



CIMEC

Cooperative Institute for Marine Ecosystems and Climate

Scripps Institution of Oceanography, UCSD
California State University Los Angeles
Humboldt State University
University of California Davis
University of California Los Angeles
University of California Santa Barbara
University of California Santa Cruz

PROGRESS REPORT

2011-2012





CIMEC

Cooperative Institute for Marine Ecosystems and Climate (CIMEC)

Scripps Institution of Oceanography

University of California, San Diego

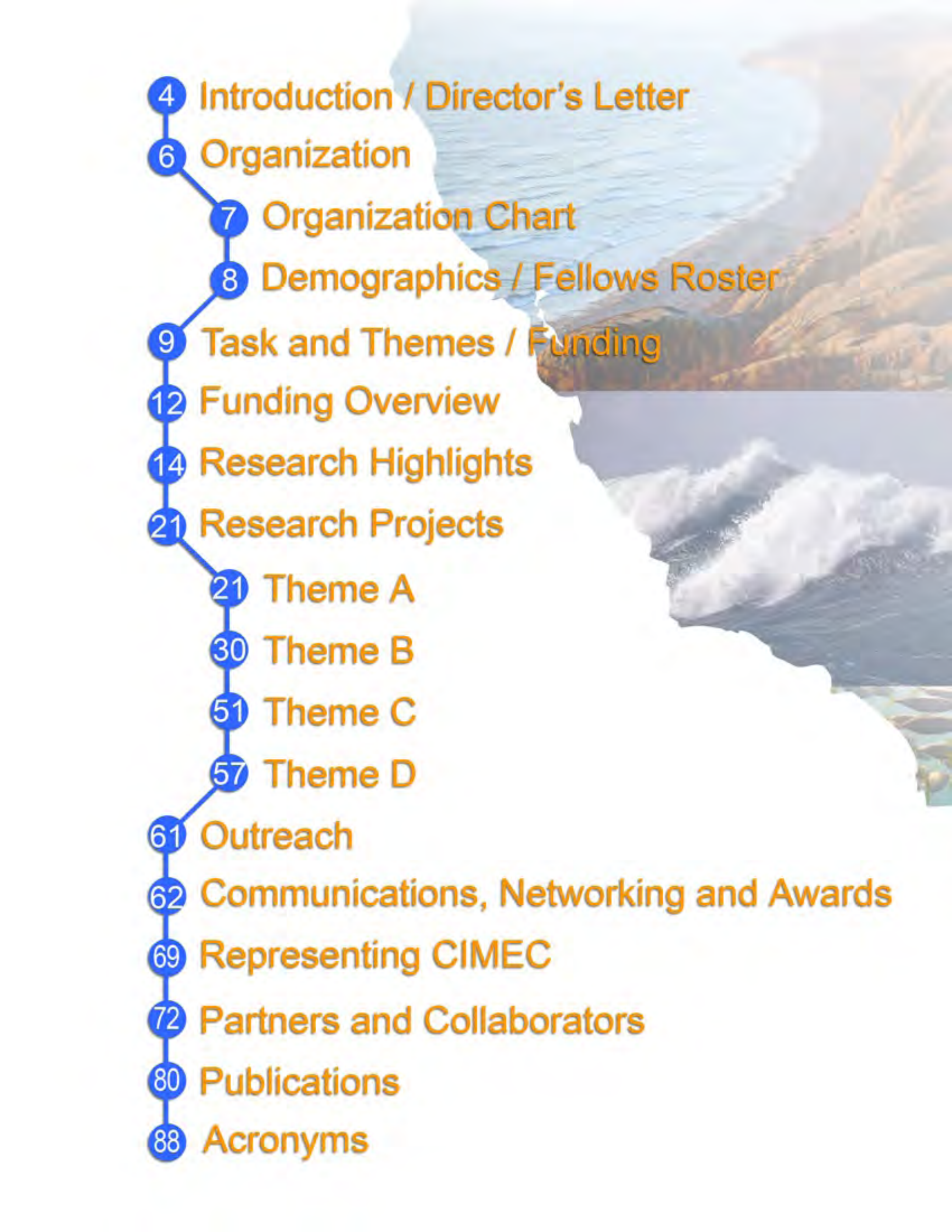
291 Rosecrans Street

San Diego, California 92106

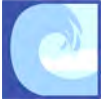
Phone: (858) 534-1795

Fax: (858) 822-0665

<http://www.cimec.ucsd.edu>



4	Introduction / Director's Letter
6	Organization
7	Organization Chart
8	Demographics / Fellows Roster
9	Task and Themes / Funding
12	Funding Overview
14	Research Highlights
21	Research Projects
21	Theme A
30	Theme B
51	Theme C
57	Theme D
61	Outreach
62	Communications, Networking and Awards
69	Representing CIMEC
72	Partners and Collaborators
80	Publications
88	Acronyms



INTRODUCTION

The Cooperative Institute for Marine Ecosystems and Climate (CI-MEC) research and program activities for the first year (2011-2012) of the **National Oceanic and Atmospheric Administration** (NOAA) grant **NA10OAR4320156** are outlined in this report. CI-MEC is affiliated with the **Scripps Institution of Oceanography** (SIO), and is a multi-disciplinary Institution for ocean, climate, earth and environmental research as part of the University of California, San Diego (UCSD) campus and greater University of California (UC) system. Included in this report are the individual projects, activities and accomplishments of CI-MEC researchers and partners at SIO, UC and Cal State, as well as other collaborating organizations associated with CI-MEC.

CI-MEC's purpose is to facilitate and enhance research cooperation between NOAA entities and SIO, in particular, and the University of California (UC) and California State Universities (Cal State), in general, pertinent to the mission of NOAA.

During the April 1, 2011 to March 31, 2012 period, the NOAA research entities listed below were engaged with SIO as part of CI-MEC in marine, atmospheric and climate research, education and outreach efforts, data collection, and collaborative activities:

- Office of Oceanic and Atmospheric Research (OAR)
- Climate Program Office (CPO)
- Earth System Research Laboratory (ESRL)
- Integrated Ocean Observing System (IOOS)
- National Marine Fisheries Service (NMFS)
- National Ocean Service (NOS)
- Ocean Assessment Program (OAP)
- Pacific Island Fisheries Science Center (PIFSC)
- Pacific Marine Environmental Laboratory (PMEL)
- Southeast Fisheries Science Center (SEFSC)
- Southwest Fisheries Science Center (SWFSC)



DIRECTOR'S LETTER

CIMEC is strong as it nears the end of its second year. Nearly all of JIMO projects have continued in CIMEC and several new projects have started. Our funding totals \$20 million. We are grateful to NOAA for its continued support, despite the challenging fiscal times. We take pride in our contribution to NOAA's mission and look forward to continuing to do so. Below, I note highlights of the past year.

A major accomplishment was the publication by Roemmich, Gould, and Gilson in Nature Climate Change using Argo data to infer that the temperature of the global ocean is increasing. Temperature data from the HMS Challenger (1872-76) and Argo (2004-10) showed the oceans have warmed at least since the late 19th or early 20th century. In the past year, SIO deployed 69 SOLO-II Argo floats and work progresses on development of a deep Argo float, to fully sample the ocean's heat content.

Climate and ocean observations and research continued unabated. The Global Drifter Program was maintained and enhanced. The High-Resolution XBT program continued observing of the major western boundary and Southern Ocean currents. HF Radar Network data management challenges are being met. A workshop was held on extreme weather events in California in the context of a changing climate with attendees from academia, government, and the private sector. A downward trend in atmospheric oxygen constrained global land and ocean carbon sink estimates. Two highly instrumented moorings in the California Current Ecosystem provided realtime data on ocean physics, chemistry (including carbon and oxygen), and the ecosystem.

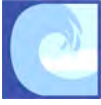
Marine ecosystem and fishery science remain strong in CIMEC. CalCOFI is increasingly valuable to ecosystem, biogeochemistry, and fishery science. It is augmented by observations off Humboldt and Monterey. The CSTAR program remains strong in education and research on quantitative fisheries science. Fishery research in both the sea and freshwaters occurred at UCSD, UCSC, and HSU. NOAA facilitated hiring by Scripps of a faculty member in quantitative population dynamics. Acoustic studies of protected species continued. A workshop was held on nonlinear forecasting in fisheries.

The future home of the La Jolla Laboratory of the Southwest Fisheries Science Center is scheduled for use in August 2012. The NIST-funded MESOM building is scheduled for use in January 2013 and will house CIMEC offices. I hope the NOAA Ship Reuben Lasker will have San Diego as its homeport.

CIMEC held its first Executive Board meeting in February. The Council of Fellows is being constituted. I commend Anne Footer, Rose Keuler, and Garrett Eaton for their service.

Looking forward, significant uncertainty exists regarding the FY13 NOAA budget. I remain optimistic, however, that CIMEC will continue to be vital to NOAA's mission.

David M. Checkley, Jr.
CIMEC Director



ORGANIZATION

Mission Statement

The mission of CIMEC is, in collaboration with NOAA, to develop and consolidate leading researching and educational programs across its member institutions in support of NOAA's mission "to understand and predict changes in the Earth's environment and conserve and manage coastal and marine resources to meet our Nation's economic, social and environmental needs."

Vision Statement

CIMEC shares the fundamental mission and goals of NOAA research and strives to achieve several objectives based on the unique resources and character of the Scripps Institution of Oceanography (SIO) and the other partner institutions in California: (1) to foster collaborative research between NOAA and UC/Cal State scientists; (2) to facilitate participation of UC/Cal State and other academic scientists in NOAA programs; and (3) to use the educational strength of CIMEC both to train students for productive work in environmental activities and to educate the citizenry about the intellectual excitement and importance of studying and managing our environment.

CIMEC will build upon SIO's experience from nearly twenty years of management of the Joint Institute for Marine Observations, and work closely with NOAA line offices, goal teams and laboratories to assist in transitioning research and development into NOAA data products and services. NOAA leadership and researchers will be strongly represented on CIMEC's Executive Board and Council of Fellows. An annual meeting will be held to communicate progress on CIMEC's projects and to seek input on research directions and priorities from NOAA leadership and scientists and stakeholder groups. CIMEC institutions will work to ensure that wherever possible NOAA's needs are represented in their educational programs, from undergraduate to postdoctoral levels. The education and outreach program will also address ocean-literacy needs at the K-12 levels and in the broader community.

CIMEC LEADERSHIP

Director:

David Checkley is a professor at Scripps Institution of Oceanography, University of California, San Diego. His research interests are in the areas of long-term change in pelagic zooplankton and fish, including climate-biota interactions; role of zooplankton in the marine nitrogen cycle; effects of weather and air-sea interactions on plankton and fishes; ecology of marine zooplankton and fish; the biological pump, including the role of particles and plankton; ocean acidification; and instrument development. He holds a B.S. from the University of Washington and both an M.S. and Ph.D. from SIO.

Deputy Director:

Dean Roemmich is a professor at Scripps Institution of Oceanography, University of California, San Diego. His research interests are the role of the oceans in climate and climate variability, general circulation of the oceans, and the California Current system. He holds a B.S. from the Swarthmore University and a Ph.D. from the Massachusetts Institute of Technology—Woods Hole Oceanographic Institution.



UCSD CHANCELLOR
Mary Anne Fox

CIMEC
Organizational
Chart

VICE CHANCELLOR,
MARINE SCIENCES /
SIO DIRECTOR
A.D.J. "Tony" Haymet

CIMEC DIRECTOR
David Checkley

BUSINESS MANAGER
Anne J. Footer

CIMEC ADMINISTRATION
Rose Keuler

REPORTS / WEBSITE / DATABASE
Garrett Eaton



CIMEC Employee Summary (April 1, 2011 – March 31, 2012)

Personnel Supported by NOAA/JIMO Funding				
Category	Number	B.S. / B.A.	M.S.	Ph.D.
Associate Professor	1			1
Academic Researcher	1			1
Project Scientist	1			1
Postdoctoral Fellow	14			14
Research Specialist	4		4	
Programmer/Analyst	1	1		
Staff Research Assoc/Asst	4	1	3	
Laboratory Asst	7	7		
Marine Technician*	2	1		

Total (≥ 50% support)	35	10	7	17
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Undergraduate Students	19			
Graduate Students	31			
Employees that receive < 50% NOAA Funding (not including students)	92			
Located at Lab (include name of lab)	27	NOAA/NMFS – Santa Cruz Laboratory		
Obtained NOAA employment within the last year	2			
Sub-awards				
Postdoctoral Fellow	3			
Graduate Students	8			
Undergrad Student	-			

*one Marine Technician did not obtain a college degree

CIMEC Fellows Roster (April 1, 2011 – March 31, 2012)

Jeffrey Abell (Humboldt State)

Douglas Bartlett (SIO)

Yehuda Bock (SIO)

Dan Cayan (SIO)

Luca Centurioni (SIO)

Andrew Dickson (SIO)

Gary Griggs (UC Santa Cruz)

David Hankin (Humboldt State)

John Hildebrand (SIO)

Ralph Keeling (SIO)

J. Anthony Koslow (SIO)

Marc Mangel (UC Santa Cruz)

Baldo Marinovic (UC Santa Cruz)

V. Ramanathan (SIO)

Dean Roemmich (SIO)

Uwe Send (SIO)

Eric Terrill (SIO)

Darren Ward (Humboldt State)



RESEARCH TASKS AND THEMES

Research Tasks

Under the Cooperative Institutes' cooperative agreement, five tasks are outlined by CIMEC and agreed upon by NOAA, allowing CIMEC to group and account for research more easily. The tasks are defined as follows:

Task 1. Administration

Task 1 funding is for administration of the Institute and includes support for the CIMEC Director's office and minimal support for the staff. It includes costs associated with annual scientific meetings that are deemed important for the CIMEC Director to attend, workshops sponsored by CIMEC, web-site development and maintenance, funding for the Joint Institute Director's and executive board and fellows meetings.

Task 2. Joint NOAA Laboratory/CIMEC Collaboration

Collaborative proposals have NOAA and participating California University partners working together jointly on research themes. These proposals are divided by theme and include all research associated with funding including the funding of salaries, benefits, travel as well as instrumentation and computer time.

Task 3. Individual Science Projects

Cooperative research proposals are specific to the CIMEC theme areas, but submitted by individual scientists of CIMEC. The distinction here is that there is a loosely bound tie between individuals working on similar themes or topics. It is also seen that this may be a mechanism for developing collaborative proposals in the future, as well as encouraging new areas of research to develop. These proposals are divided by theme and include all research associated funding including the funding of salaries, benefits, travel and instrumentation and computer time.

Task 4. Education and Outreach

In support of NOAA's Mission and Strategic Plan, CIMEC's Task 4 was developed to strengthen and coordinate an education and outreach component to compliment and convey CIMEC research into the academic and public realms.

Task 5. CIMEC Research Infrastructure Proposals

Because proposals relevant to CIMEC will use a variety of observation platforms in order to carry out the research objectives, an infrastructure task by theme area was defined, which includes proposals for platform and specialized research facilities.

Research Themes

Four thematic areas form the basis for research performed in partnership with NOAA. Each of these areas are relevant to the NOAA mission elements, particularly those of environmental assessment and prediction and environmental stewardship.

A. Climate and Coastal Observations, Analysis and Prediction Research

The primary goals for this research theme are to understand the remote forcing functions that control fundamental ocean and atmosphere processes and to utilize this knowledge for prediction. For CIMEC the basis of interest is primarily the Pacific, although other areas may be studied as a model or to put the Pacific information in context (e.g., Indian, Arctic). These thrust areas include the following:

Oceanic roles in climate and global change

The oceans contain 96% of the Earth's free water. They are the source of 86% of all evaporation and the direct recipient of 78% of rainfall. The salinity of the ocean surface layer reflects the global pattern of evaporation minus precipitation, with salinity maxima in regions of excess evaporation and minima in regions of excess rainfall. The meridional transport of water vapor in the atmosphere is equal and opposite to the freshwater transport in the ocean. Long-term trends in salinity show the evaporative regions of the ocean



becoming saltier and the high precipitation areas fresher indicating an acceleration of the global hydrological cycle. Slow freshening of the oceans as a whole is a yardstick for the melting of glaciers, ice sheets, and sea ice. Past research in the hydrological cycle has been focused on the land and atmosphere, while the large role of the oceans has been poorly observed. It is increasingly clear that the complete global hydrological system, including the oceans, must be addressed.

Last, and very importantly among (physical) global change issues, is sea level rise. The present observing system includes satellite and in situ observations of total sea level, plus satellite measurements of changes in ocean mass and in situ observations of the ocean's steric height. While the majority of future sea level rise may come from melting Antarctic and Greenland ice sheets, the steric component of sea level is nonetheless significant, and the increasing heat content of the high latitude oceans is a key factor in understanding and predicting melting and precipitation (ice deposition) rates.

CIMEC projects contribute to datasets in an effort to build the models to address these important issues.

Coastal oceans and climate

The scientific community is faced with challenging issues across our coastal waters:

- How do human activities impact the coastal ocean?
- How do coastal ecosystems respond to climate change?
- How does climate change and sea level rise present itself at local scales?
- What role does the coastal ocean play in the global biogeochemical cycles?
- What processes determine community structure in coastal ecosystems?
- How can we predict and mitigate coastal hazards that impact human populations?

CIMEC has a myriad of tools within its partner institutions, including the long-running CalCOFI program with its 60-year time series of the California Current, at its disposal to help investigate these questions and find the solutions to the problems some of these questions pose.

B. Climate Research and Impacts

Observations and model simulations are crucial elements needed to guide decisions over the next several decades as global scale changes in climate, sea level and other environmental components such as aerosols and land surface changes continue to produce great impacts across the United States. Regions affected by these changes include the region of the western mountainous states, in particular, California and the adjacent coastal zone. CIMEC research will study climate and its impact on society to serve the nation's needs for climatic information with programs conducting applied climate research to assist decision makers prepare for and adapt to climate changes, both natural and (potentially) anthropogenic.

C. Marine Ecosystems

CIMEC will directly address NOAA's Ecosystem Mission Goal to "protect, restore, and manage the use of coastal and ocean resources through the ecosystem approach to management". Fisheries and protected species and their relation to the environment, including climate change, are broad areas of research and teaching within CIMEC, and will include participation from faculty, graduate students, postdocs, and NOAA colleagues.

Ecosystem characteristics of particular interest are marine population dynamics, biodiversity, and biogeochemistry. The means by which these will be investigated include observing, process studies, and modeling. Collectively, the results are used to assess and predict ecosystem productivity and health for decision makers. Fishing affects both the target species and their environment. Climate change will affect marine ecosystems through rising sea level, warming, ocean acidification, deoxygenation, and potential changes in productivity and circulation.

Primary regions of interest are the California Current Ecosystem (CCE), the Eastern Tropical Pacific (ETP), and the Southern Ocean (SO). Fisheries management research, such as the long-running 60-year time series of the California Current conducted under the CalCOFI program, provides policymakers and management officers with the information needed to manage the nation's marine resources.



D. Ecosystem-Based Management

Fisheries management has undergone a paradigm shift in recent years from an exclusive focus on individual assessments of commercially-exploited stocks to maximize sustainable yield (or comparable metric) to a precautionary, ecosystem-based approach. Ecosystem-based management (EBM) explicitly considers human impacts on key predator, prey and competitor species, on bycatch species and benthic habitat, as well as on directly targeted stocks. NOAA is mandated to manage US fisheries within an EBM framework and is implementing integrated ecosystem assessments (IEA) as a critical science-support tool.

The 60-year California Cooperative Oceanic Fisheries Investigations (CalCOFI) program is one of the longest running ocean observation programs in the world. A joint program of the Scripps Institution of Oceanography, the Southwest Fisheries Science Center (NMFS/NOAA), and the California Department of Fish and Game, CalCOFI is designed to provide data for stock assessment of key commercial species, as well as physical, chemical, and biological data on the state of the California Current ecosystem (CCE), including quantitative observations on ecologically critical species of krill, fish, seabirds and mammals. CalCOFI observations have provided the basis for much of our current understanding of the impact of climate variability (the El Niño, Pacific Decadal Oscillation, and the North Pacific Gyre Oscillation) on the CCE. In the future, CalCOFI will provide much of the observational 'backbone' for integrated ecosystem assessments (IEAs) and ecosystem-based management (EBM) of the CCE, as well as for modeling and understanding the impacts of long-term climate change.

Integration of Marine Protection Areas (MPAs) and Conventional Fishery Management

More than 15 percent of the coast of California will soon be in MPAs implemented under California's Marine Life Protection Act. Modeling of the effects of these for decision makers has been done by Partner labs, and will soon be started in a Sea Grant project to develop models to use in the evaluation of ongoing monitoring efforts.

The Center for Stock Assessment Research (CSTAR)

CSTAR was formed in 2001, as a collaboration between the NMFS laboratories in Santa Cruz and Pacific Grove, with the objective of undergraduate, graduate and post-doctoral research and training associated with the problems of assessing the numerical abundance, spatial distribution, size distribution and reproductive status of commercially important fish species and thereby increasing the pool of quantitatively trained biologists available to be hired by NMFS. The program of research and training at CSTAR is science done in the national interest and moves in the direction outlined by the National Research Council in its report "Recruiting Fishery Scientists."

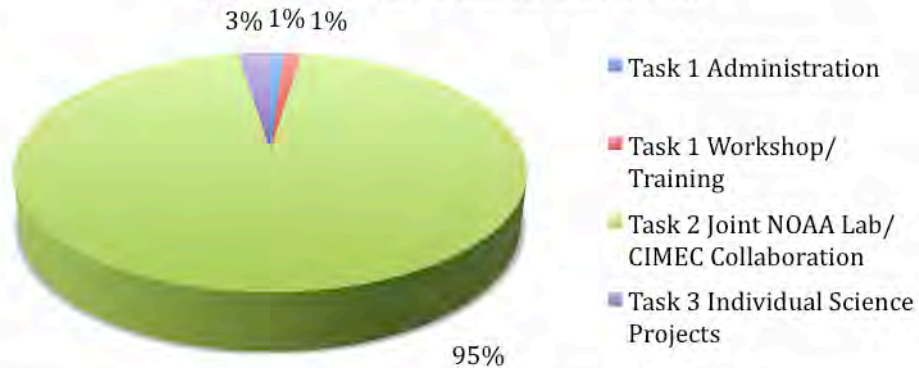


Funding Summary

CIMEC Funding by Task

\$16,051,288

April 1, 2011 - March 31, 2012

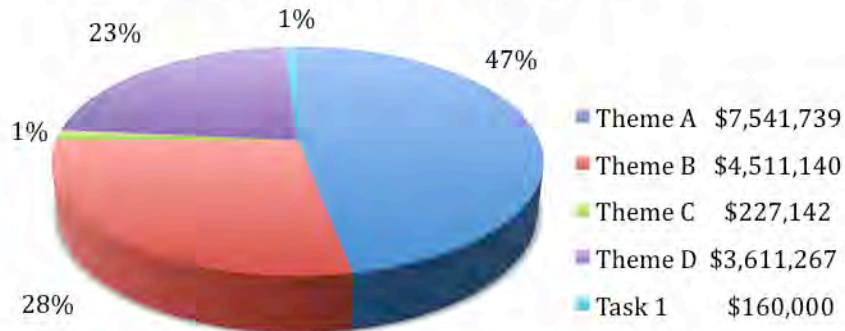


Task 1: CIMEC Administration
Task 1: Workshop/Training
Task 2: Joint NOAA Lab/CIMEC Collaboration
Task 3: Individual Science Projects

CIMEC Funding by Theme

\$16,051,288

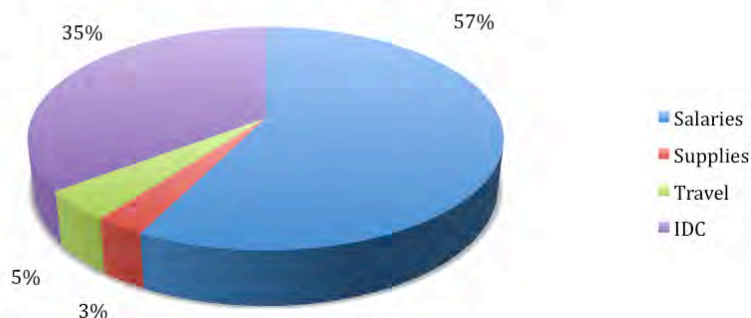
April 1, 2011 - March 31, 2012



Theme A: Climate and Coastal Observations,
Analysis and Prediction Research
Theme B: Climate Research and Impacts
Theme C: Marine Ecosystems
Theme D: Ecosystem-Based Management



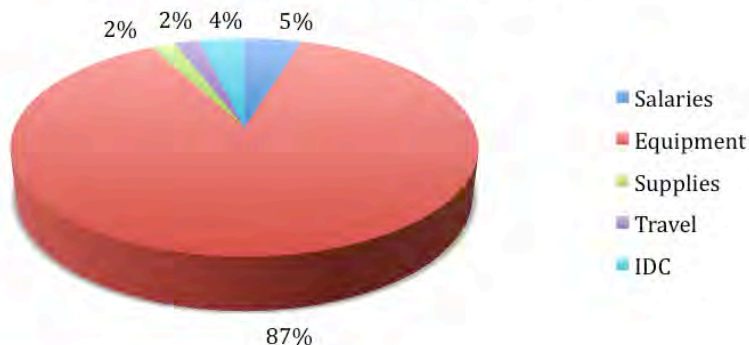
CIMEC Task 1 Administration Expenditures \$142,992 April 1, 2011 - March 31, 2012



Category	Awarded	Expensed
Salary and Benefits	\$95,214	\$82,072
Supplies	\$4,605	\$4,190
Travel	\$3,741	\$6,289
IDC	\$56,440	\$50,441
	\$160,000	\$142,992

Salary and Benefit expenditures are comprised of support for the CIMEC Director and Administrative staff. Supply expenditures comprise NGN costs (network support), catering costs associated with our Executive Board Meeting held on Feb 10, 2012, postage and meeting supplies. Travel expenses are for costs for the CIMEC Director to attend the NOAA Ecosystems Research Science Workshop held in November 2011, the CIMEC Director to attend the annual CI Meeting held in March 2012, and for the CIMEC Partners to participate in the CIMEC Executive Board Meeting held in Feb 2012. Indirect Costs are charged at 54.5% of the Direct Charges.

CIMEC Task 1 Workshop/Training Expenditures \$126,375



Category	Awarded	Expensed
Salary and Benefits	\$110,955	\$5,931
Equipment	\$ -	\$110,636
Supplies	\$27,168	\$2,527
Travel	\$5,313	\$2,549
IDC	\$76,564	\$4,733
	\$220,000	\$126,375

Note: The Task 1 "Training of the Next Generation of Marine Population Dynamics Scientist" received year 2 funding during FY'12. Year 1 requested and was approved to rebudget funding into equipment. The equipment expense was charged during the Year 2 award period.



RESEARCH HIGHLIGHTS

CIMEC research activities are categorized by the following themes:

- A. Climate and Coastal Observations, Analysis and Prediction Research
- B. Climate Research and Impacts
- C. Marine Ecosystems
- D. Ecosystem-Based Management

Research highlights, or Executive Summaries, of the most recent individual research projects are summarized in the tables below and are more fully developed in the body of this report.

A. Climate and Coastal Observations, Analysis and Prediction Research

Collection and Analysis of Seawater Samples from the California Coast [Andrew G. Dickson, SIO]

- Have submitted manuscript to Journal of Geophysical Research, Oceans (collaboratively with Simone Alin and others) detailing empirical relationships for estimating pH and carbonate saturation states in the southern California Current System

CO₂/CLIVAR Repeat Hydrography Program CO₂ Synthesis Science Team [Andrew G. Dickson, SIO]

- Have submitted manuscript to Limnology & Oceanography Methods detailing our approach to making pH measurements
- Have submitted manuscript to Global Biogeochemical Cycles (together with other Science Team members) detailing decadal changes in calcite and aragonite saturation depths in the North Pacific

HF Radar National Network Data Management Development [Eric Terrill, SIO]

- Updated and supported ten data portals, systems designed for collecting HF radar site data and transferring to within the network for the participating Universities: Scripps Institution of Oceanography; Rutgers University; University of Southern Mississippi; University of California, Santa Cruz; University of California, Santa Barbara; San Francisco State University; California Polytechnic State University; University of Southern California; Oregon State University; University of Maine, and University of Miami
- Three nodes, systems designed to act as data repositories and vector processing, have been maintained and upgraded for the participating Institutions: SIO, NDBC, and Rutgers University.
- Purchased hardware for OI national network computation
- Maintained THREDDS server for near real-time RTV's
- HFRNET code repository established for cleaner installations and maintenance
- Incorporated the HF Radar National Network (non-OI) into SAROPS through the ASA environmental data system (EDS)
- New Codar sites were made available to all Nodes for RTV processing: Cape Charles, VA (Old Dominion University) <http://cordc.ucsd.edu/projects/mapping/stats/?sta=SUNS> ; Slaughter Beach, DE Point Arguello, CA (University of Delaware) <http://cordc.ucsd.edu/projects/mapping/stats/?sta=SLTR&aff=UD> ; Belmar, NJ (Rutgers University) <http://cordc.ucsd.edu/projects/mapping/stats/?sta=BELM&aff=Rutgers> ; Strathmere, NJ (Rutgers University) <http://cordc.ucsd.edu/projects/mapping/stats/?sta=RATH&aff=Rutgers>



	<p>gers ; Brigantine, NJ (Rutgers University) http://cordc.ucsd.edu/projects/mapping/stats/?sta=BRMR&aff=Rutgers ; North Wildwood, NJ (Rutgers University) http://cordc.ucsd.edu/projects/mapping/stats/?sta=WOOD&aff=Rutgers ; Angel Island, CA (San Francisco State University) http://cordc.ucsd.edu/projects/mapping/stats/?sta=ANGL&aff=SF SU ; Torrance Beach, CA (University of Southern California) http://cordc.ucsd.edu/projects/mapping/stats/?sta=SCTB ; Georgetown, SC (University of South Carolina) http://cordc.ucsd.edu/projects/mapping/stats/?sta=GTN&aff=SC ; Fort Caswell, NC http://cordc.ucsd.edu/projects/mapping/stats/?sta=CSW&aff=SC</p> <ul style="list-style-type: none"> Decommissioned Sites: BSWP Bayshore Waterfront Park (Rutgers University) – 8/12/2011; Pritchard's Island, SC (University of South Carolina) – 2/21/2012 Supported Domains and available data: USEGC - US East and Gulf Coast - 2008-03 through present; USWC - US West Coast - 2008-03 through present; GAK - Gulf of Alaska - 2009-05 through 2009-07; PRVI - Puerto Rico and US Virgin Islands - 2010-01 through present The HF-Radar Network started as a prototype at SIO with a single portal and node and 4 sites in December 2003 that grew to an operational status produced by 112 sites from 30 participating institutions in 2007, is currently operating with 157 sites from 31 participating institutions. http://cordc.ucsd.edu/projects/mapping/maps/
Ocean Observing and Fisheries Oceanography Research of the Coastal Ocean off Northern California [Jeffrey Abell, Humboldt State]	<ul style="list-style-type: none"> Research technician hired to support ocean observing cruises and data management
Collaborative Scientific and Technical Support to the NOAA Earth System Research Laboratory [Yehuda Bock, SIO] [Peng Fang, SIO]	<ul style="list-style-type: none"> Maintained high reliability orbit solutions in terms of two global sub-networks in parallel with an automatic failover system Continued using the latest global gravity model and most recent global reference frame, updated absolute antenna phase center model, most recent ocean tidal loading model, updated differential phase bias correction, and improved ambiguity resolution for long baselines Continued comprehensive orbit quality control procedure to reduce the risk of contaminating the IPW estimates in the GPS/Met solutions
Training the Next Generation of Marine Population Dynamics Scientists [Douglas Bartlett, SIO] [Brice Semmens, SIO]	<ul style="list-style-type: none"> Published 3 peer-reviewed manuscripts, and submitted two additional manuscripts (one in revision, one in press) Initiated a recreational fishery tagging program Presented an invited Keynote presentation at the 6th Global COE International Symposium Advised a graduate student Taught a seminar in data analysis and model fitting for graduate students
B. Climate Research and Impacts	
Global Drifter Program [Luca Centurioni, SIO] [Bruce Cornuelle, SIO]	<ul style="list-style-type: none"> Maintained the "Global Surface Drifting Buoys" array at Status quo, with an average total number of ~1100 drifters Technical improvements to increase the life of the drogue SIO drifter design introduced Continued cooperation with VOS to deploy drifters Real-time data distribution, datasets, data storage and distribution The Argos 3 Pilot Project concluded and technology transitioned



Integrated Boundary Current Observations in the Global Climate System (CORC III) [Uwe Send, SIO]	<ul style="list-style-type: none"> ○ Continuous occupation of two CC sections with gliders, one CC section with moorings/PIES, one SS section with gliders, with 100% data return ○ Quarterly deployments of SVP drifters in the CCS ○ Identification of summarizing indicators of Solomon Sea heat and mass transports. ○ Improvements in routine subsurface data retrieval via gliders, construction of modern gliders ○ Improved design of the Bottom Release Drifter ○ Identification of suitable sites for PIES in the SS and deployments there ○ Incorporated more observations into assimilations (IES in particular) ○ Better model fits to observations in general and eddy features in particular, including experiments with shorter assimilation windows ○ Several publications, covering local effects of El Niño, poleward transport, thermohaline variance, and physical and biological processes in the CCS, analyses of broad-scale ocean heat and freshwater content and transport, and technology developments
Meridional Overturning Variability Experiment (MOVE) [Uwe Send, SIO]	<ul style="list-style-type: none"> ○ Moorings recovered, fresh moorings/PIES deployed, 11 years of data in hand now ○ GRL publication about MOVE results, with a lot of visibility ○ Joint analyses and presentations now under way with RAPID community and modellers
Moored Climate, Carbon, Biogeochemical, and Ecosystem Observations in the Southern California Current (CCE) [Uwe Send, SIO]	<ul style="list-style-type: none"> ○ First deployment of two equivalent highly instrumented realtime moorings across the California Current ecosystem with physical, chemical, carbon, and ecosystem sensors ○ Improvements in sensor calibration and data quality control techniques, allowing intercomparisons with other data sets (e.g. CalCOFI) ○ Analyses of carbon (DIC) budgets ○ Analyses of climate anomalies in subsurface oxygen ○ Quantification of total chlorophyll using light absorption
Measurements of Atmospheric O₂/N₂, Ar/N₂ and CO₂ Abundances in Relation to Carbon Cycling [Ralph Keeling, SIO]	<ul style="list-style-type: none"> ○ Quantifying downward trend in atmospheric potential oxygen, useful as constraint on global land and ocean carbon sinks ○ Providing constraints on trends in ocean productivity (and biomass). Results suggest little change over past 20 years ○ New estimates of ocean net community production
Development of Water Vapor Flux Measurements Systems for Lightweight UAVs [V. Ramanathan, SIO] [Richard Thomas, SIO]	<ul style="list-style-type: none"> ○ Finalized publication of test flight data from NASA Dryden's flight research facility ○ Conducted over 21 scientific flights in the Maldives as part of an NSF funded campaign collecting 38 hours of boundary layer flux data and better characterize the system. ○ System improvements include: a reduction in analogue noise to almost undetectable levels; a redesigned gust probe mount; improved telemetry data; and test flights with a fast response temperature sensor
The Argo Project – Global Observations for Understanding and Prediction of Climate Variability [Dean Roemmich]	<ul style="list-style-type: none"> ○ Deployment of 69 SOLO-II Argo floats – a longer-lived and more capable Argo float design from SIO. ○ 1000 research publications since 1998 have used Argo data (http://www.argo.ucsd.edu/Bibliography.html) ○ The Argo Program has sustained its global coverage, with over 3500 Argo floats presently active. ○ A comparison of Argo temperature measurements with those made by <i>HMS Challenger</i> in the 1870's, on oceanography's first global expedition, establishes that global ocean warming has a centennial timescale



SIO High Resolution XBT/XCTD Transects
[Dean Roemmich]
[Bruce Cornuelle]
[Janet Sprintall]

- The mean and time-varying volume transport of all five subtropical gyre western boundary currents and the Antarctic Circumpolar Current are being observed regularly by the High Resolution XBT Network
- The California Current and northeast Pacific Ocean circulation were analyzed using High Resolution XBT and Argo datasets
- Several High Resolution XBT routes have produced time-series of 20 years or longer

Workshop on Vulnerability and Adaptation to Extreme Events in California in the Context of a Changing Climate
[Dan Cayan, SIO]

- Convened an extreme events/climate change workshop on December 13, 2011, which fed into Governor Brown's program to prepare for climate change and consequences in the State of California

C. Marine Ecosystems

The Center for Stock Assessment Research (CSTAR)
[Marc Mangel, UC Santa Cruz]

- CSTAR students Valerie Brown, Robert Curzon and Daniel Hively completed MS degrees in Statistics and Applied and started new positions (Brown as Assistant Specialist at UCSC, working with NOAA Fisheries; Hively at the University of Washington with Ray Hilborn, Andre Punt, Tim Essington, and Trevor Branch), and Curzon at McGraw Hill
- CSTAR student Cristie Boone completed her Ph.D. in Anthropology, studying fisheries in Monterey Bay 6-11 thousand years ago, using modern quantitative methods
- CSTAR student Kate Richerson is a Trainee in the Science and Justice program at UCSC
- CSTAR Assistant Specialist Mariah Boyle and CSTAR PhD student Kate Richerson, traveled to West Africa at the end of 2011 to study artisanal fish landings in a data poor fisheries. During their stay in John Obey, Sierra Leone, they identified, photographed, counted and measured the fish caught by the fishermen paddling dugout canoes, which will be used to generate productivity-susceptibility analyses (PSA) for the most important species in the fishery. Kate conducted interviews with the fishermen to try to understand how fish abundance has changed over time. This information will be shared with the Fisheries Ministry and used to guide regulations for a marine protected area in development in the Sherbro River. A short film was made about the project by research partner Environmental Justice Foundation and Mariah's research was funded by the PADI Foundation
- CSTAR student Justin Yeakel developed new methods for understanding the dynamics of fish stocks following a Shepherd/Maynard Smith stock recruitment relationship and for identifying the parameters in this relationship
- CSTAR student Taal Levi adapted the method developed by CSTAR student Kate Richerson, Director Mangel, and NOAA Fisheries colleague Phil Levin for balancing incommensurate values and indirect effects in the North Sea Sand Eel fishery and applied it to salmon fisheries in Alaska and British Columbia.
- CSTAR undergraduate research fellow Roxanna Pourzand worked on connecting steepness of the stock recruitment relationship and life history parameters.
- CSTAR post-doc Andrew Ole Shelton and Director Mangel published fundamental work testing hypotheses about why fish populations fluctuate.
- CSTAR post-doc Shelton was offered NOAA employment, at the Northwest Fisheries Science Center, effective 9 April 2012
- CSTAR post-doc Simone Vincenzi introduced novel ideas on developmental programming to the study of kittiwakes in the



	<p>Bering Sea, and the response of such individuals to climate change</p> <ul style="list-style-type: none"> ○ 15 Talks or Posters by CSTAR members at the meeting of the American Fisheries Society in Seattle, Sept 2011 ○ CSTAR member (and former post-doc) Steve Munch was awarded a Pew Fellowship in Marine Conservation ○ CSTAR Director Marc Mangel shared in the Queen's Award to the Sea Mammal Research Unit at the University of St. Andrews, for his work on the Special Committee on Seals ○ Short-term visitors to CSTAR included Andrew Constable (Pew Fellow in Marine Conservation and Australian Antarctic Division), Noel Cressie (Ohio State University), Jeffrey Hutchings (Dalhousie), Joseph Travis (Florida State University), and Chris Wikle (University of Missouri)
Shipboard Monitoring of the California Current System Off Central California [Baldo Marinovic, UCSC]	<ul style="list-style-type: none"> ○ September/October 2011 – Occupation of CalCOFI line 67 (n=20 hydrographic stations) with complete physical, chemical, phytoplankton, and zooplankton sampling at all 10 standard CalCOFI stations and complete physical, chemical, phytoplankton sampling at 10 supplemental NPS stations ○ Mar 2011- Occupation of CalCOFI line 67 (n=20 hydrographic stations) with complete physical, chemical, phytoplankton, and zooplankton sampling at all 10 standard CalCOFI stations and complete physical, chemical, phytoplankton sampling at 10 supplemental NPS stations
Investigations in Fisheries Ecology [Gary Griggs, UC Santa Cruz]	<ul style="list-style-type: none"> ○ Completed aging of 6,000 rockfish specimens and continued studies on reproductive biology of rockfish, which will provide improved demographic data for groundfish stock assessments and life history studies ○ Initiated study to use dendrochronological methods to assess climate-driven variability in groundfish growth patterns ○ Completed initial mapping of historical spatial distribution of groundfish catches from catch reconstruction databases ○ Developed improved analytical methodologies for data-poor groundfish stocks using Bayesian sampling methods to extend depletion-based stock reduction analysis (DB-SRA) approaches ○ Initiated study to assess how stream communities, with steelhead as a focal species, and physical habitat respond to the experimental addition of large wood; completed pre-wood addition sampling of fish, stream invertebrates and algae, and habitat mapping ○ Completed study demonstrating thermal transgenerational plasticity (TGP) in a marine fish, and initiated experiments to test for local adaptation in thermal TGP in minnows and smolting TGP in steelhead ○ Completed studies to describe and develop habitat-based predictive models and maps of deep-sea coral (DSC) and other benthic marine communities in southern California ○ Completed analysis of thousands of images from Autonomous Underwater Vehicle (AUV) surveys for use in modeling population abundances of demersal fishes with respect to seafloor habitat ○ Initiated study to evaluate the potential economic effects of salmonid restoration projects in California's Central Valley on affected human uses ○ Completed a high-resolution stream temperature model for the upper Sacramento River and a linked fish bioenergetics model that refines the Wisconsin model to incorporate intra-daily temperature fluctuations and to model subdaily growth; completed laboratory experiments to parameterize bioenergetics model for juvenile salmonids ○ Initiated a project to develop a life cycle population model to



	<p>evaluate the effects of large water projects and habitat restoration on Chinook salmon in California's Central Valley</p> <ul style="list-style-type: none"> Completed analyses of green sturgeon distribution and physical habitat use in the coastal Pacific Ocean using electronic tag data Initiated an Integrated Ecosystem Assessment for the California Current, including selecting ecosystem indicators, identifying and summarizing available data and conducting new analyses for indicator species, and developing risk assessment and management strategy evaluation approaches Completed first year of study on juvenile Chinook salmon mortality associated with predation at large water intake structures on the Sacramento River and expanded study protocol to add two additional research sites for 2012 Completed summer and fall ocean surveys to determine salmon distributions off the coast of central Oregon to central California and to tag adult Chinook salmon with acoustic telemetry tags to track movements in the coastal ocean and during spawning migrations Completed study on the effect of disease on the population dynamics of Klamath River fall Chinook salmon. Developed improved methods and models for analyzing salmon populations, conducting stock assessments, and evaluating fishery harvests and management Completion of discovery and validation of novel genetic markers for coho salmon and production of draft manuscript Completion of first round of genotyping of intergenerational genetic tagging markers for Central Valley steelhead hatchery programs Completion of the genotyping, analysis and reporting of over 8,000 tissue samples from ocean-caught Chinook salmon collected as part of the West Coast Salmon Genetic Stock Identification Project Generation of analyses to evaluate performance of IronGate Hatchery coho salmon program and presentation to hatchery staff, management agencies and stakeholders
Freshwater Ecology Research Collaboration [Gary Griggs, UC Santa Cruz]	<ul style="list-style-type: none"> A national recruitment for a new assistant professor was completed and the selected individual will begin duties 7/1/12
Collaborative Studies of Cetaceans with the Southeast Fisheries Science Center [John Hildebrand, SIO]	<ul style="list-style-type: none"> Participated in two AMAPPS cruises on the NOAA Ship Gordon Gunter Collected broadband sound data on a range of marine mammal species Obtained the first recordings of northern Gulf of Mexico Brydes whales in the wild
D. Ecosystem-based Management	
California Cooperative Fisheries Investigations (CalCOFI), an Ocean Observation Program for the Southern California Current, FY 2011 [J. Anthony "Tony" Koslow, SIO] [Ralf Goericke, SIO]	<ul style="list-style-type: none"> CalCOFI featured in more than 40 peer-reviewed papers and 10 book chapters published this past year, including papers in Science, Nature, and PNAS. CalCOFI featured in major conferences and symposia, including AAAS, the ASLO/AGU annual Ocean Sciences meeting, and PICES, as well as many workshops, seminars, and symposia. Studies ranged from microbes and the plankton to whales, from fisheries to the biogeochemical and ecological implications of climate variability and change. The wide-ranging use and dissemination of CalCOFI data are arguably the best measure of the value of the CalCOFI program to the marine scientific, conservation, and



	<p>management communities. The length, breadth, and quality of the CalCOFI time series make it indispensable to address the most difficult and contentious issues confronting marine scientists and managers</p> <ul style="list-style-type: none"> ○ A study published in Science used CalCOFI data to develop and test a model showing how basin-scale physical forcing (changes in thermocline depth) drives nonlinear decadal changes in intermediate-water oxygen levels and denitrification in the Northeast Pacific. The study is a landmark in understanding the potential biogeochemical and ecological impacts of warming, acidification, and deoxygenation due to climate change ○ Spatial modeling studies applied to CalCOFI data are making progress in elucidating pelagic habitat features conducive to reproductive success in key pelagic fishes, such as Pacific mackerel, anchovy, and sardine ○ Marine mammals: improved acoustical census methodology with advances in localization software, acoustic species-identification and group size estimation; developed database and experimental design for spatio-temporal modeling of cetacean density and abundance in the CalCOFI study area; and expanded habitat modeling analysis through integration of larger and more diverse sample of environmental variables with cetacean distribution data ○ Publication of the first fishery-independent time series for spiny lobster and market squid populations off southern California based on CalCOFI ichthyoplankton sampling provide a milestone in the sustainable management of these species. ○ Several scientific papers this year successfully combined CalCOFI data with mooring and glider observations to provide new insights into high-frequency variability in pH and oxygen concentrations in nearshore and offshore environments and to examine the arrival of El Niño conditions with greater resolution
Studies in Anadromous Fisheries [Darren Ward, Humboldt State]	<ul style="list-style-type: none"> ○ Graduate student Meiling Roddam started her program and developed a research proposal ○ Preliminary analysis of otolith samples complete and field work underway as of Spring 2012
Freshwater Fish Ecology Research Collaboration [David Hankin, Humboldt State] [Darren Ward, Humboldt State] [Jim Howard, Humboldt State]	<ul style="list-style-type: none"> ○ Two new graduate students developed research proposals, both focusing on salmon conservation in the Klamath River ○ New funded graduate project on marine survival of coho to start in Fall 2012 ○ Continuing field investigations of juvenile coho overwinter survival and impacts of invasive New Zealand mud snails
Collaborative Studies of Cetaceans with the Pacific Islands Region [John Hildebrand, SIO]	<ul style="list-style-type: none"> ○ Collected ocean noise at 7 sites across the central and western Pacific ○ Constructed a small autonomous acoustic recorder for attachment to longline fishing gear



THEME A: CLIMATE AND COASTAL OBSERVATIONS ANALYSIS, AND PREDICTION RESEARCH



Collection and Analysis of Seawater Samples from the California Coast

Andrew G. Dickson (SIO)

NOAA Technical Contact: Joel Levy (CPO)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

The goal of this work is to provide information that can be used to test an algorithm developed by Dr. Richard Feely (NOAA/PMEL) and his colleagues for predicting aragonite saturation state in the upper water column of waters off the California coast. This algorithm (which is specific to a particular geographic region) is based on measurements of salinity, temperature, depth, and oxygen concentration.

We thus collect water samples from cruises off the coast of California where the appropriate ancillary measurements (in particular oxygen concentrations) are also made. Examples of such cruises are the quarterly CalCOFI cruises (California Cooperative Oceanic Fisheries Investigations) and cruises off Northern California performed by Dr. Jeff Abell of Humboldt State University. These water samples are returned to the Scripps Institution of Oceanography, where they are analyzed for total dissolved inorganic carbon, total alkalinity, and salinity. Once the analyses are complete, and the data have been evaluated, they are reported to Drs. Feely & Alin at NOAA/PMEL where they are used to compare with the proposed algorithms.

Research Accomplishments

To date, 60 samples have been collected on each of the following CalCOFI cruises: July/August 2010; October 2010; January 2011; and April 2011. In addition, 20-40 samples were collected by Humboldt State University on cruises on the RV Coral Sea in August 2010; February 2011; and April 2011. We expect to collect additional samples as the year progresses. In addition, some samples were collected on trips to turn around the buoys operated as part of the California Current Ecosystem LTER.

All but the most recent sets of samples have been analyzed. The CalCOFI data to the end of 2010 have been sent to Dr. Alin at NOAA/PMEL who has shown that, thus far, the algorithms that she had generated based on a calibration data set from the NOAA 2007 NACP West Coast Cruise imply values for the aragonite saturation state that are in excellent agreement with those inferred from the samples collected and analyzed as part of this project. This was true despite the fact that the newer data cover a wider range of seasons than the original calibration data set. This work was presented by Dr. Alin at the Fall AGU meeting in San Francisco in December 2010 in a poster entitled: "Predictive relationships for pH and carbonate saturation in the Southern California Current System using oxygen and temperature data."



CO2/CLIVAR Repeat Hydrography Program CO2 Synthesis Science Team

Andrew G. Dickson (SIO)

NOAA Technical Contact: Joel Levy (CPO)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

The NOAA/NSF Repeat Hydrography CO2/tracer Program is a component of the Carbon Cycle Science Program (CCSP) and is a collaborative effort between NOAA and NSF to conduct a global decadal time-scale sampling of ocean transports and inventories of climatically significant parameters. It provides a core set of carbon and tracer measurements and anticipates that additional carbon/CLIVAR measurements will be added to the cruises on an "as required" basis. The sequence and timing for the sections takes into consideration the CCSP objectives, and considers the timing of national and international programs. The new data from this program needs to be synthesized into a globally consistent data set (e.g., corrected for analytical errors and systematic biases) and combined with similar data sets from our international partners working on this same problem.

The CO2 Science Team has been formed to meet these goals. It usually meets once a year, and corresponds in between meetings working to ensure that the surveys are carried out in an efficient manner, and that the data obtained are consistent and correct.

Research Accomplishments

The Science Team funded by this grant (Project Director, Dr. C. Sabine, NOAA/PMEL) did not meet in this time period.

During this reporting period, we have continued to work on finalizing data from the various CLIVAR cruises we participated in.

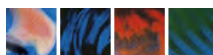
- Alkalinity data from our I08 (2007) cruise has been finalized and submitted.
- Alkalinity data from our I05 (2009) cruise has been finalized and submitted.
- Alkalinity data from our S4 (2011) cruise has been finalized and submitted.

The various pH data measured on our recent CLIVAR cruises: I06S (2008); I05 (2009); A13.5 (2010); and S4 (2011) have been examined, and data with obvious flaws flagged.

Unfortunately, we subsequently learned that the indicator dye that we had used for these pH measurements (a dye commercially available from Acros) had colored impurities in it that compromised the accuracy of the measured pH values. A recently published paper by Liu et al. (Environ. Sci. Technol. 2011, 45, 4862–4868) provides some information about the likely magnitude of the error resulting from using such impure dye, and the data from I05 have been reprocessed to incorporate the adjustment they show.

We have plans during our upcoming cruise in the North Atlantic (A20) to directly estimate the magnitude of adjustment needed by measuring a suite of samples with both pure dye (obtained from Prof. Byrne) and the Acros dye we have usually used. The adjustment we measure will then be applied to all our earlier data, and we will then submit final data sets.

Even then, there will still be significant uncertainty in the measured pH values, estimated as about 0.006 in pH (although the reproducibility is ± 0.0005).



HF Radar National Data Management Development

Eric Terrill (SIO)

NOAA Technical Contact: Jack Harlan (NOAA/IOOS) and Richard Crout (NOAA/NWS/NDBC)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

NOAA Goal 3: Serve Society's Needs for Weather and Water Information

NOAA Goal 4: Support the Nation's Commerce with Information for Safe, Efficient, and Environmentally Sound Transportation

NOAA Goal 5: Provide Critical Support for NOAA's Mission

Research Objectives and Specific Plans to Achieve Them

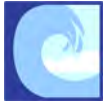
Local, state, regional, and federal support for the Integrated Ocean Observing System (IOOS) have supported the installation, development, and operation of a network of surface current mapping systems for use by a broad range of end users. Central to the operational success of a large scale network is a scalable data management, storage, access, and delivery system. The objectives for this project are to continue the research, development, and implementation of the data management system for ocean surface current information derived from HF radar with a primary focus on preparing the data for integration into the United States Coast Guard (USCG) Search and Rescue Optimal Planning System (SAROPS).

The architecture of the HF-Radar Network lends itself well to a distributed real-time network and serves as a model for networking sensors on a national level. This proposal also includes development and prototype implementation of optimally interpolated (OI) near real-time surface currents for U.S. coastlines for integration into the USCG Search and Rescue Optimal Planning System (SAROPS). Implementation has occurred in a phased approach in partnership with the United States Coast Guard (USCG), Applied Science Associates (ASA), the University of Connecticut, and Rutgers University. OI currents will be distributed based on the national HFRNet vector grid in a NetCDF file format that includes longitude, latitude, vector current components (u and v), uncertainty components (uu , vv , and uv), using the available west coast grids used on the west coast. The OI data will be processed in parallel with the existing HF Radar national network and will be implemented as a proto-operational computational module, available and used within the national network architecture at both the NOAA NDBC DAC and the NOAA-funded servers at Scripps Institution of Oceanography. The output of the OI mapping routines will be made available in near real-time via both graphical display tools, and machine services including FTP/SSH and Thematic Real-time Environmental Distributed Data Services (THREDDS) to USCG Environmental Data Server (EDS).

Research Accomplishments

CORDC research and implementation efforts met expectations during this reporting period. Throughout this reporting period, efforts focused on continued operations, maintenance, and expansion as well as incremental improvements to backend infrastructure in preparation for national HF radar network processing of optimally interpolated surface currents. As background, the HF-Radar Network architecture is comprised of two hardware building blocks, aggregators and nodes with distinct roles. Aggregators serve as 'point of entry' machines by acquiring and serving radial data from any number of HF-Radar sites. Nodes serve as data concentrators by collecting radial data from any number of portals (or nodes). This design minimizes data requests through sometimes unstable network connections to individual sites by serving data through portals while maintaining a high degree of network flexibility through selective data collection at nodes.

As the network of HF radar systems grows nationally, programmers continue to update and incorporate new data streams into the mapping system. A total of 12 new sites were added to the network during this period: 2 sites on the West coast and 10 sites on the East coast.



As transition to an optimally interpolated product advances, programmers bench tested the processing speed required for computation. Bench tests (cpu time, secs) for the same task in four different Linux machines are shown in Table 1. The proposed task is the derivation of a set of hourly OI-mapped HFR products, including vector currents, divergence, vorticity, stream function, and velocity potential, with 6 km resolution from 40 to 60 HFR radial velocity maps off the U.S. West Coast. Considering the HFR national network, the hourly OI-mapped products with 6 km resolution should be computable within 10 minutes using the latest computing resource.

Table 1: Bechmark test results (cpu time; seconds) for the derivation of hourly OI-maps HFR products in four different Linux machine.

(seconds)	Machine 1	Machine 2	Machine 3	Machine 4
Processors/cpu/me memory	8p/2.4GHz/4 8GB	8p/1.1GHz/1 6GB	4p/2.5GHz/2 4GB	2p/2.4GHz/ 8GB
Data inputs	77.2	85.2	81.3	83.3
Vector currents	13.6	33.3	18.9	36.3
Divergence and vorticity	0.8	1.23	0.8	1.35
Stream function and velocity potential	87.3	118.6	74.3	177.3
Total	178.9	238.3	175.4	298.2

Progress continues on SQL query capability from National Network backend datascope database which will provide additional functionality for web support. Programmers have designed and are testing a program called 'db2sql' which monitors database for all relevant changes and translates to MySQL server. This allows web applications for metadata to rely on the more familiar, widespread, and sometimes faster MySQL database for serving the collected near real-time radial data and metadata.

In support of the SAROPS integration, CORDC programmers developed a THREDDs server for hosting the near real-time vectors (RTV). Radar derived surface currents are now available through the following protocols:

- Data Access via CORDC THREDDs Server
- Data Access via FTP (3 day rolling archive)
- Shapefile Access (California) via FTP (3 day rolling archive)
- Shapefile Access (Gulf Coast) via FTP (3 day rolling archive)

And operational support the following organizations:

- University of Connecticut Short Term Prediction System (STPS)
- Applied Science Associates (ASA) Environmental Data Server (EDS)
- U.S. Coast Guard Search and Rescue Optimal Planning System (SAROPS)
- Office of Response and Restoration (OR&R) Emergency Response Division (ERD) and Assessment and Restoration Division (ARD)
- Official NOAA forecasts for oil spill trajectories General NOAA Operational Modeling Environment (GNOME)

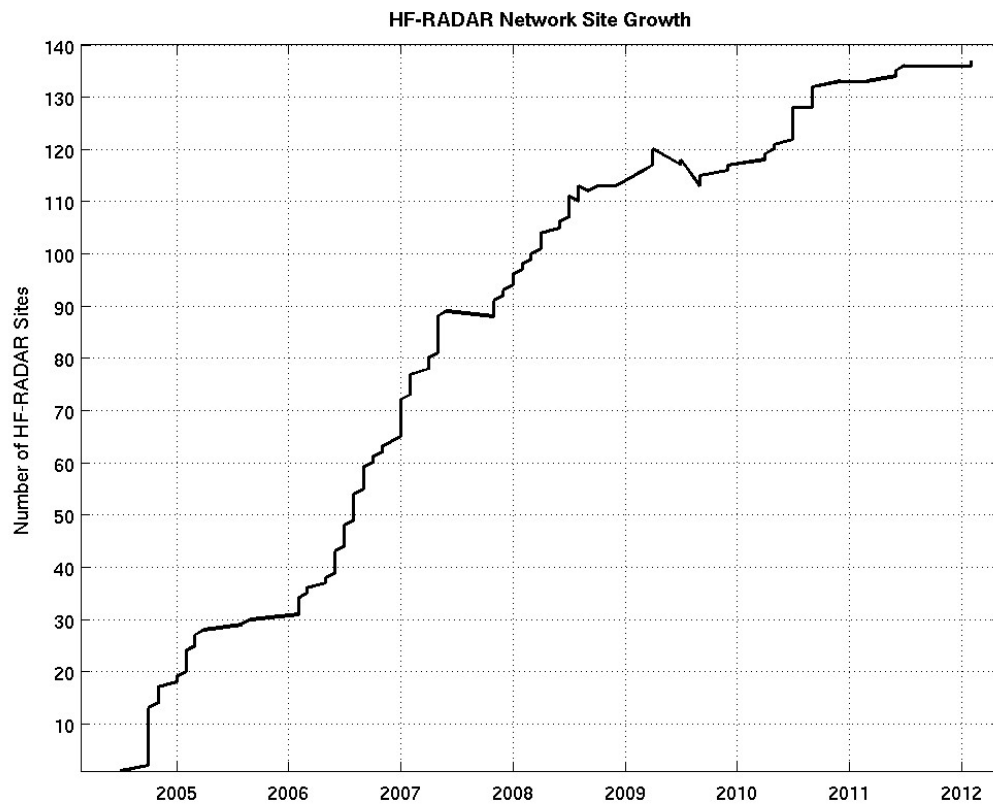


Fig. 1 HF radar national network site growth chart

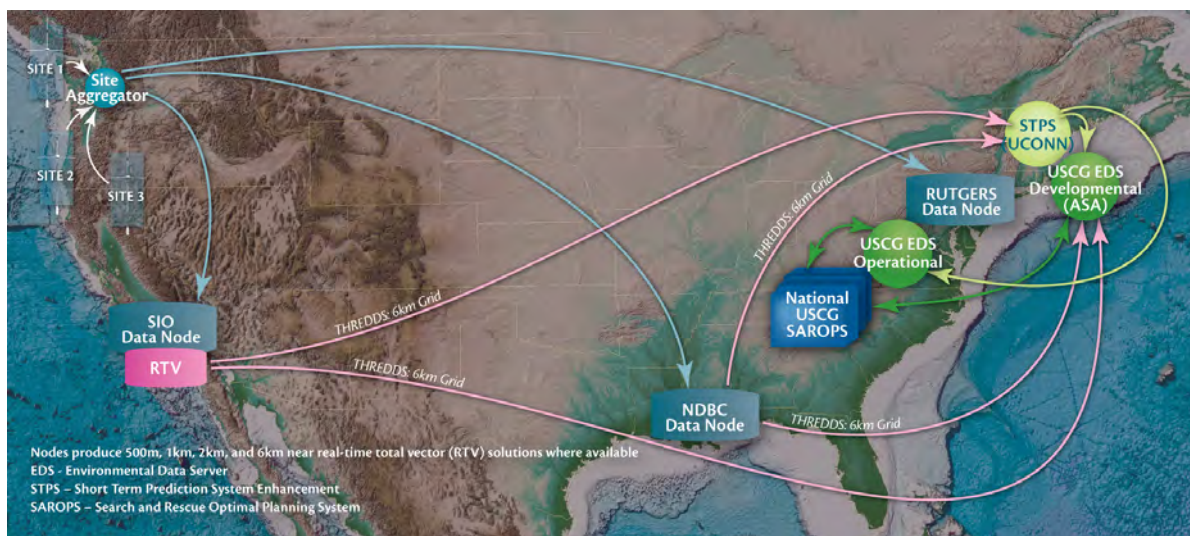


Fig. 2 HF radar national network configuration in support of integration into USCG SAROPS



Ocean Observing and Fisheries Oceanography research of the Coastal Ocean off northern California

Jeffrey Abell (HSU)

NOAA Technical Contact: Steve Miller (NMFS)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

The goals of this project are (1) to facilitate ongoing ocean observation cruises along the Trinidad Head Line, and to prepare hydrographic and biological data for analysis and inclusion in coastal observation networks, and (2) to support focused research in fisheries oceanography and recruitment dynamics off northern California. The primary strategy for achieving these goals is to support a research technician tasked with the day-to-day operations associated with planning, executing, and demobilizing from observation cruises and assisting with coordination of post-cruise laboratory analysis and data synthesis. This work is based out of Humboldt State University, and represents a collaborative effort between HSU and the Fisheries Ecology Division of NMFS' Southwest Fisheries Science Center.

Research Accomplishments

Ocean observing cruises along the Trinidad Head line have continued during the period of work, but data analysis and sample processing have lagged in the absence of technical support. Confusion regarding the structure (and even establishment) of this element of the founding CIMEC grant to HSU have delayed filling of the technician position. These issues have recently been resolved and a hiring decision and offer will be made (and hopefully accepted) by March 26, with the technician to start in April. A no-cost extension will be requested to fulfill the full terms of the grant.



Collaborative Scientific and Technical Support to the NOAA Earth System Research Laboratory

Yehuda Bock and Peng Fang (SIO)

NOAA Technical Contact: Seth Gutman (ESRL/GRD)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

To reliably estimate the absolute integrated precipitable water (IPW) at 30-minute temporal resolution with an accuracy of 1.5mm or better in near realtime using data collected from continuous GPS receivers covering the continental U.S. as a way of supplementing and improving numerical weather prediction models, i.e., short-term weather forecasting. At NOAA's Earth Systems Research Laboratory, a ground-based GPS meteorology system, capable of simultaneously processing sub-networks, has been implemented, with continued scientific input, oversight, and refinement from the Scripps Orbit and Permanent Array Center (SOPAC). The major effort has been focused on various sophisticated quality control elements of an automated data processing system,



generating precise GPS orbits and Earth orientation parameters at SOPAC, using a 24-hour sliding window in an hourly update cycle.

The precision of the orbits is approximately 3 cm within the observed session and below 7 cm in the 12-hour predicted segment. We constantly introduce the latest error modeling techniques in order to provide more robust and timely GPS satellite orbits. These include realizing the latest global gravity mode and global reference frame, incorporating the absolute antenna phase center model, applying improved tidal loading model and differential code bias correction, adding more evenly distributed raw data from global GPS tracking stations, and developing redundant and more robust quality control mechanisms. The Co-PI (Peng Fang) interacted closely with our sponsor at NOAA (Seth Gutman, his staff, and their international contacts) to enhance their systems for GPS Meteorology, providing scientific and technical consultations. In addition, he computed, upon requests, numerous special solutions for the Northern America region as well as places of global interest.

Research Accomplishments

High quality orbits are now delivered hourly with better than 99.2% (3 interruptions over a 365 day period, most of them due to internal or external Internet or centralized archive system related problems) reliability with a precision of about 3 cm, and a predictive capability of 7 cm. A redundant processing system has been implemented to improve the reliability of GPS orbit support at SOPAC for NOAA. EGM08, a new global gravity model, and ITRF2008, a new reference frame, have been adapted. A few improved error modeling schemes have been incorporated into the data processing system. This research directly contributes to atmospheric sounding research in general and directly contributes to operational weather forecasting by NOAA in the U.S. Techniques developed for this system can support other applications in geodynamics and surveying/navigation.



Training the Next Generation of Marine Population Dynamics Scientists

Douglas Bartlett (SIO) and Brice Semmens (SIO)

NOAA Technical Contact: S. Murawski (NMFS)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

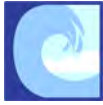
NOAA Goal 4: Support the Nation's Commerce with Information for Safe, Efficient, and Environmentally Sound Transportation

Research Objectives and Specific Plans to Achieve Them

The goal of this project was to facilitate the initiation of a research program for new faculty member Brice Semmens. Brice Semmens was hired during a search for a marine population dynamics scientist with the ability to train future practitioners in the science of population assessment and development of enhanced assessment methods that incorporate environmental variability, food web linkages and spatial heterogeneity. The intent of the appointment was to build upon a long record of accomplishment and collaboration between Scripps Institution of Oceanography and NOAA Fisheries Service. Thus, the objective of these funds included: build a working laboratory suitable for both research and training, initiate field studies, and jumpstart the overall research program on population assessment and dynamics, and characterization of community interactions.

Research Accomplishments

Since beginning his appointment (start date of July 1, 2011), Dr. Semmens has focused on: 1) developing connections and collaborations with other scientists at both SIO and at the Southwest Fisheries Science Center, 2) outfitting his lab space with the computing infrastructure necessary to support analytic tool development and applications, 3) developing a research plan for field based tagging studies aimed at quantifying the movement, behavior and demography of near-shore California fisheries in the context of newly established coastal



reserves, and 4) developing and publishing peer-reviewed manuscripts. Additionally, Dr. Semmens graduate student (Lyll Belquist) and he have begun developing a large scale tagging program for basses (genus *Paralabrax*) targeted by recreational anglers in southern California. This program involves collaborations among the recreational angler community and the San Diego Oceans Foundation. In February of this year, Lyll organized a tagging effort in conjunction with the San Diego Anglers 17th Annual Open Bass tournament. During the one day tournament, 285 fish were visually tagged and subsequently transported to large holding pens in San Diego Bay. After a two week holding period designed to assess short term capture mortality, the fish were released into the bay as part of a mark-recapture population assessment. Currently, they are revising a proposal for the Sea Grant Collaborative Fisheries Research West program to expand this effort throughout southern California in collaboration with the recreational angler community.



Fig. 1 Members of the San Diego recreational angler community and local Boy Scout troops assisting in *Paralabrax* tagging efforts at the San Diego Anglers 17th Annual Open Bass tournament



Fig. 2 Pictures of Lyll Belquist (SIO graduate student) and a volunteer tagging *Paralabrax* during the San Diego Anglers 17th Annual Open Bass tournament



THEME B: Climate Research and Impacts



The Global Drifter Program

Luca Centurioni (SIO) and Bruce Cornuelle (SIO)

NOAA Technical Contact: Candyce Clarke (CPO)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

NOAA Goal 3: Serve Society's Needs for Weather and Water Information

NOAA Goal 4: Support the Nation's Commerce with Information for Safe, Efficient, and Environmentally Sound Transportation

Research Objectives and Specific Plans to Achieve Them

1) Provide to the Global Telecommunication System (GTS) a near-operational, near-real time data stream of drifter position, SST, Sea Level Air Pressure (SLAP). 2) observe the 15m depth velocity on a global basis with a nominal 5.0° resolution and, jointly with satellite altimeter data, produce circulation charts of the world ocean at 0.5° resolution that can be used to trace pollution laden particles or turbulent dispersion of vorticity and thermal energy due to the tropical eddy field; 3) develop and implement drifter's technological advances in sensors, electronics, power, methods of assembly and deployment packaging. 4) provide enhanced research quality data sets of ocean circulation that include drifter data from individual research programs.

All the research objectives were met or exceeded. All drifters' derived data of location, SST and SLAP were posted on the GTS. GTS compatible data of winds, subsurface temperature (Tz) and SSS were also provided basis when these sensors are mounted on the drifters. In collaboration with AOML we maintained an array of 1100 drifters (average) to chart the circulation of the world ocean. In the past two years, these technological advances have introduced new drifter wind sensors integration, drogue-on sensors (strain gauges), improved air pressure ports and improved drogue construction technology; Gridded, global data sets of SST, near surface circulation and dynamic topography, or absolute sea level, are available on line for assimilation into and use in the verification of the processes, such as wind-driven Ekman currents and spatial patterns of the seasonal circulation in ocean climate models.

Research Accomplishments

Requirements to maintain the "Global Surface Drifting Buoys" array at Status Quo

Since September 2005 the fully implemented global drifter array has consisted of between 1100-1400 drifters. This 'required' global drifter array size by JCOMM is based on the need to return instrumental observations of daily average SST ($\pm 0.10^\circ\text{C}$) over the global ocean at a 5° resolution, or the spatial scale of the error covariance function of operational NOAA satellite infrared SST sensors. Surface pressure sensors are also supported by national meteorological agencies based on regional needs. On January 9, 2012 there were 416 GDP-T (Temperature) drifters, 544 GDP-TB (Temperature-Barometer), and 13 GDP-S (Salinity) for a total of 974 instruments, operational on the array. The status of the GDP array can be seen at the AOML website: <http://www.aoml.noaa.gov/phod/dac/index.php>

The present drifter array is 22% smaller than the nominal size. In late summer 2011 an alarming failure rate was noticed by AOML, with drifters stopping functioning on, or within weeks from, deployment. The cause was



identified in two companies installing battery packs made of defective cells and improper hardware. A more robust drogue design has also been enforced.

During early 2011, the difficulty to troubleshoot drifters of significantly different designs that are composing the GDP array and the long time occurring between the identification of a technical problem and subsequent corrective actions, highlighted the urgent need to rationalize and minimize the differences in the SVP/GDP drifter's design. SIO is currently leading this effort. To this end, a new drogue buoy attachment has been designed as well as a new surface buoy and electronics to support both Argos and Iridium communications. New drogue wheels are being tested as well as tethers of different types to address the problem of early drogue losses that was detected in 2010 and addressed at the 27th DBCP meeting in Geneva. The first two Iridium drifters entirely made by SIO were deployed on October 13, 2011, in the Mediterranean Sea.

SIO has implemented a real-time drifter data viewer which now allow us to troubleshoot every drifter in the array in near-real time, by comparing the air-pressure and SST data with several re-analysis products.

Logistical requirements

Most drifters were deployed by "Volunteer Observing Ships" and during research cruises. Shaun Dolk at AOML co-ordinates the drifters deployment. SIO also facilitates the deployment of drifters from research cruises. No drifters were deployed during this hurricane season due logistical difficulties.

Technical developments and data enhancements

- 87 SEACAT SSS sensors to upgrade SVP drifters were procure in support of SPURS
- A new subsurface thermistor chain for the ADOS was designed
- Real time data distribution, datasets and data storage

Service Argos, Inc., within 2 hours of measurement, applies a quality control to the drifter data from the array of 1250 units and distributes these on GTS for operational applications. Within three months, AOML's Drifter Data Assembly Center performs a re-analysis of the data and distributes the six-hourly-interpolated observations upon request to the international scientific community. CIMEC-SIO maintains files for surface currents in which a wind slip correction has been applied and these are distributed also upon request. Such data are updated through September 30th, 2011 and further updates occur approximately every three months. Every year, AOML files a "Global Drifter Program Report" on the statistics of survivability of power, drogues and sensors with the DBCP, which is available on the DBCP web site.

Use of GDP data for SST reanalysis

The drifter data is the most extensive and accurate in situ instrumental data set of SST that is used as the ground truth for the construction of the 7-day average SST maps of the ice-free oceans (Zhang et al. 2009). This product is used globally for analysis of climate, long-range weather prediction and for initialization and verification of ocean circulation models.

Argos 3 Pilot Project

The Argos 3 Pilot Project (A3PP) has ended and the conclusions support the use of the PMT in Argos 2 mode. Argos 3 PMTs are now being used throughout the GDP fleet, including the SIO drifters.

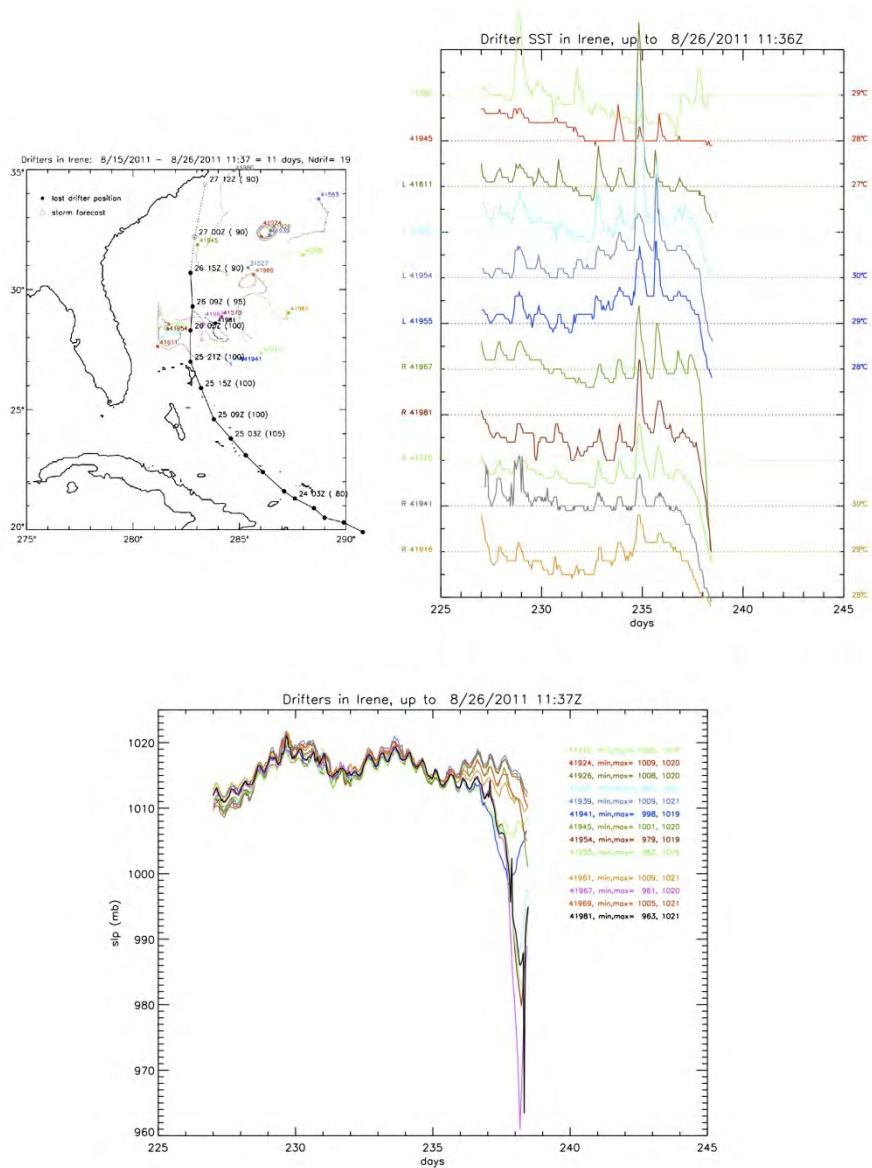


Fig 1 Upper left: tracks of GDP-TB drifter nearby hurricane Irene on August 26, 2011. Upper right: SST as measured by the drifters and; lower panel: SLP measurements from drifters

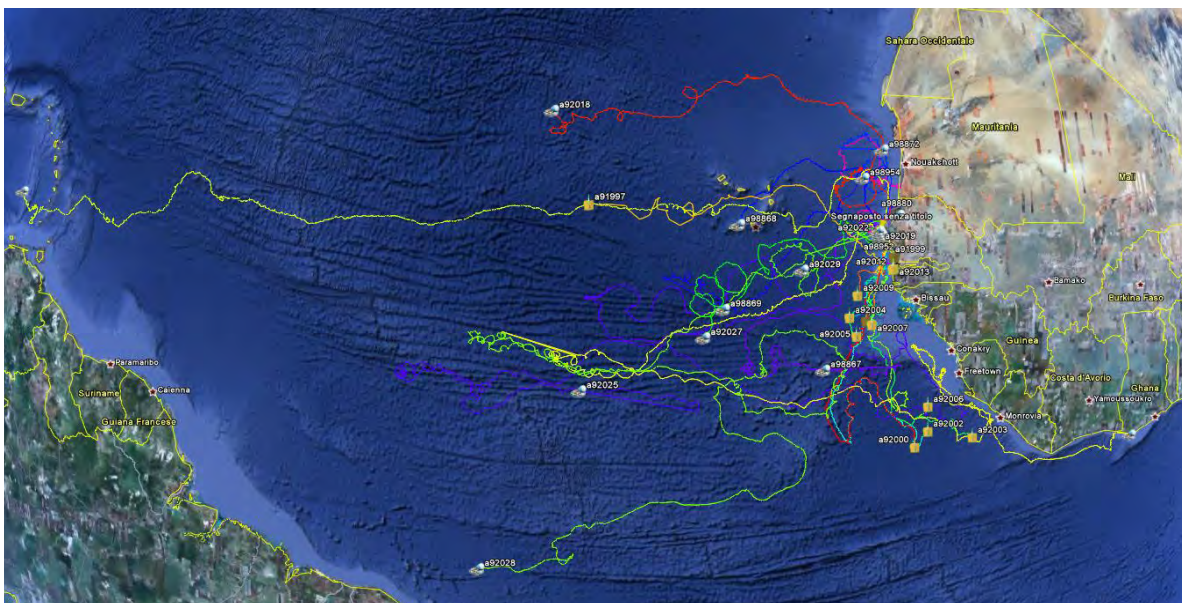


Fig 2 Trajectories of the SVP drifters in the tropical Atlantic Ocean between May 2009 and September 2011. Drifter identification numbers are posted at the end of the tracks (picture courtesy of Dr. Pierre-Marie Poulain)



Integrated Boundary Current Observations in the Global Climate System (CORC III)

Uwe Send (SIO)

NOAA Technical Contact: Diane Stanitski (CPO)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

The project develops, demonstrates, and implements systems that can fully monitor the intensity (mass and heat transports) of most boundary currents in a sustained and routine mode, delivering indicators about the state of those regimes in near-realtime. To this end we will merge several technologies and techniques that have been used by the P.I.'s in the past, and that were partly developed in prior CORC phases. These include:

- underwater gliders: upper-layer distributions of heat, currents, and some biological parameters every few weeks
- end-point moorings: dynamic height differences, and thus mass transports, throughout the water column with high temporal resolution (horizontal integral)
- inverted echosounders/bottom pressure (PIES): 2 vertical integrals (e.g. dynamic height and heat content) at each location along a section with high temporal resolution.
- XBT sections: cost-effective upper-layer sections of heat and currents; historical comparisons
- Surface drifters: Ekman flow and eddy activity
- data assimilation: state estimate of heat and flow distributions, merged from all the data types, plus satellite altimetry and forcing fields (wind) and large-scale information.

Additionally underwater telemetry has been developed for the PIES and (subsurface) moorings using gliders equipped with acoustic modems as "data shuttles" to the surface.

California Current: All components of the observing system are implemented and operating in the California Current which has large climate and socio-economic relevance and does not have a routine monitoring system. Concentration on CalCOFI line 90 in southern California assures synergy with other programs, and coincides



approximately with the high resolution XBT line PX31. First results reveal important northward flow cores, large variability in transports, and barotropic flows. The modem shuttle gliders have shown the capability to deliver quasi-daily data from the subsurface moorings. Data assimilation is now starting to reproduce eddy features in the region.

Solomon Sea: Technological and methodological developments continue, and implementation of the system in a climatically highly relevant western boundary current is underway. The initial choice is in the low-latitude western Pacific, where a western boundary current feeds the Equatorial Undercurrent through the Solomon Sea. This has large potential climate impact by modulating the equatorial conditions for El Niño through upwelling of this water along the equator. Initial exploration with gliders has revealed dominating eddy variability and large vertical extent in the flow there, which requires addition of integrating techniques and drifters. End point PIES installations have been added, and two simple moorings will be added in a few months.

Research Accomplishments

CORC has now made routine the glider-based acoustic modem telemetry and data downloads from both CORC moorings and the CORC inverted echosounder/bottom pressure sensors (PIES) are now highly successful. Also, “deep loitering” has been implemented for the gliders, which will greatly enhance the endurance of gliders on site, by saving power and reducing biofouling. Also, several new GDP style drifters were successfully designed, built, tested and deployed as part of international research programs.

CORC supports gliders in the California Current (CC) on line 90 off Dana Point, and line 66.7 off Monterey. We produce data products consisting of profiles of temperature, salinity, density, velocity, chlorophyll fluorescence, and acoustic backscatter on uniform grids for each glider transit along all lines. The resulting sections allow calculation of the transport of such quantities as heat, salt, phytoplankton, and zooplankton, directly addressing the Climate Program Office deliverables of Ocean Heat Content and Transport, and Ocean Carbon Uptake and Content. The two CORC moorings and five PIES complement the glider measurements by covering the CC over deep water. Due to the acoustic glider telemetry, fully processed transports between the end-point moorings exist now until Dec 2011. We found that the sea level difference (SLD) between the moorings (inshore minus offshore) is highly correlated with the mooring-derived geostrophic internal volume transport referenced to 3500 dbar and closest to the transport over the layer 0-300dbar (correlation $R^2=0.79$). Drifter deployments continued in the CCS (subcontract to Dr. Carter Ohlmann, UCSB). A total 39 drifters were deployed during FY11. The increasing historical drifter dataset in the CCS now supports a robust estimate of the mean-state near-surface surface geostrophic flow, which can be used as an assimilation field.

In FY2011 we continued the time series of Solomon Sea (SS) transport above 700 m begun in 2007. An additional ten transects of the southern SS were completed with 100% data return. These observations are the only repeated indicator of the subsurface western boundary current in the tropical South Pacific. A detailed analysis of the time series through CY 2010 was completed with the goal of developing specific products that can serve as indices of transport in the SS. The time series (Fig. e1) from 2007 to 2011 showed a typical equatorward transport of 15 Sv above 700 m varying from zero to 25 Sv in synchronism with the two La Niñas and one El Niño in the period. The transports and heat contents of the two layers have been tentatively identified as the best indicators of equatorial transport through the Solomon Sea. We are now implementing streamlined procedures to report the indices in near real-time. In order to provide more complete temporal sampling, we are now adding an end-point component across the Solomon Sea, starting with a PIES on each side, followed by two simple small moorings on each side by summer 2012.

The Argo Program and the High Resolution XBT (HRX) Network provide the basin-scale and regional context for CORC observations in the California Current System (CCS) and the Solomon Sea low latitude western boundary current.

With the Argo program now having provided 8 years of global coverage, the combined value of the HRX and Argo datasets is increased by having accurate estimates of heat storage and reference velocities for the 800 m XBT transects from Argo. Mass and heat budgets can be closed with unprecedented accuracy. New estimates have been obtained of the mean equatorward transport of the California Current (5 Sv) and the poleward California Undercurrent (2.5 Sv), of the time variations of heat and freshwater content caused by alongshore advection, and of the interactions of coastal and interior ocean water masses. Argo data in the ocean interior east of the Solomon Islands and in the Solomon Sea, provide basin-integrated estimates of the mean and time-varying transport of the of the South Pacific's shallow overturning circulation. HRX transect PX05 (Brisbane-Solomon Sea-Yokohama) crosses, from south to north, all of the tropical current systems in the western tropical



South Pacific Ocean. Hence, together with Argo it provides the regional context for the intensive CORC observations within the Solomon Sea.

The state estimation component of the CORC project uses modern methods to synthesize multiple observation types in a dynamically-consistent way. The goal is to use reliable dynamical constraints such as conservation of mass, heat, salt, and momentum to complement the observing system and attempt to fill in the gaps in the coverage. The main questions to be answered are: 1) What are the key features of the current, with relevance to both the gyre circulation, climate influences (such as ENSO), and local bio-geochemistry? 2) How accurately can the observation network resolve the key features of the current (e.g. transport, heat content, ecosystem-relevant variables such as upwelling or CO₂)? 3) How can the observations be best arranged for maximum coverage of these features? And how consistent are these observations to one another? 4) Can the model reproduce the observed features (and over what time range?), and what is required in terms of forcing and boundary conditions to make that happen?

In addition to the science questions, many technical problems have been addressed, such as the treatment of open boundaries, the effects of the Boussinesq approximation in the model, and new data types, such as transport, IES, and averaged velocities from gliders. The ability of the model to reproduce observed properties and features like transports or eddies has dramatically improved since summer 2011. We are now starting to extend the time period covered by the model, and to implement shorter runs that will converge more quickly.

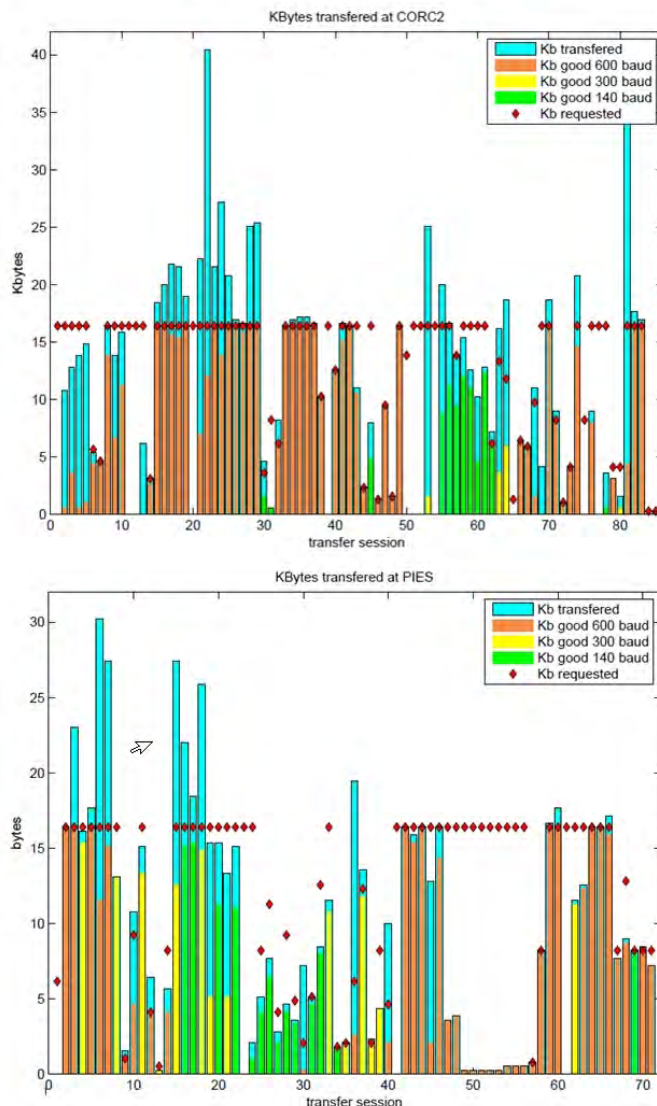


Fig. 1 Diagram summarizing the acoustic data transfer success from a 160-day Spray glider mission, for the CORC2 mooring (top) and all the functioning PIES (bottom), each bar represents one dive. The red diamonds show the number of kbytes requested/sought during the dive. The overall height of the bar shows the number of Kbytes received, and green/yellow/brown show the amount of good data received (color coded by baud rate)

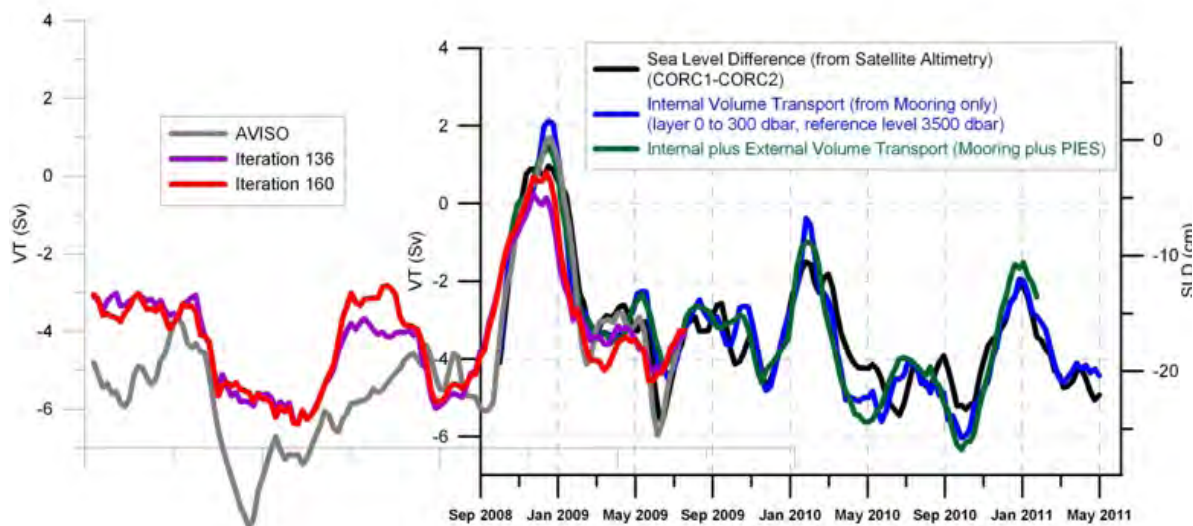


Fig. 2 Comparison of the SSH difference between the CORC mooring locations (as a proxy for transport of the CC between the moorings) between AVISO (gray) and the adjoint state estimate iteration 136 and 160. Before the mooring data become available (October 08) the deep water CC transport across the CORC line is not well reproduced by the model, inspite of assimilating ARGO, altimetry, gliders, and XBTs. With the mooring data, the transport is captured by the state estimate. Also, in contrast to iteration 108 from last summer, the adjoint now is able to reproduce the transport fluctuations observed by the moorings. This is a big improvement and step forward, and represents a better convergence of the model toward meanders and eddies in the CC on the CORC line



Meridional Overturning Variability Experiment (MOVE)

Uwe Send (SIO)

NOAA Technical Contact: Diane Stanitski (CPO)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

A present gap in the sustained ocean climate observing system are techniques and programs for monitoring the circulation and mass/heat/freshwater transports of major current systems, sometimes called "transport reference sites". For broad-scale and deep-reaching circulations, a recently demonstrated method consists of fixed-point installations with moored and bottom-mounted instruments to obtain horizontally and vertically integrated measurements throughout the watercolumn. The MOVE project now maintains the developed elements of the first such system by having taken over operation of a moored transport array in the Atlantic. This had been initiated via the German CLIVAR programme from 2000 to 2006 in the subtropical west Atlantic along 16N, in order to observe the transport fluctuations in the North Atlantic Deep Water layer.

With the NOAA MOVE project, SIO/CIMEC/NOAA operates the two geostrophic endpoint moorings between the western boundary and the Midatlantic Ridge (yielding dynamic height and bottom pressure differences), plus a small current meter mooring on the slope. This is complemented on the eastern side of the Atlantic with a German-funded and operated mooring (near the Cape Verde islands). In the first years of the NOAA MOVE project, the acquisitions for complete configuration of the moorings had taken place, and the array has been built up to its full implementation. Routine operation is now achieved with two-year long deployments, and



routine delivery of indicators about the state of the thermohaline overturning circulation at this latitude will be enabled.

Research Accomplishments

Since only part of the MOVE work could be accomplished on the NOAA cruise in December 2010 due to insufficient ship time allocations, one smaller mooring near Guadeloupe needed to be recovered in the reporting period with a local boat. This extra operation took place successfully in May 2011 out of Guadeloupe with two participants from SIO, but with ship charter, shipping, and travel it cost the project an additional unexpected \$25,000. As of beginning 2011, fresh MOVE moorings and PIES have been in the water. All new moorings and PIES now carry acoustic modems, using the technology developed under CORC, to allow data retrieval with gliders. Moorings are designed for 2-year endurance currently.

On the science side, the previously reported 9-1/2 years of data which showed a weakening trend in the Meridional Overturning Circulation (MOC), amounting to approximately 20% over 10 years, has finally been published in *Geophysical Research Letters* and has been widely used/discussed in the community, including in a research highlight in the journal *Nature Climate Change*, in an *GRL* editor's highlight, in an *AGU* press release journal highlight, and in *EOS* as a "research spotlight" story (see below under "publications"). These MOVE results are being included in the next IPCC Assessment report.

With the newly recovered moorings our data set now represents a timeseries of 11 years length (see figure 1). A large southward transport event now makes the weakening trend insignificant, which could be either an anomaly or the beginning of a reversal of the expected decadal-scale oscillations. Work also continues to merge/compare MOVE data with that from other efforts such as RAPID, and with modeling results.

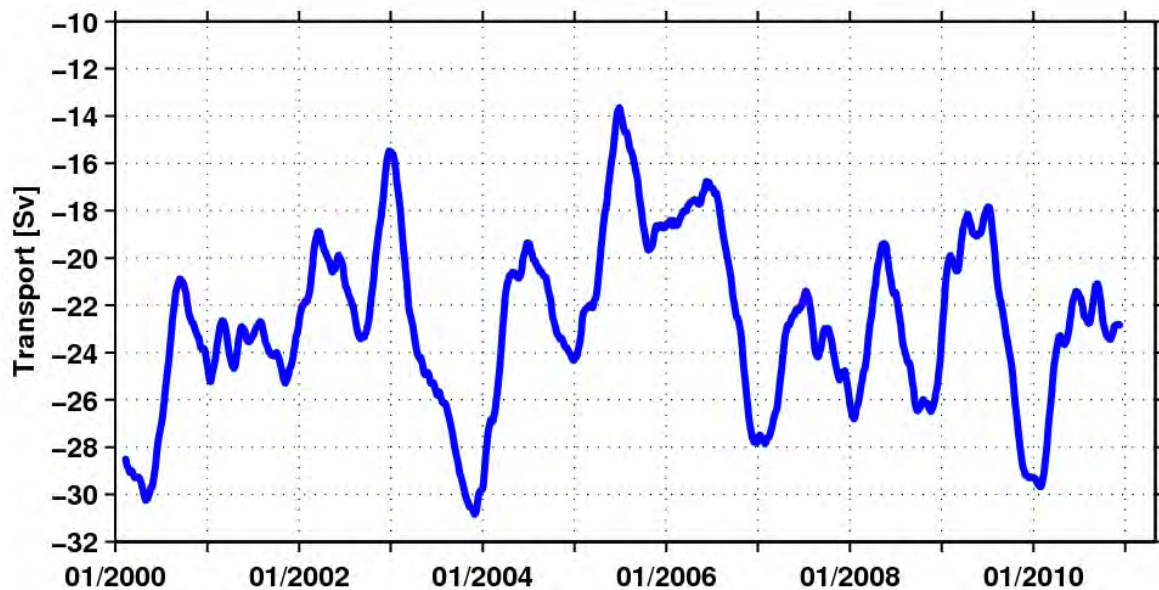
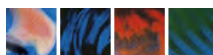


Fig. 1 New extended timeseries of NADW transport from the internal geostrophic component (referenced to 4900m) plus the boundary current component



Moored Climate, Carbon, Biogeochemical, and Ecosystem Observations in the Southern California Current (CCE)

Uwe Send (SIO)

NOAA Technical Contact: Diane Stanitski (CPO)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

The California Current is a region of large ecological significance and known sensitivity to climate forcing. Climate processes, complex physical systems, carbon and nutrient chemistry, and ecosystem dynamics all interact to create a rich, societally important, and scientifically fascinating ocean environment off the west coast of the US. This project will establish a unique highly multidisciplinary mooring presence in the southern California Current, to complement the flow and transport monitoring system that has been initiated under CORC, and to start building a comprehensive continuous real-time monitoring system for this region.

Two moorings, called CCE(California Current Ecosystems)-1 and -2 are located in the core of the California Current and in the upwelling regime on the continental slope, respectively, along CalCOFI line 80, and measure

- atmospheric conditions ($x(\text{CO}_2)$, wind, temperature, humidity, precipitation, irradiance),
- surface ocean conditions (temperature, salinity, $p(\text{CO}_2)$, O_2 , pH, currents, point and integrated measures of phytoplankton chlorophyll content over the euphotic zone, and nitrate supply), and mixed-layer depth,
- multi-frequency active-acoustic observations of zooplankton and fish biomass over the upper 300m.

The data will be telemetered in real-time and made available via websites to other researchers and agencies. The moorings contribute unique timeseries for the US ocean acidification and carbon observing programs, and add a time dimension to regular ship surveys under CalCOFI, CCE-LTER, and fisheries stock assessment programs.

Research Accomplishments

The FY2011 funding was used for the first installation of two nearly identical moorings CCE1 and CCE2 along CalCOFI line 80 in March 2011, in the offshore and the upwelling regimes off Pt. Conception. The moorings have been upgraded in a number ways: at CCE1 there are now additional oxygen and pH and chlorophyll fluorescence sensors (all at 40m). At CCE2 we have added several oxygen sensors in response to research and suggestions by S. Alin and R. Feely (PMEL) and added a second pH sensor. And both moorings now carry a 7-wavelength irradiance sensor at the surface (on the buoy) and at varying depths, as well as acoustic zooplankton/fish backscatter systems by D. Demer from SWFSC. New deployments of the moorings are taking place in spring/summer 2012 – CCE2 was deployed successfully in March 2012 and CCE1 is planned for early summer 2012.

Many of the multi-sensor data sets are currently being calibrated, quality-controlled, and analyzed. One example is the irradiance data set from the surface and 80m/40m depth. Our goal at present is to determine the absolute chlorophyll content of the water column, and initial analyses look extremely promising. In addition we are starting to build carbon budgets from the CCE moorings. Much of the mooring estimate of dissolved inorganic carbon (nDIC, black line) which was calculated from the $p\text{CO}_2$ data and total alkalinity (the latter derived from salinity according to the method by Simone Alin), can be explained from advection (using mooring ADCP currents) of large-scale DIC gradients alongshore and cross-shore determined from ship surveys. The acoustic backscatter data from the Longranger ADCP can be used as a proxy for zooplankton concentration and shows surprising overall variability very similar to the mooring-derived DIC and its advective estimate. There also appear to be extended phases of anticorrelation between acoustic backscatter and chlorophyll fluorescence, which is a curious result and will require further investigation.



Even though our timeseries at CCE are still short, we have covered part of the recent El Nino/La Nina events and we can start to analyze impacts of these climate processes on the biogeochemical system and ecosystem conditions at the moorings. This is still in the early stages, but some first steps are under way. For oxygen we can use the long CalCOFI data set from 1950 to 2010 to construct a mean seasonal cycle (or a climatology) and can then compare the mooring oxygen data from the El Nino and La Nina years 2009/2010 and 2010/2011 with the typical climatological conditions. At 40m depth (at CCE1) and at 76m depth (at CCE2) there is a clear decrease in oxygen during the La Nina phase.

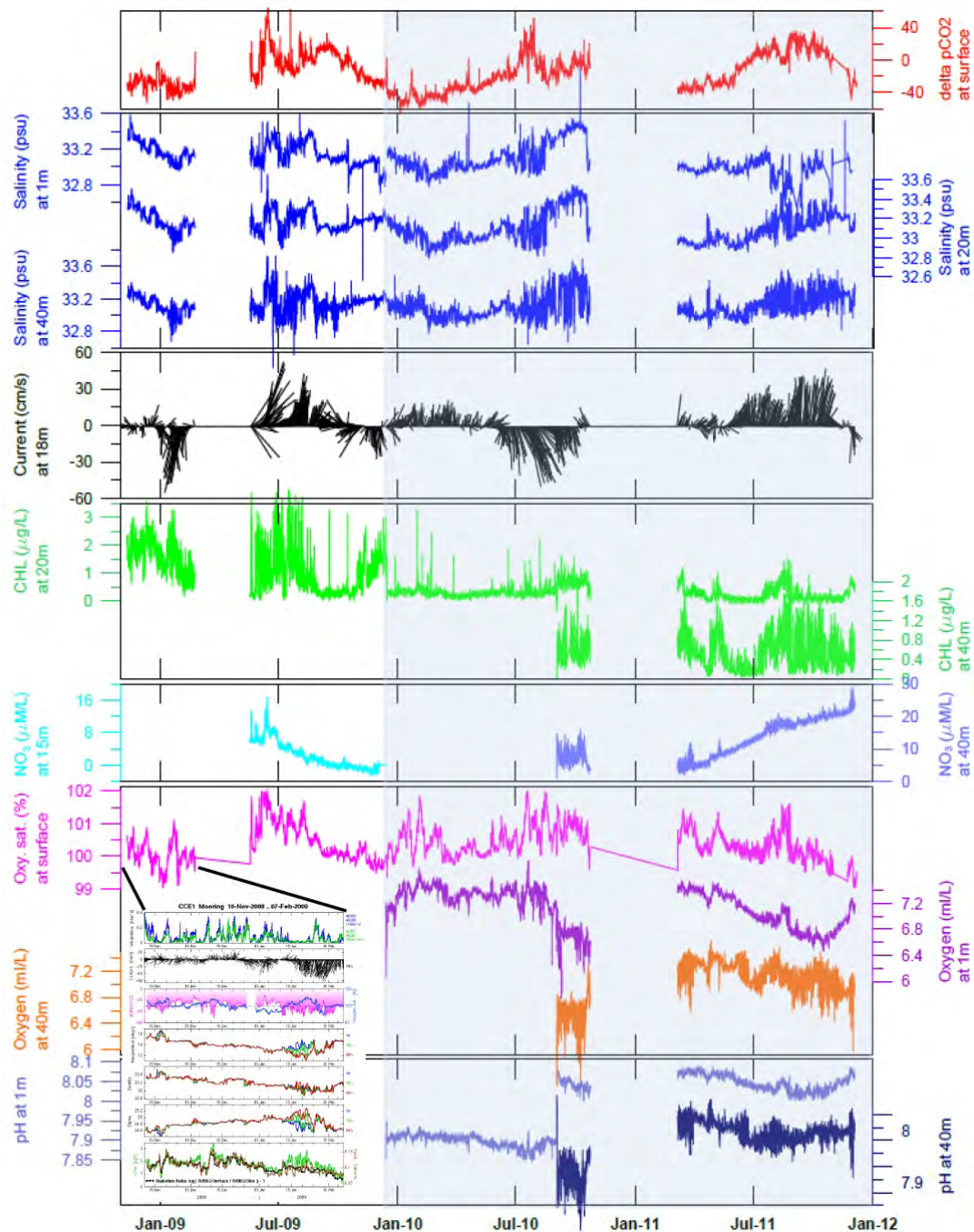


Fig. 1 Available data from all CCE1 mooring deployments from the surface pCO₂ sensor (PMEL), some of the T/S sensors, currents at 20m (the shaded period has an ADCP covering the upper 500m), chlorophyll estimates, nitrate concentration, dissolved oxygen data, and pH readings. All data are raw with factory calibration. The shaded period shows the NOAA funded deployments.

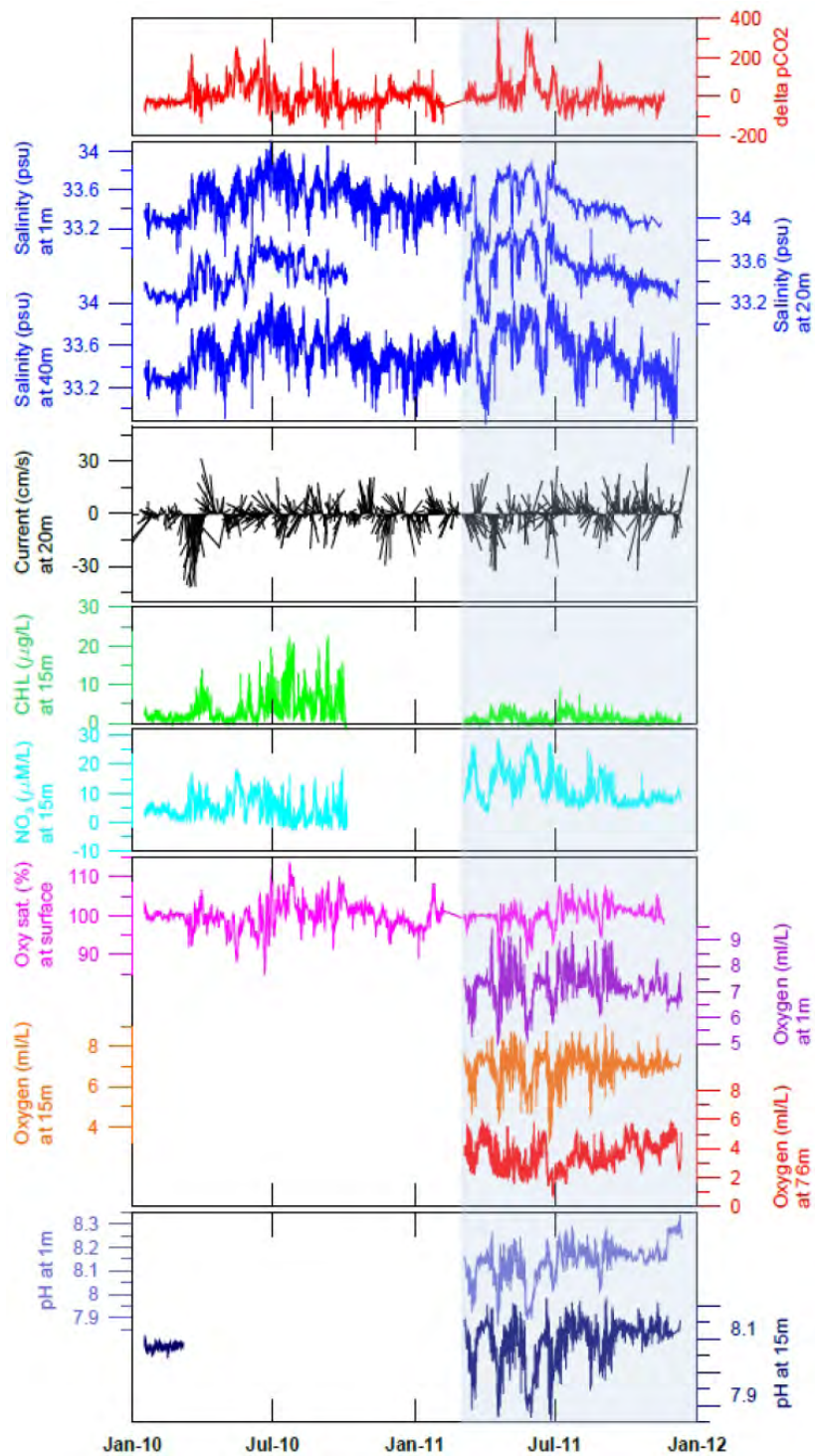


Fig. 2 Available data from all CCE2 mooring deployments from the surface pCO₂ sensor (PMEL), some of the T/S sensors, currents at 20m (the shaded period has an ADCP covering the upper 500m), chlorophyll estimates, nitrate concentration, dissolved oxygen data, and pH readings. All data are raw with factory calibration. The shaded period shows the NOAA funded deployments



Measurements of Atmospheric O₂/N₂, Ar/N₂ and CO₂ Abundances in Relation to Carbon Cycling

Ralph Keeling (SIO)

NOAA Technical Contact: Ken Mooney (CPO)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

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NOAA Goal 4: Support the Nation's Commerce with Information for Safe, Efficient, and Environmentally Sound Transportation

Research Objectives and Specific Plans to Achieve Them

This project continues and expands time series measurements of O₂/N₂ and Ar/N₂ ratios and CO₂ concentration at background air stations by the Scripps O₂ project. These measurements enable refined estimates to be made of land and ocean carbon sinks and provide benchmark tests for models depicting the response of ocean biogeochemistry to changing climate on a range of time scales, extending from seasonal, El Niño, to multi-decadal. The measurements are also relevant for quantifying the global loss of O₂ from the oceans, or “deoxygenation” and for detecting changes in ocean ventilation and production associated with warming-induced stratification that may influence future deoxygenation. The measurement may enable improved atmospheric inversions that take account of processes internal to the ocean influencing carbon dioxide. The measurements have strong synergistic relationship to measurements by the carbon cycle group of the NOAA Global Monitoring Division, the Argo float program, to measurements made as part of the HIAPER Pole-to-Pole (HIPPO) mission to survey the distribution of long-lived atmospheric tracers related to carbon dioxide, and to the Scripps CO₂ program.

The primary proposed activity involves sustaining ongoing time series at a global array of nine stations extending from the Arctic to the Antarctic along a (mostly) Pacific transect. One new site, Barrow, Alaska, has been added to the flask network during this three-year grant period in order to sustain the Barrow time series initiated by the Princeton atmospheric O₂ program

An integrally related activity involves the assessment and reduction of systematic errors which may impact the ongoing measurements or the merging with these measurements with measurements of other programs. The project supports interpretive activities related to detecting and reporting such errors. It also supports activities to reduce errors, and it enables the Scripps O₂ program to continue its central role in an international intercalibration effort for O₂ measurements, as endorsed by the World Meteorological Organization.

The proposal supports collaborative interpretive activities with investigators at other institutions to develop methods for incorporating O₂/N₂ measurements into atmosphere/ocean inversions for detecting trends in land and ocean sinks on decadal time scales.

Research Accomplishments

Flask collections and analyses have proceeded largely without disruption at the nine primary long-term stations in the Scripps O₂ network (Figure 1). Sampling at the new station, Barrow Alaska, has proceeded without major issues since May 2011, although inspection of the data shows a few sampling times with very elevated CO₂, indicating that the air was contaminated by a local source. Overall the time series looks very promising (Figure 2).

At our request, staff at the South Pole station installed a new intake to allow sampling from a 30m tower in Jan 2012. We plan to overlap sampling between the older (roof) line from the AERO Building and the newer tower



for at least one year to establish any offsets. The change is motive in part because of concerns that the air near the surface may be altered by gravitational or thermal fractionation. Such fractionation would be reduced at the tower site, giving signals more representative of the larger atmospheric background.

At Palmer Station, we moved the tower on the Tera Lab building (which has been in use for some years) to a cleaner side of the building. We expect this will help reduce contamination especially in the summer, when there are more activities around the building (e.g. power equipment, deliveries, etc.).

The PI is collaborating with Bruce Cornuelle of Scripps to assess trends in the amplitude of the seasonal cycles in APO, where APO is a combination of O₂/N₂ and CO₂ which largely eliminates variability due to land biota (APO ~ O₂ + 1.1CO₂). This cycle largely reflects the seasonal exchange of O₂ with the ocean, which is substantially driven by the seasonal cycle in photosynthesis in the upper ocean. These trends will be examined in light of the publication by Boyce et al. ("Global phytoplankton decline over the past century." *Nature* 466(7306): 591-596.), which suggests trends have occurred in marine biomass over the past century. Bruce Cornuelle adds to this effort by providing expertise in the modeling of data and statistical assessments of fitted parameters.

A draft is in preparation by the PI summarizing the main value of atmospheric O₂ measurements to global change research. Entitled, "Studies of recent changes in atmospheric O₂ concentration", the draft describes motivation and methods for measuring changes in O₂/N₂ abundance, the relation to atmospheric oxygen, an overview of basic phenomena, including seasonal cycles, secular and interannual trends, and provides updated estimated of global land and ocean carbon sinks, as summarized in Table 1 below.

A draft is in preparation, by Manfredi Manizza, the PI, and Cindy Nevison to compare observed cycles in Ar/N₂ and APO with results from a high resolution biological ocean model. The ratio of the amplitudes of the seasonal cycles of APO and Ar/N₂ appear to be well measured (Figure 3), and provide a measure of the seasonal biological response of the ocean biota (via APO) to the seasonal physical forcing of the upper ocean (via Ar/N₂). A correct depiction of the processes influencing the seasonal exchange of O₂ is critical also for accurate depiction of the seasonal controls on surface water pCO₂. The purpose of the paper is to illustrate the power of the Ar/N₂ and APO constraints for challenging ocean models used for assessing ocean biological and carbon cycle processes.

The O₂/N₂ and Ar/N₂ data from the Scripps program have figured prominently in a collaborative study led by Dr. Cindy Nevison of the University of Colorado and including the PI to decompose the seasonal cycles in APO into the three main components: (1) photosynthesis, (2) ventilation, and (3) warming/cooling induced solubility changes. The study leads to a new estimate of marine net community production for the oceans south of 50S of ~1 Pg C yr⁻¹, and illustrates how O₂ measurements can be reconciled with satellite estimates of ocean productivity. This study is in press in *Global Biogeochemical Cycles* (Nevison et al., 2012).

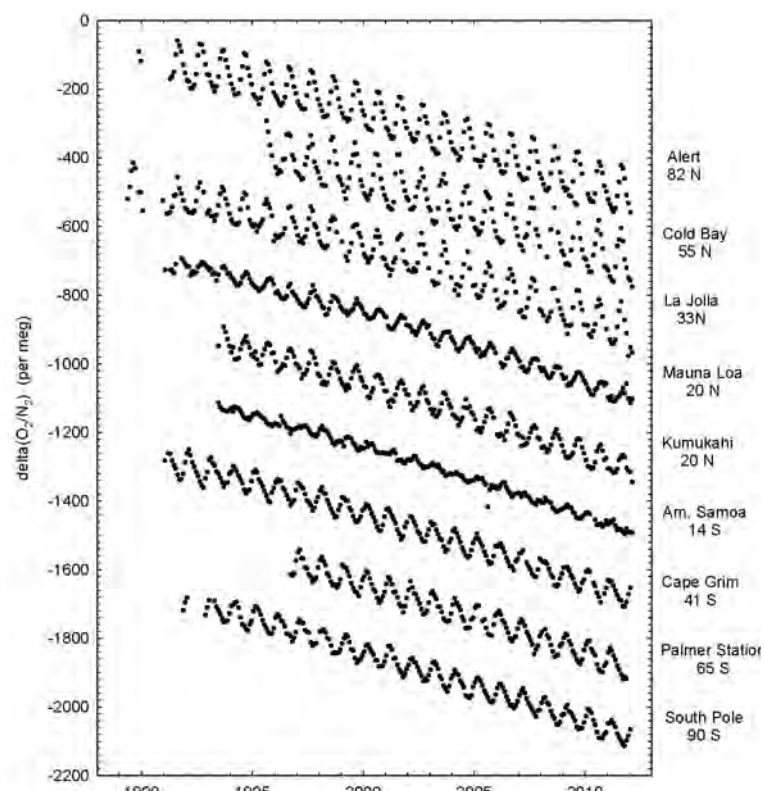


Figure 1. Time series of O₂/N₂ ratio at sites in the Scripps O₂ program

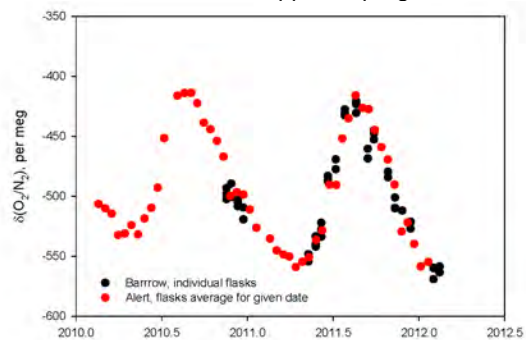


Figure 2. Comparison of O₂/N₂ data at our two arctic stations Barrow, and Alert

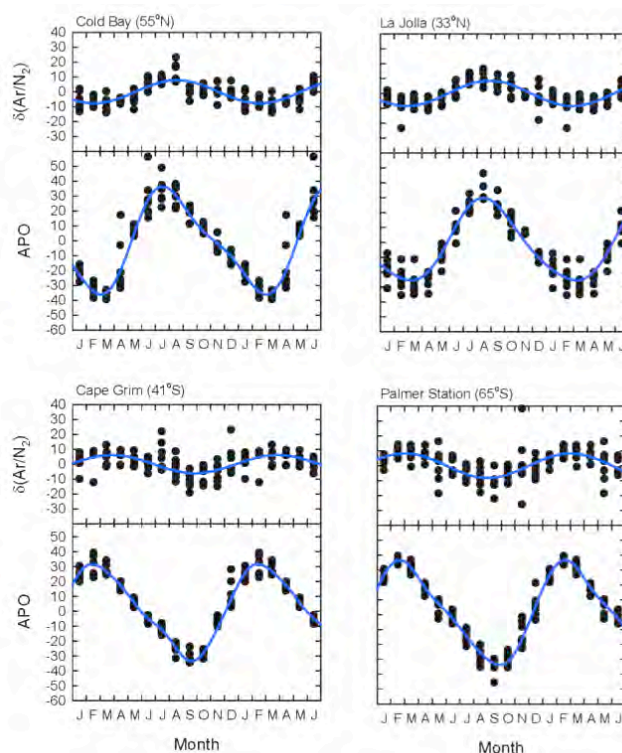
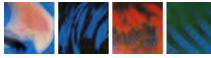


Figure 3. Interannually-detrended monthly O₂/N₂ and Ar/N₂ concentrations at four sites.

Time frame	$\Delta\delta\text{APO}$ per meg yr ⁻¹	ΔCO_2 ppm yr ⁻¹	Z_{eff} 10 ¹⁴ mol yr ⁻¹	α_F	Fossil-fuel Pg C yr ⁻¹	Atm. CO ₂ . Pg C yr ⁻¹	Ocean sink Pg C yr ⁻¹	Land Sink Pg C yr ⁻¹
1990-2000	7.79 (0.72)	1.52 (0.02)	0.34 (0.40)	1.391 (0.03)	6.39 (0.38)	3.23 (0.04)	1.83 (0.57)	1.33 (0.75)
1993-2003	8.60 (0.50)	1.74 (0.02)	0.34 (0.40)	1.393 (0.03)	6.60 (0.40)	3.70 (0.04)	2.10 (0.53)	0.80 (0.72)
2000-2010	10.41 (0.52)	1.90 (0.02)	0.34 (0.40)	1.378 (0.03)	7.81 (0.47)	4.04 (0.04)	2.61 (0.55)	1.16 (0.80)
1991.5-2011	9.49 (0.42)	1.76 (0.01)	0.34 (0.40)	1.384 (0.03)	7.24 (0.43)	3.74 (0.02)	2.34 (0.52)	1.16 (0.75)

Table 1: Oxygen based carbon budget over different time periods from data from the Scripps O₂ Program. $\Delta\delta\text{APO}$ is the observed change in atmospheric potential oxygen, which is the key observed input from the Scripps O₂ program. ΔCO_2 is the change in CO₂ concentration from the NOAA GMD program. Z_{eff} is a correction term allowing for warming-induced ocean outgassing of O₂. The remaining columns detail the main terms in the global carbon budget, with the atmospheric increase, ocean sink and land sink summing to equal the fossil-fuel emissions. Estimated uncertainties (1 σ) are in parenthesis.



Development of Water Vapor Flux Measurements Systems for Lightweight UAVs

V. Ramanathan (SIO)

NOAA Technical Contact: Gary Wick (ESRL)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

The main objective of this project is to develop a lightweight UAV based system for the measurement of water vapor fluxes to complement existing NOAA field programs and satellite observations in the eastern Pacific region for the observation of atmospheric rivers (ARs), with the ultimate goal of improving understanding and forecasts of such events. These ribbon-like structures, extending 1000s of Km, are contained within the lowest 3km of the troposphere and are a critical pathway for meridional moisture transport. In California, AR systems play a key role in flooding events.

By providing localized, targeted sampling of the turbulent wind field and the water vapor content, UAVs can provide data on ARs on temporal and spatial resolutions not possible with satellites or easily obtainable with manned aircraft. In order to properly resolve the key components of an atmospheric river, any flux system needs to adequately distinguish between latent heat flux (λE) ranges expected within the hydrometeorological regimes typical of an AR system. In the 2011-2012 period we have improved system performance and continued testing in maritime conditions during a scientific field campaign in the Maldives. We are also preparing for final NOAA flights in San Nicolas Island May-June 2012, as per instruction from NOAA program manager, Dr. Gary Wick.

Research Accomplishments

The first publication arising from the system tests was published in its final form in January 2012. Based on the result from those flights and a subsequent test flight a NASA Dryden a number of system improvement/characterizations were made including: a) a redesigned gust probe mount to simplify consistent mounting of the gust probe; b) improved in-flight telemetry to supply 1Hz temperature, humidity and altitude (for profiles), and to monitor performance of the pressure transducers, hygrometer probe and GPS/INS device. Noise in the analogue systems was further reduced to near-undetectable limits by improved wiring and timing of the data logging system. The system has been flown for over 38 hours as part of a scientific measurement campaign (CARDEX) conducted in the Maldivian maritime environment. Flight legs of 10 nautical miles were routinely conducted. Targets included the cloud-topped entrainment zone and levels within the boundary layer. In-flight gust probe calibration maneuvers were also accomplished. We have also tested a fast response temperature probe for the measurement of sensible heat fluxes. The system is due to fly final test flights at San Nicolas Island in late May/early June, following flight permissions obtained through NOAA.

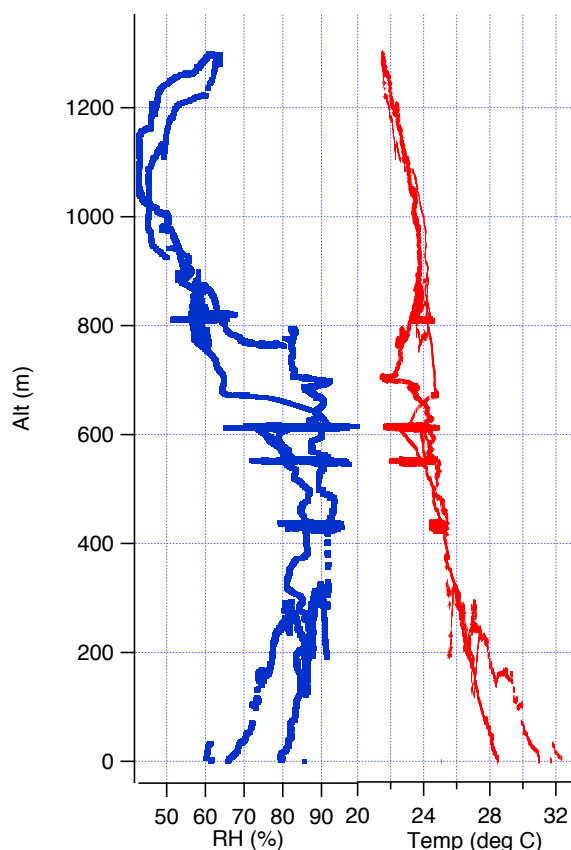


Fig. 1 Preliminary field data from CARDEX showing temperature and relative humidity profiles to 1.3km in a tropical marine setting in the Maldives on the 20th March 2012

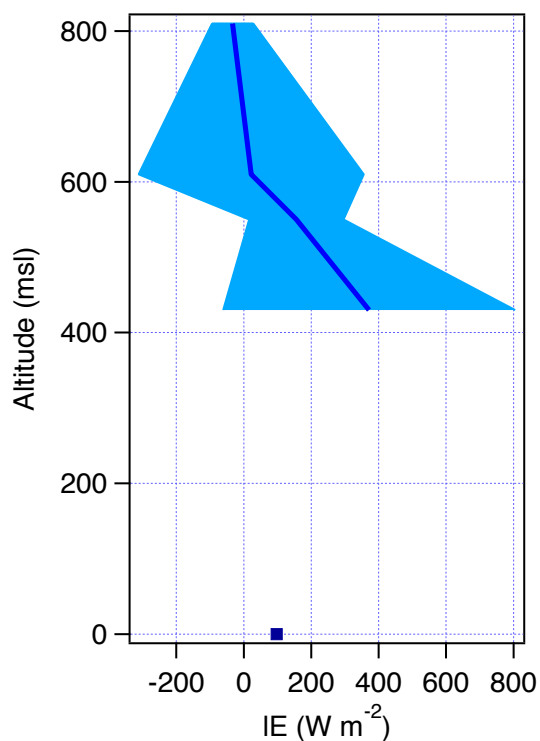


Fig. 2 Preliminary field data showing mean latent-heat (λE) fluxes obtained by the UAV at altitudes above the ocean surface for the same flight period shown in Figure 1. Surface tower data for the time period concurrent with the flight period is shown for comparison



The Argo Project – Global Observations for Understanding and Prediction of Climate Variability

Dean Roemmich (SIO)

NOAA Technical Contact: Steve Piotrowicz (CPO)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

NOAA Goal 3: Serve Society's Needs for Weather and Water Information

Research Objectives and Specific Plans to Achieve Them

Argo is an international collaboration providing a global array of profiling CTD floats for a broad range of operational and scientific applications (<http://www.argo.ucsd.edu>). The Argo array, now including about 3500 active floats, is providing unprecedented real-time views of the evolving physical state of the ocean. These measurements reveal the physical processes that balance the large-scale mass, heat, and freshwater budgets of the ocean on basin-to-global scale. Argo is a large initiative for oceanography, merging research and



operational objectives to provide a uniquely valuable global dataset for climate science, ocean state estimation, seasonal-to-decadal forecasting, and other applications. All Argo data are freely available in near-real time.

SIO plays a number of key roles within U.S. and international Argo. The U.S. provides over 50% of the international Argo array, including instrumentation development, float production and deployment, communications and data management, and scientific analyses to demonstrate the value of Argo data. SIO produces and deploys one-fourth of the U.S. floats, carries out float technology development, participates in delayed-mode quality control, coordinates the U.S. Argo partnership, and provides leadership for international Argo through the Argo Steering Team.

Research Accomplishments

During the 9 months covered by this report (07/2011 – 03/2012), 110 SIO Argo floats were built, shipped, and deployed. An additional 11 have been built and shipped awaiting deployment (in 05/2012). Of the 110 floats deployed, 41 are of the original SOLO-I design, including 11 deployed by RV Kaharoa in August-October 2011, 6 by SS Horizon Hawk in October 2011, 12 by RV Aurora Australis in October 2011, and 12 by RV Spirit of Enderby in March 2012. The remaining 69 floats are of the new SOLO-II design, including 50 deployed by RV Kaharoa in August-October 2011 and 19 by RV Revelle in February-March 2012. SIO Argo produces about 90 floats per year. The large number during the present 9-month period was to reduce a backlog of float deployments due to restricted supply of CTD pressure sensors.

The total number of active SIO Argo floats is now 447. For all active floats, profile and engineering data are carefully monitored to identify any technical problems with the instrument or sensor. Technology development continues to focus on further improvements in reliability and capability of profiling floats. Deployments of the newly designed SOLO-II float have been successful, including both SOLO-II floats built at Scripps and SOLO-II floats produced under commercial license by MRV Systems LLC. The SOLO-II design provides greater buoyancy adjustment, more robust operation, and increased lifetime relative to all existing Argo floats.

A new initiative during this reporting period is the design and development of Deep Argo floats, which should be capable of more than 100 cycles to full ocean depth (6000 m). Extensive testing of materials for pressure housings of Deep Argo floats has been carried out. Modifications to the pumping system used in SOLO-II have been made to allow high pressure operation. Discussions with SeaBird Electronics have provided the initial weight and dimensions of the CTD to be integrated in Deep Argo floats. Energy budgets calculations have been carried out to estimate the energy consumption and battery lifetime of the float. It is planned for prototype Deep Argo floats to be produced and deployed by late in 2012.

Scientific quality control of all SIO Argo profile data has been carried out by J. Gilson and M. Scanderbeg according to protocols set by the international Argo Data Management Team. All eligible delayed-mode profiles (i.e. > 12 months old) have been reviewed. SIO Argo data are available from either of the two Argo Global Data Assembly Centers.

D. Roemmich has been Chairman of the international Argo Steering Team since its inception in 1998. The AST, which is responsible for coordinating the international Argo partnership, was hosted by Euro-Argo in its March 2012 meeting. The meeting report for AST-13 is available from http://www.argo.ucsd.edu/FrMeeting_reports.html. M. Scanderbeg provides support for a wide variety of AST functions, including Steering Team and Data Management Team meeting planning, reporting, and inter-session activities, and is responsible for designing and updating of the Argo web site, <http://www.argo.ucsd.edu>.

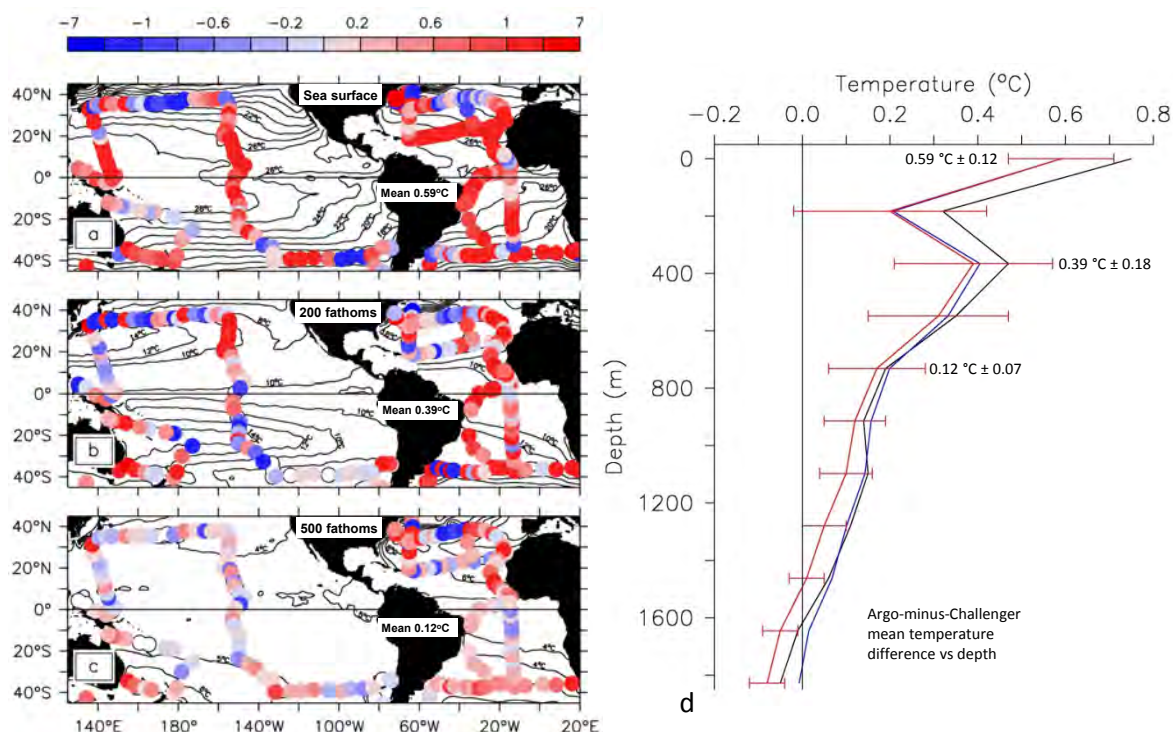


Fig. 1 Temperature difference, Argo data (2004-2010) minus HMS Challenger (1872-1876). Challenger made the first-ever global-scale measurements of subsurface ocean temperature. All differences are corrected for the annual cycle according to the time of year when the Challenger measurements were collected. (a) Difference at the sea surface, (b) 200 fathoms (366 m), (c) 500 fathoms (914 m), (d) global average of temperature difference. Black is the simple average; red is an area-weighted average using the ratio of Atlantic to Pacific ocean areas; blue is the area-weighted average with a correction for the effect of pressure on the Challenger pressure-protected thermometers. Because the 0-700 m average temperature difference is twice that estimated for the past 50 years of modern oceanographic data, it appears that ocean warming has at least a century-long timescale. (Roemmich, Gould and Gilson, Nature Climate Change, 2012)



SIO High Resolution XBT/XCTD Transects

Dean Roemmich, Bruce Cornuelle and Janet Sprintall (SIO)

NOAA Technical Contact: Candyce Clark (OAR)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

NOAA Goal 3: Serve Society's Needs for Weather and Water Information

Research Objectives and Specific Plans to Achieve Them

The SIO High Resolution XBT Network is a set of basin-spanning shipping routes (<http://www-hrx.ucsd.edu>) along which eddy-resolving temperature transects are collected four times per year. The HRX Network was initiated in 1986 along a commercial shipping route between New Zealand, Fiji, and Hawaii. It was subsequently



expanded during the 1990's to include basin-spanning temperature transects in all of the oceans. Major partners in the HRX network include Scripps (Pacific and Indian Ocean), NOAA/AOML (Atlantic), and CSIRO (SW Pacific, Indian). Typically, each transect is repeated on a quarterly basis to resolve variability in temperature, geostrophic circulation and transport on annual and longer periods. Scientific objectives of the HRX Network are:

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- Measure the seasonal and interannual fluctuations in the transport of mass, heat, and freshwater across transects which define large enclosed ocean areas.
- Determine the long-term mean, annual cycle and interannual fluctuations of temperature, geostrophic velocity and large-scale ocean circulation in the top 800 m of the ocean.
- Obtain long time-series of temperature profiles at precisely repeating locations in order to unambiguously separate temporal from spatial variability.
- Determine the space-time statistics of variability of the temperature and geostrophic shear fields.
- Provide appropriate in situ data (together with Argo profiling floats, tropical moorings, air-sea flux measurements, sea level etc.) for testing ocean and ocean-atmosphere models.
- Determine the synergy between HRX transects, satellite altimetry, Argo, and models of the general circulation. What are the minimal sampling requirements for in situ data?
- Identify permanent boundary currents and fronts, describe their persistence and recurrence and their relation to large-scale transports.
- Estimate the significance of baroclinic eddy heat fluxes.
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Research Accomplishments

The first publication arising from the system tests was published in its final form in January 2012. Based on the result from those flights and a subsequent test flight a NASA Dryden a number of system improvement/characterizations were made including: a) a redesigned gust probe mount to simplify consistent mounting of the gust probe; b) improved in-flight telemetry to supply 1Hz temperature, humidity and altitude (for profiles), and to monitor performance of the pressure transducers, hygrometer probe and GPS/INS device. Noise in the analogue systems was further reduced to near-undetectable limits by improved wiring and timing of the data logging system. The system has been flown for over 38 hours as part of a scientific measurement campaign (CARDEX) conducted in the Maldivian maritime environment. Flight legs of 10 nautical miles were routinely conducted Targets included the cloud-topped entrainment zone and levels within the boundary layer. In-flight gust probe calibration maneuvers were also accomplished. We have also tested a fast response temperature probe for the measurement of sensible heat fluxes. The system is due to fly final test flights at San Nicolas Island in late May/Early June, following flight permissions obtained through NOAA.

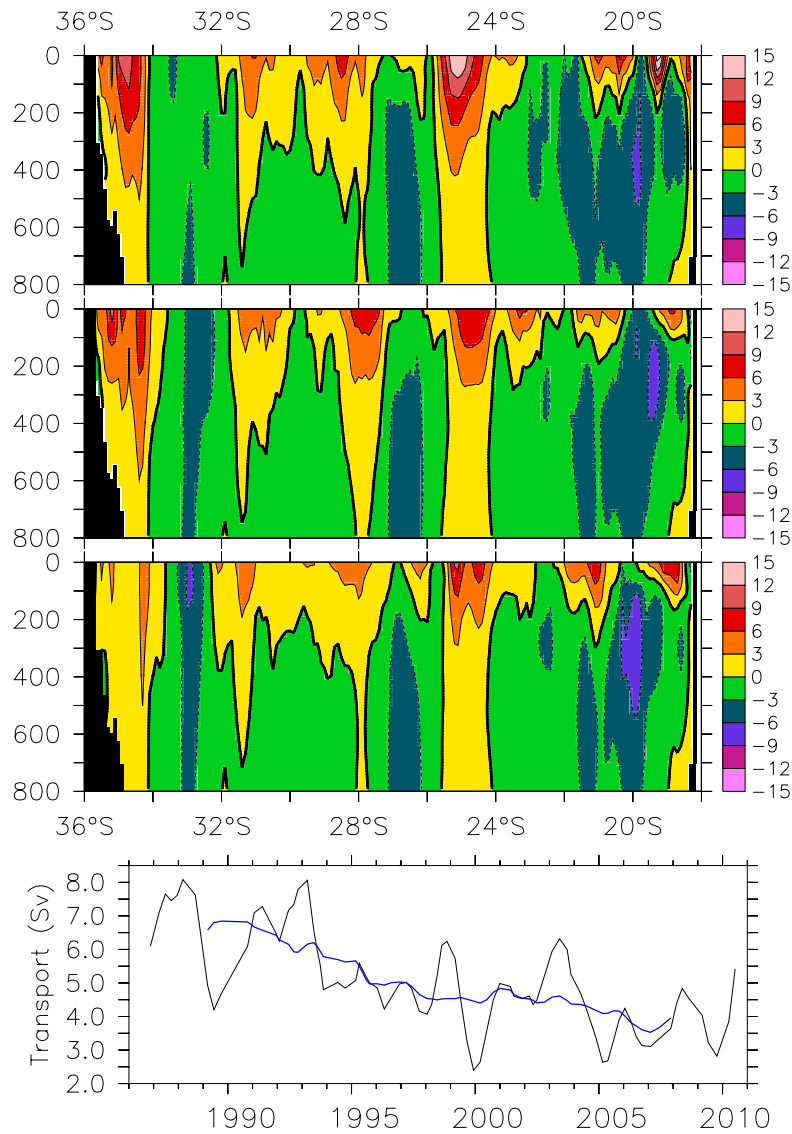
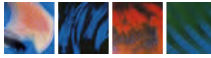


Fig. 1 Decadal variability is seen in geostrophic velocity (cm/s) across the High Resolution XBT transect between New Zealand (at left) and Fiji (at right), spanning the southern half of the South Pacific subtropical gyre. The top 3 panels are averages for the periods 1986-1994 (28 cruises), 1995 – 2002 (31 cruises), and 2003-2010 (27 cruises). The bottom panel is a time-series of volume transport (Sv) for the “Tasman Outflow”, here defined as 0-300 m, and from New Zealand to 24-degrees S



Workshop on Vulnerability and Adaptation to Extreme Events in California in the Context of a Changing Climate

Dan Cayan (SIO)

NOAA Technical Contact: Adam Parris (CPO)

Links to NOAA Strategic Plan:

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

NOAA Goal 3: Serve Society's Needs for Weather and Water Information

Research Objectives and Specific Plans to Achieve Them

Held the workshop 13 December 2011 to bring together a team of disciplinary and multi-disciplinary experts to discuss extreme weather-related events in different sectors of the economy such as energy, public health, agriculture, coastal resources, and ecosystems. The presentations characterized extreme events in an historical context and explore how they might be altered under scenarios of climate change. Speakers will include noted scientists including Professor Terry Root (Stanford), Professor Michael Hanemann (UC Berkeley), Dr. Marty Ralph (NOAA), Professor Gary Griggs (UC Santa Cruz) and several others.

Research Accomplishments

The workshop was open to the public and presentations were tailored for a general audience.

This workshop is one of a series of events focusing on climate change that the State of California will be undertaking over the next several months. Governor Brown is dedicated to ensuring that California is prepared for the impacts of climate change, and that the state continues to lead the nation with its innovation, policy initiatives and commitment to reducing greenhouse gas emissions. The Governor's main conference on 15 December will bring statewide leaders together to focus on the risks of unpredictable and extreme weather events caused by climate change. The conference will assess these risks and explore how our communities can prepare and adapt in response.

Full workshop details are available on the web:

http://sio.ucsd.edu/extreme_climate/

Copy of the workshop agenda is available here:

http://sio.ucsd.edu/extreme_climate/Climateextremes_agenda.pdf

All videos of the event are available publicly:

<http://www.youtube.com/playlist?list=PLCC84D9BC84619712&feature=plcp>



THEME C: MARINE ECOSYSTEMS



The Center for Stock Assessment Research (CSTAR)

Marc Mangel (UC Santa Cruz)

NOAA Technical Contact: Steve Ralston (NMFS)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

The objective of CSTAR is undergraduate, graduate, and post-graduate training in the science associated with the problems of assessing the numerical abundance, spatial distribution, size distribution and reproductive status of commercially important fish species. A broad and deep understanding of population processes is critical to the development and management of sustainable fisheries.

Finding means to conserve fish populations and to achieve sustainable fisheries requires understanding the effects of fishing on behavior, life history and population biology of exploited fishes. At CSTAR, work focuses on using mathematical, statistical, and computer models to solve important environmental and ecological problems. The work is grounded in data, and also seeks to expand the base of basic knowledge that supports rigorous application of science to real-world problems. Furthermore, research on marine fisheries conducted at CSTAR allows testing theoretical predictions via natural and human experiments on a scale that is appropriate for understanding the dynamics of ecosystems. Such large-scale experiments are rarely available to the scientific community.

The CSTAR grant provides a level of core support which is then leveraged by teaching assistantships and graduate research assistantships from other grants or contracts (with recent or current support from the CalFed Science Program, the Lenfest Ocean Program, and the National Science Foundation). This enables us to create a relatively large and interactive group of quantitative scientists working on a wide range of problems in fishery management.

During the review period, members of CSTAR were

Eric Anderson (Staff Member, NMFS Santa Cruz Laboratory)

Mariah Boyle (Assistant Project Director, FishWise)

Valerie Brown (Assistant Specialist, UCSC)

Robert Curzon (MS student, Statistics and Applied Mathematics)

Maria DeYoreo (PhD student, Statistics and Applied Mathematics)

Edward (EJ) Dick (Staff member, NMFS Santa Cruz Laboratory)

Chris Edwards (Faculty, UCSC)

Sigrunn Eliassen (sabbatical visitor from the Theoretical Ecology Group, University of Bergen, 2011-12)

John Field (Staff Member, NMFS Santa Cruz Laboratory, co-Director)

Jarl Giske (sabbatical visitor from the Theoretical Ecology Group, University of Bergen, summer 2011)

Xi He (Staff member, NMFS Santa Cruz Laboratory)

Daniel Hively (MS student, Statistics and Applied Mathematics)

Christian Jorgensen (postdoctoral visitor from the Theoretical Ecology Group, University of Bergen, fall) 2011

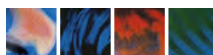
Meisha Key (Staff member, California Department of Fish and Game)



Roxanna Pourzand (Administrative and Scientific Assistant)
Thanassis Kottas (Faculty, UCSC)
Taal Levi (PhD student, Environmental Studies)
Alec MacCall (Staff member, NMFS Santa Cruz Laboratory)
Marc Mangel (Faculty UCSC, Co-director)
Steve Munch (Staff member, NMFS Santa Cruz Laboratory)
Roxanna Pourzand (Undergraduate research fellow)
Steve Ralston (Staff member, NMFS Santa Cruz Laboratory)
Kate Richerson (PhD student, Ecology and Evolutionary Biology)
Jarrod Santora (Independent AMLR contractor)
Braden Soper (PhD student, Statistics and Applied Mathematics)
Bruno Sanso (Faculty, UCSC)
Will Satterthwaite (Assistant Researcher, UCSC and Assistant Director, CSTAR)
Ole Shelton (Post-doctoral scholar)
Simone Vincenzi (Research scientist, MRAG Americas)
Brian Wells (Staff member, NMFS Santa Cruz Laboratory)
Justin Yeakel (PhD student, Ecology and Evolutionary Biology)

Research Accomplishments

During the review period, CSTAR students and post-docs continued to do novel and important work in quantitative population biology as it pertains to sustainable fisheries. Students Valerie Brown, Robert Curzon and Daniel Hively completed MS degrees in Statistics and Applied and started new positions (Brown as Assistant Specialist at UCSC, working with NOAA Fisheries; Hively at the University of Washington with Ray Hilborn, Andre Punt, Tim Essington, and Trevor Branch), and Curzon at McGraw Hill. CSTAR student Cristie Boone completed her PhD in Anthropology, studying fisheries in Monterey Bay 6-11 thousand years ago, using modern quantitative methods. Student Kate Richerson is a Trainee in the Science and Justice program at UCSC and with Assistant Specialist Mariah Boyle traveled to West Africa at the end of 2011 to study artisanal fish landings in a data poor fisheries. During their stay in John Obey, Sierra Leone, they identified, photographed, counted and measured the fish caught by the fishermen paddling dugout canoes, which will be used to generate productivity-susceptibility analyses (PSA) for the most important species in the fishery. Kate conducted interviews with the fishermen to try to understand how fish abundance has changed over time. This information will be shared with the Fisheries Ministry and used to guide regulations for a marine protected area in development in the Sherbro River. CSTAR student Justin Yeakel developed new methods for understanding the dynamics of fish stocks following a Shepherd/Maynard Smith stock recruitment relationship and for identifying the parameters in this relationship and CSTAR student Taal Levi adapted the method developed by student Kate Richerson, Director Mangel, and NOAA Fisheries colleague Phil Levin for balancing incommensurate values and indirect effects in the North Sea Sand Eel fishery and applied it to salmon fisheries in Alaska and British Columbia, with partners from both universities and the NGO community. CSTAR post-doc Andrew Ole Shelton and Director Mangel published fundamental work testing hypotheses about why fish populations fluctuate, in connection with work by the Lenfest Forage Fish Task Force (on which Mangel served); Shelton was offered NOAA employment, at the Northwest Fisheries Science Center. CSTAR post-doc Simone Vincenzi introduced novel ideas on developmental programming to the study of kittiwakes in the Bering Sea, and the response of such individuals to climate change. CSTAR member Steve Munch was awarded a Pew Fellowship in Marine Conservation. CSTAR was well represented at the 2011 meeting of the American Fisheries Society: 15 Talks or Posters were presented by CSTAR members. CSTAR Director Marc Mangel shared in the Queen's Award to the Sea Mammal Research Unit at the University of St. Andrews, for his work on the Special Committee on Seals. Short-term visitors to CSTAR included Andrew Constable (Pew Fellow in Marine Conservation and Australian Antarctic Division), Noel Cressie (Ohio State University), Jeffrey Hutchings (Dalhousie), Joseph Travis (Florida State University), and Chris Wikle (University of Missouri).



Shipboard Monitoring of the California Current System Off Central California

Baldo Marinovic (UC Santa Cruz), Francisco Chavez¹ and Curtis Collins²

1) Monterey Bay Aquarium Research Institute

2) Naval Postgraduate School

NOAA Technical Contact: Churchill Grimes (NMFS)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

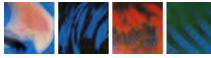
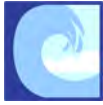
NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

In cooperation with the NMFS, we propose to continue shipboard measurements along CalCOFI Lines 67 and possibly 60 through September 2012. Personnel will be provided to assist in the collection of data during the NMFS run Winter and Spring cruises of 2012. Additional surveys along Lines 67 and 60 will be conducted in the Fall of 2011 and the Summer of 2012, pending the availability of opportunistic shiptime. Potential measurements in Fall 2011 and Summer 2012 will consist of CTD/rosette casts, plankton tows, VMADCP current observations, and continuous underway measurements of sea surface and meteorological parameters. Seawater will be assayed for nutrients (nitrate, nitrite, phosphate and silicate). Water samples in the upper 200 m will also be assayed for chlorophyll-a, primary production, phytoplankton taxonomy and cell counts. Zooplankton sampling will include standard bongo oblique tows to 210 m depth. Samples will be preserved in 10% buffered formalin/seawater and processed post-cruise in the laboratory. Biovolume displacements will be initially determined and then samples will be archived at NMFS-La Jolla where taxon specific processing will be conducted by various research groups. All data collected on the fall and potential summer cruises will be made available as soon as possible to other researchers via web based archives and technical reports, e.g. Rago et al., 2010.

Research Accomplishments

CalCOFI Line 67 was successfully occupied between Sep 30 and Oct 4 2011. A total of 10 standard CalCOFI stations were occupied with complete hydrographic, phytoplankton, and zooplankton sampling. An additional 10 NPS station (interspersed between the standard CalCOFI stations) were occupied and sampled for hydrography and phytoplankton only. Personnel were prepared to assist in the collection of hydrographic data for the northern portion of the NMFS winter cruise but the cruise was cancelled at the last minute. Finally we were able to obtain opportunistic ship time on the R/V Pt. Sur in March 2012 that allowed for a complete supplemental occupation of CalCOFI L-67 consisting once again of 10 standard CalCOFI stations with complete hydrographic, phytoplankton, and zooplankton sampling and an additional 10 NPS station with hydrography and phytoplankton only.



Investigations in Fisheries Ecology

Gary Griggs (UC Santa Cruz)

NOAA Technical Contact: Churchill Grimes (NMFS)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

Research Objectives and Specific Plans to Achieve Them

This cooperative research program encompasses a large number of individual studies conducted by scientists from University of California Santa Cruz (UCSC) and the National Marine Fisheries Service, Southwest Fisheries Science Center, Fisheries Ecology Division (FED) and many collaborators at other institutions and agencies. The overall objectives are to conduct research needed to support (1) management and recovery planning for Pacific salmonids and sturgeon listed under the Endangered Species Act; (2) stock assessments and harvest management for West Coast groundfish and Pacific salmon fisheries; and (3) economic assessment of fisheries and fishing communities in California.

Specific research projects addressed 10 objectives: (1) develop improved historical catch statistics and demographic data for groundfish; (2) develop advanced population assessment methodologies for marine fishes; (3) examine effects of habitat complexity and life-history evolution on juvenile salmonids in the context of habitat restoration and climate change; (4) develop habitat-based predictive models and maps of distribution and abundance of deep-sea coral community taxa and demersal fishes in southern California; (5) evaluate the potential economic effects of salmonid restoration on affected human uses; (6) develop an integrated genetic monitoring and evaluation program for salmon and steelhead in California; (7) develop physical and biological models and decision support tools to aid fisheries and water management and habitat restoration for listed salmonids; (8) develop ecosystem indicators, risk assessments, and management strategy evaluation tools to guide management of anadromous species as part of an Integrated Ecosystem Assessment for the California Current; (9) develop population models to evaluate the effects of disease on population dynamics of Klamath River fall-run Chinook salmon; and (10) conduct comparative studies of salmon ecology and life history across small and large rivers and estuaries. Project scientists used a wide range of methods to address these research questions, including field sampling, laboratory experiments, physical and biological modeling, spatial analysis and modeling using GIS and remote sensing, and economic data collection and analysis.

Research Accomplishments

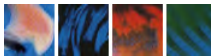
Project scientists met research goals and milestones for each of the 10 projects described above, which addressed a wide range of topics on biology, analytical methods, and economics related to the management of groundfish, salmon, and sturgeon. Accomplishments included final completion of a number of major projects resulting in publication of papers and reports; completion of several large field and laboratory data collection efforts, data analyses, and modeling projects; and initiation of a number of new studies through hiring research staff, developing research plans and protocols, and beginning data collection or model development. Results were published in 21 journal articles, 3 book chapters, and 13 reports, and an additional 15 articles were in press or submitted. Project scientists engaged in more than 24 conferences, workshops, symposia, and outreach events to present research, network and collaborate with other scientists, contribute to training and professional development within the field, and provide information to the public. Academic development was provided to six undergraduate and graduate students through employment and support of thesis and dissertation research.



Fig. 1 NOAA/CIMEC researchers prepare to release an acoustically-tagged adult Chinook salmon caught during an ocean survey. A tissue sample was taken from the salmon for DNA analysis to determine its river of origin, and the acoustic tag will track its movements at sea and during its up-river spawning migration



Fig. 2 NOAA/CIMEC researchers deploying hydrophones in San Francisco Bay to detect acoustic tags implanted in green sturgeon, steelhead, and Chinook salmon to track movement of these species between the ocean and Central Valley rivers



Freshwater Ecology Research Collaboration

Gary Griggs (UC Santa Cruz)

NOAA Technical Contact: Churchill Grimes (NMFS)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

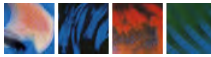


Research Objectives and Specific Plans to Achieve Them

A faculty member will be selected to be the Project Leader for the Freshwater Ecology Research Collaboration. The individual will develop a research program with primary components of population dynamics, evolutionary development and environmental dynamics that complements ongoing and future science needs of NMFS. This work is relevant to improved understanding of ecological factors influencing anadromous fishes utilizing California freshwater ecosystems. Also, he/she will be the faculty adviser and mentor of students conducting research relevant to NMFS interests, through which means he/she is able to direct students to potential collaborations with NMFS researchers. In addition, the faculty member will be expected to teach graduate and undergraduate classes, adding elements of environmental resource analysis and management to the curriculum, incorporating the Marine Ecosystems theme of CIMEC and support fostering the public understanding of NOAA and its programs.

Research Accomplishments

The faculty position has been vacant during this period. In lieu of the Freshwater Ecology faculty member, acting PI is Dr. Gary Griggs. Dr. Griggs has been the liaison of the UCSC Institute for Marine Science to NMFS Santa Cruz lab, and has provided continuing oversight for projects underway. The new faculty member is expected to begin duties 7/1/12.



Collaborative Studies of Cetaceans with the Southeast Fisheries Science

John Hildebrand (SIO)

NOAA Technical Contact: L. Garrison (NMFS/SEFSC)

Links to NOAA Strategic Plan:

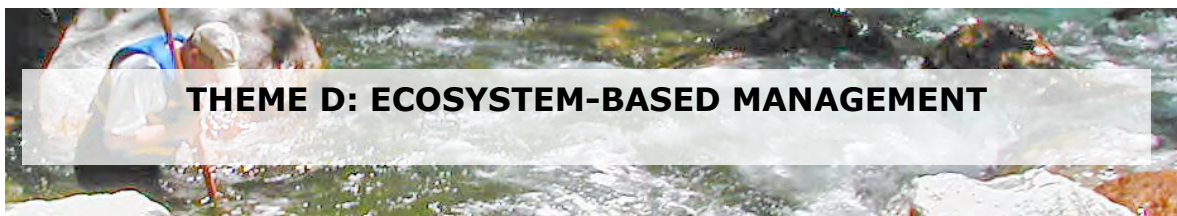
NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

Research Objectives and Specific Plans to Achieve Them

The goal of this collaborative research is to assist with the collection of broadband acoustic data during the AMAPPS (Atlantic Marine Assessment Program for Protected Species) cruise in collaboration with the South East Fisheries Science Center. The specific objectives of this project are to: (1) provide a broadband array for use on the AMAPPS cruise; (2) provide two personnel to operate the array; and (3) write a report summarizing AMAPPS cruise acoustic data collection.

Research Accomplishments

SIO provided personnel and logistic support for conducting towed array acoustic measurement on the NOAA Ship Gordon Gunter during two cruises in June-July 2011 and July- August 2011. SIO provided an acoustic array and two trained personnel to collect data on cetacean presence and sound production on these cruises. The array provided broadband (1 kHz – 200 kHz) frequency response to provide characterization of the full bandwidth of cetacean sounds. The array also provided the direction to calling cetaceans. The acoustic array information will be used to better characterize the acoustic repertoire of cetacean populations in the Atlantic and Gulf of Mexico regions. One significant accomplishment was the collection of acoustic data on the Gulf of Mexico Brydes whale. These are the only baleen whale that is resident in the northern Gulf of Mexico, and the data collected during the AMAPPS cruise is the only known recording of these whales in the wild. These sound data allow Brydes whale calls to be identified in un-attended acoustic recordings, a critical step for using acoustic data for passive acoustic monitoring of these animals.



THEME D: ECOSYSTEM-BASED MANAGEMENT



California Cooperative Fisheries Investigations (CalCOFI), an Ocean Observation Program for the Southern California Current, FY 2011

J. Anthony Koslow and Ralf Goericke (SIO)

NOAA Technical Contact: Roger Hewitt (NMFS)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

NOAA Goal 2: Understand Climate Variability and Change to Enhance Society's Ability to Plan and Respond

Research Objectives and Specific Plans to Achieve Them

CalCOFI's primary objectives are 1) to continue its 60+ year time-series of comprehensive, high-quality physical, chemical and biological observations of the California Current ecosystem, with an emphasis on the living marine resources, and 2) to contribute through its data and analyses to a scientific understanding of the human impacts and influence of climate variability and climate change on living resources of the California Current in support of an ecosystem approach to management.

CalCOFI successfully carried out its quarterly 2011-2012 cruises aboard Scripps and NOAA vessels, processing the physical, chemical and biological data, exercising quality control, and making the data available. Ancillary projects based on partnerships and external funding continue to be fostered and expanded to provide 'end-to-end' ecosystem observations of regional biogeochemistry (NSF-funded California Current Ecosystem Long-Term Ecological Research (CCE-LTER) project), seabirds (W. Sydeman, Farallon Institute), marine mammals (J. Hildebrand, SIO with ONR funding), and acoustic/trawl observations of micronekton (Koslow, SIO). There were more than 40 peer-reviewed papers published in this reporting period based on CalCOFI data on various aspects of fisheries, conservation, climate, and ecosystem dynamics in the California Current, as well as many reports and numerous presentations at conferences, workshops, and seminars.

Research Accomplishments

The four quarterly CalCOFI cruises were completed successfully. The cruises continue to be used as a platform for ancillary research programs: the NSF-funded CCE-LTER studies of biogeochemical and lower trophic level processes, ONR-funded marine mammal observations, and independently funded observations of seabirds, and acoustic and trawl sampling of the krill and other micronekton.

Fishery-independent time series were published for market squid (*Doryteuthis opalescens*) and spiny lobster (*Panulirus interruptus*), two key California invertebrate fisheries. The time series, based on the abundance of the early larvae stages in CalCOFI ichthyoplankton samples, provide indices of spawning stock biomass. The abundance of both species appears to be related to several regional and large-scale oceanographic variables/indices. This study will aid the stock assessment and management of these species.

Declining oxygen levels in the North Pacific and tropical oceans are predicted to be a key consequence of global warming. The CalCOFI deepwater oxygen time series, the longest in the world, was used along with the



physical, chemical and biological time series to model how decadal-scale changes in thermocline depth, through its influence on metabolic rates, have led to a nonlinear expansion of suboxic waters in the North Pacific and increasing denitrification in the eastern Pacific, with implications for long-term ocean productivity. Analysis of the CalCOFI ichthyoplankton data further indicates a dramatic decline in midwater fish populations in apparent response to declining midwater oxygen levels, the first report of the ecosystem impacts of deoxygenation.

Moorings and glider lines coinciding with CalCOFI lines are now providing high resolution temporal and spatial data that complements CalCOFI sampling. The mooring data reveal considerable high-frequency variability of acidic and hypoxic conditions, particularly nearshore in relation to upwelling events.

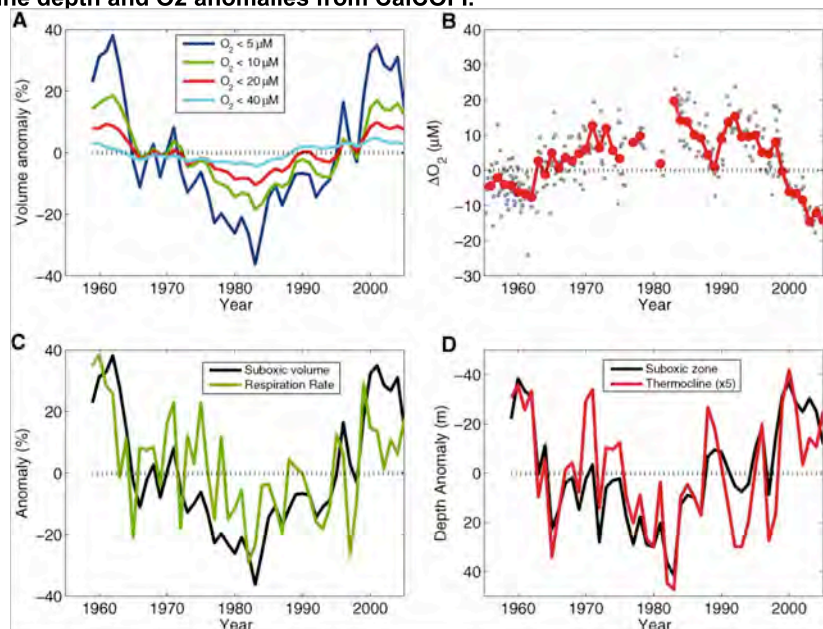
High-throughput methods to identify fish eggs and larvae were developed using molecular techniques. This will enable species, such as various rockfishes (*Sebastes* spp.), to be identified that have thus far eluded identification morphologically. This work will significantly expand the scope of CalCOFI ichthyoplankton studies for the assessment and sustainable management of heavily fished coastal species.

CalCOFI data provided critical input for several controversial debates featured in high-impact journals with regard to global and regional trends in phytoplankton (is it declining?) and the status of the Pacific sardine population.

The spatial extent of CalCOFI sampling has provided the basis for a series of studies defining critical spawning habitat for coastal species, such as anchovy and sardine, as well as of habitat critical for the conservation of protected marine mammal species. CalCOFI spatial coverage also enhances its ability to calibrate and complement satellite data, which is being used to examine regional trends in chlorophyll and frontal dynamics. CalCOFI data also enables new climate proxy time series to be calibrated and developed, including the use of long-lived bamboo corals to examine changes in deepwater nutrient content on decadal and century time scales.

The first book-length review of the role of CalCOFI in the development of fisheries research and management in the California Current has been contracted with Springer.

Fig. 1 (A to D) Time series from 1959 to 2005 of simulated changes in global hypoxic water volumes (A), observed O₂ anomaly off the coast of California (B), changes in respiration rate (C), and depth anomalies of the thermocline (13°C isotherm, red) and top of the suboxic zone (black) (D) in the eastern tropical Pacific Ocean, which contains 95% of the ocean's suboxic water. Data on thermocline depth and O₂ anomalies from CalCOFI.



C Deutsch et al. Science 2011;333:336-339



Studies in Anadromous Fisheries

Darren Ward (HSU)

NOAA Technical Contact: Steve Miller (NMFS)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

Research Objectives and Specific Plans to Achieve Them

This project provides support for research activities at Humboldt State University providing information for restoration and conservation of anadromous salmonids in Northern California and the Klamath basin. Research emphasizes ecological studies of species and habitats of conservation concern, evaluation of restoration effectiveness, and assessment of issues relating to improvement and restoration of salmon production in the northern California and the Klamath River system.

Research Accomplishments

In the 2011-2012 project period, this project supported the thesis research of a graduate student in the Ward lab, Meiling Roddam. Roddam developed a proposal to evaluate the relative productivity of the two primary rearing areas for Chinook salmon in the Shasta River terms of outmigrating smolts, the relative quality of the smolts, and their contributions to adult returns. The project includes both a field component of current conditions and a long-term analysis using archived otolith samples collected over the past five years. This ongoing work will provide insight into the demographics of this key Klamath River tributary and into the effects of habitat restoration activities recently implemented at one of the rearing locations. Roddam started preliminary analysis of archived otolith samples in Fall 2011 and field work in the Shasta began in Spring 2012.



Freshwater Fish Ecology Research Collaboration

David Hankin, Darren Ward and Jim Howard (HSU)

NOAA Technical Contact: Steve Miller (NMFS)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

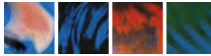
Research Objectives and Specific Plans to Achieve Them

This project provided support for the Department of Fisheries Biology at Humboldt State University (HSU) to establish a long-term collaboration between HSU and NOAA/NMFS addressing salmon conservation and restoration in Northern California and the Klamath River basin. This objective was implemented through partial funding for a faculty position at HSU to develop research projects focusing on evaluation of restoration effectiveness and assessment of issues related to restoration of salmon production in the Klamath River. Project funding allowed this position to be established as a 50% research and 50% teaching appointment, as compared to typical 100% teaching appointments at HSU, to allow research efforts that complement NMFS efforts and fill needs for management and conservation planning.



Research Accomplishments

In the 2011-2012 project period, Darren Ward- the HSU faculty hired under the project, brought in two new graduate students, Meiling Roddam and Shari Anderson. Both students planned to develop proposals to do research on salmon ecology related to conservation and restoration of populations. Continuing graduate student Jennifer Hauer continued field work, tagging a cohort of young-of-the-year coho salmon in a small coastal basin for a study of factors that affect overwinter survival. Field work for this project will continue through spring 2012. Additional recent and ongoing projects include an investigation of the spread and potential impacts of invasive New Zealand mud snails in Redwood National park, with USGS collaborator Adam Sepulveda, and continuing participation in development of monitoring plans for coho salmon restoration in the Shasta River.



Collaborative Studies of Cetaceans with the Pacific Islands Region

John Hildebrand (SIO)

NOAA Technical Contact: Erin Oleson (NMFS/PIFSC)

Links to NOAA Strategic Plan:

NOAA Goal 1: Protect, Restore, and Manage the Use of Coastal and Ocean Resources Through an Ecosystem Approach to Management

Research Objectives and Specific Plans to Achieve Them

The goal of this project is to collaborate with the NOAA Pacific Island Fisheries Science Center (PIFSC) to conduct analysis of acoustic data focusing on cetaceans and noise recorded through the central and western Pacific Ocean. Scripps Institution of Oceanography (SIO) will conduct two studies: (1) examining the interaction of false killer whales and long-line fisheries; and (2) characterizing local and regional ocean noise from data collected in the Pacific Islands region.

Research Accomplishments

We characterized monthly and daily low frequency noise, from 15 Hz to 1 kHz, from data collected at seven sites across the central and western Pacific Ocean. Sounds at these lower frequencies propagate over long distances and thus have contributions from shipping and other distant sources, as well as nearby anthropogenic sources. Noise at higher frequencies (>1 kHz) is usually dominated by local sea conditions (sea state, precipitation). We found that the contributions to the sound field can be attributed to anthropogenic, environmental, and cetacean sources. Interestingly, noise levels from distant shipping were commonly lower during 2009 than 2010, possibly a reflection of the change in shipping levels in the Pacific as the recession eased in 2010, resulting in increasing shipping. Other anthropogenic sources of sounds across the Pacific include low-frequency sonar (recorded off Saipan) and Navy underwater communication modem signals. Cetacean contributions to background noise were seasonal and we detected substantial contributions from blue whales, fin whales, humpback whales, and Bryde's whale calls during parts of the year. SIO also constructed a small, acoustic recorder for attaching to longline fishing gear. Ocean tests have been conducted with NMFS-PIFSC and the recorders have been deployed and recovered from longline fishing gear near Hawaii.



OUTREACH

K-12 Education - SIO

T. Koslow and CalCOFI personnel trained San Diego area high school students in the lab for science fair projects on the California current and CalCOFI's role in monitoring it.

Fellowship Programs/Internships

CalCOFI cruise volunteer program 3 UCSD undergraduates provided research internships in Koslow lab, working with CalCOFI midwater trawl samples

Oceanographic research experience for public volunteers

Approximately 6 people per year provided opportunity to experience oceanographic research, volunteering on CalCOFI cruises

Marine Mammal Survey - SIO

Under T. Koslow's direction, CalCOFI associates gave K-12 students hands-on marine science and research experience via field trips, formal and informal education programs

Earth Day Assembly Presentation

U. Send presented "The ocean's role in climate change," at La Costa Canyon High School Earth Day Assembly in Apr 2011, Carlsbad, CA. Attended Ocean Discovery Institute, Jun 2011, San Diego

Public outreach and education about biodiversity relating to Salmon

T. Levi of CSTAR, in cooperation with the Haines, AK community, gave a public talk on the importance of salmon to bears, eagles and other wildlife.

Integration of HF Radar data on Surface Currents into public exhibit

To educate and bring awareness of ocean energy to the general public, the "Boundless Energy Exhibit" at Scripps' Birch Aquarium was updated with integrated surface currents as collected by the HF radar network.

Salmon Biology K-12 Outreach – Gary Griggs (UC Santa Cruz)

Classroom presentations, DeLaveaga Elementary School (Santa Cruz CA) and Santa Catalina High School (Monterey CA)

Workshop for K-12 teachers in salmon biology and conservation

Provided information to elementary and high school students on salmon biology and conservation and research at Santa Cruz laboratory.

Trained 20 K-12 teachers in a salmon biology and conservation curriculum for the classroom

Monterey Bay Salmon and Trout Project



COMMUNICATIONS, NETWORKING, ACADEMIC DEVELOPMENT and AWARDS

ACTIVITY TYPE	OBJECTIVE	PARTNERS
Communications		
CORDC Mapping Site http://cordc.ucsd.edu/projects/mapping/	Provide online access to surface current mapping sites, radial data, and diagnostics for participating sites	
Cetacean public information website www.cetus.ucsd.edu	Provide on-line information on marine mammal research activity	Pacific Life Foundation
Argo Science Team web site (http://www-argo.ucsd.edu)	Provide information on the Argo project, its objectives, status and data system, including how to access Argo data.	International Argo partnership
Argonautics Newsletter (http://www.argo.ucsd.edu/Fnewsletter.html)	Distribute information on Argo status, applications, and progress on key issues.	International Argo partnership
Global Drifter Program Media coverage	<p>Interview, Associated Press. To raise awareness of marine debris in the Pacific Ocean and the role of the GDP. http://www.msnbc.msn.com/id/42383112/ns/technology_and_science-science/t/japan-tsunami-debris-wash-west-coast/</p> <p>Interview with local TV channel. To raise awareness of marine debris in the Pacific Ocean and the role of the GDP. http://www.fox5sandiego.com/news/kswb-tsunami-trash-current,0,6389360.story</p> <p>Newspaper article. To raise awareness of marine debris in the Pacific Ocean and the role of the GDP. http://blogs.laweekly.com/informer/2011/04/radioactive_ocean_surf_la.php</p> <p>Magazine article. To raise awareness of marine debris in the Pacific Ocean and the role of the GDP. http://news.discovery.com/earth/radioactive-debris-japan-ocean-110414.html</p> <p>TV interview. To raise awareness of marine debris in the Pacific Ocean and the role of the GDP.</p>	L. Centurioni, SIO



<http://video.app.msn.com/watch/video/top-chef-judge-stops-serving-japanese-seafood/629o5wf>

TV interview. To raise awareness of marine debris in the Pacific Ocean and the role of the GDP.
http://www.sandiego6.com/news/local/story/Seafood-Safe-to-Eat-San-Diego-Seafood-Nuclear/gOIQkg3BHE2Wm77EvOmk_A.csp

TV interview. To raise awareness of marine debris in the Pacific Ocean and the role of the GDP.
<http://www.cbs8.com/story/15875194/tons-of-japanese-tsunami-debris-drifting-this-way>

TV interview. To raise awareness of the Global Drifter Program. Italian TV. Documents the deployment of the first two SIO drifters.
http://www.youtube.com/watch?v=au7_rqdv5uw

Public Presentations:
20 May 2011: Bolin Lecture at the Stockholm University "Rising atmospheric CO₂: A never ending story?"

Dissemination of Global Carbon monitoring data and the effects the resulting Climatic changes could have on Society.

Ralph Keeling, SIO

9 Nov 2011: Mission Trails Regional Park (MTRP) Trail Guides Monthly Meeting Presentation: "Rising Carbon Dioxide, A Never Ending story?"

21 Jan 2012: San Diego Independent Scholars: "Rising Carbon Dioxide, A Never Ending Story?"

Professional Presentations:
21 Apr 2011 Guest speaker at La Jolla Research and Innovations Summit, "The future of greenhouse gas measurements"

28 Apr 2011 UCSD Physics Colloquium, "Precision measurements of air and recent changes to the planet"

17 May 2011 NOAA Global Monitoring Division annual meeting "Measurements of atmospheric O₂ and future carbon budgeting"

20 May 2011 Bolin Lecture at the Stockholm University "Rising atmospheric CO₂: A never ending story?"



13 Sept 2011 U. Toronto Physics
Department Colloquium: "Atmospheric
signals of changing global
biogeochemistry"

15 Sept 2011 Cary Institute Seminar:
Atmospheric Perspectives on the Global
Carbon Cycle

25 Oct 2011 16th WMO/IAEA Meeting on
Carbon Dioxide, Other Greenhouse
Gases, and Related Measurement
Techniques (GGMT-2011), Wellington,
New Zealand: "Calibration strategy for the
Earth Networks greenhouse gas
monitoring network and other topics"

2 Feb 2012: Presentation at Scripps
Institution of Oceanography Director's
Cabinet in Rancho Santa Fe., "Our
Changing Climate"

10 Feb 2012 Cooperative Institute for
Marine Ecosystems and Climate (CIMEC)
Executive Board Meeting at Scripps:
Relevance of atmospheric O₂/N₂
measurements to assessing long-term
changes in the biosphere.

UCSC Seymour Marine Discovery Center Docent Orientation Tour, February 2012	Inform volunteer docents about research conducted at the laboratory	UCSC Seymour Marine Discovery Center
California Department of Fish and Game salmon fishery information meeting	Presentation to public regarding upcoming salmon fishing season	CA Department of Fish and Game
SOPAC website	Precise hourly orbits are published on the SOPAC Web Site (http://sopac.ucsd.edu) and freely available.	International GNSS Service (IGS)
Birch Aquarium public lecture	T. Koslow: CalCOFI and ocean climate off California	Birch Aquarium, SIO, La Jolla, CA
Fisheries biology training for undergraduate and graduate students	D. Hankin and Fisheries Biology faculty at Humboldt State	Humboldt State University
High Resolution XBT Network web site: http://www-hrx.ucsd.edu	Describe scope and objectives of the Pacific/Indian HRX network; display data from all cruises; provide downloadable datasets on a cruise-by-cruise basis.	CSIRO Australia, NIWA New Zealand, Tohoku University Japan
Outreach as part of tagging studies in southern California	Inform the recreational angler community of our tagging work, involve citizens in project science.	San Diego Oceans Foundation



ACTIVITY TYPE	OBJECTIVE	PARTNERS
Networking		
CalCOFI networking activities	Continuing collaborative relationships with other ocean observation programs on the west coast	Partner to CenCOOS, close collaboration with SCCOOS
	Provide CalCOFI input to end-to-end coupled biophysical California Current ecosystem model including pelagic fish and fisheries	Co-PIs in collaboration with CAMEO project (Curchitser, Rose, et al)
	Provide CalCOFI data to global ocean time series data center	CalCOFI partnership with OceanSites
	Ongoing partnerships with to maintain ancillary observations of seabirds, marine mammals, and biogeochemistry and lower trophic levels	Collaborations with Farallon Institute, Hildebrand SIO laboratory and CCE-LTER program
	Provide CalCOFI input to integrated ecosystem assessment and ecosystem-based management of the California Current	Pacific Fisheries Environment Lab/SWFSC/NOAA
	Establish ocean acidification monitoring	Network with PMEL/NOAA
	Workshops to monitor California south coast MPAs	MPA Monitoring Enterprise, California Conservancy and Ocean Protection Council (OPC)
	Foster CalCOFI partnerships with North Pacific rim marine research	Active member of PICES, joined PICES Technical Committee on Data Exchange (TCODE)
	Foster collaboration with fisheries acoustics groups in ICES and globally	ICES Fisheries Acoustics Science and Technology Working Group (WGFAST)
Member of National Research Council Ocean Studies Board, attend at least three meetings per year.	Collaboration with CICESE in to deploy gliders in the Mexican EEZ in the Gulf of Mexico.	CICESE
Presented at Oil Spill Area Committee Meetings in San Diego	Provided updated information regarding HF radar surface current application to oil spill response	U.S. Coast Guard, Office of Spill Prevention and Response (OSPR), Marine Resources Advisory Committee (MRC), Chevron
Pacific Island Global Ocean Observing System (PI-GOOS) Advisory Committee (Roemmich)	Assist Pacific island nations in gaining benefit from global ocean observations and products.	South Pacific Applied Geosciences Commission (SOPAC), NOAA, BoM Australia, NIWA New Zealand, Intergovernmental Oceanographic Commission, South Pacific nations
ScrippsO2.ucsd.edu ScrippsCO2.ucsd.edu	Dissemination of global oxygen and carbon dioxide datasets to public and research community	Ralph Keeling, SIO



Correspondence with Jordan Stout and Judd Muskat, OSPR	Support San Diego NPREP Planning Meeting May 2011	NOAA OR & R and Office of Spill Prevention and Response
Dissemination of Ecology methods internationally	Development of methods for data poor artisanal fisheries	Ministry of Fisheries, Sierra Leone; Environmental Justice Foundation; PADI Foundation & CSTAR members M Boyle, K Richerson
Hosted Vietnamese and Korean Delegation	Discussed HF Radar applications and site deployment and maintenance.	E. Terrill and CORDC group

ACTIVITY TYPE	OBJECTIVE	PARTNERS
Academic Development		
CSTAR Academic Development efforts	<p><u>M. Mangel</u> Member External Scientific Advisory Committee Meeting, Center for Complex Biological Systems, University of California, Irvine</p> <p>Member, Steering Committee, University of Florida IGERT in Spatial Ecology</p> <p>Member, Scientific Advisory Board, Florida State University Coastal and Marine Laboratory</p>	
Graduate student development in ocean observing	Graduate students Samuel Wilsons, Jesse Powell, and Xue Fan, and post-doctoral scholar SungHyun Nam are using the CCE mooring data for their research	U. Send
<u>Fellowships Programs / Internships</u>		
	Science and Justice Training Program	K. Richerson, UC Santa Cruz
	ESPCA Sao Paul School on Ecological Networks; Sao Paulo, Brazil – Sept 16-23, 2011	Justin Yeakel, UC Santa Cruz
Train graduate and undergraduate students in Fisheries Biology	Humboldt State University	D. Ward, HSU
Graduate Student Education in Population Dynamics at SIO	Teach a seminar course in statistical methods and model fitting	Brice Semmens, SIO
Graduate students: Kim Brewitt (PhD), Maya Friedman (MS), Ann-Marie Osterback (MS), and Nic Retford (MS)	Support graduate education and research	UCSC
Undergraduate students: Kacey Munson (BS), Craig Dudenhoeffer (BS)	Provide research experience in fisheries science through school-year and summer employment	UC Davis, UCSC
Hands on student training in oceanography research at Humboldt State University	The ocean observing cruises provide opportunities for student training and collection of ancillary	HSU Departments of Fisheries Biology, Oceanography, and Biology.



	samples and shared data for analysis in classroom/laboratory settings. Several students are employed as occasional or part time technicians to support surveys and laboratory analysis while gaining applied experience in fields related to their majors.	
CalCOFI academic development	1 – 2 university students recruited for each cruise to volunteer and gain sea-going scientific experience	Universities throughout USA
	Laboratory training provided to graduate and undergraduate students with CalCOFI instrumentation	Mostly Scripps and UCSD
Marie Curie Action fellowship (European Union)	Host a senior researcher for two years at SIO	Dr. Pedro Velez
Programme "PEOPLE" (European Union)	Researcher mobility between US, Italy, Brazil, Bulgaria and Portugal	Dr. Diego Vicinanza,
SERREAD program	Develop curricular units and conduct teacher training seminars for teaching of weather, climate, sea level, and the ocean's role in climate in Pacific island school systems . See http://www.argo.ucsd.edu/FrEducational_use.html	SOPAC, UNESCO, NOAA, NIWA/NZ, IOC, Education ministries in Cook Is, Samoa, and Tonga.
Scripps Global Carbon lab Graduate Student Development	The data from this lab's operations were relevant to the Ph.D. thesis projects of two students, Jonathan Bent and Lauren Rafelski	Ralph Keeling, SIO
Participated in NOAA IOOS Data Management and Communications (DMAC) discussions	To provide guidance for HF radar real-time vector data formats and distribution	NOAA IOOS
CORC Student Development in Ocean Remote Sensing	Undergraduate student Chelsea Didingier joined the CORC group in January 2011. In addition, 3 postdocs and 1 graduate student were partially supported by CORC	U. Send, SIO
SOPAC international scientific consultation	Provide ongoing scientific and technical consultations to scientists and graduate students from USA, Germany, France, Italy, Finland, Sweden, Japan, China, Taiwan, Korea, India, Indonesia, New Zealand, Australia, Brazil, Argentina, South Africa	Yehuda Bock, SIO
Listening for whales lecture by K. Merkens	Experiments in graduate school and marine biology.	School for Field Studies, July 2010, Turks and Caicos.



AWARD	RECIPIENT	YEAR
Awards and Honors		
Faculty of 1000 Publication Notice	JD Yeakel	2011
Distinguished Alumnus Lecture, Institute of Applied Mathematics, University of British Columbia	M Mangel	2012
Queens Award	Sea Mammal Research Unit, University of St. Andrews [M Mangel sharing this for his work on the Special Committee on Seals]	2011
PEW Marine Conservation Fellowship	Stephan B. Munch	2012
National Science Foundation (NSF) ADVANCE workshop competition: Advancement Toward Professorship in Biology, Ecology, and Earth System Science	Lisa Wedding	2012
NSF graduate research fellowship based on a proposal to use the CCE moorings for carbon budgets: "Carbon Cycle eddy flux measurements in the California Current System using a Mooring", Award ID: 2011118694, April-2011	Samuel Wilson	2011
Fellow, American Geophysical Union	Dan Cayan	2012



REPRESENTING CIMEC

EVENT	DATE / LOCATION	REPRESENTATIVE
2011 Central Valley Operating Criteria and Plan (OCAP) Integrated Annual Review	Nov. 8, 2011, Sacramento CA	Eric Danner
2011 World Conference on Natural Resource Modeling	June 2011/Ottawa, Ontario, Can	V Brown, D Hively
2012 Ocean Sciences Meeting	Salt Lake City Utah	Nathalie Zilberman
AAAS Symposium: Documenting a changing ocean through international multidisciplinary collaboration session	Vancouver, Canada, February, 2012	J.A. Koslow
Acoustical Soc. of America & Am. Fisheries Soc workshop: Acoustic challenges in aquatic ecosystem assessment	Seattle, WA, May, 2011	P. Davison, A. Lara-Lopez
AFS Annual Meeting	Sept 2011/Seattle	V Brown, D. Hively, M Mangel, K Richerson, WH Satterthwaite, AO Shelton, S Vincenzi, JD Yeakel
AGU/ASLO Ocean Sciences Meeting	February 2012, Salt Lake City	U.Send, M.Ohman, S.Nam, H.Kim, X.Fan, S.Wilson
America Fisheries Society Annual Meeting	Sept. 4-8, 2011, Seattle WA	David Huff, Kerrie Pipal, Will Satterthwaite, Mary Yoklavich
American Geophysical Union (AGU)	December 5-9, 2011, San Francisco, CA	Yehuda Bock, R. Davis
American Geophysical Union Fall Meeting	Dec. 5-9, 2011, San Francisco CA	Eric Danner, Lee Harrison, Andrew Pike, Leora Nanus
Annual Graduate Research Symposium	May 2011/Santa Cruz	V Brown, D Hively, K Richerson
Annual Meeting of the Society for American Archaeology	Sacramento/April 2011	C Boone
Annual Meeting of the Society for California Archaeology	San Diego/March 2012	C Boone
Annual Sturgeon and Paddlefish Conference	July 11-14, 2011, Nanaimo, BC, Canada	David Huff
Association for the Sciences of Limnology and Oceanography/ American Geophysical Union Ocean Sciences Meeting	Feb. 20-24, 2012, Salt Lake City UT	David Huff, Brian Wells
Biennial Conference on the Biology of Marine Mammals	Nov. 27-Dec. 2, 2011, Tampa FL	Danielle Frechette and C.S. Oedekoven
CalCOFI Conference	Scripps, La Jolla, CA, December 12-14, 2011	G.S. Campbell, J.A. Koslow, M. Ohman, L. Sala, S. Bargu, U. Send, S. McClatchie, N. Bowlin, W. Watson, R. Goericke, L. Rogers-Bennett, A.R. Thompson, S. Charter, J. Hyde, E. Bjorkstedt, E. Weber, M. Kahru, B. Wells, U. Send
California Department of Fish and Game mark-recapture workshop	May 2011, Sacramento CA	Arliiss Winship
Cary Institute Weekly Seminar	15 Sep 2011, Cary Institute, New York	Keeling
Climate Diagnostics and Prediction Workshop	October 4-7, 2010 / Raleigh, NC	S.Y. Kim (presentation)
Coast Colour User Consultation Meeting	Lisbon, Portugal, 2011	M. Kahru
Coastal Altimetry Workshop and Ocean Surface Topography Science Team (OSTST) Meeting	October 17-21, 2011 / San Diego, CA	S.Y. Kim (presentation)
Data Poor Workshop	April 2011/Santa Cruz	M DeYoreo
DBCP 27 technical workshop	September 26, Geneva	L. Centurioni
Delta Science Program Salmonid Integrated Life Cycle Models Workshop	April 2011/Sacramento	WH Satterthwaite



Eastern Pacific Ocean Conference	Oct. 11-14, 2011, South Lake Tahoe CA	Brian Wells
Ecological Society of America Annual Meeting	Austin, TX/August	JD Yeakel
Environmental Science, Policy and Management, Department Seminar	UC Berkely/Dec 2011	S. Vincenzi
Fellowships in Population Dynamics and Marine Resource Economics: 2011 Fellows Meeting	May 2011/Miami, FL	V Brown
FUTURE workshop: Indicators of status and change within North Pacific marine ecosystems	Honolulu, Hawaii, April, 2011	J.A. Koslow
GEO International HF Radar Meeting	March 13-15 2012/ London, UK	L. Hazard
GGMT Meeting	25 Oct 2011, Wellington, New Zealand	Keeling
Global COE International Symposium "International Symposium on Advanced Studies by Young Scientists on Environmental Pollution and Ecotoxicology (YSEPE 2011)"	August 4-6, 2011, Ehime University, Matsuyama, Japan	B.X. Semmens (Keynote speaker)
GLOBEC Final Symposium	Washington, D.C., October 2011	M. Ohman
GMD Annual Meeting	17 May 2011 Boulder	Keeling, Graven, Welp
Gulf and Caribbean Fisheries Institute	November 1-5, 2011, Puerto Morelos, Mexico	B.X. Semmens
International Argo Data Management Team Meeting	Seoul Korea, November 2011	John Gilson, Megan Scanderbeg, Dean Roemmich
International Argo Steering Team Meeting	Paris France, March 2012	Dean Roemmich, Megan Scanderbeg
International Flatfish Symposium	November 2011/ Ijmuiden, the Netherlands	C Jorgensen
International Forum on Illegal, Unreported, and Unregulated (IUU) Fishing	London/Feb 2012	M Boyle
International Marine Conservation Conference	April 2011, Vancouver, BC, Canada	Lisa Wedding
International workshop on marine ecosystem monitoring & assessment	Busan, Korea, December, 2011	J.A. Koslow
ITOP Workshop	May 17-20, Santa Fe, NM	L. Centurioni
IUGG Assembly	June 2011, Melbourne	U.Send
IUGG Assembly	June 2011, Melbourne	U.Send
JCOMM OCG meeting	April 2011, Hobart	U.Send
JCOMM OCG meeting	April 2011, Hobart	U.Send
JCOMM OCG meeting	April 2011, Hobart	U.Send
Korean Delegation Workshop	September 1-2, 2011 / San Diego, CA	S.Y.Kim, T. Cook, L. Hazard, M. Otero, T. de Paolo
Leibniz Institut fur Meereskunde Presentations	Kiel, German	C. Deutsch
Los Angeles / Long Beach NPREP Table Top (TT)	September 13-15, 2011 / Ventura County, CA	Remote Support
Marine Science Institute Presentations	Concepcion, Chile	C. Deutsch
Max Planck Institute for Marine Microbiology Presentations	Bremen, Germany	C. Deutsch
Mixed effect modeling workshop	May 2011, Halifax, Nova Scotia, Canada	Lisa Wedding
Monterey Bay National Marine Sanctuary Symposium, Sanctuary Currents 2011	April 2011/Monterey	V Brown
NASA Applied Sciences annual meeting	Oct. 3, 2011, Washington DC	Eric Danner
National Park Service Climate Change Workshop	UCLA, Los Angeles, CA	C. Deutsch
NWFS Seminar	Seattle/Sept 2011	A.O. Shelton



OCB & US CLIVAR	Woods Hole, MA, 2011	C. Deutsch
Ocean Sciences Meeting	February 20-24, 2012 / Salt Lake City, UT	S.Y. Kim
OKMC Workshop (Videoconference)	28-Apr-10	L. Centurioni
ONR peer review	November 7, Denver	L. Centurioni
Pacific Climate Workshop	Asilomar, Pacific Grove, CA, 2011	J.A. Barron
Pacific Fishery Management Council and committee meetings	Multiple dates and locations	Edward Dick, Michael O'Farrell
Pacific States Marine Fisheries Commission Pacific Coast Steelhead Meeting	Mar. 13-15, 2012, Port Townsend WA	David Boughton
PICES annual symposium	Khabarovsk, Russia, October, 2011	J.A. Koslow
Principles of ecological modeling workshop	July 2011, Santa Cruz CA	Arliss Winship, Shanae Allen
Public Lecture on Sustainable Fishing in West Africa	Moss Landing Marine Laboratories/January 2012	M Boyle
Radiowave Operators Working Group (ROWG)	April 25-27, 2011 / Santa Barbara, CA	T. Cook, M. Otero, J. Chen
RAPID-USAMOC International Science Meeting	July 2011, Bristol	M.Lankhorst
Research Review Day	October 2011/Santa Cruz	V Brown
Salmon Ocean Ecology Meeting	Mar. 21-22, 2012, Newport OR	Brian Wells, Lindsey Woodson
San Diego National Preparedness for Response Exercise Program (NPREP)	May 10-13, 2011 / San Diego, CA	L. Hazard
Sensing the Ocean with Marine Radars (SOMaR-1)	May 2-4, 2011 / Lerici, Italy	T. de Paolo
Ships of Opportunity Program (SOOP) Operations Meeting	March 2011, Miami Florida	Glenn Pezzoli
SIO ONR site visit	August 21, La Jolla	L. Centurioni
Southern California Coastal Water Research Project (SCCWRP) workshop on coastal habitat conservation in a changing climate	Costa Mesa, CA, November, 2011	J.A. Koslow
Southern California workshop on marine mammals in the California Current	Pacific Life Foundation, Newport, CA, February, 2012	J.A. Koslow, M. Ohman, J. Hildebrand, D. Checkley, C.F. Nickels
SPURS meeting	January 18, Seattle	L. Centurioni
Symposium on Harmful Algae in the US	Austin, TX, November, 2011	S. Bargu
TOS/ASLO/AGU Ocean Sciences Meeting	Salt Lake City, UT, 20-24 February, 2012	C. Deutsch, M. Kahru, M. Ohman, J.R. Powell, K. Nieto, S. McClatchie, T. Kuo, C-h Hsieh
U Toronto Physics Colloquium	13 Sep 2011, Toronto	Keeling
UCSD Physics Colloquium	17 May 2011 UCSD	Keeling
Unidata Training and HF Radar meeting	July 20 - 26, 2011 / Boulder, CO	M. Otero, T. Cook, J. Chen
University of Georgia Presentation	November, 2011	M. Ohman
Upper Klamath River coho salmon supplementation workshop	February 15-16, 2012. Yreka, California.	Darren Ward
USGS GIS user group workshop	Marc. 19, 2012, Santa Cruz CA	Lisa Wedding
Vietnamese Delegation Workshop	April 19, 2011 / San Diego, CA	L. Hazard, T. Cook, M. Otero
WCRP Open Science Conference	October 2011, Denver	M.Lankhorst, D. Giglio, U. Send
West Coast Salmon Genetic Stock Identification Collaboration Meeting	24-25 October 2011/Santa Cruz	W. Satterthwaite, M. O'Farrell, S. Allen, E. Crandall
West Coast Salmon Genetic Stock Identification Project	Portland, OR –March 16, 2012	Dr. Eric Crandall
Western Groundfish Conference	Portland/Feb 2012	M DeYoreo
Western Groundfish Conference	Feb. 6-10, 2012, Seattle, WA	John Field, Edward Dick, Lisa Krigsmann, Lyndsey Lefebvre, Rebecca Miller, Mary Yoklavich
World Ocean Council Workshop on Ship/Platform Observations	December 2011, Paris France	Glenn Pezzoli
World Ocean Summit	Singapore/Feb 2012	M Boyle
XBT Science Workshop	July 2011, Melbourne Australia	Dean Roemmich



CIMEC PARTNERS AND COLLABORATORS

INTERAGENCY

Antarctica Ecosystem Research Division, NMFS
Atlantic Oceanic and Meteorological Laboratory (AOML)
Fisheries Ecology Division, NMFS
Integrated Ocean Observing System (IOOS)
Monterey Bay National Marine Sanctuary
National Aeronautics and Space Agency (NASA)
 AMES Research Center
 Jet Propulsion Lab (JPL)
National Data Buoy Center (NDBC)
National Ocean Service (NOS)
National Parks Service (NPS)
National Science Foundation (NSF)
 NSF Division of Polar Programs (OPP)
National Weather Service (NWS)
Northeast Fisheries Science Center (NEFSC), NMFS
Northwest Fisheries Science Center (NWFSC), NMFS
Office of Naval Research (ONR)
Pacific Fisheries Management Council
Pacific Islands Fisheries Science Center (PIFSC)
Pacific Marine Environment Lab (PMEL)
Pacific States Fisheries Commission
Redwood National Park
Southeast Fisheries Science Center (SEFSC)
Southwest Fisheries Science Center (SWFSC)
U.S. Army Corps of Engineers (USACE)
U.S. Bureau of Reclamation (USBR)
U.S. Department of Agriculture (USDA)
U.S. Fish and Wildlife Service (USFWS)
U.S. Geological Survey (USGS)

PARTNERSHIPS

Australian Antarctic Division (AAD)
Australian Bureau of Meteorology and CSIRO
British Antarctic Survey (BAS)
CalFed Science Program
California Coastal Conservancy
California Department of Fish and Game (CDFG)



California Department of Forestry and Fire Prevention
California Department of Parks and Recreation
California Department of Water Resources (CDWR)
California Ocean Protection Council
California Polytechnic State University San Luis Obispo
California Salmon Commission
California State University Monterey Bay (CSUMB)
California Wetfish Producers Association
Centro Investigacion Cientifica y de Educacio Superior de Ensenada (CICSE), Mexico
Centro Regional de Investigacion Pesquera (CRIP), Instituto Nacional de la Pesca, Mexico
Columbia River Intertribal Fisheries Commission.
Commission for the Conservation of Antarctic Marine Living Resources (AMLR)
Commonwealth Scientific and Industrial Research Organisation (CSIRO)—Australia
Cramer Fish Sciences
CSIRO
Dalhousie University
Duke University Marine Laboratory
East Bay Municipal District
Environment Canada
Farallon Institute
Fisheries Centre, University of British Columbia
Georgia Institute of Technology
Hoopa Valley Tribe
Humboldt State University, CA, USA
ifM-Geomar, Kiel, Germany
IFREMER, France
INCOIS, India
Investigaciones Mexicanas de la Corriente de California (IMECOCAL)
IOS, Canada
IRD, Noumea, New Caledonia
James Cook University
JAMSTEC, Japan
KORDI, South Korea
Lenfest Ocean Program
Lindquist Consulting Inc.
Los Angeles County Museum (LACM)
Massachusetts Institute of Technology (MIT)
Monterey Bay
Monterey Bay Aquarium Research Institute (MBARI)
Moss Landing Marine Laboratories
MRAG Americas
NIWA New Zealand
Northwest Indian Fisheries Commission
Ocean Protection Council



Oregon Department of Fish and Wildlife (ODFW)
Oregon Salmon Commission
Oregon State University (OSU)
Pew Environmental Group
Pt. Reyes Bird Observatory (PRBO)
Raincoast Conservation
Resource Conservation District of Santa Cruz County
Rosenstiel Schools of Marine and Atmospheric Science
Rutgers University, Coastal Ocean Observation Lab (COOL)
San Francisco State University (SFSU)
San Jose State University, San Jose, CA
Save the Redwoods League
Scottish Association for Marine Science
Scripps Institution of Oceanography (SIO), Coastal Observing Research and Development Lab (CORDC)
Servicio Hidrográfico y Oceanográfico de la Armada (SHOA), Chile
Simon Fraser University
Simon Fraser University (SFU)
South Africa Weather Service
South African Chief Directorate of Surveys and Mapping
Spatial Ecosystems, Olympia, WA
Special Committee on Seals, UK
St. Andrews University
Stanford University
Station Biologique de la Tour du Valat
Stony Brook University
Sustainable Fishery Advocates
Tenera Environmental, California
Texas A&M University (TAMU)
Tohoku University, Japan
University of Alaska Fairbanks (UAF)
University of Bergen, Norway
University of Calgary, Canada
University of California Berkeley
University of California Davis
University of California Santa Barbara (UCSB)
University of California, Riverside (UCR)
University of California, Santa Barbara (UCSB)
University of California, Santa Cruz (UCSC)
University of Colorado Boulder
University of Maine (UMA)
University of Miami (UM)
University of Padua, Italy
University of Parma



University of Southern Mississippi (USM)
University of St. Andrew
University of Victoria, Canada
University of Washington (UW)
Washington Department of Fish And Wildlife (WDFW)
Woods Hole Oceanographic Institution (WHOI)
Yurok Tribe

COLLABORATORS

A. Bednarek, Pew Environment Group
A. Blumberg, Stevens Institute of Technology
A. Cooper, Simon Fraser University
A. Crivelli, Station Biologique de la Tour du Valat
A. Ganachaud, IRD, Noumea
A. Kinzinger, Humboldt State University
A. Kitaysky, University of Alaska Fairbanks
A. Kozyr, CDIAC
A. MacCall, NOAA Fisheries
A. Sepulveda, USGS
A. Vega, Centro Regional de Investigacion Pesquera, CRIP, Instituto Nacional de la Pesca, Ensenada/La Paz, Mexico
A.-K. Osterback, EEB, UCSC
B. Black, OSU
B. Dietterick, California Polytechnic State University
B. Emery, UCSB, Marine Science Institute
B. King, National Oceanographic Centre, UK
B. Null, USFWS
B. Owens, WHOI
B. Rajagopalan, University of Colorado Boulder
C. Bean, CDFG
C. Darimont, Raincoast Conservation and University of Victoria
C. Foster, ODFW
C. Greene, Cornell University
C. Nevison, University of Colorado
C. Ohlman, UCSB, Santa Barbara, Ca
C. Roedenbeck, Max Planck Institute for Biogeochemistry, Jena, Germany
C. Romsos, OSU
C. Sabine, NOAA/PMEL
C. Simpfendorfer, James Cook University
C.-H. Hsieh, Zac, Institute of Oceanography National Taiwan University
D. Anderson, NPS Redwood National Park
D. Demer, Southwest Fisheries Science Center, SWFSC
D. Dugdale, SFSU
D. Frechette, NOAA Fisheries



D. Hankin, HSU
D. Kaplan, UCSC
D. Keith, Dalhousie University
D. Milward, WDFW
D. Reznick, University of California Riverside
D. Swank, NMFS Southwest Region
D. Thompson, University of St Andrews
E Di Lorenzo, Georgia Institute of Technology
E. Ateljevich, CDWR
E. Bjorkstedt, NOAA/NMFS/SWFSC
E. Chapman, New Hampshire Sea Grant, University of New Hampshire
E. Collins, CDFG
E. Curchitser, Rutgers University
E. D'Asaro, University of Washington
E. Howlett, Applied Science Associates, ASA
E. Oleson, NOAA/NMFS-PIFSC
E. Weber, Southwest Fisheries Science Center, SWFSC
EJ Dick, NOAA Fisheries
F. Chai, University of Maine
F. Chavez, MBARI
F. J. Millero, University of Miami
F. Melton, NASA Ames and CSUMB
F. Micheli, Stanford University
G. A. De Leo, Stanford University_
G. Goni, NOAA/AOML
G. Greene, Moss Landing Marine Laboratories
G. Johnson, NOAA/PMEL
G. Ortuno, Centro Regional de Investigacion Pesquera, CRIP, Instituto Nacional de la Pesca, Ensenada/La Paz, Mexico
G. Reverdin, University of Paris
H. Freeland, IOS
H. Osborne, NOAA National Weather Service
H. Roarty, Rutgers University, COOL
H. Yuen, USFWS.
I. Boyd, University of St Andrews
J. Bartholomew, OSU
J. Barlow, Southwest Fisheries Science Center, SWFSC
J. Bizzarro, UW
J. Brodziak, NOAA Fisheries
J. Estes, USGS, Santa Cruz
J. Giske, University of Bergen
J. Harlan, NOAA/NOS
J. Israel, USBR
J. Kelly, NOAA/NMFS/PIRO



J. Kindopp, CDWR
J. Kohut, Rutgers University, COOL
J. Machetti, NOAA/NMFS/PIRO
J. Merz, Cramer Fish Sciences
J. Moore, SFU
J. Morzel, Rosetta Consulting, Boulder, Co
J. Paduan, UCSC
J. Phinney, Southwest Fisheries Science Center, SWFSC
J. Vesecky, UCSC
J. Wiedenmann, MRAG Americas
J. Wilkin, Rutgers University, MARCOOS
K. Benson, NPS Redwood National Park
K. Laws, UCSC
K. Lindquist, Lindquist Consulting Incorporated
K. Lutz, Northwest Indian Fisheries Commission
K. Nieto, Southwest Fisheries Science Center, SWFSC
K. Ravichadran, INCOIS
K. Ridgway, CSIRO, Australia
K. Rose, Louisiana State University
L. Balance, Southwest Fisheries Science Center, SWFSC
L. Garrison, NOAA/NMFS/SEFSC
L. Gourdeau, IRD, Noumea
L. LaVoy, NMFS Northwest Region
L. Pecquerie, UCSB
L. Washburn, UCSB, ICES
M. Beakes, Simon Fraser University
M. Bruno, Stevens Institute of Technology
M. Fujiwara, Texas A&M University
M. Heimann, Max Planck Institute for Biogeochemistry, Jena, Germany
M. Love, UCSB
M. MacDuffee, Raincoast Conservation
M. Mohr, NOAA Fisheries
M. Moline, CalPoly
M. O'Farrell, NOAA Fisheries
M. Palmer Zwahlen, CDFG
M. Pisano, CDFG
M. Pujolar, University of Padua
M. Soldevilla, NOAA/NMFS/SEFSC
N. Maximenko, International Pacific Research Center, IPRC, SOEST, University of Hawaii
P. Klimley, UC Davis
P. La Civita, USACE
P. Levin, NMFS Northwest Fisheries Science Center
P. Paquet, Raincoast Conservation and University of Calgary
P. Rafter, Princeton University



P. Sutton, NIWA/New Zealand
P. Velez, Instituto Español de Oceanografía, IEO Centro Oceanográfico de Canarias, Santa Cruz de Tenerife, Spain
P.-Y. le Traon, IFREMER
P.M. Poulain, OGS, Trieste, Italy
R Hewitt, Southwest Fisheries Science Center, SWFSC
R. Barnett-Johnson, USBR
R. Feely, NOAA/PMEL
R. Key, Princeton
R. Kope, NMFS Northwest Fisheries Science Center
R. Lumpkin, AOML/NOAA
R. Mendelssohn, NOAA/NMFS
R. Nemani, NASA Ames
R. Nisbet, UCSB
R. Starr, UC Sea Grant
R. Titus, CDFG
R. Vetter, Southwest Fisheries Science Center, SWFSC
R. Wanninkhof, NOAA/AOML
R.-S. Tseng-NSYSU, Kaohsiung, Taiwan, ROC
S McClatchie, Southwest Fisheries Science Center, SWFSC
S. Alin, NOAA/PMEL
S. Bograd, Southwest Fisheries Science Center, SWFSC
S. Carlson, UC Berkeley
S. Chen, University of Miami
S. Foott, USFWS
S. Garzoli, NOAA/AOML
S. Gutman, NOAA/ESRL
S. Hankin, NOAA/PMEL
S. Hayes, NOAA Fisheries
S. Jan, National Taiwan University, Taipei, Taiwan
S. K. Auer, Montana Cooperative Wildlife Research Unit, University of Montana
S. Ralston, NOAA Fisheries
S. Ricker, CDFG
S. Riser, University of Washington
S. Salinas, Stony Brook University
S. Sogard, NOAA Fisheries
S. Swope, USDA
S. Vincenzi, University of Parma
S. Wijffels, CSIRO, Australia
T. Sanford, University of Washington
T. Suga, Tohoku University, Japan
T. Tinker, USGS
T.-H. Peng, NOAA/AOML
W. Chesney, CDFG



W. Kessler, PMEL/NOAA

W. Sydeman, Farallon Institute for Advanced Ecosystem Research, Petaluma, CA

W. Wakefield, NMFS Northwest Fisheries Science Center

W. Watson, Southwest Fisheries Science Center, SWFSC

X. Jianping, Second Institute of Oceanography, China

Yi Chao, NASA JPL



PUBLICATIONS

Published Papers

- Ainsworth, C. H., I. C. Kaplan, P. S. Levin, and M. Mangel 2011 A statistical approach for estimating fish diet compositions from multiple data sources: Gulf of California case study. *Ecol. Applic.*, 20:2188-2202.
- Auad, G., D. Roemmich, and J. Gilson 2011 The California Current System in relation to the Northeast Pacific Ocean circulation Progress in Oceanography, 91, 576-592
<http://www.sciencedirect.com/science/article/pii/S0079661111001157>
- Barnett, L.A.K, and B.C. Spence 2011 Freshwater survival of stranded steelhead kelts in coastal central California streams North American Journal of Fisheries Management. 31: 757-764.
- Bednarek, A. T., A. B. Cooper, K. A. Cresswell, M. Mangel, W. H. Satterthwaite, C. A. Simpfendorfer, and J. R. Wiedenmann 2011 Marine conservation in the 21st century: the certainty of uncertainty and what to do about it. *Bulletin of Marine Science* 87:177-195
- Bednarek, A.T., A.B. Cooper, K.A. Cresswell, M. Mangel, W.H. Satterthwaite, C.A. Simpfendorfer, and J.R. Wiedenmann 2011 Marine conservation in the 21st century: the certainty of uncertainty and what to do about it *Bulletin of Marine Science*. 87: 177-195
- Bevacqua D, Andrello M, Melià P, Vincenzi S, Leo GA, Crivelli AJ 2011 Density-dependent and inter-specific interactions affecting European eel settlement in freshwater habitats *Hydrobiologia* 671:259-265
- Bjorkstedt, E., R. Goericke, S. McClatchie, B. Peterson, R. L. Emmett, R. D. Brodeur, J. Peterson, M. N. C. Litz, J. Gomez-Valdez, G. Gaxiola-Castro, B. E. Lavaniegas, F. Chavez, C. A. Collins, D. B. Field, K. Sakuma, S. J. Bograd, F. B. Schwing, P. Warzybok, R. Bradley, J. Jahncke, G. S. Campbell, J. A. Hildebrand, W. J. Sydeman, S. A. Thompson, J. L. Largier, C. Halle, S. Y. Kim and J. Abell. 2011 State of the California Current 2010-2011. Regionally variable responses to a strong (but fleeting?) La Niña. *California Cooperative Oceanic Fisheries Investigations Reports* 52:36-68.
- Black, B., I.D. Schroeder, W.J. Sydeman, S.J. Bograd, B.K. Wells and F.B. Schwing 2011 Winter and summer upwelling modes and their biological relevance in the California Current Ecosystem *Global Change Biology* 17: 2536-2545.
- Block, B.A., I.D. Jonsen, S.J. Jorgensen, A.J. Winship, S.A. Shaffer, S.J. Bograd, E.L. Hazen, D.G. Foley, G.A. Breed, A.-L. Harrison, J.E. Ganong, A. Swithenbank, M. Castleton, H. Dewar, B.R. Mate, G.L. Shillinger, K.M. Schaefer, S.R. Benson, M.J. Weise, R.W. Henry, and D.P. Costa 2011 Tracking apex marine predator movements in a dynamic ocean *Nature*
- Broquet, G., A. M. Moore, H. G. Arango and C. A. Edwards. 2011 Corrections to ocean surface forcing in the California Current System using 4D variational data assimilation. *Ocean Modelling* 36(1–2):116-132.
- Carlson, S. M., and W. H. Satterthwaite 2011 Weakened portfolio effect in a collapsed salmon population complex *Canadian Journal of Fisheries and Aquatic Sciences* 68:1579-1589
- Carlson, S.M., and W.H. Satterthwaite 2011 Weakened portfolio effect in a collapsed salmon population complex *Canadian Journal of Fisheries and Aquatic Sciences*
- Chapman EW, Jørgensen C, Lutcavage M. (2011) Atlantic bluefin tuna (*Thunnus thynnus*): a state-dependent energy allocation model for growth, maturation, and reproductive investment 2011 Atlantic bluefin tuna (*Thunnus thynnus*): a state-dependent energy allocation model for growth, maturation, and reproductive investment *Canadian Journal of Fisheries and Aquatic Sciences* 68: 1934-1951
- D'Asaro, E., P. Black, L. Centurioni, P. Harr, S. Jayne, I.-I. Lin, C. Lee, J. Morzel, R. Mrvaljevic, P.P. Niiler, L. Rainville, T. Sanford, and T.Y. Tang 2011 Typhoon-ocean interaction in the western North Pacific: Part 1 *Oceanography* 24(4):24–31
- Deutsch, C., H. Brix, T. Ito, H. Frenzel and L. A. Thompson. 2011 Climate-forced variability of ocean hypoxia. *Science* 333(6040):336.
- Dick, E.J., and A.D. MacCall 2011 Depletion-based stock reduction analysis: A catch-based method for determining sustainable yields for data-poor fish stocks *Fisheries Research*
- Doron, M., M. Babin, O. Hembise, A. Mangin and P. Garnesson. 2011 Ocean transparency from space: Validation of algorithms estimating Secchi depth using MERIS, MODIS and SeaWiFS data. *Remote Sensing of Environment* 115(12):2986-3001.
- Dorval, E., K. Piner, L. Robertson, C. S. Reiss, B. Javor and R. Vetter. 2011 Temperature record in the oxygen stable isotopes of Pacific sardine otoliths: Experimental vs. wild stocks from the Southern California Bight. *Journal of Experimental Marine Biology and Ecology* 397(2):136-143.



- Dowling, N.A., Wilcox, C., Mangel, M. and S. Pascoe 2011 Assessing opportunity and relocation costs of marine protected areas using a behavioural model of longline fleet Fish and Fisheries DOI: 10.1111/j.1467-2979.2011.00422.x dynamics
- Doyle, M. J., W. Watson, N. M. Bowlin and S. B. Sheavly. 2011 Plastic particles in coastal pelagic ecosystems of the Northeast Pacific ocean. *Marine Environmental Research* 71(1):41-52.
- Fissel, B. E., N. C. H. Lo and S. F. J. Herrick. 2011 Daily egg production, spawning biomass and recruitment for the central subpopulation of northern anchovy 1981–2009. *California Cooperative Oceanic Fisheries Investigations Reports* 52:116-135.
- Fujiwara, M., M.S. Mohr, A. Greenberg, J.S. Foott, and J.L. Bartholomew 2011 Effects of Ceratomyxosis on population dynamics of Klamath fall-run Chinook salmon *Transactions of the American Fisheries Society*. 140: 1380-1391.
- Gawarkiewicz, G., S. Jan, P.F.J. Lermusiaux, J.L. McClean, L. Centurioni, K. Taylor, B. Cornuelle, T.F. Duda, J. Wang, Y.J. Yang, T. Sanford, R.-C. Lien, C. Lee, M.-A. Lee, W. Leslie, P.J. Haley Jr., P.P. Niiler, G. Gopalakrishnan, P. Velez-Belchi, D.-K. Lee, and Y.Y. Kim 2011 Circulation and intrusions northeast of Taiwan: Chasing and predicting uncertainty in the cold dome *Oceanography* 24(4):110–121
- Goericke, R. 2011 The size structure of marine phytoplankton—what are the rules? *California Cooperative Oceanic Fisheries Investigations Reports* 52:198-204.
- Goericke, R. 2011 The structure of marine phytoplankton communities—patterns, rules and mechanisms. *California Cooperative Oceanic Fisheries Investigations Reports* 52:182-197.
- H.-H. Gennerich, H. Villinger 2011 Deciphering the ocean bottom pressure variation in the Logatchev hydrothermal field at the eastern flank of the Mid-Atlantic Ridge *Geochemistry Geophysics Geosystems*, Vol. 12, Q0AE03, 2011. doi:10.1029/2010GC003441
- Hayes, S.A., M.H. Bond, C.V. Hanson, A.W. Jones, A.J. Amman, J.A. Harding, A.L. Collins, J. Perez, and R.B. MacFarlane 2011 Down, up, down and “smolting” twice? Seasonal movement patterns by juvenile steelhead (*Oncorhynchus mykiss*) in a coastal watershed with a bar closing estuary *Canadian Journal of Fisheries and Aquatic Sciences* 68: 1341-1350
- Huff, D.D., S.T. Lindley, P.S. Rankin, and E.A. Mora 2011 Green sturgeon physical habitat use in the coastal Pacific Ocean *PloS ONE*. 6(9): e25156.
- Jan, S., C.-C. Chen, Y.-L. Tsai, Y. J. Yang, J. Wang, C.-S. Chern, G. Gawarkiewicz, R.-C. Lien, L. Centurioni, and J.-Y. Kuo 2011 Mean Structure and Variability of the Cold Dome Northeast of Taiwan *Oceanography*, 24(4), 100-109
- Javor, B., N.C.H. Lo, and R. Vetter. 2011 Otolith morphometrics and population structure of Pacific sardine (*Sardinops sagax*) along the west coast of North America. *Fishery Bulletin* 109: 402-415.
- Justin D. Yeakel, Mark Novak, Paulo R. Guimaraes Jr., Nathaniel J. Dominy, Paul L. Koch, Eric J. Ward, Jonathan W. Moore, Brice X. Semmens 2011 Merging Resource Availability with Isotope Mixing Models: The Role of Neutral Interaction Assumptions *PLoS One*. 6 (7) e22015
- King, J. R., V. N. Agostini, C. J. Harvey, G. A. McFarlane, M. G. G. Foreman, J. E. Overland, E. Di Lorenzo, N. A. Bond and K. Y. Aydin. 2011 Climate forcing and the California Current ecosystem. *ICES Journal of Marine Science: Journal du Conseil* 68(6):1199-1216.
- Koslow, J. A. and C. Allen. 2011 The influence of the ocean environment on the abundance of market squid, *Doryteuthis (Loligo) opalescens*, paralarvae in the Southern California Bight. *California Cooperative Oceanic Fisheries Investigations Reports* 52:205-213.
- Koslow, J. A., R. Goericke, A. Lara-Lopez and W. Watson. 2011 Impact of declining intermediate-water oxygen on deepwater fishes in the California Current. *Marine Ecology Progress Series* 436:207-218.
- Koslow, J.A., Rogers-Bennett, L., Vetter, R., Allen, A. 2011 The Report of the CalCOFI Committee 2010. *CalCOFI Reports* 52: 5 – 12.
- LaVigne, M., T. M. Hill, H. J. Spero and T. P. Guilderson. 2011 Bamboo coral Ba/Ca: Calibration of a new deep ocean refractory nutrient proxy. *Earth and Planetary Science Letters* 312(3–4):506-515.
- Lee, W.-S., Metcalfe, N.B., Monaghan, P., and M. Mangel 2011 A Comparison of Dynamic-State-Dependent Models of the Trade-Off Between Growth, Damage, and Reproduction *The American Naturalist*
- Levi, T., Lu, F., Yu, D.W., and M. Mangel 2011 The behaviour and diet breadth of central-place foragers: an application to human hunters and Neotropical game management *Evolutionary Ecology Research* 13:171-185
- Lopez A.L., P. Davison, & J.A. Koslow. 2011 Introduction of multi-frequency acoustics and mid-water trawl sampling to the CalCOFI program. *J Acoust Soc Am* 129: 2692 (Abstract)
- Lucas, A. J., P. J. S. Franks and C. L. Dupont. 2011 Horizontal internal-tide fluxes support elevated phytoplankton productivity over the inner continental shelf. *Limnology & Oceanography: Fluids & Environments* 1:56-74.
- Mazzillo, F.F.M., D.J. Staaf, J.C. Field, M.L. Carter, and M.D. Ohman 2011 A Note on the Detection of the Neurotoxin Domoic Acid in Beach-Stranded *Dosidicus Gigas* in the Southern California Bight. *CalCOFI Reports* 52: 109-115.



- McQuatters-Gollop, A., P. C. Reid, M. Edwards, P. H. Burkill, C. Castellani, S. Batten, W. Gieskes, D. Beare, R. R. Bidigare, E. Head, R. Johnson, M. Kahru, J. A. Koslow and A. Pena. 2011 Is there a decline in marine phytoplankton? *Nature* 472(7342):E6-E7.
- Mortyn, P. G., J. C. Herguera and M. A. Martínez-Botí. 2011 Instrumental validation of Globigerinoides ruber Mg/Ca as a proxy for NE Pacific summer SST. *Geophysical Research Letters* 38(16):L16601.
- Nam, S., H.-J. Kim, and U. Send. 2011 Amplification of hypoxic and acidic events by La Nina conditions on the continental shelf off California *Geophysical Research Letters*. VOL. 38, L22602. doi:10.1029/2011GL049549
- Nur, N., J. Jahncke, M. P. Herzog, J. Howar, K. D. Hyrenbach, J. E. Zamon, D. G. Ainley, J. A. Wiens, K. Morgan, L. T. Ballance and D. Stralberg. 2011 Where the wild things are: predicting hotspots of seabird aggregations in the California Current System. *Ecological Applications* 21(6):2241-2257.
- Pujolar JM, Vincenzi S, Zane L, Jesensek D, Leo GA De, Crivelli AJ. 2011 The effect of recurrent floods on genetic composition of marble trout populations *PLoS One* 6:e23822
- Roch, M. A., H. Klinck, S. Baumann-Pickering, D. K. Mellinger, S. Qui, M. S. Soldevilla and J. A. Hildebrand. 2011 Classification of echolocation clicks from odontocetes in the Southern California Bight. *J. Acoust. Soc. Am* 129(1).
- Roemmich, D., and J. Gilson. 2011 The global ocean imprint of ENSO *Geophysical Research Letters*, 38, L13606, doi:10.1029/2011GL047992
- Rudnick, D. L., S. Jan, L. Centurioni, C. M. Lee, R.-C. Lien, J. Wang, D.-K. Lee, R.-S. Tseng, Y. Y. Kim, and C.-S. Chern. 2011 Seasonal and Mesoscale Variability of the Kuroshio Near Its Origin *Oceanography*, 24(4), 52-63
- Santora, J.A., W.J. Sydeman, I.D. Schroeder, B.K. Wells, and J.C. Field. 2011 Mesoscale structure and oceanographic determinants of krill hotspots in the California Current: Implications for trophic transfer and conservation *Oceanography*. 91: 397-409
- Send, U., M. Lankhorst, T. Kanzow. 2011 Observation of decadal change in the Atlantic Meridional Overturning Circulation using 10 years of continuous transport data *Geophysical Research Letters*, Vol. 38, L24606, 2011. doi:10.1029/2011GL049801
- Shelton, A.O. and M. Mangel. 2011 On the fluctuations of fish populations and the magnifying effects of fishing *Proceeding of the National Academy of Sciences (USA)* 108:7075-7080
- Shelton, A.O. and M. Mangel. 2011 Response to Sugihara et al.: The biology of variability in fish populations *Proceedings of the National Academy of Sciences (USA)* 108:E1226
- Song, H., A. J. Miller, B. D. Cornuelle and E. Di Lorenzo. 2011 Changes in upwelling and its water sources in the California Current System driven by different wind forcing. *Dynamics of Atmospheres and Oceans* 52(1-2):170-191.
- Tai, V., R. S. Burton and B. Palenik. 2011 Temporal and spatial distributions of marine Synechococcus in the Southern California Bight assessed by hybridization to bead-arrays. *Marine Ecology-Progress Series* 426:133-147.
- Todd, R. E., D. L. Rudnick, M. R. Mazloff, R. E. Davis, and B. D. Cornuelle. 2011 Poleward flows in the southern California Current System: Glider observations and numerical simulation *Journal of Geophysical Research*, 116, C02026, doi:10.1029/2010JC006536
- Todd, R. E., D. L. Rudnick, R. E. Davis, and M. D. Ohman. 2011 Underwater gliders reveal rapid arrival of El Niño effects off California's coast *Geophysical Research Letters*, 38, L03609, doi:10.1029/2010GL046376
- Ward, D.M., K.H. Nislow, and C.L. Folt. 2011 Seasonal shift in the effects of predators on juvenile Atlantic salmon *Salmo salar* energetics *Canadian Journal of Fisheries and Aquatic Sciences* 68: 2080-2089
- Wedding, L. B. Gibson, W. Walsh, and T. Battista. 2011 Integrating remote sensing products and GIS tools to support marine spatial management in west Hawaii *Journal of Conservation Planning*. 7: 60-73
- Wedding, L., C. Lepczyk, S. Pittman, A. Friedlander, and S. Jorgensen. 2011 Quantifying seascape structure: extending terrestrial spatial pattern metrics to the marine realm *Marine Ecology Progress Series*. 427: 219-232
- Whitney, F. 2011 Nutrient variability in the mixed layer of the subarctic Pacific Ocean, 1987–2010. *Journal of Oceanography* 67(4): 481-492.
- Wiedenmann, J., Cresswell, K.A., Goldbogen, J., Potvin, J., and M. Mangel. 2011 Exploring the effects of reductions in krill biomass in the Southern Ocean on blue whales using a state-dependent foraging model *Ecological Modelling* 222 (2011) 3366– 3379
- Williams, R., M. Krkosek, E. Ashe, T.A. Branch, S. Clark, P.S. Hammond, E. Hoyt, D.P. Noren, D. Rosen, and A. Winship. 2011 Competing conservation objectives for predators and prey: estimating killer whale prey requirements for Chinook salmon *PLoS ONE*. 6: e26738
- Yeakel, J.D., M. Novak, P.R. Guimarães Jr., N.J. Dominy, P.L. Koch, E.J. Ward, J.W. Moore, B.X. Semmens. 2011 Merging resource availability with isotope mixing models: the role of neutral interaction assumptions *PLoS ONE*. 6(7): e22015



- Zeidberg, L. D., J. L. Butler, D. Ramon, A. Cossio, K. L. Stierhoff and A. Henry. 2011 Estimation of spawning habitats of market squid (*Doryteuthis opalescens*) from field surveys of eggs off Central and Southern California. *Marine Ecology*: 1-11.
- Zhang, J., Fleming, J., Goericke, R. 2011 Fishermen's perspectives on climate variability. *Marine Policy*, doi:10.1016/j.marpol.2011.06.001.
- Zwolinski, J. P., R. L. Emmett and D. A. Demer. 2011 Predicting habitat to optimize sampling of Pacific sardine (*Sardinops sagax*). *ICES Journal of Marine Science: Journal du Conseil* 68(5):867-879.
- Allen, L. Z., E. E. Allen, J. H. Badger, J. P. McCrow, I. T. Paulsen, L. D. H. Elbourne, M. Thiagarajan, D. B. Rusch, K. H. Nealson and S. J. Williamson. 2012 Influence of nutrients and currents on the genomic composition of microbes across an upwelling mosaic. *The ISME Journal*.
- Ammann, A.J., C.J. Michel, and R.B. MacFarlane 2012 The effects of surgically implanted acoustic transmitters on laboratory growth, survival and tag retention in hatchery yearling Chinook salmon *Environmental Biology of Fishes*. DOI: 10.1007/s10641-011-9941-9.
- Archer, S.K., S.A. Heppell, B.X. Semmens, C.V. Pattengill-Semmens, P.G. Bush, C.M. McCoy, B.C. Johnson 2012 Patterns of color phase indicate spawn timing at a Nassau grouper *Epinephelus striatus* spawning aggregation *Current Zoology*. 58 (1): 73-83
- Bargu, S., M.W. Silver, M.D. Ohman, C.R. Benitez-Nelson, and D.L. Garrison. 2012 Mystery Behind Hitchcock's Birds. *Nature Geosciences* 5, no. 1: 2-3.
- Brooks, R. T., S. L. Eggert, K. H. Nislow, R. K. Kolka, C. Y. Chen, and D. M. Ward Preliminary assessment of mercury accumulation in seasonal forest pools 2012 Preliminary assessment of mercury accumulation in seasonal forest pools *Wetlands*
- C. Shultz 2012 Moored instruments show decadal drop in AMOC strength *Eos Trans. AGU*, Vol. 93, No. 8, 2012. doi:10.1029/2012EO080013
- Carlisle, A.B. S.L. Kim, B.X. Semmens, D.J. Madigan, S.J. Jorgensen, C.R. Perle, S.D. Anderson, T.K. Chapple, P.E. Kanive, B.A. Block 2012 Using Stable Isotope Analysis to Understand the Migration and Trophic Ecology of Northeastern Pacific White Sharks (*Carcharodon carcharias*) *PLoS ONE*, 7(2): e30492
- Deutsch, C. and T. Weber. 2012 Nutrient ratios as a tracer and driver of ocean biogeochemistry. *Annual Review of Marine Science* 4(1):113-141.
- Dickey-Collas, M., S. Somarakis, P. R. Witthames, C. J.G. van Damme, A. Uriarte, N.C.H. Lo and M. Bernal. 2012 Where do egg production methods for estimating fish biomass go from here? *Fisheries Research* 117-118: 6-11.
- Enberg K, Jørgensen C, Dunlop ES, Varpe Ø, Boukal DS, Baulier L, Eliassen S, Heino M. 2012 Fishing-induced evolution of growth: concepts, mechanisms, and the empirical evidence *Marine Ecology* 33:1-25
- Gleason, L. U. and R. S. Burton. 2012 High-throughput molecular identification of fish eggs using multiplex suspension bead arrays. *Molecular Ecology Resources* 12(1):57-66.
- Hayes, S.A., N.M. Teutschel, C.J. Michel, C. Champagne, P.W. Robinson, M. Fowler, T. Yack, D. Mellinger, S. Simmons, D.P. Costa, and R.B. MacFarlane 2012 Mobile Receivers: Releasing the mooring to 'see' where fish go *Environmental Biology of Fishes*. DOI: 10.1007/s10641-011-9940-x.
- Krigsman, L.M., M.M. Yoklavich, E.J. Dick, and G.R. Cochrane 2012 Models and maps: predicting the distribution of corals and other benthic macro-invertebrates in shelf habitats *Ecosphere*. 3: 1-16
- Lorenzen, K. Beveridge, M.C.M., and M. Mangel 2012 Cultured fish: integrative biology and management of domestication and interactions with wild fish *Biological Reviews* doi: 10.1111/j.1469-185X.2011.00215.x
- Macias, D., M. R. Landry, A. Gershunov, A. J. Miller and P. S. Franks. 2012 Climatic Control of Upwelling Variability along the Western North-American Coast. *PLoS ONE* 7(1):e30436.
- N. Jones 2012 Atlantic current slowdown *Nature Climate Change*, Vol. 2, Pages 22-23, 2012. doi:10.1038/nclimate1362
- Ohman, M. D., G. H. Rau and P. M. Hull. 2012 Multi-decadal variations in stable N isotopes of California Current zooplankton. *Deep Sea Res. (I Oceanogr. Res. Pap.)* 60:46-55.
- Ohman, M.D. 2012 Estimation of Mortality for Stage-Structured Zooplankton Populations: What Is to Be Done? *Journal of Marine Systems* 93: 4-10.
- Pierce, S. D., J. A. Barth, R. Kipp Shearman and A. Y. Erofeev. 2012 Declining oxygen in the Northeast Pacific. *Journal of Physical Oceanography*.
- Roemmich, D., W.J. Gould and J. Gilson 2012 135 years of global ocean warming from the Challenger Expedition to the Argo Program *Nature Climate Change*
- Rundio, D.E., T.H. Williams, D.E. Pearse, and S.T. Lindley 2012 Male-biased sex ratio of nonanadromous *Oncorhynchus mykiss* in a partially migratory population in California *Ecology of Freshwater Fish*. 21: 293-299
- Salinas, S. and S.B. Munch 2012 Thermal legacies: transgenerational effects of temperature on growth in a vertebrate *Ecology Letters*. 15: 159-163



- Shelton, A.O., E.J. Dick, D. Pearson, S. Ralston, and M. Mangel 2012 Single-species landings and uncertainty estimates from multi-species fisheries landings data: hierarchical Bayesian models for California groundfish fisheries *Canadian Journal of Fisheries and Aquatic Sciences*. 69:231-246
- Song, H., A. J. Miller, S. McClatchie, E. D. Weber, K. M. Nieto and D. M. Checkley Jr. 2012 Application of a data-assimilation model to variability of Pacific sardine spawning and survivor habitats with ENSO in the California Current System. *Journal of Geophysical Research* 117: C03009, doi:10.1029/2011JC007302.
- Stukel, M.R., Landry, M. R., Ohman, M.D., Goericke, R., Samo, T., Benitez-Nelson, C.R. 2012 Do inverse ecosystem models accurately reconstruct plankton trophic flows? Comparing two solution methods using field data from the California Current *Journal of Marine Systems* 91 20–33
- Swope, S. M. and W. H. Satterthwaite 2012 Variable effects of a generalist parasitoid on a biocontrol seed predator and its target weed *Ecological Applications* 22:20-34
- Thomas RM, Lehmann K, Nguyen H, Jackson DL, Wolfe D, and Ramanathan V. 2012 Measurement of turbulent water vapor fluxes using a lightweight unmanned aerial vehicle system *Atmos. Meas. Tech.*, 5, 243-257, 2012 www.atmos-meas-tech.net/5/243/2012/ doi:10.5194/amt-5-243-2012
- Vincenzi S, Leo GA De, Bellingeri M 2012 Consequences of extreme events on population persistence and evolution of a quantitative trait *Ecological Informatics* 8:20-28
- Vincenzi, S., A. J. Crivelli, J. Giske, W. H. Satterthwaite, and M. Mangel 2012 Selective consequences of catastrophes on growth rates in a stream-dwelling salmonid *Oecologia* 168:393-404
- Vincenzi, S., W.H. Satterthwaite, and M. Mangel 2012 Spatial and temporal scale of density-dependent body growth and its implications for recruitment, population dynamics and management of stream-dwelling salmonid populations *Reviews in Fish Biology and Fisheries*. DOI: 10.1007/s11160-011-9247-1
- Visioli G, Vincenzi S, Marmioli M, Marmioli N 2012 Correlation between phenotype and proteome in the Ni hyperaccumulator *Noccaea caerulea* subsp. *caerulea* *Environmental and Experimental Botany* 77:156-164
- Ward, D. M., B. M. Mayes, S. Sturup, C. L. Folt, and C. Y. Chen 2012 Assessing element-specific patterns of bioaccumulation across New England lakes *Science of the Total Environment* 2012:230-237
- Weber, E.D. & S. McClatchie 2012 Effect of environmental conditions on the distribution of Pacific mackerel *Scomber japonicus* larvae in the California Current. *Fishery Bulletin* 110: 85-97.
- Winship, A.J., S.J. Jorgensen, S.A. Shaffer, I.D. Jonsen, P.W. Robinson, D.P. Costa, and B.A. Block 2012 State-space framework for estimating measurement error from double-tagging telemetry experiments *Methods in Ecology and Evolution*. DOI: 10.1111/j.2041-210X.2011.00161.x
- Wong, S. H. C., A. E. Santoro, N. J. Nidzieko, J. L. Hench and A. B. Boehm. 2012 Coupled physical, chemical, and microbiological measurements suggest a connection between internal waves and surf zone water quality in the Southern California Bight. *Continental Shelf Research* 34(0):64-78.
- Zwolinski, J. P. and D. A. Demer. 2012 A cold oceanographic regime with high exploitation rates in the Northeast Pacific forecasts a collapse of the sardine stock. *Proceedings of the National Academy of Sciences*.

Conference Proceedings / Abstracts / Presented Papers / Reports

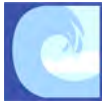
- Harlan, J., A. Allen, E. Howlett, S. Glenn, J. Kohut, H. Roarty, J. O'Donnell, T. Fake, E. Terrill, S. Y. Kim, M. Otero. 2011: National IOOS HF radar search and rescue project (MTS/IEEE OCEANS 2011, Kona, HI USA)
- Kim, S. Y., 2011. 2011. Observations of sub-mesoscale eddies using high-frequency radar-Derived kinematic and dynamic quantities. Gordon Research Conference: Coastal Ocean Modeling 2011, South Hadley, MA USA
- Kim, S. Y., E. J. Terrill, B. D. Cornuelle, B. Jones, L. Washburn, M. A. Moline, J. D. Paduan, N. Garfield, J. L. Largier, G. Crawford, and P. M. Kosro. 2011. Mapping the U.S. West Coast surface circulation: A multi-year analysis of high-frequency radar observations. The Korean Society of Oceanography Biannual Meeting (Spring), Busan, South Korea
- Kim, S. Y. and E. J. Terrill. 2011 Characterization of oceanic mesoscale and submesoscale energy spectra 2011 Ocean Surface Topography Science Team Meeting, San Diego, CA USA
- Kim, S. Y. 2011. Characterization of oceanic mesoscale and submesoscale energy spectra, 5th Coastal Altimetry Workshop, San Diego, CA USA
- Oedekoven, C. S., Buckland, S. T., Mackenzie, M. L., Campbell, G. S., Thomas, L. and J. A. Hildebrand. 2011. Using spatio-temporal models of line transect abundance estimates for trend estimation. Spoken Presentation: 19th Biennial Conference on the Biology of Marine Mammals, November 27-December 2, 2011, Tampa, Florida
- Roemmich, D. and J. Gilso. 2011. Ocean circulation and the mass and heat budgets of large ocean regions. Invited presentation at the 1st XBT Science Workshop, Melbourne Australia. 1st XBT Science Workshop, Melbourne Australia
- Send, U. and J.A. Koslow. 2011. An integrated ocean observation system for the California Current. Symposium on Integrated Ecosystem Assessment and Ecosystem Modeling of the California Current. CalCOFI Conference, December, 2011, La Jolla, CA



- Lindseth, B. and K. Baker. 2012. Collaborative design of an oceanographic event logger. Proceedings of the ACM 2012 conference on Computer Supported Cooperative Work. Seattle, Washington, USA, ACM, pp. 1195-1198.
- Ting-Chun Kuo, Janet Nye, Franz Mueter, Nicholas K. Dulvy, and Chih-hao Hsieh. 2012. Environmental sensitivity of latitudinal shifts in marine fishes depends on latitude and fishing effects. Ocean Sciences meeting, Salt Lake City, 2012
- Ward, D.M. and A.P. Kinziger. 2012 Upper Klamath River Coho Salmon Workshop: Considerations for Genetic Conservation and Artificial Propagation. Report to California Department of Fish and Game

In Press / Submitted / In Preparation

- Alin, S. R., Feely, R. A., Dickson, A. G., Hernandez-Ayon, J.M., Juranek, L. W., Ohman, M. D., Goericke, R. Robust empirical relationships for estimating pH and carbonate saturation states in the southern California Current System *Journal of Geophysical Research, Oceans* 2011JC007511
- Bestelmeyer, B.T., A.M. Ellison, Fraser.W.R., K. B. Gorman, S. J. Holbrooke, C. M. Laney, M.D. Ohman, D.P.C. Peters, F.C. Pillsbury, A. Rassweiler, R.J. Schmitt, and S. Sharma Analysis of Abrupt Transitions in Ecological Systems *Ecosphere* 2
- Bevacqua D, Capoccioni F, Melià P, Vincenzi S, Pujolar JM, Leo GD, Ciccotti E Fishery-induced selection for slow somatic growth in European eel *PLoS ONE*
- Brown, V. and D. Hively Assessing the assessments: A life history simulator to test stock assessment models and methods *Natural Resource Modeling*
- Carter, B.R., Radich, J.A., Doyle, H.L., & Dickson, A.G An automated system for spectrophotometric seawater pH measurements *Limnology & Oceanography Methods*
- Chang, Yu-Chia, Guan-Yu Chen, Ruo-Shan Tseng, Luca R. Centurioni Observed near-surface flows under category 4 and 5 typhoons using drifters in the northwestern Pacific *J. Phys. Oceanogr.*
- Davis, R.R., W.S. Kessler and J.T. Sherman Gliders measure western boundary current transport from the South Pacific to the Equator *J. Phys. Oceanogr*
- Feely, R. A., Sabine, C. L., Byrne, R. H., Millero, F. J., Dickson, A. G., Wanninkhof, R., Murata, A., Miller, L. & Greeley, D. Decadal changes in the aragonite and calcite saturation state of the Pacific Ocean *Global Biogeochemical Cycles* 2011GB004157
- Giglio, D., D. Roemmich and S.T. Gille Wind-driven variability of the subtropical North Pacific Ocean *Journal of Physical Oceanography*
- Giske, J., Eliassen, S., Fiksen, O., J. Jakobsen, P., Aksnes, D.L., Jørgensen, C. and M. Mangel A psychological theory of animal behavior *PNAS*
- Hitchman S.M., Reynes N.B., Thompson A.R. Age-specific association with potential adult habitat in larval bocaccio, *Sebastes paucispinis*, in the Southern California Bight Marine Ecology Progress Series
- Kahru, M., E. Di Lorenzo, M. Manzano-Sarabia and B. G. Mitchell Spatial and temporal statistics of sea surface temperature and chlorophyll fronts in the California Current *Journal of Plankton Research*
- Koslow, J.A., R. Goericke, W. Watson. Climate and fish assemblages in the southern California Current *Fisheries Oceanography*
- Lee, D.-K., and L.R. Centurioni. Wintertime Subtropical Current in the Northwestern Pacific. *Deep Sea Res*
- Levi, T., Darimont, C.T., MacDuffee, M., Mangel, M., Paquet, P., Wilmers, C.C. Using Grizzly bears to assess harvest and ecosystem tradeoffs in salmon fisherie *PLoS Biology*
- Levi, T., Wilmers, C.C. Wolves-Coyotes-Foxes: A cascade among canids *Ecology*
- MacCall, A. D., Hill, K. T., Crone, P., and Emmett, R. Weak evidence for sardine collapse *Proceedings of the National Academy of Sciences*
- Macías, D., P. Franks, M. Ohman and M. Landry Modeling the effects of coastal wind-and wind-stress curl-driven upwellings on plankton dynamics in the Southern California current system. *Journal of Marine Systems*
- Maximenko, N., R. Lumpkin and L. Centurioni Ocean Surface Circulation "Ocean Circulation and Climate", edited by G. Siedler and J.W. Gould.
- McClatchie, S., R. K. Cowen, K. M. Nieto, A. Greer, J. Y. Luo, C. Guigand, D. A. Demer, D. A. Griffith, and D. L. Rudnick Resolution of fine biological structure including small narcomedusae across a front in the Southern California Bight *Journal of Geophysical Research*
- McClatchie, S., R.K. Cowen, K.M. Nieto, A. Greer, J.Y. Luo, C. Guigand, D.A. Demer, D.A. Griffith, D.L. Rudnick. Resolution of fine biological structure including small narcomedusae across a front in the Southern California Bight *Journal of Geophysical Research*
- Micheli, F., K.W. Heiman, C.V. Kappel, R.G. Martone, J.M. Tanner, S.A. Sethi, G.C. Osio, S. Fraschetti, and A.O. Shelton Combined impacts of natural and human disturbances on rocky shore communities *Marine Ecology*



- Nevison, C. D., R. F. Keeling, M. Kahru, M. Manizza, B. G. Mitchell, and N. Cassar Estimating net community production in the Southern Ocean based on atmospheric potential oxygen and satellite ocean color data *Global Biogeochem. Cycles*, doi:10.1029/2011GB004040
- Satterthwaite, W. H., and M. Mangel Using behavioral models to predict impacts of environmental change on seabirds and fur seals *Deep Sea Research II*
- Satterthwaite, W. H., M. S. Mohr, M. R. O'Farrell, and B. K. Wells A Bayesian hierarchical model of size-at-age in ocean-harvested stocks – quantifying effects of climate and temporal variability *Canadian Journal of Fisheries and Aquatic Sciences*
- Satterthwaite, W. H., S. A. Hayes, J. E. Merz, S. M. Sogard, D. M. Frechette, and M. Mangel State-dependent migration timing and use of multiple habitat types in anadromous salmonids. *Transactions of the American Fisheries Society*
- Send, U., and S. Nam Relaxation from Upwelling: the effect on dissolved oxygen on the continental shelf *J. Geophys. Res*
- Send, U., L. Regier, and B. Jones Use of underwater gliders for acoustic data retrieval from subsurface oceanographic instrumentation and bi-directional communication in the deep ocean *J. Atmos. Ocean. Techn*
- Seth D. Newsome,* Justin D. Yeakel, Patrick V. Wheatley, AND M. Tim Tinker Tools for quantifying isotopic niche space and dietary variation at the individual and population level *J. Mammalogy*
- Shelton, A. O., W.H. Satterthwaite, M. P. Beakes, S. B. Munch, S. M. Sogard, and M. Mangel Among individual and among population variation in growth: estimating intrinsic and environmental contributions to growth of steelhead trout *American Naturalist*
- Shelton, A.O.(Book Review) "Modelling and quantitative methods in fisheries" by M. Haddon. *The American Statistician*
- Shelton, A.O. and M. Mangel Estimating von Bertalanffy parameters with individual and environmental variation in growth *Journal of Biological Dynamics*
- Shelton, A.O. S.B. Munch, D. Keith, M. Mangel Maternal age, fecundity, egg quality, and recruitment: linking Stock structure to recruitment using an age-structured Ricker model *Canadian Journal of Fisheries and Aquatic Sciences*
- Thompson, A. R., W. Watson, S. McClatchie and E. D. Weber Multi-scale sampling to evaluate assemblage dynamics in an oceanic marine reserve *PLoS ONE*
- Todd, R. E., D. L. Rudnick, M. R. Mazloff, B. D. Cornuelle, and R. E. Davis Thermohaline structure in the California Current System: observations and modeling of spice variance *Journal of Geophysical Research*
- Vincenzi S, Crivelli AJ, Jesensek D, Leo GA Translocation of stream-dwelling salmonids in headwaters: insights from a 15-year reintroduction experience *Reviews in Fish Biology and Fisheries*
- Vincenzi, S., W. H. Satterthwaite, and M. Mangel Spatial and temporal scale of density-dependent body growth and its implications for recruitment, population dynamics and management of stream-dwelling salmonid populations *Reviews in Fish Biology and Fisheries*. DOI: 10.1007/s11160-011-9247-1
- Zhang, X., B. Cornuelle, and D. Roemmich Sensitivity of western boundary transport at the mean North Equatorial Current bifurcation latitude to wind forcing *Journal of Physical Oceanography*
- Zilberman, N., D. Roemmich and S. Gille The mean and the time-variability of the shallow meridional overturning circulation in the tropical South Pacific Ocean *Journal of Physical Oceanography*
- Zilberman, N.V., D.H. Roemmich, and S.T. Gille The mean and the time-variability of the shallow meridional overturning circulation in the tropical South Pacific Ocean *Journal of Climate*
- Hofmann, G.E. , J.E. Smith, K.S. Johnson, U. Send, L.A. Levin, F. Micheli, A. Paytan, N.N. Price, B. Peterson, Y. Takeshita, P.G. Matson, E.D. Crook, K.J. Kroeker, M.C. Gambi, E.B. Rivest, C.A. Frieder, P.C. Yu, T.R. Martz High-Frequency Dynamics of Ocean pH: A Multi-Ecosystem Comparison *PLoS ONE* 6(12): e28983. doi:10.1371/journal.pone.0028983
- Koslow J.A., L. Rogers-Bennett, D.J. Neilson A time series of California spiny lobster (*Panulirus interruptus*) phyllosoma from 1951 to 2008 links abundance to warm oceanographic conditions in southern California *CALCOFI Reports*
- Thompson A.R., W. Watson, S. Manion Ichthyoplankton, paralarval cephalopod, and station data for surface (manta) and oblique (Bongo) plankton tows for California Cooperative Oceanic Fisheries Investigations survey and California Current Ecosystem survey cruises in 2009. U.S. Dep. Commer., NOAA Tech. Memo., NOAA-TM-NMFS-SWFSC. 177 pp.
- L. Centurioni 2011 Progress Report ,The Global Drifter Program
- Satterthwaite, W. H., A. S. Kitaysky, and M. Mangel Linking climate variability, productivity and stress in predicting demography in a long-lived seabird *Marine Ecology Progress Series*. DOI: 10.3354/meps09539
- Sogard, S. M., J. E. Merz, W. H. Satterthwaite, M. P. Beakes, D. R. Swank, E. M. Collins, R. G. Titus, and M. Mangel Contrasts in growth rates and life history patterns of juvenile steelhead in stream systems of California's central coast and Central Valley *Transactions of the American Fisheries Society*



PUBLICATION SUMMARY

	CIMEC Lead Author				NOAA Lead Author				Other Lead Author			
	2010-11	2011-12	2012-13	2013-14	2010-11	2011-12	2012-13	2013-14	2010-11	2011-12	2012-13	2013-14
Peer Reviewed	22	30			24	7			11	44		
Non Peer Reviewed	19	12			14	8			7	14		
	41	42			38	15			18	58		

Total Publications for this period: 115



ACRONYMS

AMLR	Antarctic Marine Living Resources Program
AOML	NOAA/Atlantic Oceanographic and Meteorological Lab
BAS	Birch Aquarium at Scripps
BML	Bodega Marine Laboratory, UC Davis
CA COSEE	California Center for Ocean Science Excellence in Education
CalIT	California Institute of Technology
Cal State	California State University system
Caltrans	California Department of Transportation
CAP	California Applications Program
CBNMS	Cordell Banks National Marine Sanctuary
CDFG	California Department of Fish and Game
CEC	California Energy Commission
CEFA	Climate, Ecosystem and Fire Applications
CeNCOOS	Central and Northern California Ocean Observing System
CEOP	Coordinated Enhanced Observing Period
ChESS	Biogeography of Deep-Water Chemosynthetic Ecosystems / Census of Marine Life
CICAR	Cooperative Institute for Climate Applications and Research, Palisades, New York
CICOR	Cooperative Institute for Climate and Ocean Research, Woods Hole, Massachusetts
CICS	Cooperative Institute for Climate Science, Princeton, New Jersey
CIFAR	Cooperative Institute for Arctic Research, Fairbanks, Alaska
CILER	Cooperative Institute for Limnology and Ecosystems Research, Ann Arbor, Michigan
CIMAS	Cooperative Institute for Marine and Atmospheric Studies, Miami, Florida
CIMMS	Cooperative Institute for Mesoscale Meteorological Studies, Norman, Oklahoma
CIMRS	Cooperative Institute for Marine Resource Studies
CIMSS	Cooperative Institute for Meteorological Satellite Studies, University of Wisconsin, Madison
CIOSS	Cooperative Institute for Oceanographic Satellite Studies
CIRA	Cooperative Institute for Research in the Atmosphere
CIRES	Cooperative Institute for Research in Environmental Sciences
CLIMAS	Climate Assessment for the Southwest
CLSA	California Land Surveyors Association
CMER	Cooperative Marine Education and Research
CNES	Centre National d'Etudes Spatiales



COML	Census of Marine Life
COP	NOAA/NOS/Center for Sponsored Coastal Ocean Research/Coastal Ocean Program
CPO	NOAA/Climate Programs Office (formerly, Office of Global Programs (OGP))
CRIP	Centro Regional de Investigacion Pesquera, Instituto Nacional de la Pesca, Ensenada/La Paz, Mexico
CRTN	California Real Time Network
CSIRO	Commonwealth Scientific and Industrial Research Organisation--Australia
CSRC	California Spatial Reference Center
CTD	Conductivity Temperature and Depth (as in, Underway CTD)
DBCP	Data Buoy Cooperation Panel, WMO-IOC
DOE	U.S. Department of Energy
DWR	California Department of Water Resources
ECCO	SIO's Estimating the Circulation and Climate of Oceans Consortium
ENSO	El Niño and Southern Oscillation
ESRL	NOAA/Earth System Research Laboratory
FKNMS	NOAA/Florida Keys National Marine Sanctuary
GACC	Geographic Area Coordination Centers
GEOSS	Global Earth Observation System of Systems
GEWEX	Global Energy and Water-cycle Experiment
GIS	Geographic Information Systems
GMD	NOAA/ESRL/Global Monitoring Division
GODAE	Global Ocean Data Assimilation Experiment
GPS	Global Positioning System
GSD	NOAA/ESRL/Global Systems Division
GTS	GNU Triangulated Surface
HRC	Hydrologic Research Center, San Diego, CA
HRX	Repeat high resolution expendable Bathythermograph
ICARTT	International Consortium for Atmospheric Research on Transport and Transformation
IOC	Intergovernmental Oceanographic Commission
IOOS	Integrated and Sustained Ocean Observations
IRD	Institut de Recherche pour le Développement
IRI	International Research Institute for Climate Prediction
JCOMM	Joint WMO-10C Technical Commission for Oceanography and Marine Meteorology
JIMAR	Joint Institute for Marine and Atmospheric Research
JIMO	Joint Institute for Marine Observations
JISAO	Joint Institute for the Study of Atmosphere and Ocean



JPL	Jet Propulsion Laboratory, NASA
MBARI	Monterey Bay Aquarium Research Institute
MIT	Massachusetts Institute of Technology, Harvard
MPI	Max Planck Institute, Germany
MPL	Marine Physical Laboratory, SIO, UCSD
NASA	National Aeronautics and Space Administration
NDBC	NOAA/NWS/National Data Buoy Center
NCAR	National Center for Atmospheric Research
NCEP	NOAA/National Centers for Environmental Predictions
NEFSC	NOAA/Northeast Fisheries Science Center
NESDIS	NOAA/National Environmental Satellite, Data, and Information Services
NGI	Northern Gulf Institute
NGS	NOAA/National Geodetic Survey
NIWA	National Institute of Water and Atmospheric Research, New Zealand
NMFS	NOAA/National Marine Fisheries Service
NMSP	National Marine Sanctuary Program
NOS	NOAA/National Ocean Service
NSF	National Science Foundation
NWFSC	NOAA/Northwest Fisheries Science Center, NMFS
NWS	NOAA/National Weather Service
OAP	NOAA/Ocean Assessment Program
OAR	NOAA/Ocean and Atmospheric Research
OE	NOAA/Office of Ocean Exploration
OGCM	Oceanic General Circulation Model
OGP	See CPO
ONR	Office of Naval Research
ORA	NOAA/Office of Research and Applications
PDO	Pacific Decadal Oscillation
PFEG	NOAA/NMFS/Pacific Fisheries Environmental Group
PIFSC	NOAA/NMFS/Pacific Islands Fisheries Science Center
PMEL	NOAA/Pacific Marine Environment Lab
R/V	Research Vessel
ROWG	Radio Operators Working Group
SAS	Simplified Arakawa-Schubert cumulus convection scheme
SCCWRP	Southern California Coastal Water Research Project



SDG&E	San Diego Gas & Electric
SEFSC	NOAA/Southeast Fisheries Science Center, Panama City, FL
SIO	Scripps Institution of Oceanography, UCSD
SOPAC	Scripps Orbit and Permanent Array Center
SST	Sea surface temperature
SVP	Surface Velocity Program
SWFSC	NOAA/Southwest Fisheries Science Center, NMFS
UC	University of California
UCD	University of California, Davis
UCLA	University of California, Los Angeles
UCSB	University of California, Santa Barbara
UCSC	University of California, Santa Cruz
UCSD	University of California, San Diego
UNAM	Universidad Nacional Autonoma de Mexico
USARP	U.S. Antarctic Research Program
USC	University of Southern California
USFS	U.S. Fire Service
USGS	U.S. Geological Survey
UW	University of Washington, Seattle
VAdm	Vice Admiral
VOS	Voluntary Observing Ship
WECC	Western Electricity Coordinating Council
WHOI	Woods Hole Oceanographic Institution
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
XBT	Expendable Bathythermograph
XCTD	Expendable Conductivity Temperature and Depth

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Oliver L. Asis

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Cooperative Institute for Marine Ecosystems and Climate
Scripps Institution of Oceanography
University of California, San Diego
291 Rosecrans Street
San Diego, California 92106

