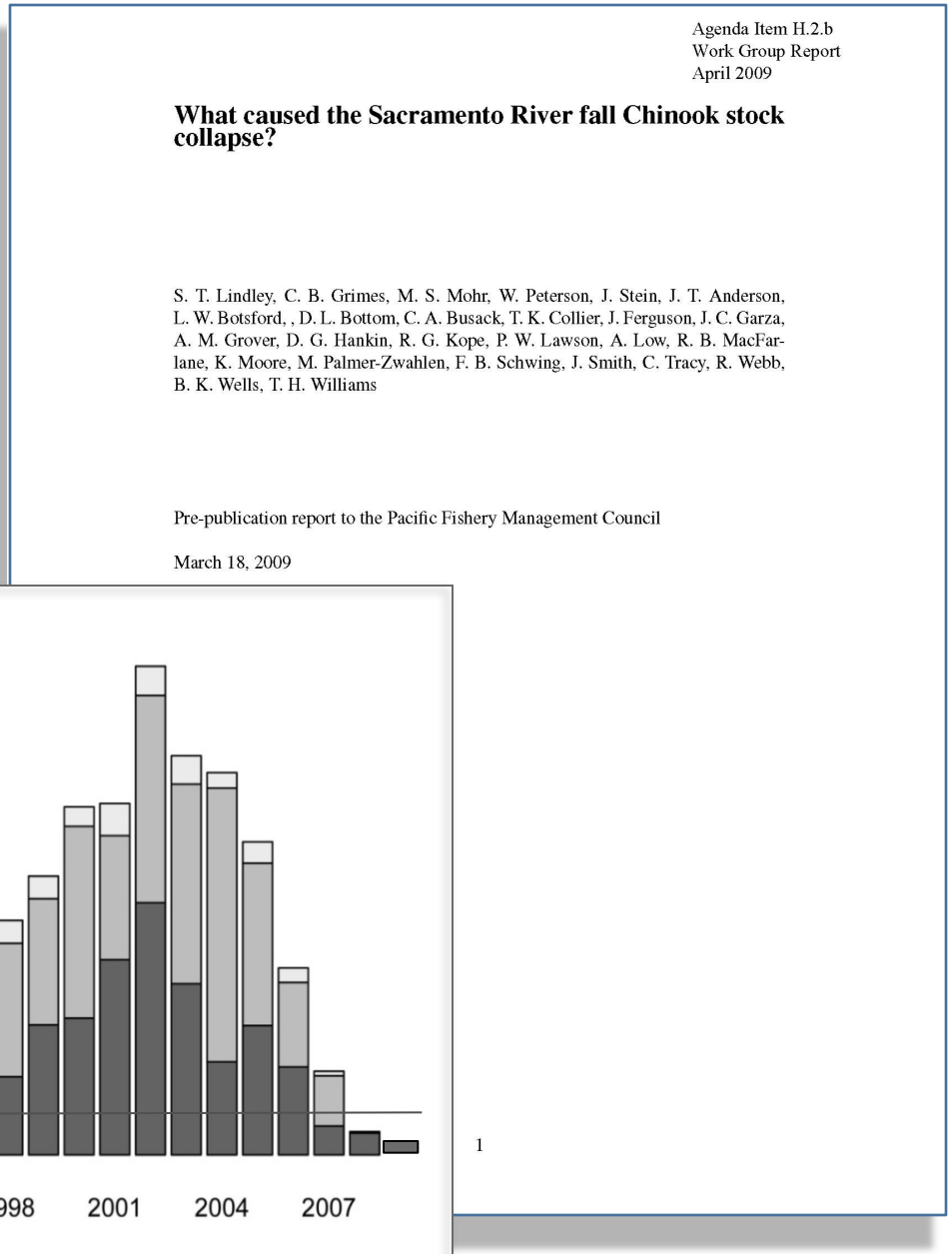
Utilizing Ecosystem Information to Improve Decision Support for Central California Salmon

Results from Salmon Applied Forecasting, Assessment and Research Initiative (SAFARI)

Chavez, F.[1], **B.K. Wells[2]**, E. Danner[2], W. Sydeman[3], Y Chao[4], F Chai[5], S. Ralston[2], J. Field[2], D. Foley[2], J. Santora[3], S. Bograd[2], S. Lindley[2], and W. Peterson[2].

1. MBARI
2. NOAA
3. Farallon Institute
4. JPL Jet Propulsion Laboratory California Institute of Technology
5. MAINE

How can NASA remote sensing and models be used to augment the decision support system for central California salmon?



Agenda Item H.2.b
Work Group Report
April 2009

What caused the Sacramento River fall Chinook stock collapse?

S. T. Lindley, C. B. Grimes, M. S. Mohr, W. Peterson, J. Stein, J. T. Anderson, L. W. Botsford, , D. L. Bottom, C. A. Busack, T. K. Collier, J. Ferguson, J. C. Garza, A. M. Grover, D. G. Hankin, R. G. Kope, P. W. Lawson, A. Low, R. B. MacFarlane, K. Moore, M. Palmer-Zwahlen, F. B. Schwing, J. Smith, C. Tracy, R. Webb, B. K. Wells, T. H. Williams

Pre-publication report to the Pacific Fishery Management Council

March 18, 2009

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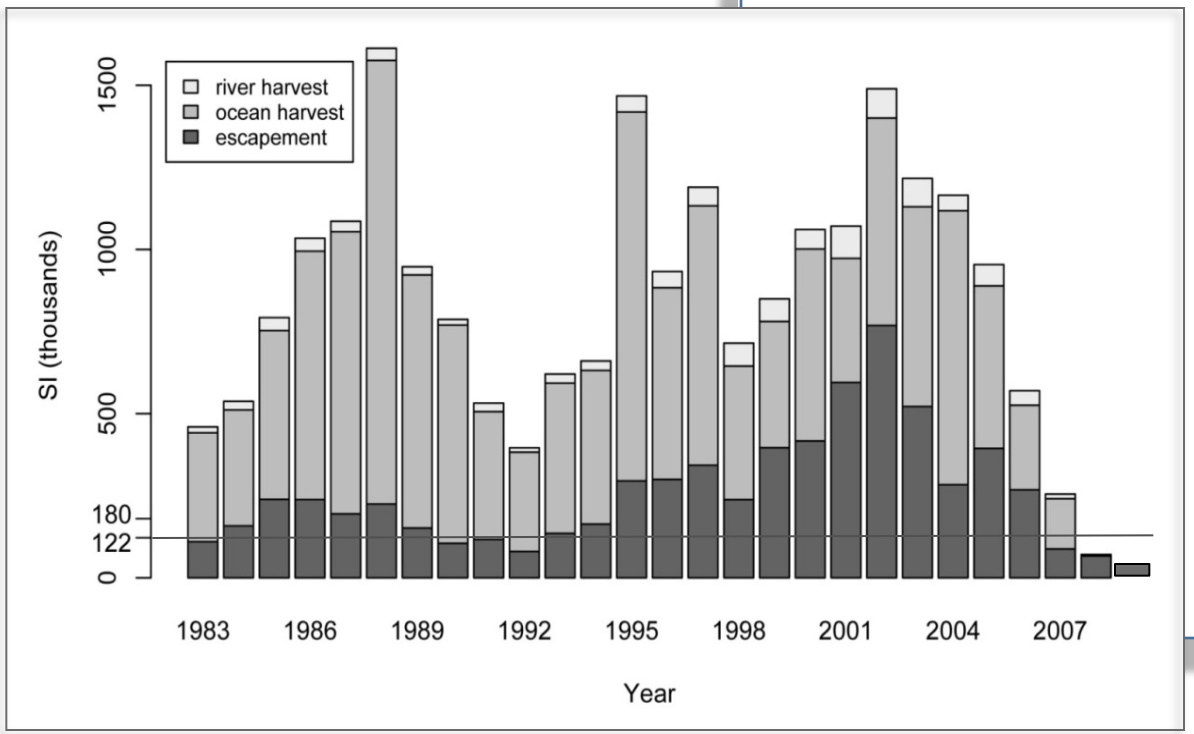
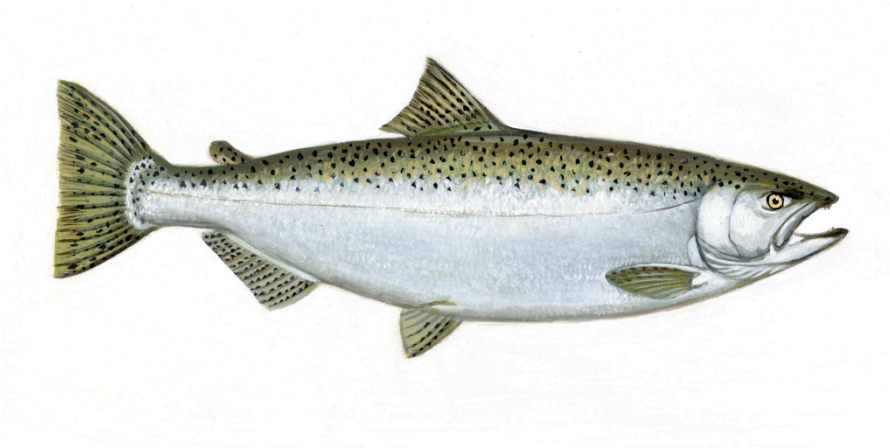
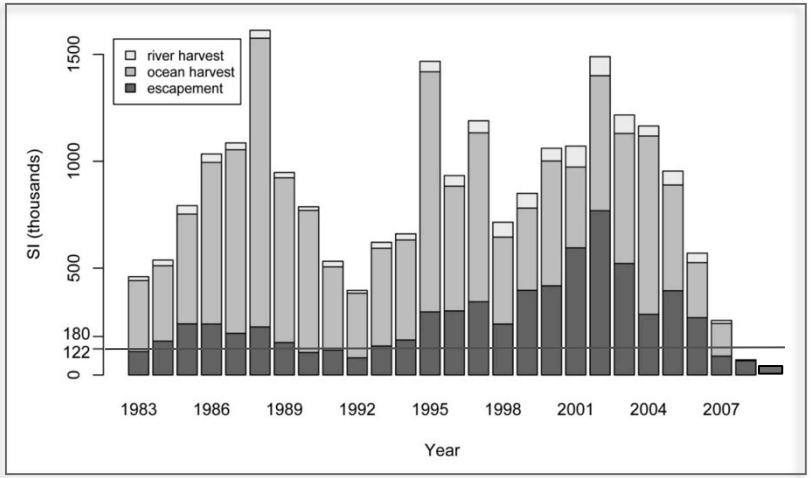
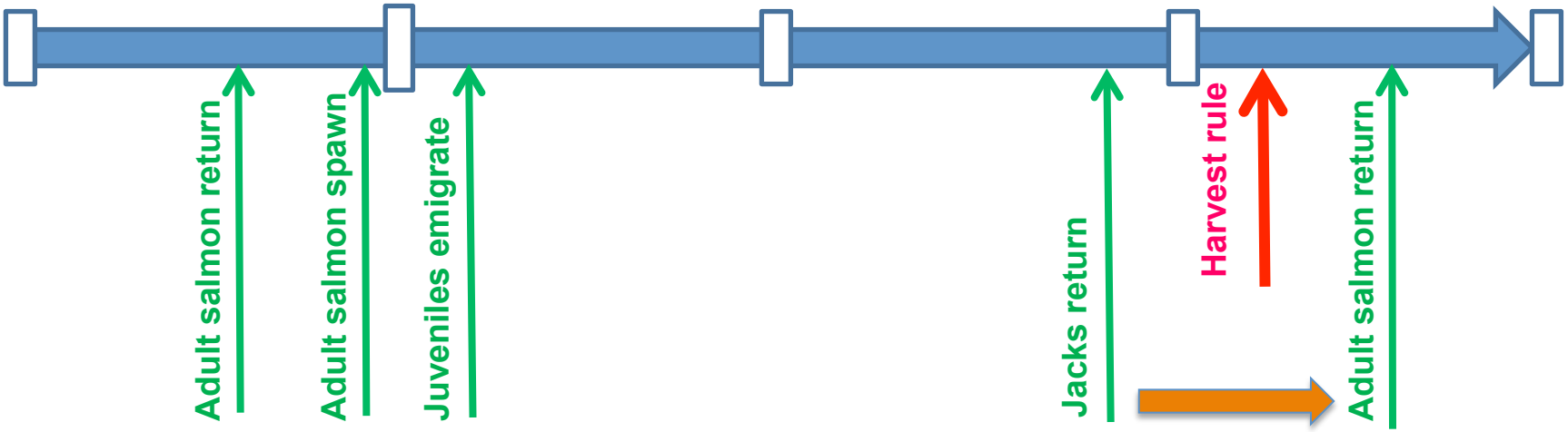


Lifecycle and management timing

Current approach predicts adult abundance from jacks (premature returns) of the same cohort







= winter

Successes

1. Building observed relationships between physics and biology
2. Modeling the ocean environment (ROMS-COSINE)
3. Combining these approaches to improve current management models
4. Transition to operations

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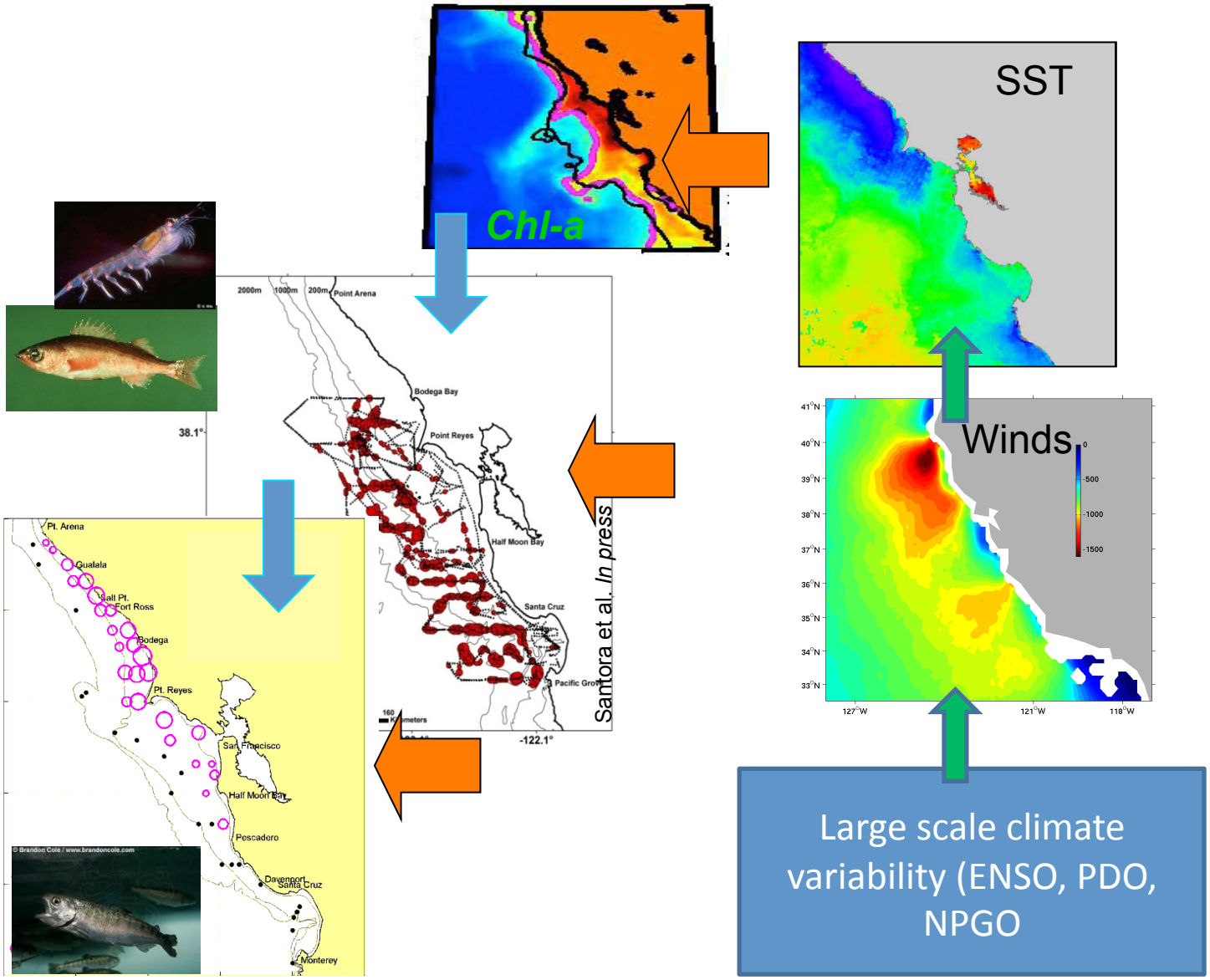
1. Building observed relationships between physics and biology



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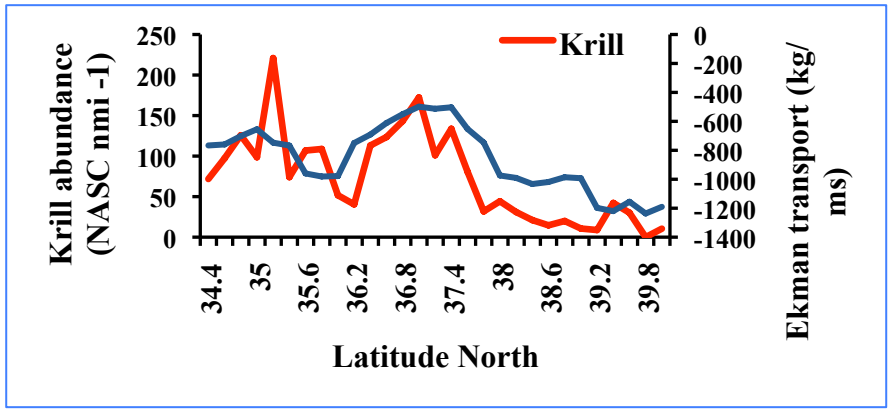
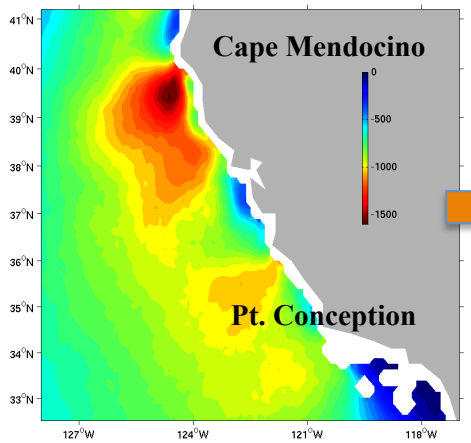
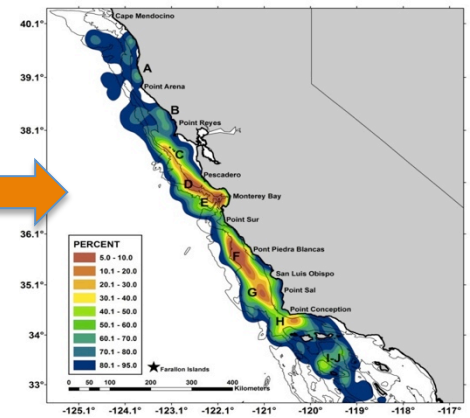


Wind



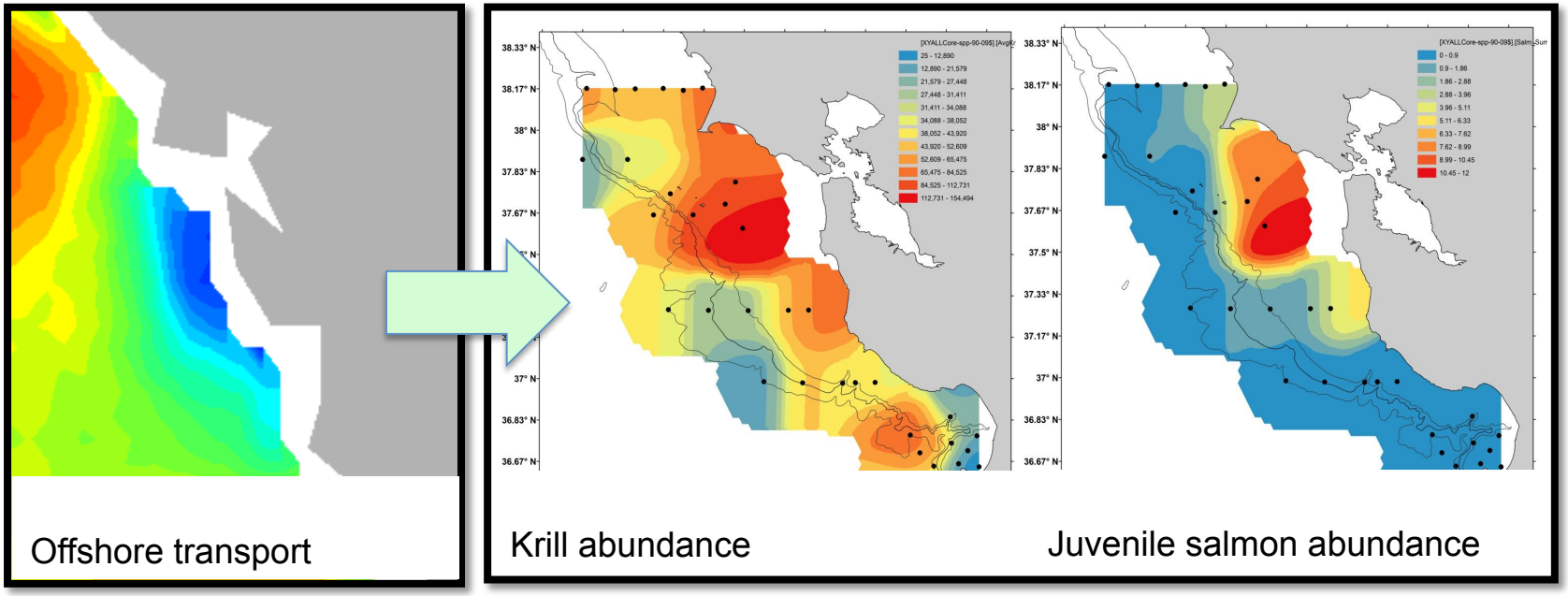
Krill



Santora, J.A., W.J. Sydeman, I.D. Schroeder, B.K. Wells, J.C. Field. 2011. Mesoscale structure and oceanographic determinants of krill hotspots in the California Current: Implications for trophic transfer and conservation. *Progress in Oceanography*. http://www.sciencedirect.com/science/article/pii/S0079661111000371

1. Building observed relationships between physics and biology

Juvenile salmon rear in a plug of krill located in a relaxed area.



Wells, B.K., J.A. Santora, J.C. Field, R.B. MacFarlane, B.B. Marinovic, and W.J. Sydeman. *In review*. An ecosystem perspective for quantifying the dynamics of juvenile Chinook salmon (*Oncorhynchus tshawyscha*) and prey in the central California coastal region. *Marine Ecology Progress Series*.

Santora, J.A., W.J. Sydeman, I.D. Schroeder, B.K. Wells, J.C. Field. 2011. Mesoscale structure and oceanographic determinants of krill hotspots in the California Current: Implications for trophic transfer and conservation. *Progress in Oceanography*. http://www.sciencedirect.com/science/article/pii/S0079661111000371

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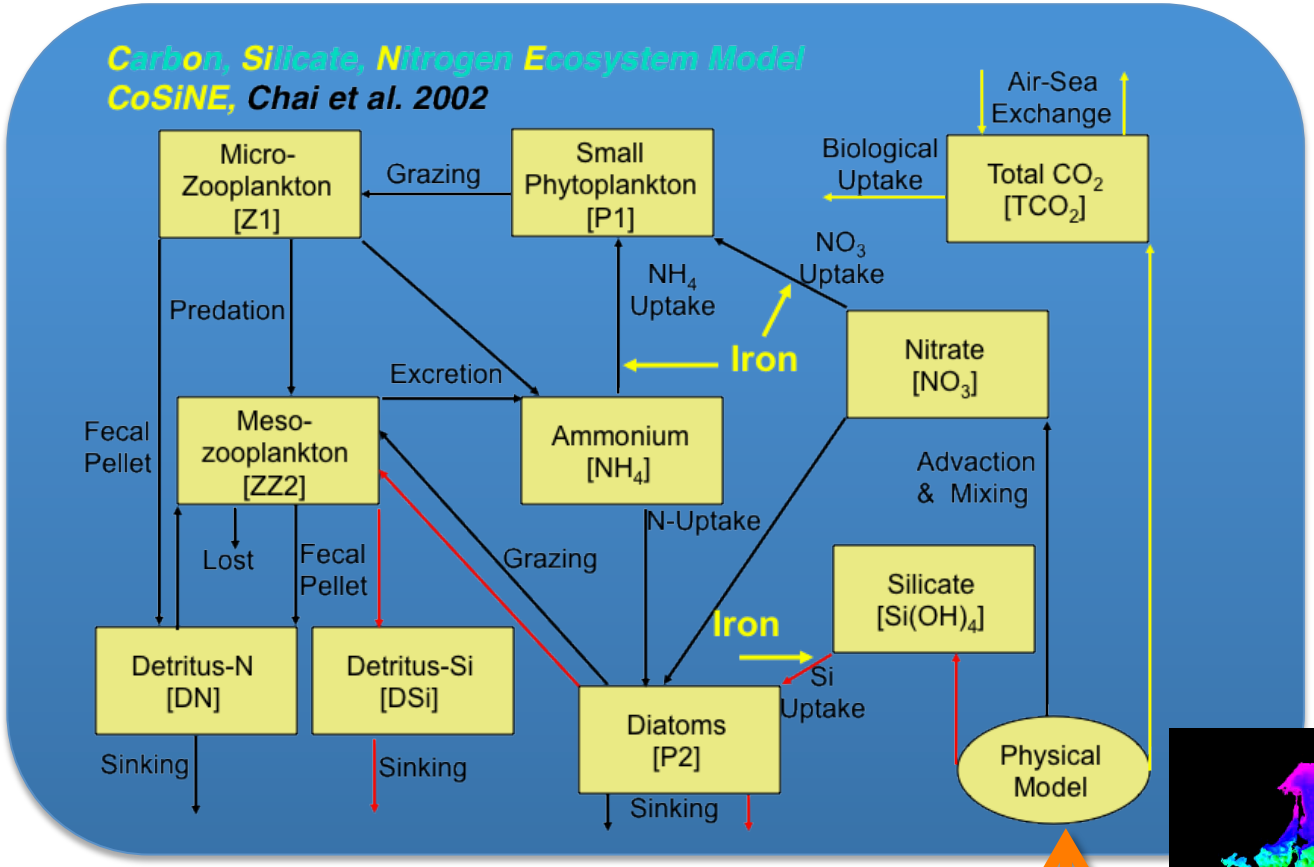
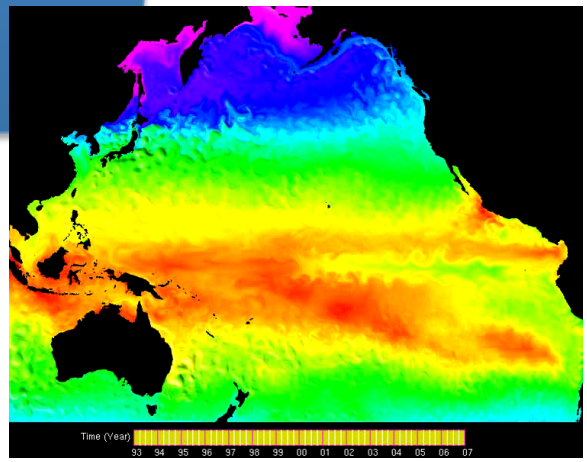
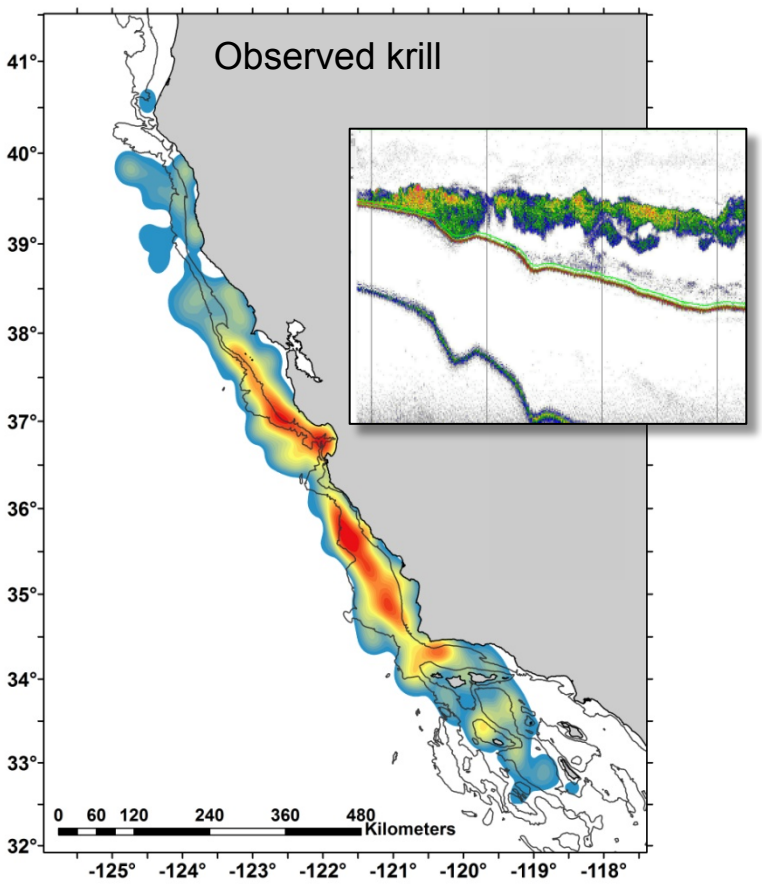


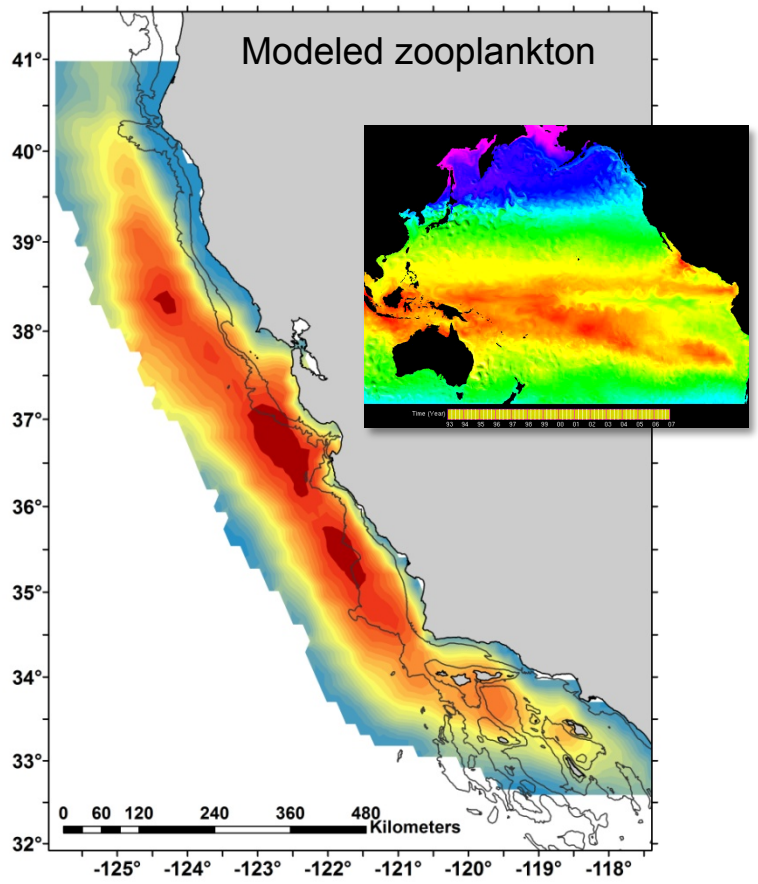


Physical model run over entire Pacific at 12.5 km resolution

2. Modeling the ocean environment (ROMS-COSINE)

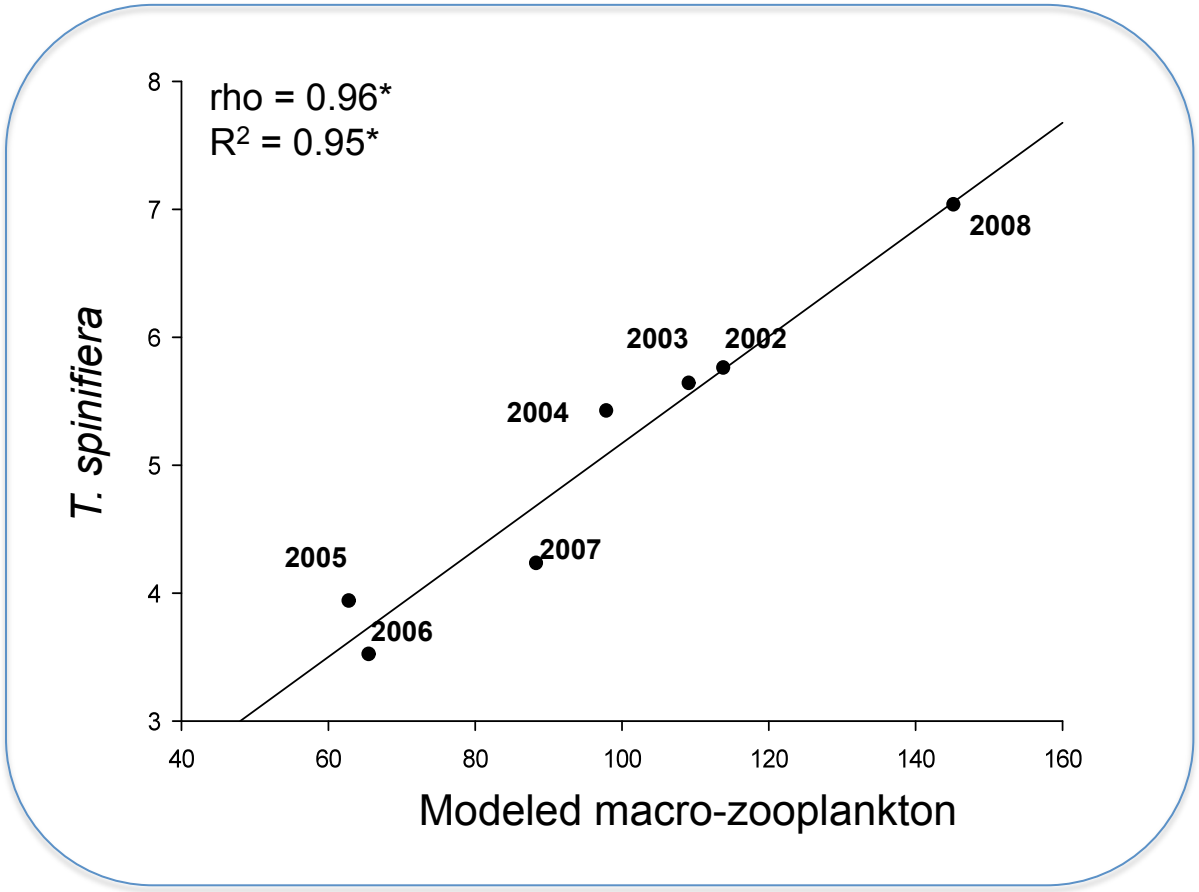
The modeling approach is capable of reproducing the zooplankton climatology demonstrated in empirical studies





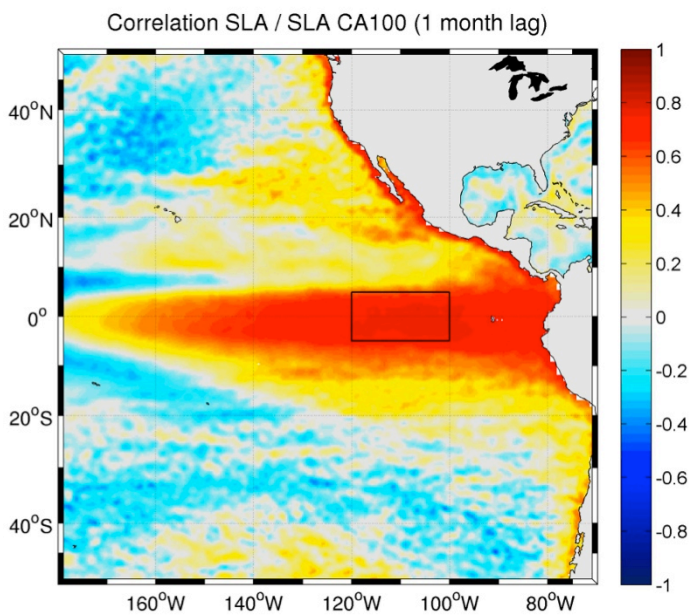
2. Modeling the ocean environment (ROMS-COSINE)

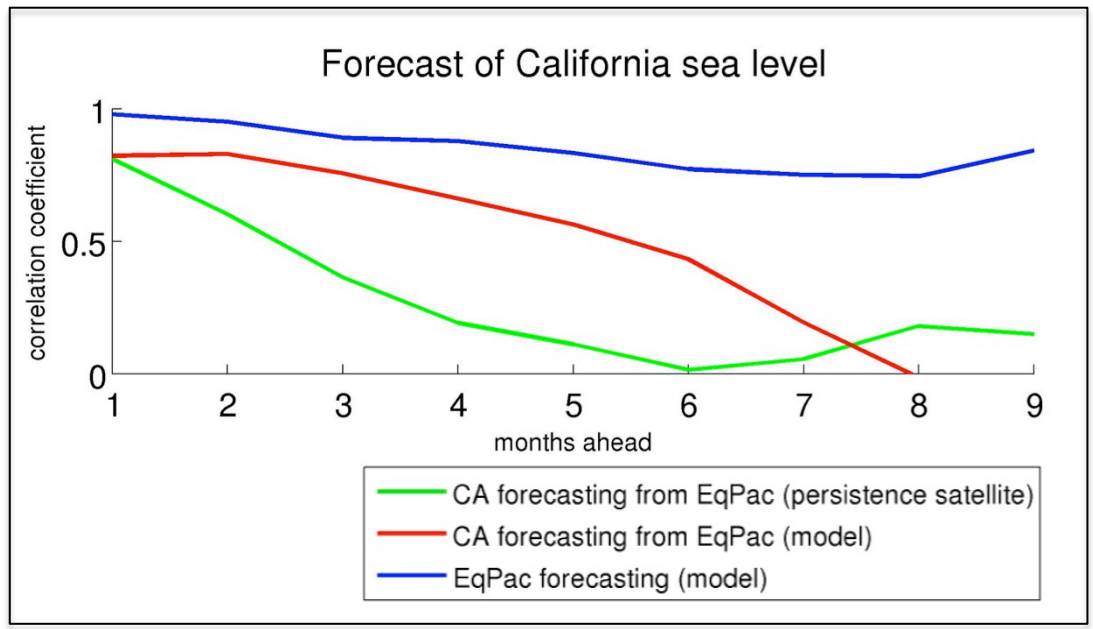
The modeling approach is capable of reproducing the temporal patterns observed in empirical studies



2. Modeling the ocean environment (ROMS-COSINE)

We can forecast SLH in California outward 4 months (red line) reasonably well; significantly better than autocorrelation (green line). To accomplish this we use the standing correlation between Equatorial Pacific SLH, which is modeled well (blue line), and California SLH.





Sea level captures both local (winds) and remote (ENSO, PDO, NPGO) forcing of the environment

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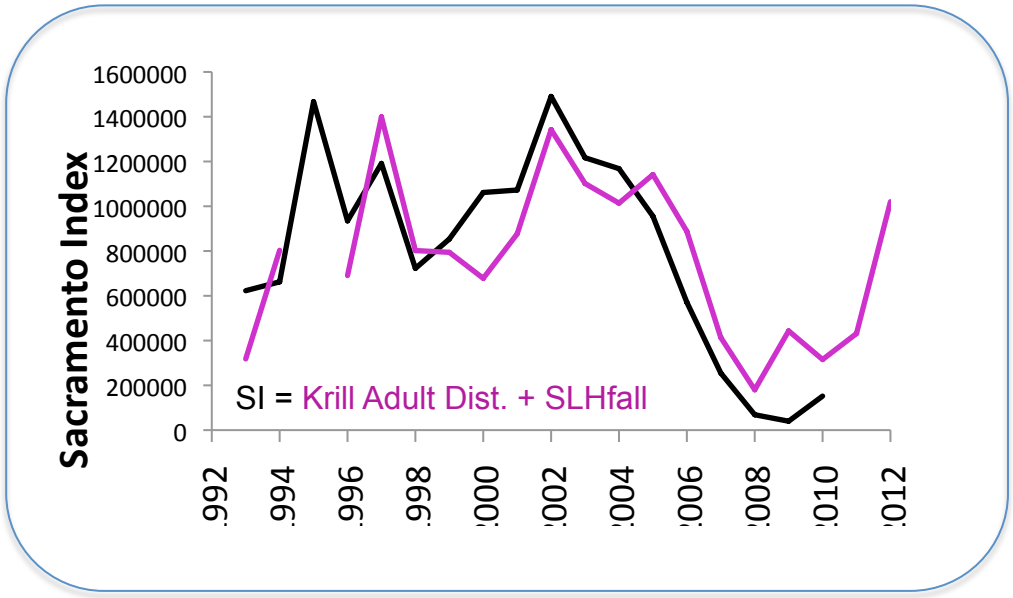
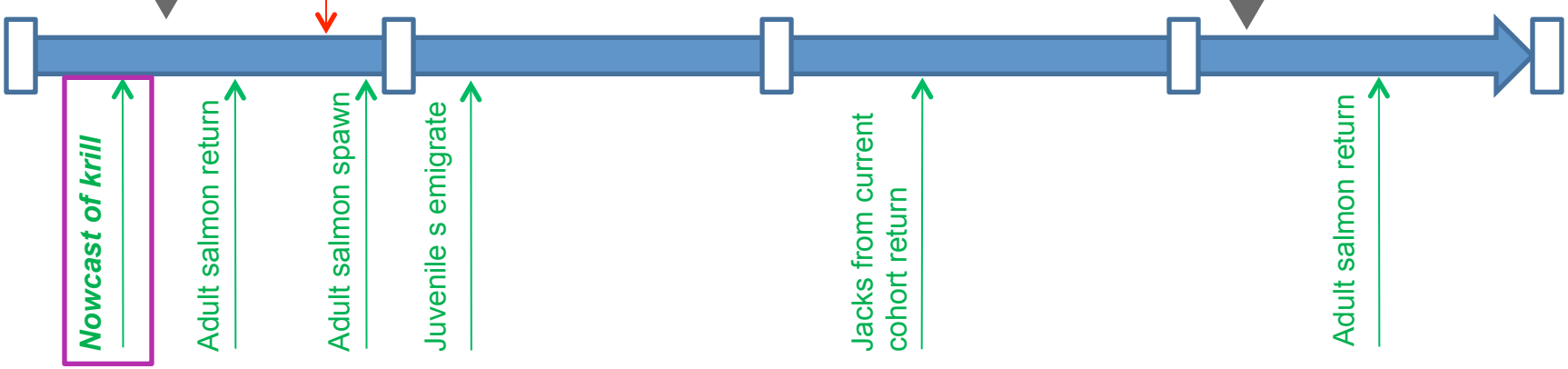


With nowcasts of krill and SLH to fall we can extend our predictions to the previous cohort.

SLH is forecasted

Current timing: Sibling model SI and harvest rule set



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We maintain a strong relationship with management: Present and explain our models to PFMC and subcommittees periodically.

Pacific Fishery Management Council
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Phone 503-820-2280 | Toll free 866-806-7204 | Fax 503-820-2299 | www.pcouncil.org
Donald K. Hansen, Chairman — Donald O. McIsaac, Executive Director

August 12, 2008

Dr. Brian K. Wells
National Marine Fisheries Service
Southwest Science Center
Fisheries Ecology Division
110 Shaffer Road
Santa Cruz, CA 95060

Re: Research Proposal for Incorporating Ecosystem Information to Improve the Decision Support System for Central California Salmon

Investigators: Brian Wells, Francisco Chavez, Eric Danner, John Field, Steven Lindley, Stephen Ralston, Jarrod Santora, William Sydeman, Julie Thayer, Fei Chai, and Yi Chao

Dear Dr. Wells:

This letter is to formally support the research proposal for incorporating ecosystem information to improve the decision support system for central California salmon. The Pacific Fishery Management Council (Council) staff has reviewed a summary of the research proposal and has attended your presentation on the initial phase of this project. The project results would have direct applicability to the Council mission and is consistent with identified needs in Council documents.

The Magnuson-Stevens Act (MSA) requires the Council to manage ocean fisheries using the best available science, and to incorporate ecosystem management principles whenever possible. This research would provide new insight into the relationship between the environment and fish population response, and could improve predictive models upon which Council management relies. In addition to applications to salmon management, this project could have implications for groundfish and other Council managed stocks and could provide a longer horizon for planning that would be valuable to the fishing industry.

The Council compiles a summary of research and data needed by the Council to implement its responsibilities as defined by the MSA, the Regulatory Flexibility Act, and other pertinent legislation. This document identifies a number of issues and tasks that would be addressed by the proposed research project, for example:

- Use of short and long term climate and ocean status, trends, and scenarios for the California Current ecosystem in stock assessments, harvest levels, and rebuilding plans;
- Identification of key physical and biological indicators for prediction of salmon early ocean survival and groundfish recruitment, as well as other conditions that are directly applicable to management;

- Investigate long term and short term relationships between environmental conditions and fluctuations in Chinook and coho salmon survival, abundance, and maturation rates;
- Characterize climate variability in the northeast Pacific and its relation to salmon survival and stock productivity;
- Collection of indices of ecosystem state on appropriate temporal and spatial scales, including upwelling, El Niño, Pacific Decadal Oscillation, Sea Surface Temperature, etc.;
- Evaluate the influence of climatic/oceanographic conditions on coastal pelagic species, and;
- Conduct studies on environmental factors, as they relate to recruitment, growth, maturity, and catch-ability of albacore.

The Council, National Marine Fisheries Service (NMFS) and other State and Federal agencies are currently involved in an investigation to determine the cause of the recent collapse of west coast salmon populations, particularly Sacramento River fall Chinook. The proposed research project has and will continue to provide valuable insight into the effects of ocean environmental conditions affecting this salmon stock. The finer scale measurements obtained from this research may help explain the localized effects of ocean conditions and also an observed north-south gradient in 2008 stock status.

In summary, this research project directly addresses some of the highest priority Council stock assessment and management needs, and could greatly assist the fishing industry in long term planning. We strongly support this project and urge that you continue to pursue funding for this valuable research. If you have any questions or need additional information, feel free to contact me or Chuck Tracy, salmon staff officer for the Council.

Sincerely,

D. O. McIsaac, Ph.D.
Executive Director

CAT:csp

c: Dr. Churchill Grimes
Dr. Gary Sakagawa
Dr. Steve Ralston
Dr. John Stein
Council Members
Staff Officers

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Next steps and beyond