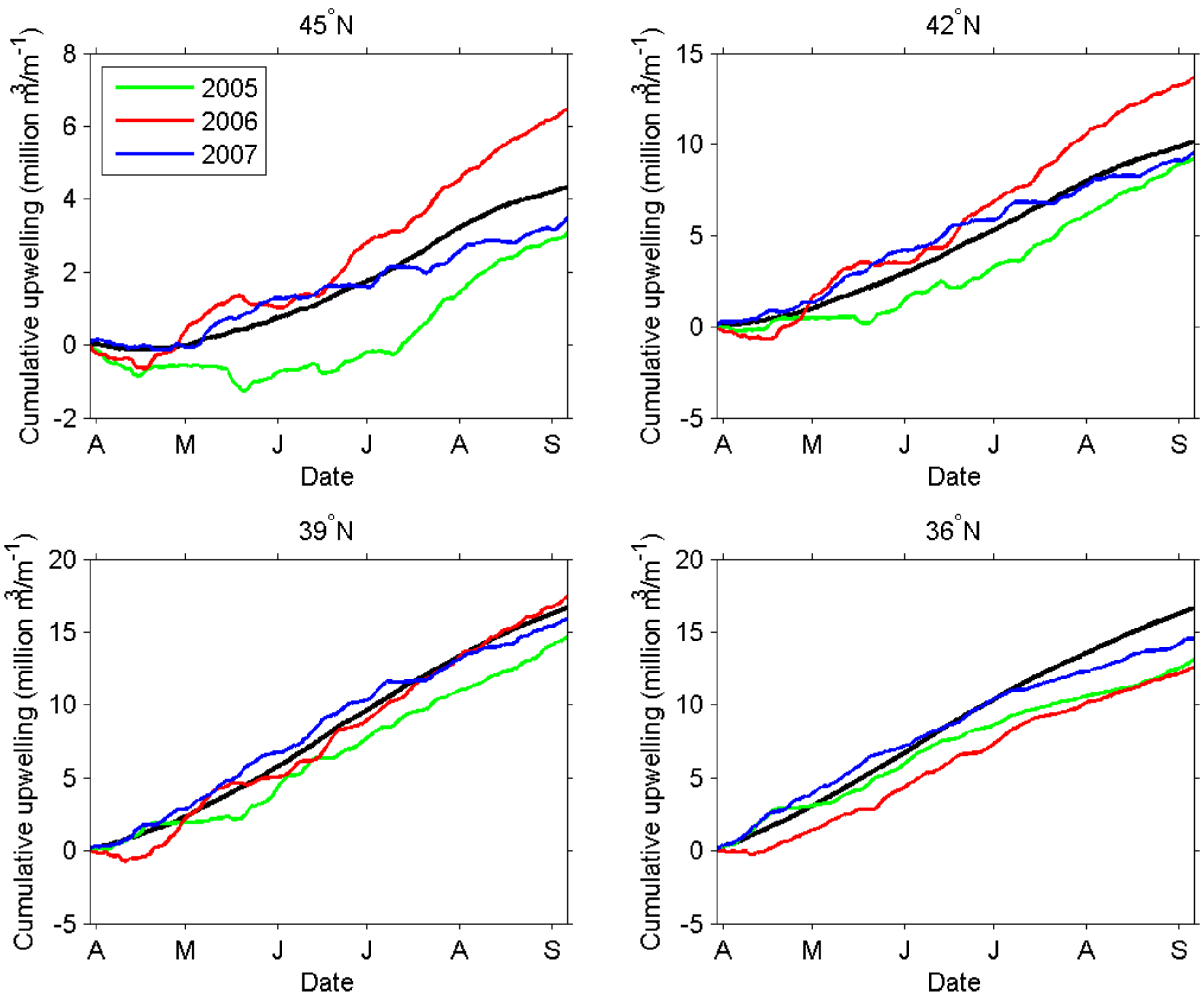








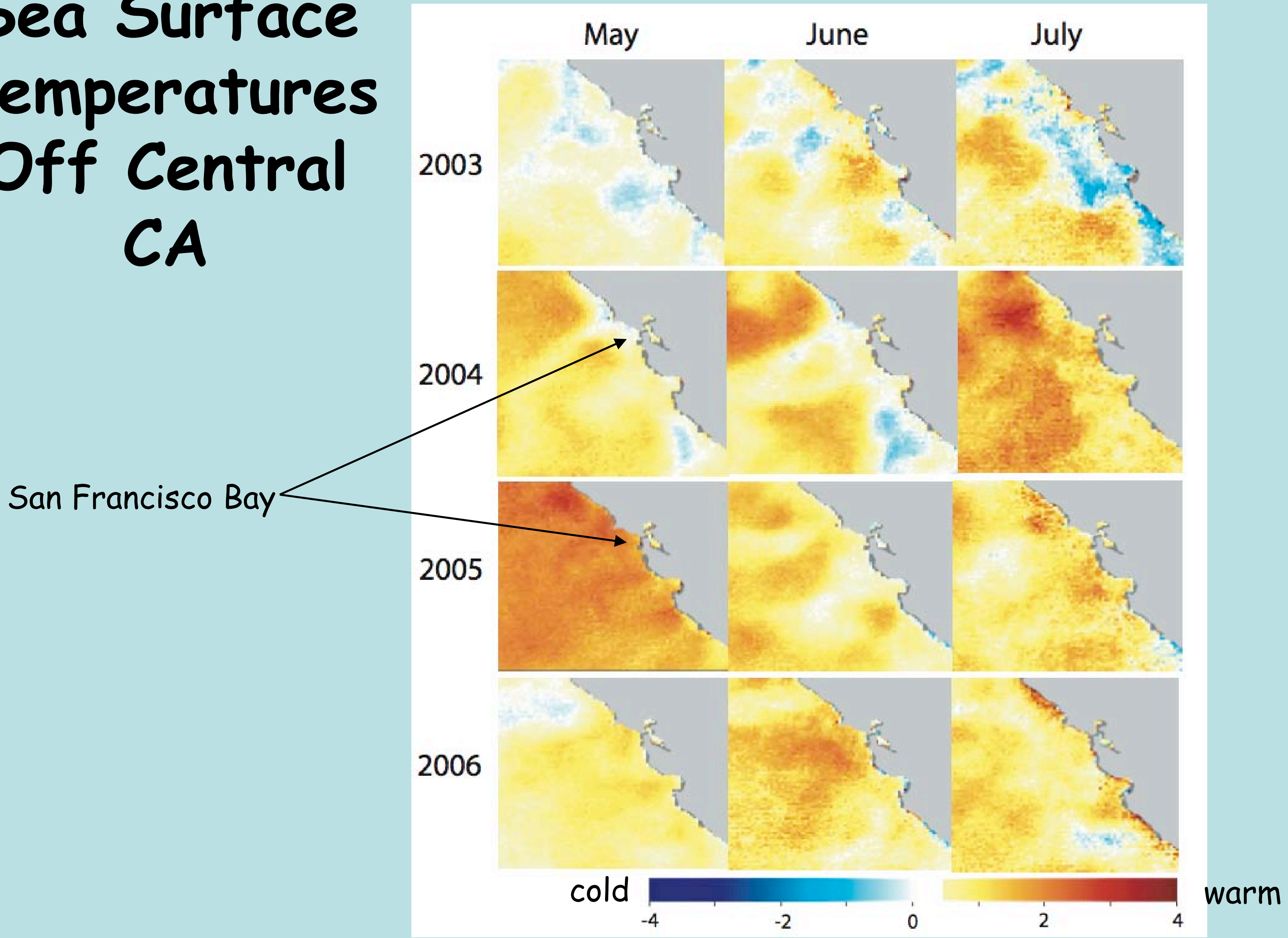
Coastal Upwelling



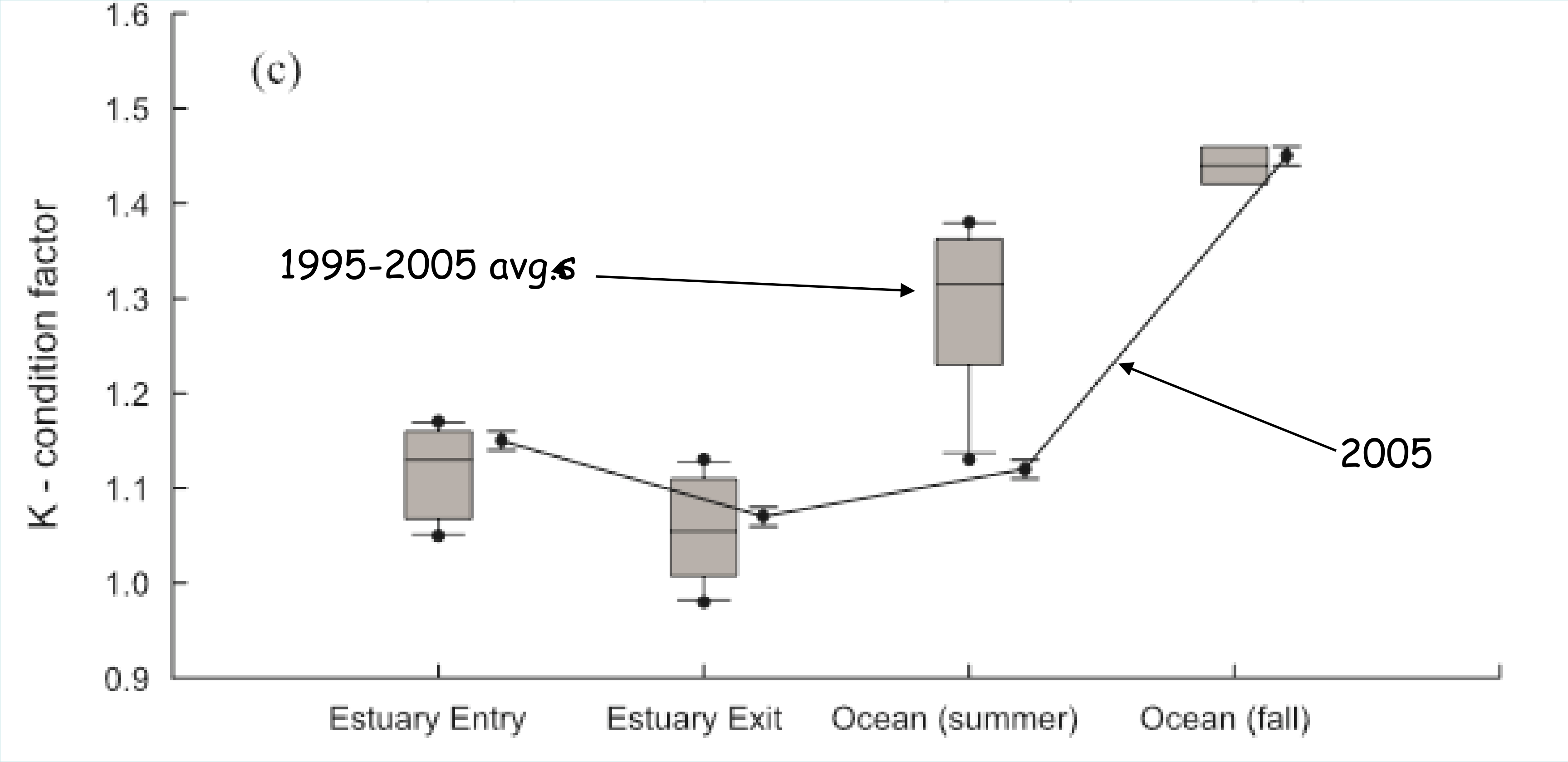
Oregon

N. California

Sea Surface Temperatures Off Central CA

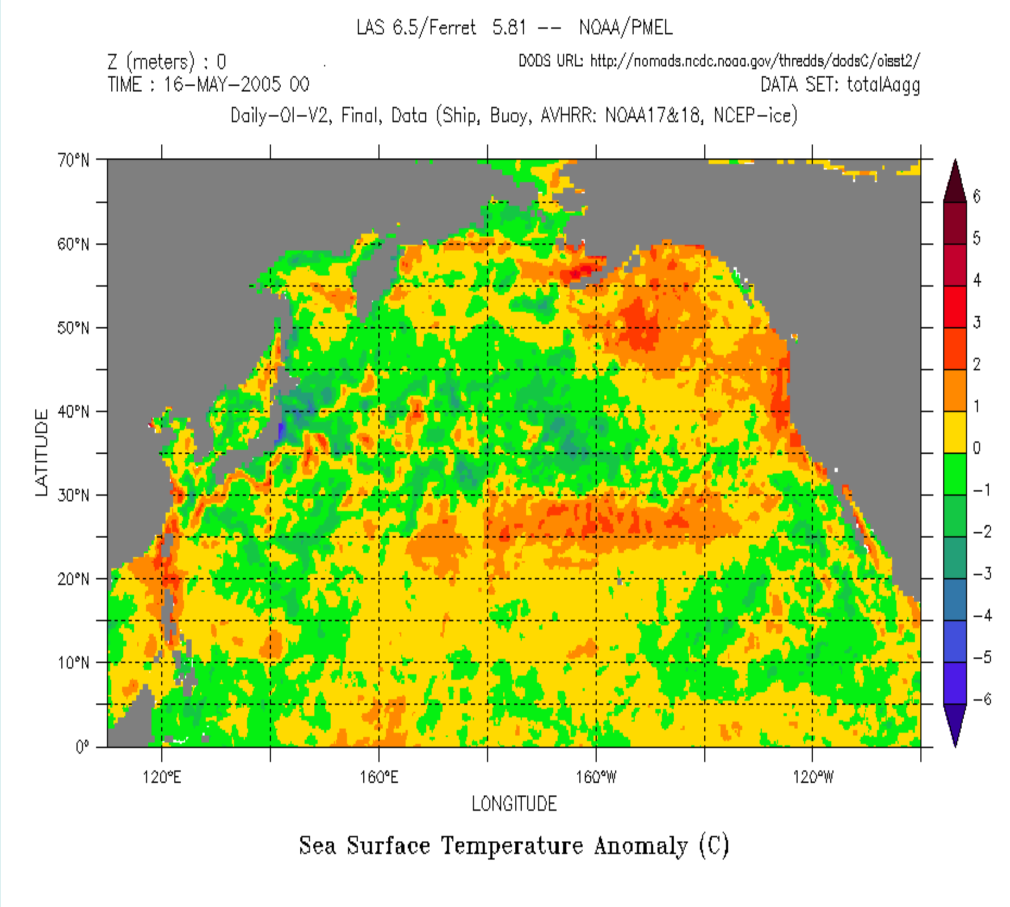


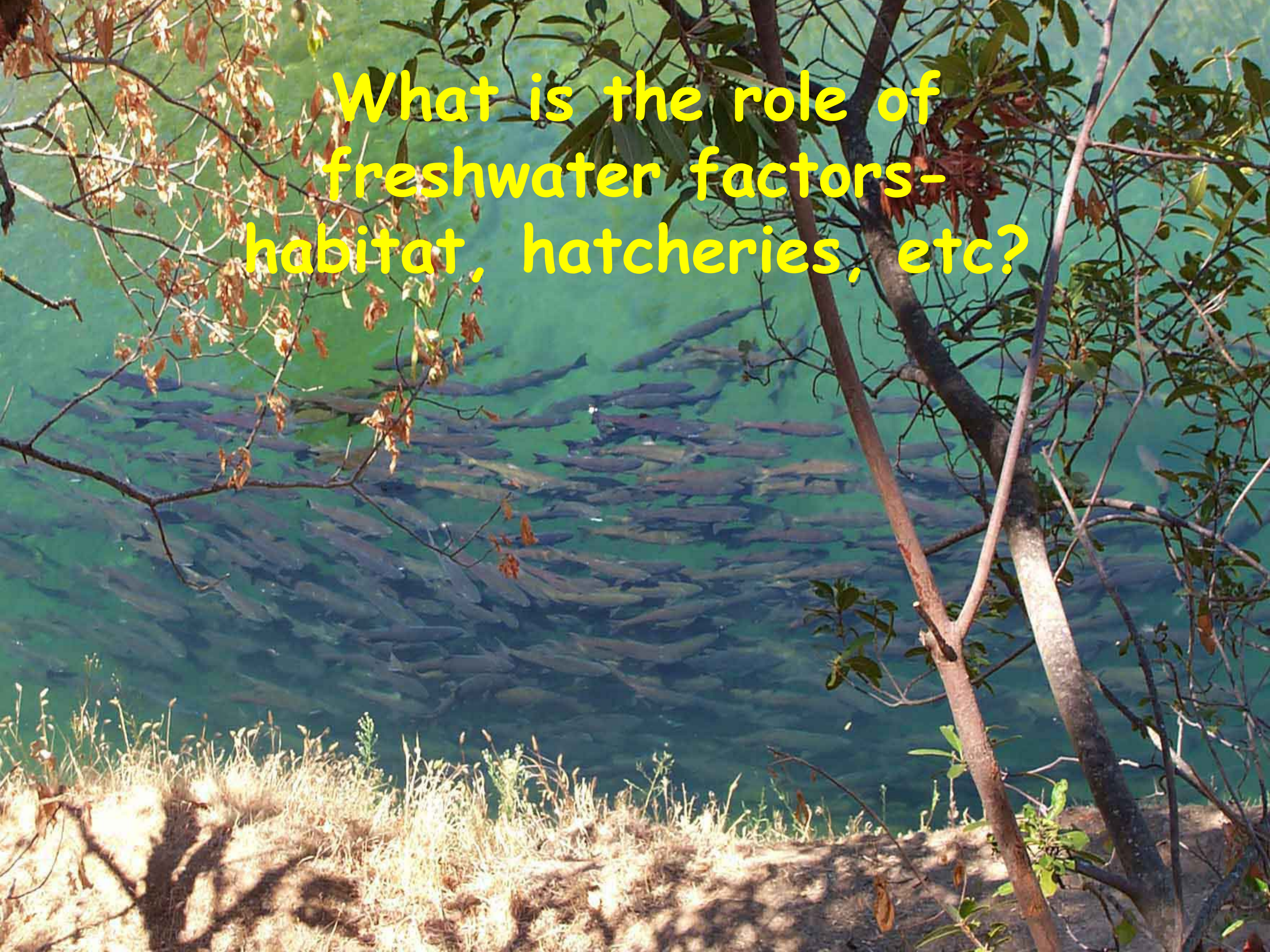
Condition Factor of Juvenile Chinook in SF Bay and GOF



Conclusion - Proximate Cause

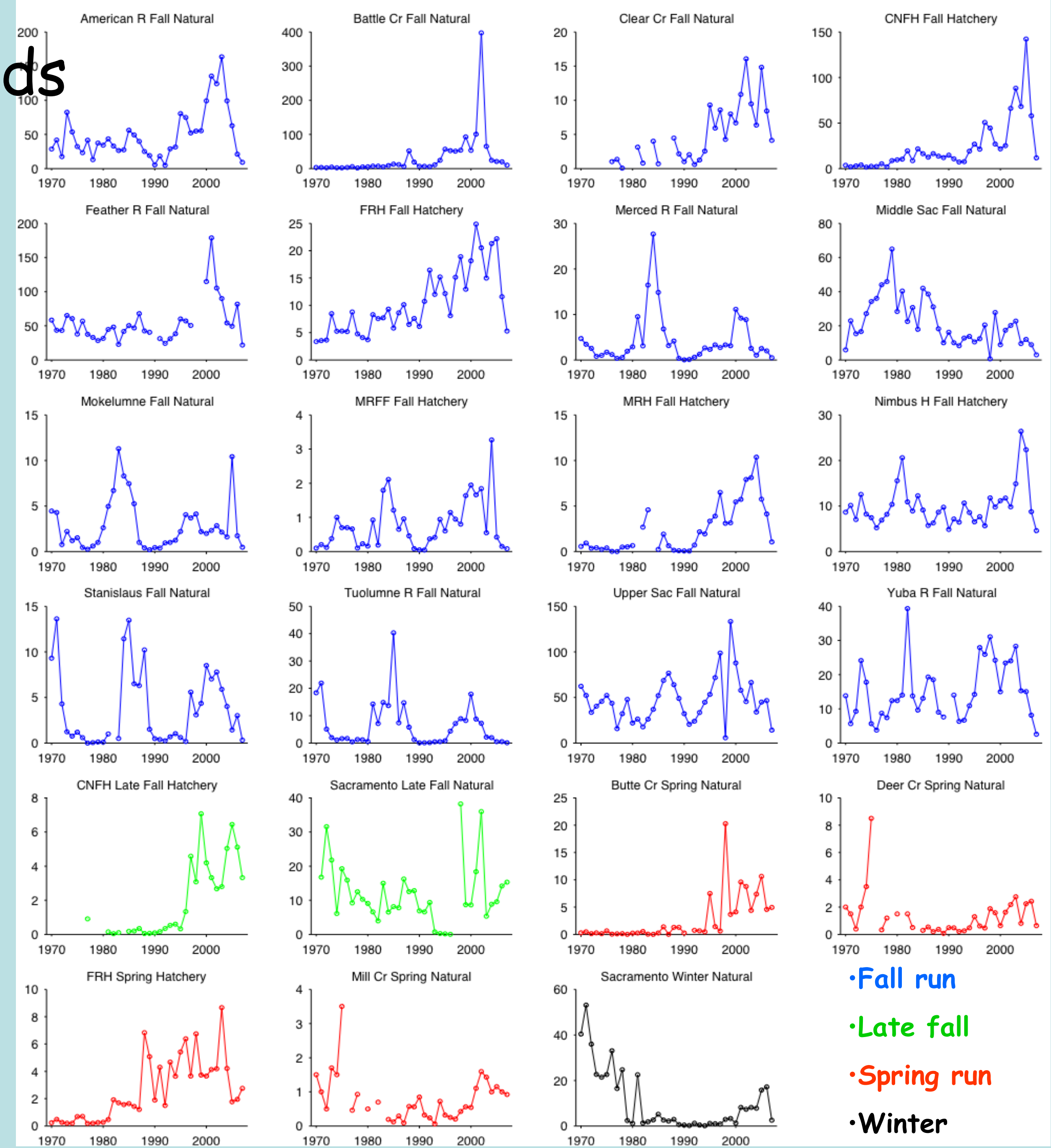
- In the Spring of 2005 and 2006 SRFC entered ocean under poor ocean conditions (upwelling and SST)
- Normal food chain did not develop and instead of feast they found famine
- Starvation mortality resulted in low survival to age 2 or older
- Therefore we attribute the proximate cause of collapse to poor ocean conditions




What is the role of
freshwater factors-
habitat, hatcheries, etc?

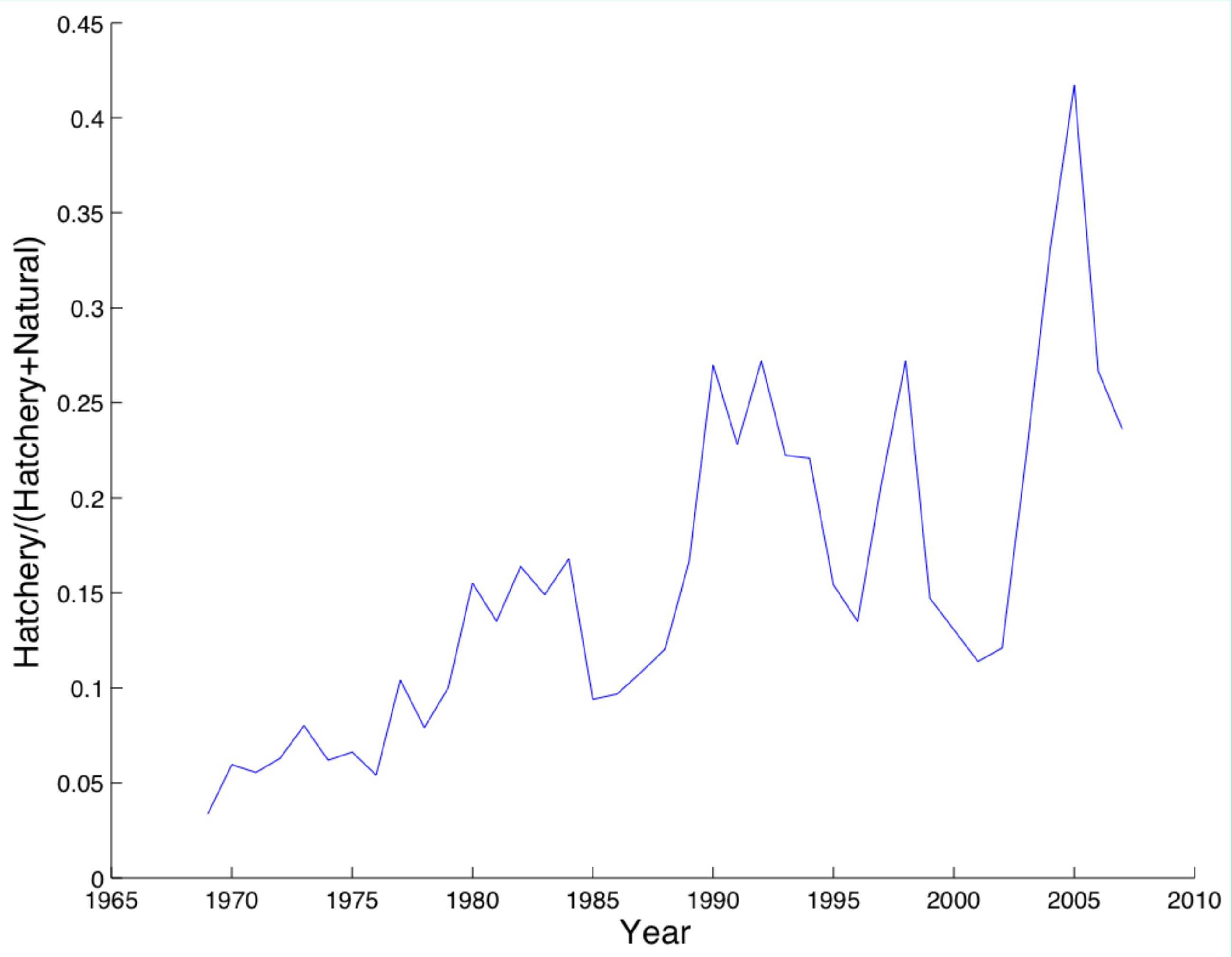
Abundance Trends in CV Chinook Populations

- Synchronous pattern w/in fall run
- Other runs not synchronous with fall run
- Different life histories spread the risk of failure
  - *-Outmigration timing*
  - *-Size at ocean entry*



What is synchronizing the dynamics of SRFC?

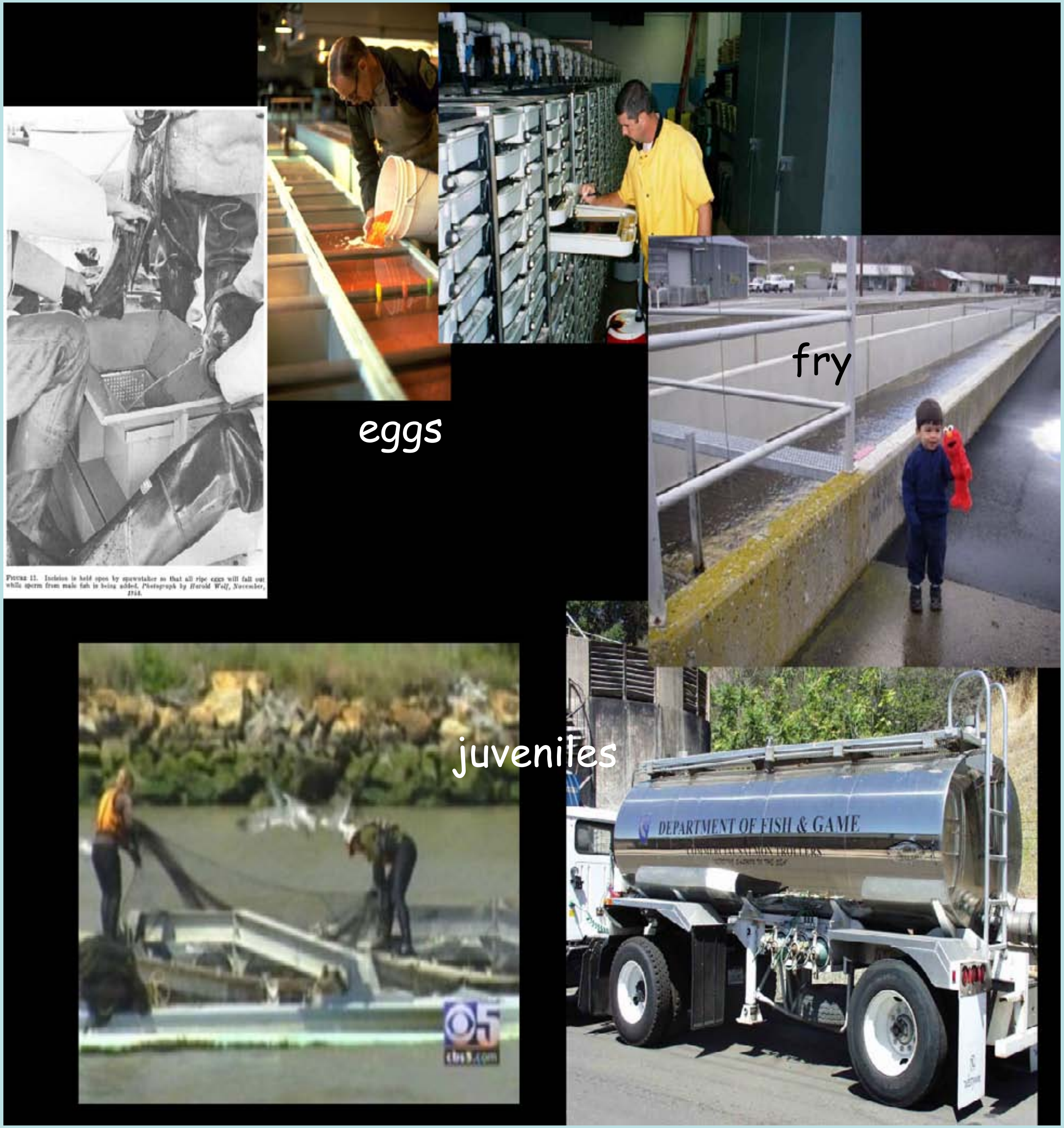
Hatcheries are an increasing proportion of total returns



Hatcheries reduce diversity

Simplify and standardize the environment

- *High correlation in survival among hatcheries*
- *High variation in survival as natural environment lines up or fails to line up with hatchery operations*
- *Domestication selection for behavioral deficiencies*
- *Off site release promotes staying and genetic homogeneity and out breeding depression*



dams

Habitat Degradation

- Reduced life-history diversity w/in and among runs

levees

Contrast SRFC with Bristol Bay, AK sockeye salmon

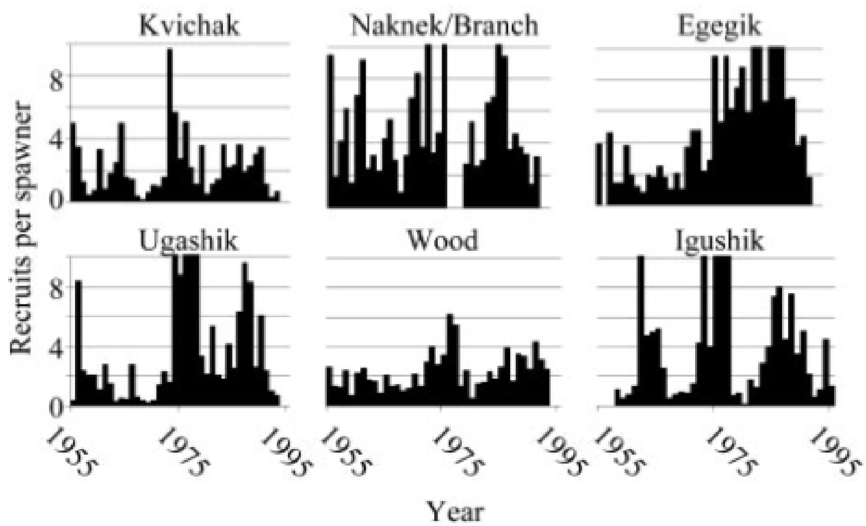


Fig. 4. Number of recruits per spawner for different Bristol Bay sockeye salmon stocks. Values >10 were truncated; the maximum was 27.4 for the Ugashik River in 1978. Hilborn et al. PNAS 100:6564 (2003

- Retained diverse life histories among populations
- Uncorrelated dynamics among populations
- Non-synchronous shifts in population productivity
- Dampened overall variation in stock abundance and harvest

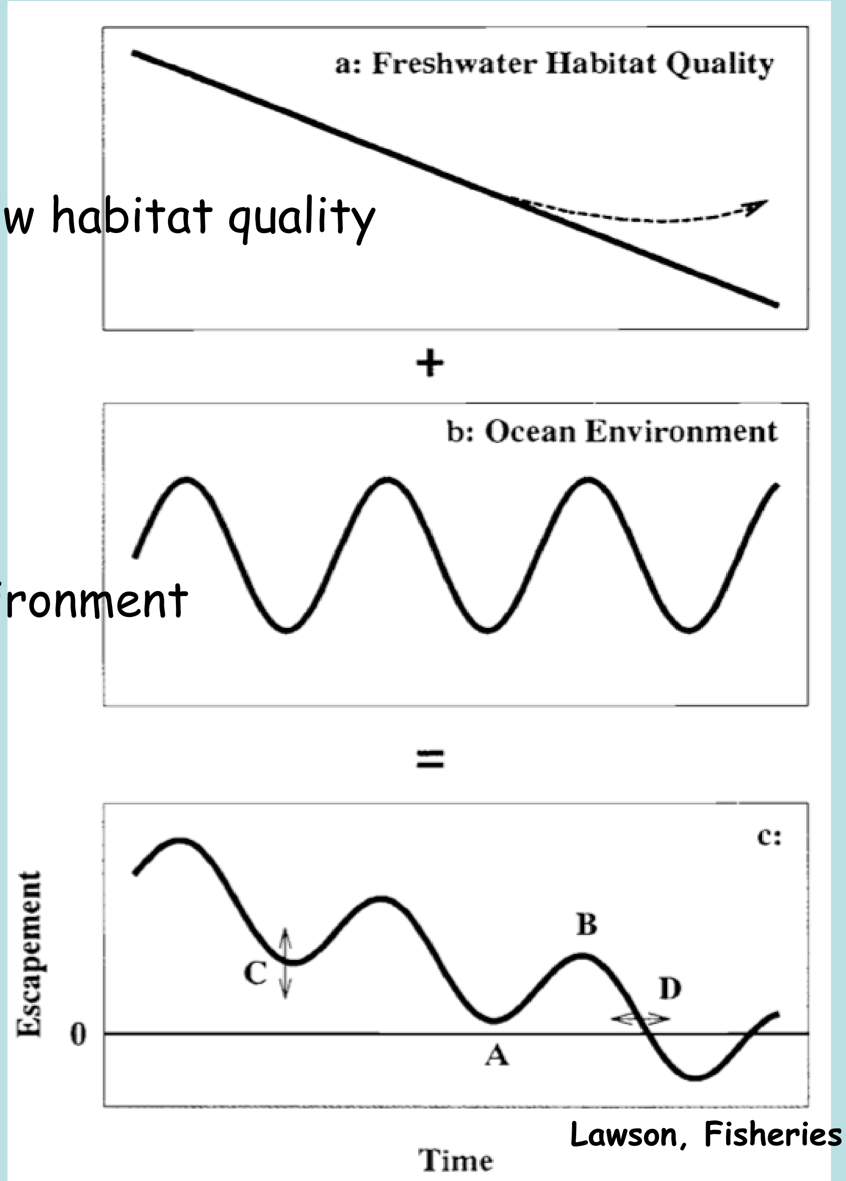
Lawson's Conceptual Model

For coho salmon in Oregon, but applies to SRFC

steadily declining fw habitat quality

rapidly varying ocean environment

abundance = sum of the 2 trends, rapid ups and downs superimposed on long-term decline



Lawson, Fisheries 18:6 (1993)

What can be done to stabilize the populations and fishery?

In general, rebuild wild populations and provide opportunity for increased diversity

Recommendations

- Hatchery reforms: HSRP to review broodstock selection, production levels, broodstock and egg transfer and rearing and release practices. Easiest near-term improvement.
- Manage natural populations to increase diversity, e.g., establish escapement goals for natural populations
- Habitat restoration, especially restoring ecological function of delta
- Ecosystem-based management and ecological risk assessment

Exports of Freshwater from the delta

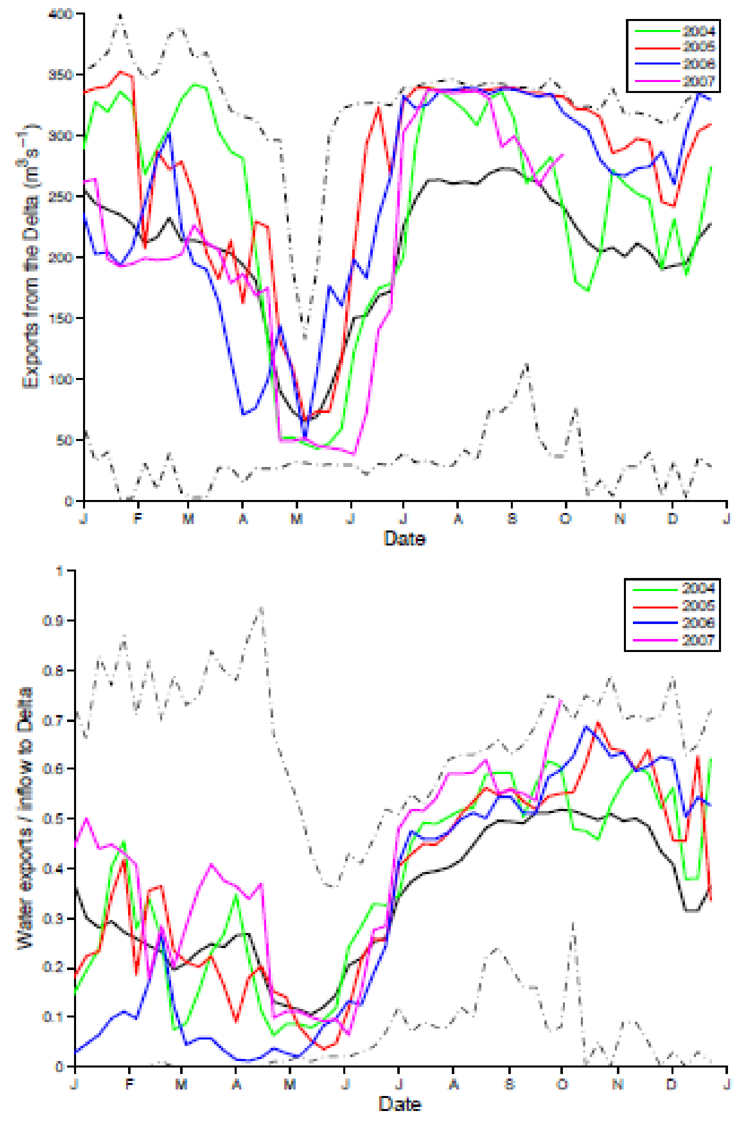
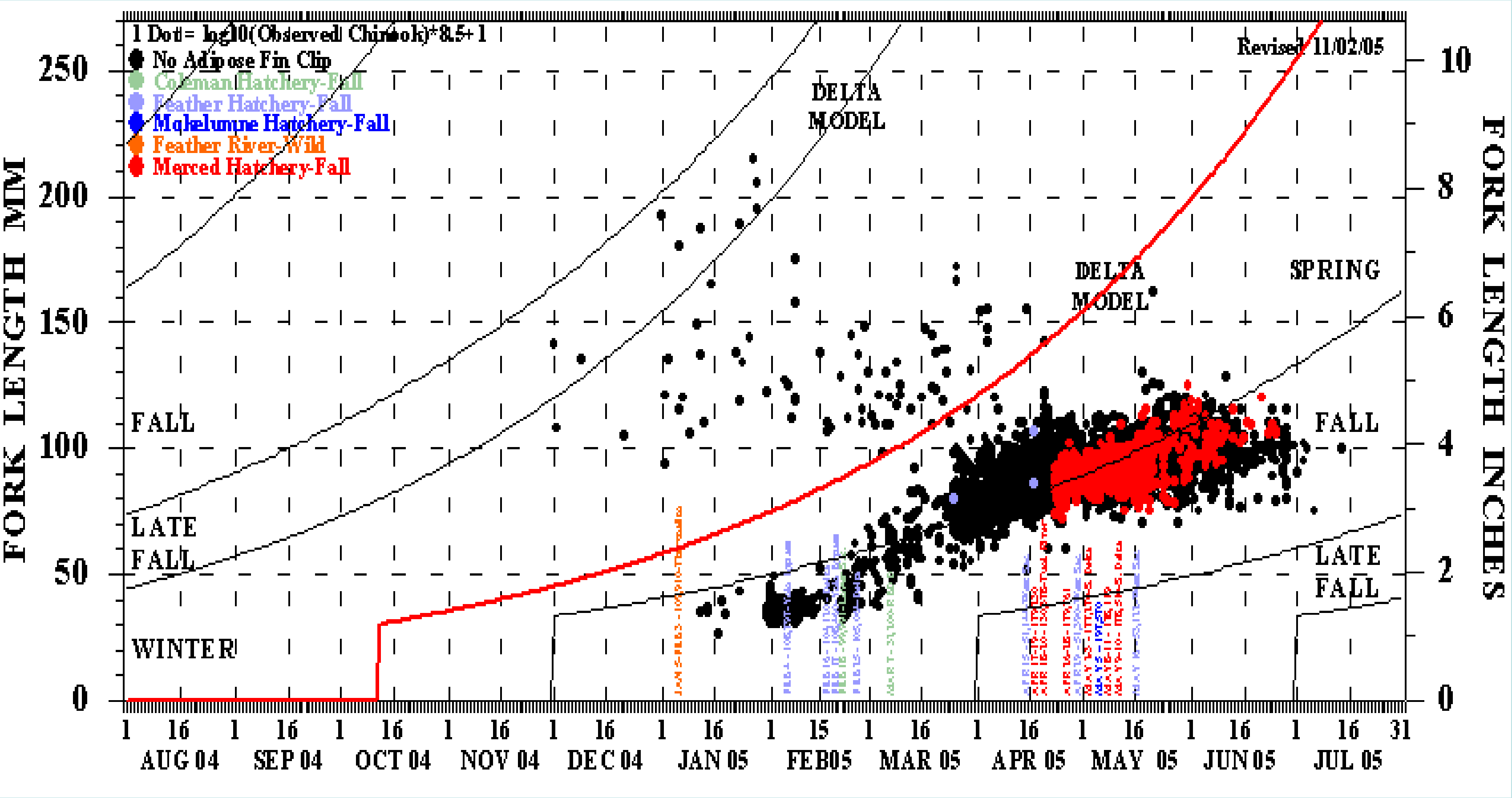


Figure 5: Weekly average export of freshwater from the Delta (upper panel) and the ratio of exports to inflows (bottom panel). Heavy black line is the weekly average discharge over the 1955-2007 period; dashed black lines indicate maximum and minimum weekly average discharges. Exports, as both rate and proportion, were higher than average in all years in the summer and fall, but near average during the spring, when fall Chinook are migrating through the Delta. Flow estimates from the DAYFLOW model (http://www.iep.ca.gov/dayflow/).

When outmigrants are in the CV river system



Hatchery releases, trucking and net pen acclimation

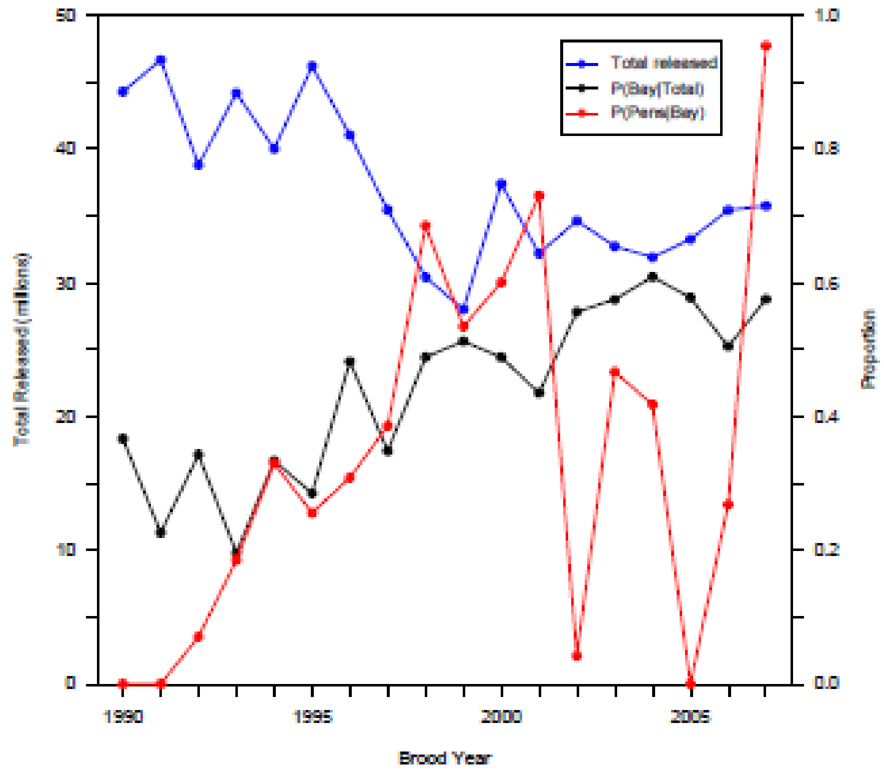
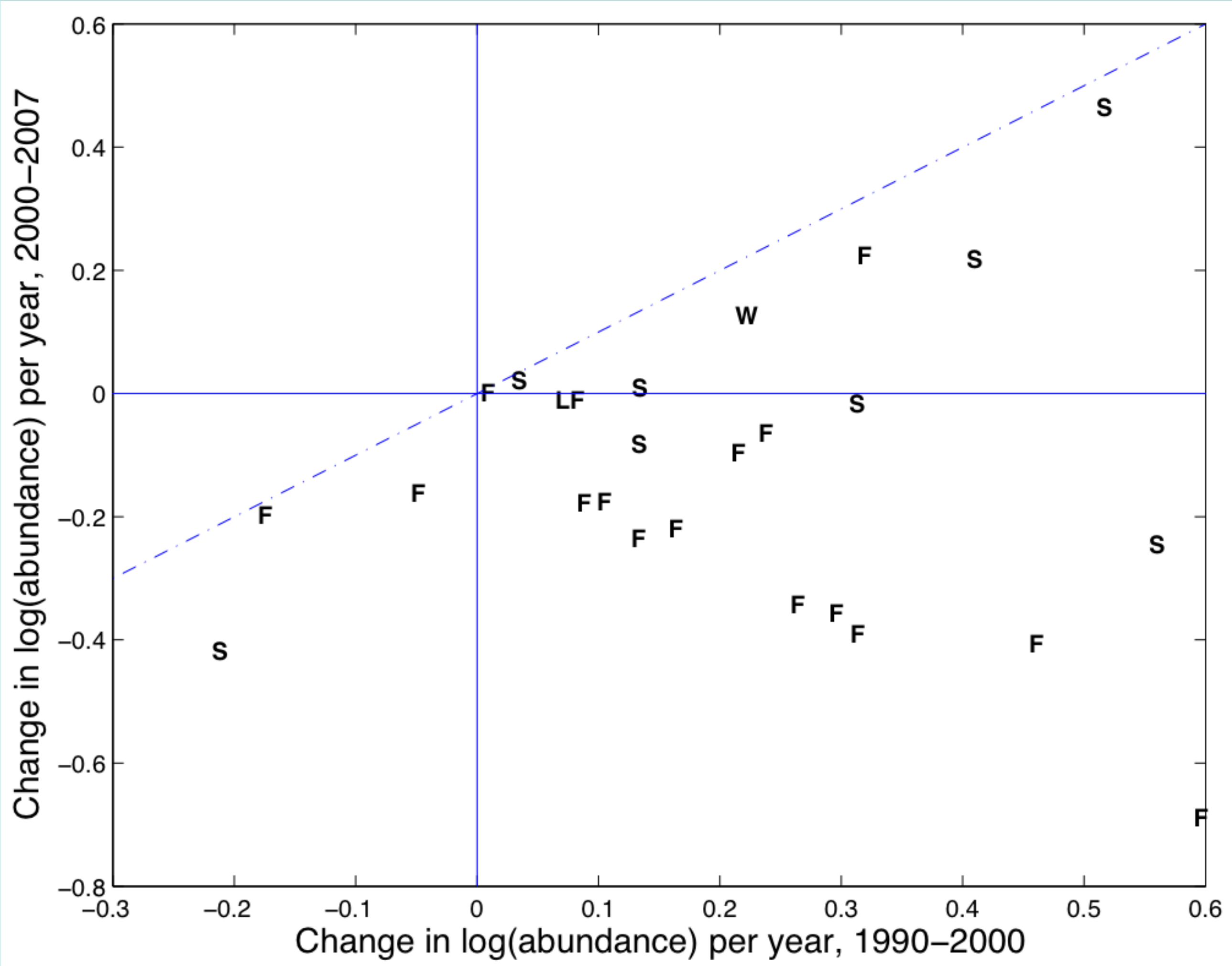
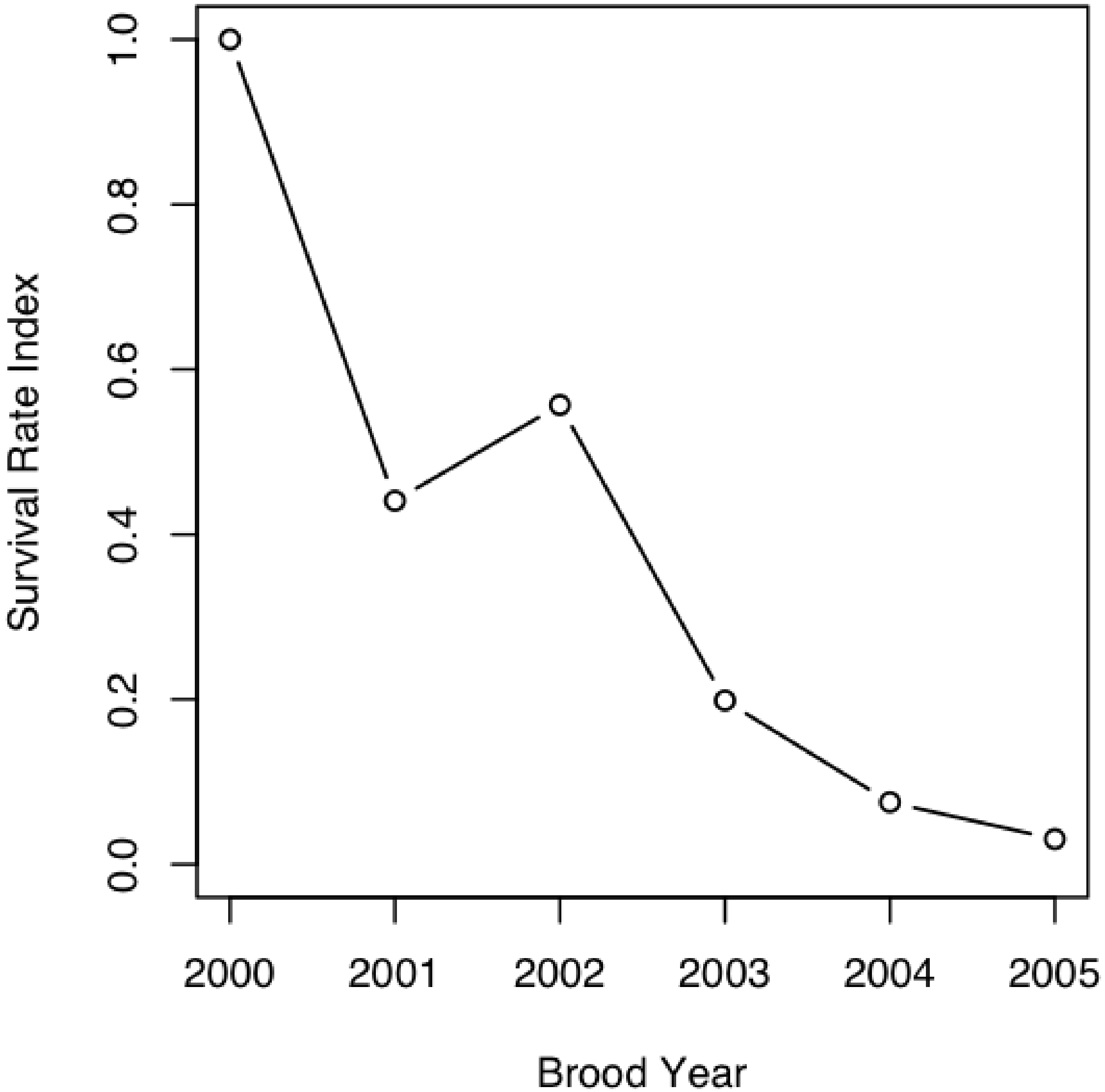


Figure 6: Total releases of hatchery fall Chinook, proportion of releases made to the bay, and the proportion of bay releases acclimatized in net pens. Unpublished data of CDFG and USFWS.



Change in log(abundance) per year, 2000–2007
Change in log(abundance) per year, 1990–2000
0.6
0.4
0.2
0
−0.2
−0.4
−0.6
−0.8
−0.3
−0.2
−0.1
0
0.1
0.2
0.3
0.4
0.5
0.6

Survival of FRH to age two



	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
PDO Winter (Dec-Mar)	9	3	4	6	2	10	6	8	7	1
PDO Summer (May-Sept)	7	1	2	3	4	9	8	10	6	5
MEI (annual)	10	1	2	4	9	8	6	7	5	3
MEI Jan-June	10	1	2	4	6	8	5	9	3	7
SST at 46050	8	1	3	4	2	6	10	7	5	9
SST at NH 05	7	2	1	3	5	6	10	9	4	8
SST winter before	10	5	3	4	2	6	9	8	7	1
Upwelling April+May	5	1	9	3	4	8	7	10	5	2
Mean Upwelling	7	6	2	3	4	1	9	10	5	8
Physical Spring Transition	9	1	7	4	2	6	8	10	3	5
Deep Temperature	10	3	5	1	1	6	7	9	8	4
Deep Salinity	10	2	2	4	7	8	9	6	5	1
Copepod spp richness	10	2	1	4	3	7	6	9	8	5
N.Copepod Anomaly	10	7	2	4	1	8	5	9	6	3
X-axis Ordination Scores	10	4	2	3	1	6	7	9	8	5
Biological Transition	10	4	1	4	3	8	6	9	7	2
Length of bio-upwelling season	10	2	4	2	1	7	8	9	6	5
June-Chinook Catches	9	1	2	7	4	6	8	10	5	3
Sept-Coho Catches	8	2	1	4	3	5	10	9	6	7
Mean of Ranks	8.9	2.6	2.8	3.6	3.4	6.6	7.7	8.8	5.7	4.6
RANK of the mean rank	10	1	2	4	3	7	8	9	6	5
Coho Salmon Survival	0.012	0.023	0.044	0.025	0.037	0.025	0.019	0.020	0.018	0.009
Number RED	15	1	1	0	1	8	10	15	3	3