CalCOFI Conference

8-10 December 2014

Scripps Institution of Oceanography
La Jolla, CA

Hosted by:

Scripps Institution of Oceanography

CalCOFI Coordinator: John Heine
Symposium Convener: Dave Checkley

In association with:
Southwest Fisheries Science Center, NOAA
California Department of Fish and Wildlife

CalCOFI Conference 2014

Scripps Institution of Oceanography
La Jolla, CA
Dec. 8-10

Monday, 8 December

12:30-1:30	Registration – Seaside Forum, SIO
1:30-1:45	**Opening of the Conference** Welcome: Dave Checkley, Scripps Institution of Oceanography
1:45-2:45	**Session I: Status of the California Current** Andrew Leising, Southwest Fisheries Science Center, NOAA
2:45-3:00	Break. Registration continues
3:00-5:15	**Session II: Status of the Fisheries** Chair: Dianna Porzio, California Department of Fish and Wildlife
3:00-3:15	Coastal pelagic species – Anna Holder
3:15-3:30	Groundfish – Bob Leos
3:30-3:45	Pacific bluefin tuna – Trung Nguyen
3:45-4:00	Basses – Heather Gliniak
4:00-4:15	Surfperch – Kristine Lesyna
4:15-4:30	Red abalone – Cynthia Catton
4:30-4:45	Kelp and edible algae – Rebecca Flores Miller
4:45-5:00	Marine aquaculture – Kirsten Ramey
5:00-5:15	Ocean salmon – Alex Letvin

Poster Session

5:15-7:15	**Ted Scripps Room, SIO.** Beer, wine, and non-alcoholic beverages, hors d'oeuvres, and dessert.

P-1. **Ocean Salmon Monitoring and Management Project.** Melodie Palmer-Zwahlen, Brett Kormos, Jennifer Simon, James Phillips, Barry Miller, Alex Letvin, Kandice Morgenstern, California Department of Fish and Wildlife, Marine Region, Ocean Salmon Project.

P-2. **Zooplankton of the San Diego Region Website.** Linsey M. Sala and Mark D. Ohman, Scripps Institution of Oceanography, University of California San Diego.

P-3. **Sampling requirements for long-term ecological monitoring of fish communities.** Tony Koslow[1] and Melaina Wright[2], [1]Scripps Institution of Oceanography, University of California, S.D., [2]Wellesley College.

P-4. **Development of a "live" State of the California Current website.** Leising, A.W., Dewitt, L., Hazen, E., Bograd, S.J., and Garfield, N., NOAA-SWFSC-ERD.

P-5. **Chaetognaths distribution and abundance in the central region of the Gulf of California during March 2010 (the onset of El Niño event 2009-2010).** María Soledad Cota-Meza, Jaime Gómez-Gutiérrez, Arturo Sánchez-Uvera, Instituto Politécnico Nacional, Centro Interdisciplinario de Ciencias Marinas, Departamento de Plancton.

P-6. **Variability in the $\delta^{18}O$ of *Uvigerina peregrina* at intermediate depth in the northeastern Pacific.** Juarez, M., Sánchez, A.[*], Cota-Meza S., Piña, J. [1]Centro Interdisciplinario de Ciencias Marinas, Instituto Politécnico Nacional, México.

P-7. **Hydrography of the Point Loma continental shelf: 2006 – 2013.** W. Enright[1], P.E. Parnell[2], A. Latker[1], A. Feit[1], G. Welch[1], T. Stebbins[1], [1]City of San Diego Marine Biology Laboratory, Public Utilities Department, San Diego, CA, [2]Scripps Institution of Oceanography, Integrative Oceanography Division, University of California, San Diego.

P-8. **Climate variability in the CCS from a 31-year (1980-2010) historical analysis computed using the ROMS 4D-Var Data Assimilation System.** William J. Crawford[1], Andrew M. Moore[1], Michael G. Jacox[2], Emilie Neveu[3], Christopher A. Edwards[1] and Jerome Fiechter[1], [1]University of California, Santa Cruz, Department of Ocean Sciences, [2]NOAA, Pacific Grove, [3]Laboratoire des Mathématiques de l'Université de Savoie, Chambery, France.

P-9. **Eureka! A review of California's commercial market squid fishery and the extension of effort north in 2014.** Laura Ryley and Chelsea Protasio, California Department of Fish and Wildlife.

P-10. **Collaborative research in the Rockfish Conservation Areas: using a stereo video system to map distribution and measure lengths of species targeted in fisheries management.** Corina Marks[1], Rick Starr[1,2], Mary Gleason[3], John Field[4], Huff McGonigal[5,6], Donna Kline[1], Christian Denney[1], Anne Tagini[1], Becky Miller[4], Amber Payne[4], Steve Rienecke[3], [1]Fisheries and Conservation Biology Lab, Moss Landing Marine Labs, [2]California Sea Grant, [3]The Nature Conservancy, [4] Southwest Fisheries Science Center, National Marine Fisheries Service, [5] Fathom Consulting, [6] Environmental Defense Fund.

P-11. **Preliminary assessment of the response of rockfish populations to Rockfish Conservation Area closures in Central California.** Ryan Fields[1], Sabrina Beyer[2], Corina Marks[1], Rebecca Miller[2], Sue Sogard[2], John Field[2], Dan Howard[3], Dale Roberts[3], Deb Wilson-Vandenberg[4], Rick Starr[1,5], [1]Moss Landing Marine Laboratories, [2] National Marine Fisheries Service, [3]Cordell Bank Marine Sanctuary, [4]California Department of Fish and Wildlife, [5]California Sea Grant Extension Program.

P-12. **Fluctuations in larval rockfish assemblages in the Southern California Bight through time.** Dustin C. Chen[1], Andrew R. Thompson[2], John R. Hyde[2], [1]University of San Diego, Department of Environmental and Ocean Sciences, [2]NOAA Southwest Fisheries Science Center, Fisheries Resources Division.

P-13. **Comparison of the distributions and concentrations of larval and young-of-the-year flatfishes off the central Oregon coast.** Toby Auth[1], Matthew Yergey[1], Waldo Wakefield[2], Lorenzo Ciannelli[3], Richard Brodeur[4], William Peterson[4], Jay Peterson[5], [1]Pacific States Marine Fisheries Commission, [2]NOAA Fisheries, Northwest Fisheries Science Center (NWFSC), Fishery Resource Analysis and Monitoring Division, [3]Oregon State University, College of Earth, Ocean, and Atmospheric Sciences, [4]NOAA Fisheries, NWFSC, Fish Ecology Division, [5]Cooperative Institute for Marine Resources Studies.

P-14. **Exploratory nearshore habitat analyses from the southern California coastal pelagic species aerial survey.** Alex Kesaris, Kirk Lynn, Dianna Porzio and Anna Holder, California Department of Fish and Wildlife, Marine Region, Coastal Pelagic Species Unit.

P-15. **Following market squid paralarvae abundance through an ENSO transition, preliminary observations from a cooperative research program.** Joel Van Noord[1], Emmanis Dorval[2], Briana Brady[3], [1]California Wetfish Producer's Association, [2]Southwest Fisheries Science Center, [3]California Department of Fish and Wildlife.

P-16. **Relating otolith growth parameters to somatic growth from laboratory-reared Pacific mackerel (*Scomber japonicus*).** Julianne Taylor[1, 2], Emmanis Dorval[1, 2], Jenny McDaniel[1], and Helena Aryafar[1, 2], [1]Fisheries Resources Division, Southwest Fisheries Science Center SWFSC), [2]Ocean Associates Inc. (OAI), Contracted to SWFSC.

P-17. **Developing Improved Spatial Maps of the Distribution of Rebuilding Stocks in the Rockfish Conservation Area (RCA) To Inform Fishing and Management.** [1]Donna Kline, [2]Mary Gleason, [1]Rick Starr, [1]Fisheries and Conservation Biology Lab, Moss Landing Marine Laboratories, [2]The Nature Conservancy.

P-18. **Aerial survey of small pelagic species in the Southern California Bight.** Kirk Lynn, Dianna Porzio, Alex Kesaris, California Department of Fish and Wildlife.

P-19. **NOAA CalCOFI Genomics Project (NCOG): Microbial 'Omics in the Southern California Bight.** Talina Konotchick[1,2], Ariel Rabines[1], Hong Zheng[1], Shonna Dovel[2], Megan Roadman[2], Kelly Goodwin[3,4], Margot Bohan[5], Andrew Thompson[3], Cisco Werner[3], Ralf Goericke[2], Dave Checkley[2], Andrew E. Allen[1,2], [1]J.Craig Venter Inst., [2]Scripps Inst. of Oceanography, [3]NOAA Southwest Fisheries Science Center, [4]NOAA Atlantic Oceanographic & Meteorological Laboratories, [5]NOAA Office of Exploration & Research.

P-20. **Coherence, variability, and potential predictability of mid-shelf copepod assemblages of the northern California Current.** Eric Bjorkstedt[1,2], Bill Peterson[3], [1]NOAA Fisheries SWFSC, Fisheries Ecology Division, [2]Humboldt State University, Department of Fisheries Biology, [3]NOAA Fisheries NWFSC.

Tuesday, 9 December

8:00-8:30 Registration – Seaside Forum, SIO

8:30 **Session III: The Symposium of the Conference: Predicting the California Current System.**
Chair: Dave Checkley, Scripps Institution of Oceanography

8:30-8:40 Introduction and overview. Dave Checkley, Scripps Institution of Oceanography.

8:40-9:20 S-1. **Representation of Eastern Boundary Currents in GFDL's Earth System Models.** John P. Dunne, Jasmin G. John, and Charles A. Stock, NOAA Geophysical Fluid Dynamics Laboratory.

9:20-10:00 S-2. **Climate—Boundary Current Interactions: Stories from East and West.** Enrique Curchitser, Rutgers University, USA, Justin Small and William Large, National Center for Atmospheric Research, USA, Raphael Dussin, Rutgers University, USA, Kate Hedstrom, U. Alaska Fairbanks, USA, Brian Kaufman, National Center for Atmospheric Research, USA.

10:00-10:40 S-3. **End-to-end modeling of sardine and anchovy in the California Current System.** Kenneth A. Rose[1], Jerome Fiechter[2], Enrique N. Curchitser[3], Kate Hedstrom[4], plus 13 others, [1]LSU, Department of Oceanography and Coastal Sciences, [2]UC at Santa Cruz, Institute of Marine Sciences, [3]Rutgers University, Department of Environmental Sciences, [4]University of Alaska at Fairbanks, Institute of Marine Science.

10:40-11:00 Break

11:00-11:40 S-4. **Hindcasting and nowcasting the physical and biological state of the California Current System.** Christopher A. Edwards[1], Andrew M. Moore[1], Hajoon Song[2], J. Paul Mattern[1], Michael G. Jacox[3,4], and Jerome Fiechter[3], [1]Ocean Sciences Department, University of California, Santa Cruz, CA, [2]Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA, [3]Institute of Marine Sciences, University of California, Santa Cruz, CA, [4]Environmental Research Division, Southwest Fisheries Science Center, NOAA, Monterey, CA.

11:40-12:20 S-5. **Effect of Eddy-Wind Interaction on Ekman pumping and Eddy Kinetic Energy: A Regional Coupled Modeling Study for the California Current System.** Hyodae Seo[1], Arthur J. Miller[2] and Joel R. Norris[2], [1] Woods Hole Oceanographic Institution, [2]Scripps Institution of Oceanography.

12:20-1:20 **Lunch**

1:20-2:00 S-6. **Predicting Hypoxia and Ocean Acidification of the coastal waters of the CCS: What do we know and what can we expect?** Siedlecki, S.A.[1], Hermann, A.[1,2], Bond, N.[1,2], Alin, S.[2], Feely, R.[2], Newton, J[3], [1]University of Washington, JISAO, [2]NOAA, PMEL, [3]University of Washington, APL.

2:00-2:40 S-7. **End-to-end modeling to predict global change effects in the California Current ecosystem.** Isaac Kaplan, NOAA Fisheries, Northwest Fisheries Science Center.

2:40-3:20 S-8. **Predicting the Future in a Nonlinear World.** Hao Ye, Ethan Deyle, George Sugihara, UCSD, Scripps Institution of Oceanography.

3:20-3:40 Break

3:40 **Session IV: Contributed Papers (15 minutes with 5 minutes for discussion).** Chair: Laura Rogers-Bennett, Calif. Dept. of Fish and Wildlife.

3:40-4:00 C-1. **Dramatic declines in coastal and oceanic fish communities off California linked to climate.** J. Anthony Koslow[1], Eric F. Miller[2], John A. McGowan[1], [1] Scripps Institution of Oceanography, University of California, S.D., La Jolla, CA 92093, [2] MBC Applied Environmental Sciences, 3000 Red Hill Ave., Costa Mesa, CA 92626.

4:00-4:20 C-2. **Forecasting cetacean abundance patterns to enhance management decisions.** E. A. Becker[1], D.G. Foley[1, 2], K.A. Forney[1], J. Barlow[1], J.V. Redfern[1], C.L. Gentemann[3]. [1]NOAA National Marine Fisheries Service, Southwest Fisheries Science Center, [2]Joint Institute for Marine and Atmospheric Research, University of Hawaii, [3]Remote Sensing Systems Inc., Santa Rosa, CA.

4:20-4:40 C-3. **Beyond the mean: 'Event-scale' phenomena and their relationship to ecosystem forecasting**. Mark D. Ohman[1], Uwe Send[1], Dan L. Rudnick[1], David A. Demer[2], Todd R. Martz[1], Richard A. Feely[3]. [1]Scripps Institution of Oceanography, La Jolla, [2]Southwest Fisheries Science Center, NMFS/NOAA, La Jolla, [3]Pacific Marine Environmental Laboratory, NOAA, Seattle.

4:40-5:00 C-4. **Towards an operational HAB forecasting system for coastal California.** Clarissa Anderson[1,6], Fred Bahr[2], Leslie Rosenfeld,[2] Mati Kahru[3], Richard Stumpf[4], David Green[5*], and Raphael Kudela[6]. [1]University of California, Santa Cruz, Institute of Marine Sciences, [2]CeNCOOS, Central and Northern California Ocean Observing System, [3]Scripps Institution of

Oceanography, Integrative Oceanography Division, [4]National Oceanic and Atmospheric Administration, NCCOS, [5]National Oceanic and Atmospheric Administration, National Weather Service *now with NASA Applied Sciences Program, [6]University of California Santa Cruz, Ocean Sciences Department.

Reception

5:00-7:00 Seaside Terrace, Scripps Institution of Oceanography. Beer, wine, and non-alcoholic beverages, hors d'oeuvres, desert.

Wednesday, 10 December

8:30 **Session V: Contributed Papers (15 minutes with 5 minutes for discussion).** Chair: Sam McClatchie, NOAA Southwest Fisheries Science Center.

8:30-8:50 C-5. **Ocean warming in a microcosm: a novel examination of potential evolution of marine fish response to ocean warming.** Eric Miller, MBC Applied Environmental Sciences, Costa Mesa, CA.

8:50-9:10 C-6. **Are Santa Barbara Basin anchovy scales controlled by a strengthened California Current?** Abella-Gutiérrez[1], J.L., J.C. Herguera[1], Alexandra Hangsterfer[2], [1] Oceanography Division, Centro de investigación Científica y de Educación Superior de Ensenada (CICESE), Baja California, México, [2] Geological Collections, Scripps Institution of Oceanography, University of California.

9:10-9:30 C-7. **Transport patterns of Pacific sardine *Sardinops sagax* eggs and larvae in the California Current.** Edward D. Weber[1], Yi Chao[2], Fei Chai[3], and Sam McClatchie[1], [1]NOAA Southwest Fisheries Science Center, [2]Remote Sensing Solutions, Inc., [3]University of Maine, School of Marine Sciences.

9:30-9:50 C-8. **Dissolved oxygen as a constraint on habitat of mesopelagic fish assemblages in the southern California Current Ecosystem.** Amanda Netburn, UCSD, Scripps Institution of Oceanography.

9:50-10:10 Break

10:10-10:30 C-9. **Inferring the larval rearing grounds of White Seabass, *Atractoscion nobilis*, based on the oxygen isotopic composition of adult otolith cores.** Alfonsina E. Romo Curiel *[1], Sharon Herzka[1], Chugey Sepulveda[2], Scott

Aalbers[2], [1] Centro de Investigación Científica y Educación Superior de Ensenada, [2] Pfleger Institute of Environmental Research.

10:30-10:50 C-10. **Incorporating predictions of North Pacific climatic signals to fishery management: The case of the pacific sardine.** Romeo Saldívar-Lucio[1*], Aida Martinez-López[1], Emanuele Di Lorenzo[2], German Ponce-Diaz[1], Jacquelynne King[3], Gordon McFarlane [3], Christian Salvadeo[1], Daniel Lluch-Cota[4] and José Alberto Zepeda-Dominguez[1], [1]Centro Interdisciplinario de Ciencias Marinas (CICIMAR-IPN), Mexico, [2] School of Earth & Atmospheric Sciences, Georgia Institute of Technology, [3]Pacific Biological Station, Fisheries and Oceans Canada, Nanaimo, BC, Canada, [4] Centro de Investigaciones Biologicas del Noroeste (CIBNOR), BCS, Mexico.

10:50-11:10 C-11. **Forage abundance, quality, and distribution drive food limitation in an expanding California sea lion population.** Sam McClatchie[1], Mark S. Lowry[2], John C. Field[3], Andrew R. Thompson[1], Edward D. Weber[1], William Watson[1], Paul C. Fiedler[2], Karen M. Nieto[4], Russell D. Vetter[1] and Daniel L. Rudnick[5], [1]NOAA Fisheries, SWFSC, Fisheries Resources Division, [2]NOAA , SWFSC, Marine Mammal and Turtle Division, [3] NOAA , SWFSC, Fisheries Ecology Division, Santa Cruz, [4]European Commission Joint Research Center, Institute for Environment and Sustainability, Ispra, Italy, [5]Scripps Institution of Oceanography, UCSD, La Jolla.

11:10-11:30 C-12. **Inter-annual and seasonal trends in cetacean distribution, density and abundance off southern California.** Gregory S. Campbell[1,2], Len Thomas[3], Katherine Whitaker[1], Annie Douglas[4],John Calambokidis[4]and John A. Hildebrand[1], [1]Scripps Institution of Oceanography, University of California San Diego, [2]Marine Mammal Behavioral Ecology Group, Texas A&M University, [3]School of Mathematics and Statistics, University of St Andrews, UK, [4]Cascadia Research Collective, Olympia, WA, USA.

11:30-12:30 Lunch

12:30 **Session VI: Contributed Papers (15 minutes with 5 minutes for discussion).** Chair: Russ Vetter, NOAA Southwest Fisheries Science Center.

12:30-12:50 C-13. **Distribution of Pacific Sardine Spawning Habitat within the Waters of the Mexican and U.S. Exclusive Economic Zones.** Jose Valencia-Gasti[1], Ed Weber[2], Timothy Baumgartner[3], Cleridy Lennert[4], Sam McClatchie[2], [1]UABC, Facultad Ciencias Marinas, [2]SWFSC (NOAA), Fisheries Oceanography, [3] CICESE, Department of Biological Oceanography, [4]IATTC.

12:50-1:10 C-14. **Impacts of basin-scale variability on ichthyoplankton assemblages throughout the California Current Ecosystem.** Andrew R. Thompson[1], Noelle M. Bowlin[1], Sam McClatchie[1], Ed Weber[1], William Watson[1], Martín E. Hernández Rivas[2], Sylvia Patricia A. Jiménez Rosenberg[2], Alejandro T. Hinojosa Medina[2], Richard D. Brodeur[3], and Toby Auth[4], [1] NOAA Fisheries, Southwest Fisheries Science Center, [2]Centro Interdisciplinario de Ciencias, Marinas-Instituto Politécnico Nacional, La Paz, BCS, MEX, [3] Northwest Fisheries Science Center, NOAA Fisheries, Newport, OR, USA, [4]Pacific States Marine Fisheries Commission, Newport, OR, USA.

1:10-1:30 C-15. **From Sea Surface Temperature to Upper Trophic Levels: Anomalous Observations Within the Central California Current in 2014.** Dan P. Robinette, Meredith Elliott, Russell Bradley, Pete Warzybok, Julie Howar, and Jaime Jahncke, Point Blue Conservation Science, California Current Group.

Conference adjourned.

Session III: Predicting the California Current System

SYMPOSIUM ABSTRACTS

S-1. Representation of Eastern Boundary Currents in GFDL's Earth System Models

John P. Dunne, Jasmin G. John, and Charles A. Stock

NOAA Geophysical Fluid Dynamics Laboratory, 201 Forrestal Rd, Princeton NJ 08540

The world's major Eastern Boundary Currents (EBC) are critically important areas for global fisheries. Computational limitations have divided past EBC modeling into two types: high resolution regional approaches that resolve the strong meso-scale structures involved, and coarse global approaches that represent the large scale context for EBCs, but only crudely resolve only the largest scales of their manifestation. These latter global studies have illustrated the complex mechanisms involved in the climate change and acidification response in these regions, with the EBC response dominated not by local adjustments but large scale reorganization of ocean circulation through remote forcing of water-mass supply pathways. While qualitatively illustrating the limitations of regional high resolution studies in long term projection, these studies lack the ability to robustly quantify change because of the inability of these models to represent the baseline meso-scale structures of EBCs. In the present work, we compare current generation coarse resolution (one degree) and a prototype next generation high resolution (1/10 degree) Earth System Models (ESMs) from NOAA's Geophysical Fluid Dynamics Laboratory in representing the four major EBCs. We review the long-known temperature biases that the coarse models suffer in being unable to represent the timing and intensity of upwelling-favorable winds. In promising contrast, we show that the high resolution prototype is capable of representing not only the overall meso-scale structure in physical and biogeochemical fields, but also the appropriate offshore extent of temperature anomalies and other EBC characteristics. In terms of representation of large scale circulation, results were mixed, with the high resolution prototype addressing some, but not all, of the biases in the coarse resolution ESM. The ability to simulation EBCs in the global context at high resolution in global ESMs represents a fundamental milestone towards both seasonal to inter-annual ecological forecasting and long term projection of climate, ecosystem, and acidification baselines and sensitivity.

S-2. Climate—Boundary Current Interactions: Stories from East and West

Enrique Curchitser
Rutgers University, USA

Justin Small
National Center for Atmospheric Research, USA

William Large
National Center for Atmospheric Research, USA

Raphael Dussin
Rutgers University, USA

Kate Hedstrom
U. Alaska Fairbanks, USA

Brian Kaufman
National Center for Atmospheric Research, USA

There is growing evidence that the large-scale climate affects character of oceanic boundary currents and by extension their ecosystems. In this talk, we present results from a climate model integration with a multi-scale ocean component capable of locally enhancing resolution. The model is the NCAR Community Earth System Model (CESM), in which the ocean component contains a high-resolution ROMS nest. We will show results from implementations in the California Current System. Results from the latest century-long integration indicate that the better representation of coastal currents has both regional and global ramifications to the climate system. Furthermore, we will show how the ocean-atmosphere coupled response differs from the one-way forced dynamics, which has implications to simulations of the evolution of upwelling under future climate conditions.

S-3. End-to-end modeling of sardine and anchovy in the California Current System

Kenneth A. Rose[1], Jerome Fiechter[2], Enrique N. Curchitser[3], Kate Hedstrom[4],
plus 13 others

[1]LSU, Department of Oceanography and Coastal Sciences

[2]UC at Santa Cruz, Institute of Marine Sciences

[3]Rutgers University, Department of Environmental Sciences

[4]University of Alaska at Fairbanks, Institute of Marine Science

We describe an end-to-end model of anchovy and sardine population dynamics in the California Current as a proof of principle that such coupled models can be developed and implemented. The end-to-end model is 3-dimensional, time-varying, and multispecies, and consists of four coupled submodels: hydrodynamics, Eulerian nitrogen-phytoplankton-zooplankton (NEMURO NP_2Z_3), an individual-based full life cycle anchovy and sardine submodel, and an agent-based fishing fleet submodel. All submodels were coded within the ROMS software, and used the same resolution spatial grid and were all solved simultaneously to allow for possible feedbacks among the submodels. A historical simulation of 1959-2008 was performed, and analyzed for the causes and factors that affected sardine and anchovy during periods of high versus low abundances. Results illustrate how slightly different temperature and diet preferences between sardine and anchovy can lead to different responses to environmental variability. Simulated adult population fluctuations were associated with age-1 growth (via age-2 egg production) and prey availability for anchovy, while they depended primarily on age-0 survival and temperature for sardine. We conclude with a discussion about the prospects for using such end-to-end models for strategic and tactical predictions.

S-4. Hindcasting and nowcasting the physical and biological state of the California Current System

Christopher A. Edwards[1], Andrew M. Moore[1], Hajoon Song[2], J. Paul Mattern[1], Michael G. Jacox[3,4], and Jerome Fiechter[3]

[1]Ocean Sciences Department, University of California, Santa Cruz, CA

[2]Department of Earth, Atmospheric and Planetary Sciences, Massachusetts Institute of Technology, Cambridge, MA

[3]Institute of Marine Sciences, University of California, Santa Cruz, CA

[4]Environmental Research Division, Southwest Fisheries Science Center, NOAA, Monterey, CA

Models of ocean physics and biogeochemistry provide imperfect representations of nature. Unavoidable errors in atmospheric forcing, initial conditions, and model parameterizations and discretization result in discrepancies between model fields observations. Data assimilation methods rigorously adjust control variables to reduce model-data discrepancies and thereby constrain ocean models to more accurately represent ocean state. We have applied 4-Dimensional Variational Data Assimilation within an implementation of the Regional Ocean Modeling System for the California Current System to produce a 31-year hindcast reanalysis of the physical ocean state from 1980 to 2010. This reanalysis includes a direct estimate of vertical velocity that is distinguished from the usual wind stress-based coastal upwelling index, particularly south of 39N, and reveals upwelling structure that relates to climate variability indices. Separately, we have implemented a new method to also assimilate biogeochemical data into fully coupled physical-biological models. This new approach, referred to as Logarithmic 4-Dimensional Variational Assimilation offers potential for historical reanalyses with internally consistent physical and biological fields. In a 1-year reanalysis, we find that biological assimilation into a moderately complex ecosystem model (NEMURO) yields benefits over use of a simpler (NPZD) model.

S-5. Effect of Eddy-Wind Interaction on Ekman pumping and Eddy Kinetic Energy: A Regional Coupled Modeling Study for the California Current System

Hyodae Seo[1], Arthur J. Miller[2] and Joel R. Norris[2]
[1]Woods Hole Oceanographic Institution, [2]Scripps Institution of Oceanography

The California Current System (CCS) is characterized by the energetic summertime mesoscale and filamentary eddies with typical anomalies in sea surface temperature (SST) and surface current exceeding 2°C and $0.5 cms^{-1}$, respectively. Recent satellite observations show that both SST and surface current at oceanic mesoscales significantly influence the Ekman pumping velocity, suggestive of a subsequent dynamical feedback effect on the eddy energetics. The extent to which this mesoscale coupling is important for the Ekman pumping and the eddy kinetic energy (EKE) budget in the CCS is the focus of this study. A series of the 7-km SCOAR regional coupled model simulations is carried out, in which the effects of mesoscale SST and mesoscale surface current are selectively removed in the formulation of surface wind stress. The total summertime Ekman pumping velocity is explained largely by two terms having comparable magnitudes: the linear Ekman pumping resulting from the curl of wind stress and the nonlinear Ekman pumping due to the gradient of surface vorticity by mesoscale current. The Ekman pumping due to the mesoscale SST through the linear relationship between the wind stress curl and the crosswind SST gradient is comparatively small. The simulated summertime EKE level in the CCS is reduced by ~30% when the mesoscale eddies are allowed to influence the wind stress, and this reduction is almost entirely due to the effect of mesoscale current. Examination of the upper ocean EKE budget terms shows that the dissipation of the EKE results mainly from the increased surface drags associated with a stronger correlation between the eddy-induced current and the wind stress. The change in SST climatology in the CCS is a resulting response from the offshore temperature advection by the mean and eddy currents of the upwelled water over the shelf. The magnitude of the mean SST change is greater with the mesoscale current than the mesoscale SST. Overall, the demonstrated importance of the eddy-wind interactions via mesoscale surface current suggests that the high-resolution ocean and coupled modeling studies over the energetic (sub)mesoscale variability and transient mixed layer fronts need to evaluate the dynamics and impact of small-scale air-sea coupling via surface current.

S-6. Predicting Hypoxia and Ocean Acidification of the coastal waters of the CCS: What do we know and what can we expect?

Siedlecki, S.A.[1], Hermann, A. [1,2], Bond, N. [1,2], Alin, S. [2], Feely, R. [2], Newton, J[3].

[1]University of Washington, JISAO
[2]NOAA, PMEL
[3]University of Washington, APL

Predictions of ocean acidification and hypoxia were incorporated into the IPCC report for the first time last year, and forecasts on shorter time scales have now been developed in the California Current System. High resolution hindcast models capable of simulating hypoxia and ocean acidification events exist and provide the foundation for forecasting efforts. One such forecast system (J-SCOPE) focuses on seasonal timescales for the ocean ecosystem on the Washington and Oregon shelves. J-SCOPE is a product of the combination of a regional oxygen model and large-scale predictions from NOAA's Climate Forecast System (CFS). Results suggest J-SCOPE forecasts have skill on timescales of a few months. Despite these developments, the limits of the predictability of biogeochemical quantities are still the subject of debate. Through comparisons of model hindcasts and re-forecasts for 2009 and 2013 with local observations, predictive capabilites will be examined for SST, oxygen, and pH. Challenges in forecasting on seasonal and other timescales in the coastal environment will also be discussed.

S-7. End-to-end modeling to predict global change effects in the California Current ecosystem

Isaac Kaplan
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Global climate models suggest that by the year 2100, carbon dioxide emissions will lead to as much as a 2.7°C increase in mean sea surface temperature and a decline in pH of 0.13-0.42. Ocean acidification may lead to declines of calcareous corals, benthos, and plankton groups in the California Current, while temperature-induced extinctions and invasions may alter the pelagic community. I will describe new end-to-end models that investigate the cumulative effects of changing temperature and carbonate chemistry in the California Current ecosystem and the fisheries it supports. End-to-end models couple climate, oceanography, food webs, and fisheries. These kinds of large-scale approaches are necessary to fully understand the cumulative and synergistic impacts of global change on multiple parts of the ecosystem. I will describe the predictive role of end-to-end models, specifically for ranking management options and investigating scenarios and hypotheses regarding how global change will unfold. I will differentiate this from the type of predictive skill that we expect from tactical models (e.g. stock assessment models) or short-term forecasts (e.g. JSCOPE seasonal predictions). Finally, I will discuss best practices that are being adopted for such models in the California Current, including multi-model approaches and review by fishery management committees and external experts.

S-8. Predicting the Future in a Nonlinear World

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Complex nonlinear dynamics are a general characteristic of ecosystems and a challenge for scientists who seek to understand, model, and manage them. These complex dynamics can result from the interaction between endogenous fluctuations, external forcing, and noise (i.e., stochasticity); and can lead to gradual shifts, switching between alternative stable states, deterministic chaos, mirage correlations, and critical transitions. However, common approaches based on parametric models assume that the hypothesized equations are essentially correct, and thus can lack the flexibility to describe important nonlinear behaviors. Here, we examine Empirical Dynamic Modeling (EDM) as a nonparametric alternative, and discuss 3 real-world examples: (1) identification of a causal linkage between sea-surface temperature and Pacific sardine populations in the California Current System, (2) an investigation into the influence of environmental variability on Fraser River sockeye salmon recruitment, and (3) predictions of algal blooms in the Southern California Bight. These examples demonstrate the utility of EDM as an empirical, data-driven approach for understanding and predicting the future in a nonlinear world.

CONTRIBUTED ABSTRACTS

C-1. Dramatic declines in coastal and oceanic fish communities off California linked to climate

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The CalCOFI ichthyoplankton surveys and southern California power plant intake (PPI) sampling programs provide independent, complementary time series to assess the health of fish communities off southern California from nearshore to oceanic environments. The PPI program has sampled the shallow nearshore fish community at 5 sites along the coast of southern California since 1972, while CalCOFI has sampled the region's fish larvae at standard stations ranging from 50 m depth to more than 500 km offshore since 1951. Many taxa in both data sets were either not present or infrequently sampled by the other. However, both time series recorded a dramatic decline in overall fish abundance since the 1970s: 78% for nearshore fishes (PPI) and 72% in larval fish abundance across the California Current (CC) system (CalCOFI). Although there was only modest overlap in taxa between the time series, dominant multivariate patterns in the two data sets (principal component (PC) 1_{PPI} and PC $2_{CalCOFI}$) were highly correlated: $r = 0.85$, $p < 0.001$. The pattern of decline was highly correlated across fish assemblages from nearshore to oceanic habitats, including epipelagic, mesopelagic, and benthopelagic fishes, unexploited as well as exploited fishes, and taxa across several trophic levels. These changes span several shifts of the Pacific Decadal Oscillation, suggesting the influence of secular climate change. The patterns are correlated with warming sea-surface temperatures, declining upwelling, and reduced transport of the CC, which advects nutrients and planktonic prey from higher latitudes. The marked decline in fishes over the past four decades suggests that climate change has produced more losers than winners in the southern CC and highlights the importance of long time series to observe and, potentially, to predict change in coastal and oceanic fish populations.

C-2. Forecasting cetacean abundance patterns to enhance management decisions

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Species-environment models are increasingly recognized as valuable tools for assessing protected species distributions and assisting decision-makers in the development and implementation of spatially explicit measures to reduce or avoid adverse impacts. Cetacean-habitat models that estimate fine-scale distribution and abundance patterns have been developed during the past two decades based on historical survey data, yielding model-based estimates of average species density within the California Current Ecosystem. In this study, we present methods to improve such habitat-based models to include near real-time and forecast capabilities using remotely sensed and modeled oceanographic data. Recent advancements in processing satellite-derived data (e.g., microwave/infrared blended sea surface temperature [SST] products) have virtually eliminated data loss due to cloud cover, allowing short-term forecasts based on single-day snapshots of oceanic conditions. Ocean circulation models (e.g., the Regional Ocean Modeling System, ROMS) allow medium-range forecast predictions of oceanic variables, including SST, salinity, chlorophyll, and mixed layer depth. We incorporated daily blended SST data and monthly ROMS SST forecasts as input variables for California Current cetacean-habitat models built with historical data, and evaluated their performance using sightings from a 2008 cetacean survey. For the three species we evaluated, predictions from models using daily blended multi-sensor SSTs were in good agreement with the actual observations during the subsequent month. Longer-term (3-4 month) predictive capability also showed good concordance between observed sighting locations and model predictions. Cetacean-habitat models that allow forecasting of cetacean abundance on time scales of weeks or months can greatly enhance both short-term decision-making and effective advanced mitigation planning.

C-3. Beyond the mean: 'Event-scale' phenomena and their relationship to ecosystem forecasting

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The advent of mooring and glider programs in the southern California Current System has made it possible to resolve 'event-scale' perturbations in the upper ocean, a significant advance over the coarse temporal and spatial resolution of the past. The detection and resolution of high-frequency phenomena is important because these events are thought to play a disproportionate role in determining nutrient fluxes, organism exposure to acidified waters and hypoxia, larval fish feeding success, and carbon export. We will illustrate examples of both temporal and spatial 'events' that have significant ecosystem impacts. Moored observations resolve upwelling event-triggered blooms, causing low pH, undersaturated conditions that first augment, then draw down pCO_2. Such observations also permit us to measure nitrate consumption and relate it to phytoplankton abundance and rapid changes of f-ratios. Echotag acoustic sensors on the moorings resolve zooplankton and fish, permitting detection of responses to changes in habitat conditions. *Spray* glider-based observations have revealed the importance of biophysical frontal systems, which are typically regions of abrupt changes (and often local increases) in phytoplankton Chl-*a* and zooplankton acoustic backscatter. Glider studies have also uncovered regions of locally elevated mixing that may affect nutrient availability.

As climate variability and climate change are expected to alter the statistical distributions of such events (i.e., their magnitude, frequency, and duration), it is increasingly important to incorporate event-scale phenomena into forecasts of the California Current Ecosystem.

C-4. Towards an operational HAB forecasting system for coastal California

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A feasibility demonstration is underway for operational HAB forecasting in coastal California, building on years of proof-of-concept studies in various hot spots off the U.S. West Coast. This project introduces a method for predicting the spatial likelihood of *Pseudo-nitzschia* blooms and dangerous levels of domoic acid (DA) using a unique blend of numerical models, ecological forecast models of target phytoplankton species, and satellite ocean color imagery. What we consider to be the most innovative aspect of our approach is the merger of satellite data with numerical forecasts of the physical data to statistically reconstruct biogeochemical fields up to three days to then force our existing statistical models for forecasting HAB events. Daily predictions that merge reconstructed satellite fields with ROMS model output are run routinely at the Central and Northern California Ocean Observing System (CeNCOOS) and posted on their website for dissemination to a select group of test end-users in aquaculture, public health, and marine mammal management. We present a case study for Spring 2014, one of the largest domoic acid events on record with unprecedented closures of sardine and anchovy fisheries in the Monterey Bay region. Model predictions were well correlated at a week lead-time with shellfish and fishery closures. Historical stranding data are compared with model hindcast runs, and marine mammals appear to be good sentinels of the offshore onset of a DA event at large spatial scales. Citizen observations of mammal strandings as part of this project provide quality control for offshore DA predictions.

C-5. Ocean warming in a microcosm: a novel examination of potential evolution of marine fish response to ocean warming

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Faunal shifts in response to ocean warming are commonly documented through time series analysis of long-term monitoring or fisheries data. While strong evidence from these studies remain correlative in nature, more focused process studies are logistically infeasible due to the variety of factors involved, such as replication, sufficient sample size, species diversity, and temperature control of the water. The one-of-a-kind fish return systems built into the cooling water system (CWS) at San Onofre Nuclear Generating Station Units 2 and 3 afforded an opportunity to replicate ocean warming in a microcosm. Unique surveys designed to increase fish return rates during CWS maintenance monitored the species composition and abundance within the CWS as the ambient seawater temperature was gradually increased by manipulating portions of the CWS plumbing. These surveys were replicated several times a year from 1989 through 2012 at each unit for a n = 217. All fishes were representative of ambient populations in the area of the CWS intakes located approximately 900 m offshore. Fauna transitioned throughout the survey period as the ambient water temperature was raised within the CWS. Nearshore species composition at the start of the survey when water temperatures were cooler were consistent with cooler-water affinity, smaller species (such as Northern Anchovy) and transitioned to deeper-bodied, warmer-water affinity species as water temperatures reached ≥ 27°C (such as Spotfin Croaker). These data provide a more refined insight into the possible future of coastal marine fish communities under progressive ocean warming.

C-6. Are Santa Barbara Basin anchovy scales controlled by a strengthened California Current?

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The anchovy stocks in the southern California Bight (SCB) are thought to increase their abundance during periods of stronger meridional current flow, and associated intensification of upwelling processes. High deposition of anchovy scales in Santa Barbara Basin (SBB) sediments has been interpreted to represent cold conditions in the SCB during the last two millenia. Little attention has been focused on the differences in anchovy scales abundances between SBB and San Lazaro Basin sediments (SLB – also called Soledad Basin – Soutar & Isaacs, 1974), a similar suboxic basin located in the dynamic southern border of the California Current System (CCS). Both regions, the SCB and the Gulf of Ulloa (GoU), show a similar seasonality; large coastal upwelling during spring and the invasion of tropical and subtropical water mases when equatorward winds relax late during summer and the subarctic cold tongue shrinks. Here we present some new results from the SLB paleoproductivity records showing that SBB anchovy scale deposition are in phase with the carbonate deposition record in SLB, indicating that high deposition of anchovy scales coincides with periods of a better stratified mixed layer implying warmer conditions in the southern dynamic boundary of the CCS.

We constructed a composite record from a collection of 3 box cores and 4 kasten cores retrieved from SLB between 1994 and 2000, based on XRF analysis with 1 mm resolution, on an Avaatech X-Ray Fluorescence core-scanner in the Geological Collections facilities at the Scripps Institution of Oceanography. Ca counts are correlated (R=0.6) with carbonate carbon, which was determined independently with a precision of 0.1% by coulometry. Br/Si XRF counts are correlated (R=0.42) with gray scale from digitalized X-ray photography, which is highly correlated with the organic matter concentration in these cores. Finally, Biogenic Silica (BSi) were measured using the wet-alkaline extraction method with a precision <0.8%. We interpret the carbonate concentrations and XRF-Ca counts as the result of coccolitophorid deposition, typical of warm well stratified periods in the southern CC domain, in contrast with the Br/Ti and BSi which are indicative of mixing processes driven by the strength of the California Current and associated upwelling events.

Spectral analysis of carbonate, XRF-Ca counts, Br/Ti and gray scale time series show large similarities with anchovy scales from SBB with common peaks in multidecadal and centennial periods. The multidecadal to centennial variability of carbonate and XRF-Ca counts are correlated (R= 0.54) with anchovy scales deposition from SBB for the last millenium. No relationship with sardine scales have been found.
Based in these new results we propose a northern migration of Baja California anchovy stocks to the SCB during warm periods as the most likely explanation for the relationship between SLB carbonate records and the SBB anchovy scales deposition. Other observations like the presence of smaller anchovy specimens in the SCB, typical of Baja California stocks, at the beginning of the last warm period (1977-1980 – Mais,1981), support our hypothesis.

C-7. Transport patterns of Pacific sardine *Sardinops sagax* eggs and larvae in the California Current

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We simulated transport of Pacific sardine eggs captured offshore of California in spring of 2001-2011 using a regional ocean circulation model. Eggs were assumed to have developed into larvae within a few days and were modeled using four behavioral patterns: passive transport, diel vertical migration, diel migration combined with migration toward shore, and diel migration combined with migration toward the best habitat. Simulated larvae with no swimming behavior were advected far offshore to poor habitat where they were unlikely to survive. Diel vertical migration resulted in less offshore transport because larvae were less affected by surface currents during the day. However, nearly all juveniles were also located in poor habitat by late summer in this scenario. Migration toward shore was the best strategy modeled. In most years, migration toward shore resulted in an even greater fraction of juveniles being located in appropriate habitat during late summer than the strategy of migrating toward the best adjacent habitat. This was because the quality of good habitat far offshore often degraded as summer progressed, leaving many larvae stranded in poor habitat. In contrast, a more stable and predictable area of appropriate habitat occurred closer to shore off northern Baja California. A large fraction of larvae were transported south into Mexican waters by late summer under all four scenarios. Surveying juvenile sardines in fall offshore of the border between the U.S. and Mexico may be an efficient means of estimating recruitment because the advection pattern of eggs and larvae to the south is opposite the migration pattern of adults.

C-8. Dissolved oxygen as a constraint on habitat of mesopelagic fish assemblages in the southern California Current Ecosystem

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Climate change induced ocean deoxygenation is expected to exacerbate hypoxic conditions in mesopelagic waters off the coast of southern California, with potentially deleterious effects for resident fauna. The mesopelagic fish assemblage, an essential link in pelagic food webs and carbon transport to the deep sea, may undergo changes in abundance and composition that, given the current state of knowledge, could go mostly unnoticed by scientists, marine managers and conservation biologists. In order to understand the potential impacts that this deoxygenation will have on these animals, I investigated the response of the depth of the deep scattering layer depth (i.e., upper and lower boundaries) to natural variations in midwater oxygen concentrations, light levels, temperature, and prey availability, over time and space in the southern California Current Ecosystem. The lower boundary of the deep scattering layer is primarily constrained by oxygen concentrations, while the upper boundary responds most strongly to irradiance (though also to oxygen levels). These findings suggest that the DSL will shoal under conditions of declining midwater oxygen and increased turbidity.

C-9. Inferring the larval rearing grounds of White Seabass, *Atractoscion nobilis*, based on the oxygen isotopic composition of adult otolith cores

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The isotopic composition ($\delta^{18}O$) of carbonate from fish otoliths serves as a natural tracer to distinguish between fishes inhabiting different environmental conditions during various life stages. Oxygen isotopes are precipitated in equilibrium with the isotopic composition of seawater, which is positively correlated with salinity. There is a negative relationship between temperature and $\delta^{18}O$ values. White seabass spawn between April and September in coastal areas off California and Baja California. The larvae are pelagic and are found in the upper water column for ca. 1 month before settling in inshore waters. Considering there is a well-documented latitudinal gradient in temperature and salinity from southern California to the southern waters off the Baja California peninsula during summer, we analyzed the $\delta^{18}O$ values of adult otolith cores to evaluate whether we could discriminate between larvae spawned reared in southern California (SC), Vizcaino Bay (VB) and the Gulf of Ulloa (GU) in an attempt to assess population structure. We back-calculated the temperature at which the carbonate in the otolith cores was precipitated and compared them to regional summer SSTs. Regional temperatures and salinities were also used to calculate predicted $\delta^{18}O$ values (i.e., isotopic habitat) for each region, which were compared with the measured $\delta^{18}O$ values of otolith cores. There were no significant differences in the $\delta^{18}O$ values of otolith cores between regions due to the high level of variability in isotopic values for fish collected in each region. However, the frequency distribution of back-calculated temperatures indicated a higher proportion of larvae reared under warmer-water in the southern VB and GU populations. Predicted $\delta^{18}O$ values for the isotopic habitat corresponding to the GU showed minimal overlap to that of SC and VB. However, the interval of measured $\delta^{18}O$ values obtained for fish from GU overlapped with the isotopic habitat corresponding to more northern regions. It was therefore not possible to assign fish to specific rearing grounds. We suggest the presence of regional gyres within Vizcaino Bay and the Gulf of Ulloa during the summer months may contribute to decreased rates of larval dispersal along the coast of Baja California. Taken together our results are consistent with some level of mixing among regional subpopulations of adult white seabass.

C-10. Incorporating predictions of North Pacific climatic signals to fishery management: The case of the pacific sardine

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The climate of the North Pacific exhibits variability at different temporal scales that determines the extent and frequency of suitable environmental conditions for the Pacific sardine (*Sardinops sagax*) lifecycle, thus modulating its abundance and distribution range (~23-59°N). The impacts of low frequency climatic forcing on Pacific sardine population also provoke long term behavior of the fishery´s economic activities, increasing the need for forecasting capacity in support of adaptive management. In this context, we developed climate-fisheries catch models based on analysis of the most persistent patterns in North Pacific climate variability, emphasizing the climatic forcing induced to the eastern boundary of the basin (Alaska and California Currents). We employed statistical downscaling to evaluate the predictive power of climatic patterns for sardine fishery catches in: British Columbia (~48°N), Washington-Oregon (~45°N), California (~38°N), Ensenada (~32°N) and Bahía Magdalena (~24°N). The macro scale atmospheric circulation, sea surface temperature and upwelling/downwelling presented particular and reproducible patterns that underlie to the physical environment that sardines occupy. While understanding the physical mechanisms underlying these connections are still to be elucidated, the North Pacific climate signals showed promising predictive capacity of sardine fishery catches ($R^2 > 0.75$; Exp. Dev. > 78%) from Bahía Magdalena through British Columbia. The pertinence and predictive performance of climatic signals to sardine catch forecasting is discussed. Additionally, climate-fishery catch analysis of the Pacific sardine could be used to identify suitable fishery reference points for resilient management strategies that could deal with natural Pacific sardine collapse/expansion phases.

C-11. Forage abundance, quality, and distribution drive food limitation in an expanding California sea lion population

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The California sea lion population increased after the Marine Mammal Protection Act (1972), but carrying capacity is currently unknown. An indicator of population status suggests that the sea lion population passed its maximum productivity level in the 1990s. In the last decade, key components of sea lion diet have either almost disappeared (anchovy), or decreased in biomass (sardine), while market squid abundance increased. During this time, sea lion abundance steadily increased, except for intermittent "unusual mortality events" (UMEs) that were often, but not always, associated with El Niños. Increasing squid abundance and declining sardine and anchovy abundance, reduced the caloric value of available forage in the last 10 years. Sardine have spawned progressively further offshore associated with increased offshore transport, likely affecting forage availability for nursing females. Population of sea lions was positively correlated with sardine and squid catches indicating that fishery take had little or no influence on sea lion population trajectory. Large population size, limited foraging range of nursing females, decreasing abundance of high calorie prey, and a trend to more offshore sardine distribution all contributed to the 2013 UME. Occurrence of numerous malnourished pups may now become frequent as the sea lion population experiences food limitation.

C-12. Inter-annual and seasonal trends in cetacean distribution, density and abundance off southern California

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Trends in cetacean density and distribution off southern California were assessed through visual line-transect surveys during thirty-seven California Cooperative Oceanic Fisheries Investigations (CalCOFI) cruises from July 2004-November 2013. From sightings of the six most commonly encountered cetacean species, seasonal, annual and overall density estimates were calculated. Blue whales (*Balaenoptera musculus*), fin whales (*Balaenoptera physalus*) and humpback whales (*Megaptera novaeangliae*) were the most frequently sighted baleen whales with overall densities of 0.91/1000 km^2 (CV=0.27), 2.73/1000 km^2 (CV=0.19), and 1.17/1000 km^2 (CV=0.21) respectively. Species specific density estimates, stratified by cruise, were analyzed using a Generalized Additive Model to estimate long-term trends and correct for seasonal imbalances. Variances were estimated using a non-parametric bootstrap with one day of effort as the sampling unit. Blue whales were primarily observed during summer and fall while fin and humpback whales were observed year-round with peaks in density during summer and spring respectively. Short-beaked common dolphins (*Delphinus delphis*), Pacific white-sided dolphins (*Lagenorhynchus obliquidens*) and Dall's porpoise (*Phocoenoides dalli*) were the most frequently encountered small cetaceans with overall densities of 705.83/1000 km^2 (CV=0.22), 51.98/1000 km^2 (CV=0.27), and 21.37/1000 km^2 (CV=0.19) respectively. Seasonally, short-beaked common dolphins were most abundant in winter whereas Pacific white-sided dolphins and Dall's porpoise were most abundant during spring. There were no significant long-term changes in blue whale, fin whale, humpback whale, short-beaked common dolphin or Dall's porpoise densities while Pacific white-sided dolphins exhibited a significant decrease in density across the ten-year study. The results from this study were fundamentally consistent with earlier studies, but provide greater temporal and seasonal resolution.

C-13. Distribution of Pacific Sardine Spawning Habitat within the Waters of the Mexican and U.S. Exclusive Economic Zones

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We used epipelagic eggs collected in the continuous underway fish-egg sampler as part of the IMECOCAL and CalCOFI programs to model the habitat of Pacific Sardine during spring 2000-2013. The model was used to predict on a regular grid, and then estimate the proportions of habitat that occurred within waters of the Mexican and U.S. exclusive economic zones (EEZ). A small fraction of the total habitat occurred in the Mexican EEZ during all years. However, sardine habitat extended well south of Punta Eugenia during some years. Although the northern sub-population was dominant, classification of the habitat based on sea-surface temperature suggested that some sardine from the southern sub-population also spawned in spring. The southern sub-population may spawn as far north as the southern California Bight in the U.S. EEZ during spring in some years.

C-14. Impacts of basin-scale variability on ichthyoplankton assemblages throughout the California Current Ecosystem

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El Niño – La Niña fluctuations are known to have profound effects on oceanographic and biological parameters worldwide. These impacts, however, can vary greatly depending on geographic location. Here, we investigate how ichthyoplankton assemblages respond to large-scale environmental variability in four widely-separated regions (central Baja California, southern California, northern California, and Oregon) of the California Current Ecosystem (CCE). El Niño /La Niña conditions, as reflected by the PDO and MEI indices, explained much more of the variation in assemblage structure in the extreme northern and southern parts of the CCE than in southern California. Further, the timing of the responses differed among regions as there were significant correlations between environmental and assemblage dynamics in winter and spring in Baja California, spring and summer in Oregon, but only in summer in southern California. These results illustrate the important of accounting for spatial scale in order to elucidate how the environment affects biological assemblages and stresses the need for broad-scale sampling to better understand the dynamics of the CCE.

C-15. From Sea Surface Temperature to Upper Trophic Levels: Anomalous Observations Within the Central California Current in 2014

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Point Blue Conservation Science, California Current Group

With an apparent El Niño event developing during the spring/summer of 2014, the California Current System (CCS) experienced warming of surface waters throughout much of its extent. Several anomalous observations have been reported throughout the CCS, especially concerning warm water species occurring north of their typical range. Biological responses to this warming have been a mix of both anomalous and ordinary (i.e., no deviation from long-term averages). Here, we summarize anomalous and ordinary observations from three biological monitoring programs in central California: Applied California Current Ecosystem Studies (ACCESS), seabird monitoring on Southeast Farallon Island (SEFI), and seabird monitoring on Vandenberg Air Force Base (VAFB). ACCESS data showed the warmest temperature on record and stronger than usual stratification of surface waters in September 2014. There was a lower than usual abundance of krill, and tropical/subtropical pteropods were observed for the first time. Summer sea surface temperatures at SEFI were the second highest on record. Krill and juvenile rockfish disappeared from seabird diets, fledging success plummeted for auklets with many chicks dying in the late season, and Cassin's auklets abandoned all of their second brood attempts. Most seabirds breeding at VAFB showed ordinary results, with the exception of Pelagic Cormorants, who had their highest nest failure rate on record. These preliminary results suggest that the initial warming from this developing event had a greater impact on offshore communities – where it's effects manifested mid July - than in nearshore communities. Thus, the underlying oceanographic conditions that have favored nearshore productivity in recent years may be buffering nearshore communities from the developing El Niño conditions.

POSTER TITLES AND ABSTRACTS

P-1. Ocean Salmon Monitoring and Management Project

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California Department of Fish and Wildlife, Marine Region, Ocean Salmon Project

The Ocean Salmon Project (OSP) provides fishery-dependent and fishery-independent data needed for the management of ocean, river, and tribal salmon fisheries. This includes annual estimates of ocean salmon harvest, fishery effort, ocean abundances, and fishery impacts on salmon stocks of special concern (ESA-listed stocks) and those managed by federal and state regulatory bodies. Field staff sample at least 20% of all landings in California ocean salmon sport and commercial fisheries to estimate harvest and effort by species, management area, and half-month period, and to assess the contributions of critical salmon stocks to these fisheries. Heads are collected from all adipose fin-clipped (ad-clipped) salmon, indicating the presence of a coded-wire tag (CWT) in the snout. At least 25% of all Chinook salmon produced in California's hatcheries are ad-clipped and implanted with a microscopic CWT which includes a unique code that provides critical release information such as brood year, run type, and hatchery/stock origin. OSP staff also assist with sampling returning spawners at several Central Valley hatcheries, collecting heads from ad-clipped salmon and scale samples for age structure analyses. OSP laboratory staff process and validate all CWTs collected in ocean fisheries (~20,000 in 2014), as well as nearly 20,000 additional CWTs collected in the Central Valley each year. CWT ocean and inland recovery information, combined with harvest and effort estimates, provide biologists and fishery managers with the information needed to create the cohort reconstruction and ocean harvest models used to design fishing seasons that protect weaker stocks while allowing the harvest of abundant stocks. CWTs are also used to determine contribution and stray rates of hatchery and natural-origin Chinook salmon returning to spawn and to evaluate hatchery release strategies. OSP staff are highly involved in the ocean salmon management process and work closely with other state, federal, and tribal biologists to forecast ocean abundances and analyze fishing season alternatives. OSP staff also participate on various multi-agency technical teams, which are responsible for ensuring the best available science is used for salmon management decisions.

P-2. Zooplankton of the San Diego Region Website

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This web-based guide of local San Diego zooplankton (https://scripps.ucsd.edu/zooplanktonguide/) serves as a tool for members of the public, students, and others curious about these drifting planktonic animals. This is not a taxonomic key, rather a pictorial guide inspired by the early University of California Publications in Zoology series. Currently, this guide consists of 19 different taxonomic groups and 131 species; where each species has an individual page with the scientific name, common name, digital photograph(s) when specimens were available, some videos, line drawings, and natural history information. The majority of these digital images have been taken in the Pelagic Invertebrates Collection (PIC) at SIO, while some have come from generous contributors. Species information and line drawings have been taken from the literature, with permission. The *Zooplankton of San Diego Region* website is a contribution by the past and present staff of the PIC and several UCSD undergraduate student assistants.

P-3. Sampling requirements for long-term ecological monitoring of fish communities

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Long-term monitoring is necessary to assess potential change in the abundance of fishes in response to natural and anthropogenic factors. Ichthyoplankton surveys provide a low-tech means to monitor fish populations: most species are found in the upper water column as larvae, and larval abundance serves as a proxy for spawning stock biomass. CalCOFI is often considered the Gold Standard for such monitoring based on its ichthyoplankton sampling program, but its extensive sampling (6 transects and 66 stations extending from the coast to hundreds of kilometers offshore) is not feasible in many regions. Our objective was to determine whether reduced sampling designs, such as sampling along a single transect, would capture patterns in annual mean abundance of dominant taxa and multivariate (community-level) change. We sub-sampled single transects from the full CalCOFI ichthyoplankton data set (1951 – 2011) and compared time series for the 12 most abundant species in the reduced and full CalCOFI data sets. Principal component (PC) analyses were carried out and PC 1 – 3 compared between the reduced and full CalCOFI data sets. Similar analyses were carried out based on stratified random sub-sampling of the full CalCOFI data set. These partial sampling approaches were also examined over varying lengths of time (e.g. 10, 20 years and full time series) to examine the effect of time series length on capturing patterns in reduced data sets. In general, reduced sampling was able to capture patterns of change in dominant taxa and multivariate PCs, with a greater number of stations and/or longer time series needed to adequately represent the variability for weaker PCs and less abundant, more patchily distributed species. It was critical that all relevant habitats (e.g. oceanic as well as coastal and shelf habitats) were sampled along reduced transects to adequately sample the range of ichthyoplankton taxa within a region.

P-4. Development of a "live" State of the California Current website

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NOAA-SWFSC-ERD

In support of CalCOFI's annual "State of the California Current Report," SWFSC's Environmental Research Division (ERD) has developed a "live" website for dissemination of up-to-date information on the state of the California Current. The purpose of the website is to provide the most up-to-date possible versions of several of the more traditional figures presented in the annual report, particularly for physical oceanographic. This online supplement takes the place of the published supplement that was provided in the past several reports. The online site includes not only live, up-to-date figures, but also brief text interpretations of the figures. Where possible, the data contributing to the live figures is drawn directly from ERD's ERDDAP, data access portal. The ultimate goal of the website is to allow no only viewing of up-to-date data on the state of the California current, but to also allow users to manipulate the figures themselves in real time, and to be able to download data sets of interest. In future, the website may also be used for uploading of datasets for use in production of the report itself. Lastly, due to the large amount of overlap, the website will be heavily crosslinked with the California Current Integrated Ecosystem Assessment web pages, providing a seamless way to examine environmental data relevant to the state of the CCS.

P-5. Chaetognaths distribution and abundance in the central region of the Gulf of California during March 2010 (the onset of El Niño event 2009-2010)

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Chaetognaths are well known voracious predators in the epipelagic planktonic food web predating a broad range of preys that mostly includes mesozooplankton and ichtyoplankton. We show preliminary information about distribution and abundance of chaetognaths species assemblages collected in the central region of the Gulf of California during March 11-25, 2010, a period near the onset of El Niño event 2009-2010 that lasted from June 2009-May, 2010. 32 zooplankton samples were collected using standard oblique Bongo net tows. We analyzed the 500 µm mesh net preserved (ethanol 96%) sorting out, identifying, and counting all the chaetognaths species. Previous studies of chaetognaths in the Gulf of California dates back 1960 decade carried out by an outstanding scientists Alvariño and in 1980-1990 decade publications by Mexican scientists. Thus, it is practically unknown the current status of such zooplanktonic predators. We detected eight species dominated by *Flaccisagitta enflata* with high densities north Tiburon Island and north of Bahía Conception featured with 17-18.5 °C and low Chl-*a* concentration (1 mg m^{-3}). Low densities of chaetognaths were detected in the cold-upwelled waters southeast of Grandes Islas region where typically occur the lowest temperatures in the entire Gulf of California.

P-6. Variability in the $\delta^{18}O$ of *Uvigerina peregrina* at intermediate depth in the northeastern Pacific

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The ocean plays an important role in regulating the Earth's climate, because it is the great reservoir of heat at intermediate depth. New data from $\delta^{18}O$ of *Uvigerina peregrina* a multicore collected at 700 m depth in the southwestern margin of Baja California Sur are presented in order to estimate relative changes in the temperature of ocean at intermediate depth. The multicore collected was allow us to constrain the $\delta^{18}O$ of *U. peregrina* for the last millennium in Magdalena margin. $\delta^{18}O$ values in Little Ice Age were enriched in ^{16}O relative to Medieval Warming and Recent. This suggests that during the last 300 years of the Medieval Warming (1100-1400 years BP) and Recent (1850-2000 years BP), intermediate depth temperature was significantly colder than during the Little Age Ice (1400-1850 years BP).

P-7. Hydrography of the Point Loma continental shelf: 2006 – 2013

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The City of San Diego, in collaboration with the Scripps Institution of Oceanography, initiated hydrographic observations off Point Loma in the summer of 2006. The initial goals were to help determine the fate of the wastewater plume discharged via the Point Loma Ocean Outfall (PLOO), and to develop an improved understanding of the predominant forces driving hydrography in the coastal waters off Point Loma. Plume dynamics are strongly influenced by water column stratification and ocean currents. Other factors influencing plume behavior include outfall depth, discharge port spacing, and wastewater flux momentum. Hydrographic observations were obtained from nearly continuous measurements supplied by moored oceanographic instruments deployed at three primary locations off Point Loma. These included one site near the present PLOO discharge zone at 100-m depth, a second site site located near the original outfall diffuser structure at 60-m depth, and a third site located ~4.7 km south of the PLOO along the 60-m depth contour. Instrumentation included seafloor mounted 300 kHz Teledyne RDI Acoustic Doppler Current Profilers (ADCPs) located at the 100-m (100A) and south 60-m (60A) sites and duplicate arrays of Onset Tidbit temperature loggers (thermistors) on mooring lines located at the 100-m (100T) and 60-m (60T) sites adjacent to the outfall. The ADCP data were recorded every five minutes in 4-m depth bins with the top three bins from each instrument excluded from analyses due to backscatter interference. Temperature data were collected every 10 minutes from the thermistors which were deployed along each mooring line beginning at 2 meters above the seafloor and extending through the water column every 4 meters to within 6 meters of the surface. The results from these eight years of data showed that ocean currents flowed predominately in a northwest-southeast direction at both 100A and 60A sites in all years. The first mode of empirical orthogonal function (EOF) analysis of subtidal currents accounted for more than 60% of the variation observed in all seasons. This mode was characterized by NNW to SSE reversing unidirectional flows. The second EOF mode, accounting for more of the variation observed during the winter, indicated shearing along the pycnocline as different water masses moved in opposite directions. Maximum current velocity was 545 mm/s at site 100A and 400 mm/s at site 60A, with greater velocities observed at shallower depths. Ocean temperatures were consistent between stations 100T and 60T, revealing a general pattern of water column mixing in late fall/winter and the greatest surface warming in late summer/early fall in all years, with slight variations in timing and intensity of the mixing events. Ocean surface temperatures tended to be cooler during 2008-2013 than during 2006 and 2007. These hydrographic observations are ongoing and will soon be augmented by the deployment of real-time oceanographic moorings deployed near the PLOO and South Bay Ocean Outfall discharge sites.

P-8. Climate variability in the CCS from a 31-year (1980-2010) historical analysis computed using the ROMS 4D-Var Data Assimilation System

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Circulation estimates calculated using ROMS 4D-Var data assimilation techniques are used to closely inspect low-frequency variability within the CCS. Our analysis includes novel application of established data analysis techniques including calculation of the leading 3-dimentional multivariate empirical orthogonal functions of the CCS circulation computed from a state matrix comprised of the full 3D field of T, S, ζ, and the horizontal components of surface velocity (u,v). The leading EOFs appear to capture the recent downward trend in the PDO, as well as, all ENSO events spanned by the analysis, although the larger amplitude events of 1982-83 and 1997-98 are largely captured by a single EOF. Secondly, the spectral characteristics of co-varying power between time series of known climate indices (MEI and NPGO) and monthly means of spatially averaged (1o latitude x 100km offshore) variables were computed at each latitude within the analysis domain. Scale-averaged cross-wavelet power within the 2-5 year (MEI) and 10-15 year (NPGO) period band are averaged and plotted against latitude. The cross-wavelet spectra reveal the nature of the variability in the coastal circulation associated with ENSO and the NPGO and indicate significant latitudinal dependence. For ENSO, the coastal response to the large events of 1982-83 and 1997-98 is quite different to that of other events within the analysis time period.

P-9. Eureka! A review of California's commercial market squid fishery and the extension of effort north in 2014

Laura Ryley and Chelsea Protasio

California Department of Fish and Wildlife

Market squid (*Doryteuthis opalescens)* is among the highest grossing and highest volume commercial fisheries in the state of California. Market squid are harvested for human consumption and as bait in recreational fisheries. The market squid resource is also an important forage item for seabirds, marine mammals, and other fish taken for commercial and recreational purposes. The fishery is a federally monitored species and is actively managed by the State as directed by the Market Squid Fishery Management Plan, which has been in effect since 2005.

An overview of the commercial fishery will be given. Topics discussed will include history of the fishery, market squid life cycle, economics, management, and recent trends. Details of the spatial and temporal distribution of catch comparing the 2012/13, 2013/14, and 2014/15 fishing seasons will be presented.

Prior to the 2014/15 season, the fishing fleet had focused their effort on areas south of Point Reyes concentrating mainly in two locations, Monterey Bay in the north and the Channel Islands in the south. The commercial market squid fleet landed squid in Eureka during the 2014/15 season indicating an extension of effort north to new fishing grounds. Details of the northern fishing grounds such as depth, predicted substrate, and sea surface temperature will be presented.

P-10. Collaborative research in the Rockfish Conservation Areas: using a stereo video system to map distribution and measure lengths of species targeted in fisheries management

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Rockfish conservation areas (RCAs) were implemented in 2002 to protect overfished species along the west coast of the United States. These closures are delineated by depth contours and restrict the use of specific bottom-fishing gear. The rocky habitats that many of these overfished species utilize, however, are under-sampled in the annual coast-wide trawl surveys. Also, the distribution and abundance of fishes inhabiting high-relief rocky areas within the RCAs are not commonly sampled. To address these issues, we developed a non-extractive method to study species in high-relief rocky areas that are of concern to fisheries managers. Through a collaboration with the Moss Landing Marine Labs, The Nature Conservancy, the Southwest Fisheries Science Center of NMFS, Marine Applied Research and Exploration (MARE), and the FV Donna Kathleen we designed and built a video lander and developed techniques to survey demersal fishes. In 2013 and 2014 we conducted surveys of fishes along the central coast of California at depths between 80-250 m. Paired stereo video cameras enabled us to measure fishes with cm accuracy while stationary surveys allowed us to calculate fish density. Here we share the distribution and length frequencies of Lingcod, Vermilion, Greenspotted, Canary, and Yelloweye Rockfishes observed offshore from San Francisco to San Simeon (a geography spanning 300 km from north to south).

P-11. Preliminary assessment of the response of rockfish populations to Rockfish Conservation Area closures in Central California

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Between 1987 and 1998, the California Department of Fish and Game (CDFG) sampled 2267 sport fishing trips on Commercial Passenger Fishing Vessels (CPFVs), and recorded data on species compositions, size and catch rates for nearly 300,000 fishes. In 2001, seven rockfish species (Bocaccio, Canary Rockfish, Cowcod, Darkblotched Rockfish, Pacific Ocean Perch, Widow Rockfish and Yelloweye Rockfish) were declared overfished, leading to the creation in 2002 of fishery closures in the form of Rockfish Conservation Areas (RCAs). In an effort to assess how the RCAs (and other factors) have affected rockfish populations along central California in the 12 years since they were implemented, we conducted surveys of some of the same areas that were fished recreationally from 1987-1998. Our primary objective was to compare estimates of species composition, density, and mean lengths of fishes before and after the RCAs were established, with effort and emphasis concentrated in relatively shallow habitats (approximately 20-50 fathoms) that were the regions of greatest significance to recreational fisheries. With the help of local captains and volunteer anglers, 29 standardized hook and line fishing surveys were conducted from October 2012 to October 2014. More than 7500 fishes were caught from our three sample areas: Half Moon Bay, the Farallon Islands, and Cordell Bank. Here, we present preliminary findings on species composition, catch rates, and size frequency from sample sites inside and outside the closed areas. Also, we present preliminary comparisons of current fishing data with the historical data set collected by CDFG.

P-12. Fluctuations in larval rockfish assemblages in the southern California Bight through time

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Over the past century, many rockfishes (*Sebastes* spp.) in Southern California were commercially and recreationally targeted, resulting in drastic reductions of their abundances. In response to these overall declines and the declaration of cowcod (*S. levis*) as overfished in 1999, a large marine reserve, the Cowcod Conservation Area (CCA) was established in 2001 in the Southern California Bight (SCB) region. Despite the spatial magnitude of this reserve, there has been only sparse monitoring of the rockfish assemblage in the SCB since the inception of the CCA. Fortunately, the CalCOFI program has collected ichthyoplankton samples on a quarterly basis within and around the CCA over the past 17 years. To help elucidate rockfish dynamics in the SCB and assess the efficacy of the CCA, we genetically identified to species larval rockfishes collected during the winter (the peak rockfish spawning season) CalCOFI cruises of select years and analyzed distribution and abundance patterns of 30 rockfish species. Overall, the assemblage was consistently dominated by relatively small, short-lived species such as squarespot (*S. hopkinsi*), pygmy (*S. wilsoni*), and shortbelly (*S. jordani*) rockfish. Certain targeted species such as bocaccio (*S. paucispinis*), bank (*S. rufus*), and widow (*S. ovalis*) rockfish were also somewhat common, and their distribution appeared to be centered on the CCA, suggesting that this reserve is protecting essential spawning habitat. We are currently developing the complete time-series of larval rockfishes. Once species from all winter cruises are identified, we will analyze the relative effects of environmental variables and the presence of the CCA on the rockfish assemblage. This should help discern if the reserves have aided the recovery of overfished rockfishes and help inform stock assessment models.

P-13. Comparison of the distributions and concentrations of larval and young-of-the-year flatfishes off the central Oregon coast

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Fish early-life history stages may be sensitive indicators of environmental conditions and of future recruitment potential in adult fish stocks within the California Current ecosystem. Limited research has been conducted on young-of-the-year (YOY) flatfishes off Oregon since the pioneering work during the late 1970s and early 1980s. In the present study, we collected YOY and adult groundfish samples using a benthic beam trawl from six stations (3-15 nm offshore) along and near the historically-sampled Newport Hydrographic (NH) line (44.67°N) monthly from July 2012 to June 2013 (excluding October, December, and May), and analyzed them for seasonal and spatial patterns. Ichthyoplankton was also analyzed from bongo samples collected from comparable stations along the NH line as part of the NWFSC's Estuarine and Ocean Ecology Program hydrography and plankton cruises (1996-present). We compared the ichthyoplankton concentrations and distributions to those found in the beam trawl with suitable lag periods to examine larval supply to the demersal environment. From a total catch of 8,600 fish from the beam trawls, 84% comprised the following flatfish taxa: *Parophrys vetulus* (38%; English sole), *Isopsetta isolepis* (20%; Butter sole), *Citharichthys* spp. (17%; Sanddabs), and *Lyopsetta exilis* (9%; Slender sole). Seasonal settlement signals were observed for three of the species (*P. vetulus*: spring/early summer; *I. isolepis*: summer; and *L. exilis*: late summer/fall), while no seasonal signal was observed for *Citharichthys* spp. The larval data revealed periods of peak concentration for all four of the examined taxa (*P. vetulus*: winter; *I. isolepis*: late winter; *L. exilis*: late spring/early summer; and *Citharichthys* spp.: winter and summer). Cross-shelf settlement signals were also observed (*P. vetulus* and *I. isolepis*: near shore; *Citharichthys* spp. and *L. exilis*: further offshore), while larvae of all four taxa were more concentrated near shore than further offshore.

P-14. Exploratory nearshore habitat analyses from the southern California coastal pelagic species aerial survey

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California Department of Fish and Wildlife, Marine Region, Coastal Pelagic Species Unit

From 2012 through 2014, the California Department of Fish and Wildlife (CDFW), in collaboration with California Wetfish Producers Association (CWPA), has been conducting seasonal aerial surveys to assess abundance and distribution of Pacific sardine (*Sardinops sagax*) and other coastal pelagic species (CPS) such as northern anchovy (*Engraulis mordax*) within the Southern California Bight (SCB). While the survey includes sampling components for open water and island coastal areas, this poster focuses on observations made within five-and-a-half kilometers of the mainland coast ("nearshore") extending from the U.S.-Mexico Border to Point Conception during the first five seasons of data collection. Data – including, daytime aerial estimates of school sizes and counts, GPS locations, high-resolution digital photographs; satellite SST and Chl-a measurements; and bathymetric contours - were analyzed using GIS, statistical and digital photogrammetric methods to explore characteristics of CPS aggregations and their associated nearshore environment. Results are described and then discussed as we make our initial attempts to characterize and contextualize CPS aggregations observed along the mainland coast and, in particular, seek to identify variables that move us toward understanding aspects of CPS nearshore habitat in the SCB.

P-15. Following market squid paralarvae abundance through an ENSO transition, preliminary observations from a cooperative research program

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The California Wetfish Producer's Association (CWPA) conducted seasonal nearshore surveys over squid aggregation sites in order to investigate trends in abundance of market squid paralarvae since 2011 in southern California, and 2014 in Monterey (17 surveys, 427 net tows). High variability in abundance between sites was evident throughout the time series, although certain sites were consistently productive. Generally, high southern California paralarvae abundance was associated with La Niña conditions. High paralaravae abundances were observed in January of 2012 (377 paralarave 1,000m^{-3} ± 184 SE) and 2013 (308 ± 178), before declining significantly (p-value = 0.008) in January 2014 (65.0 ± 24.1). Adult market squid landings showed similar trends, with high landings throughout this La Niña period (the harvest limit was reached each fishing-year from 2010/11 - 2013/14). The greatest landings per month occurred in November, 2011 (45,980 MT) and a significant relationship was found between landings during a given month and paralarvae abundance two months later (p-value = 0.0003, $r^2 = 0.75$). As 2013 and 2014 have transitioned to neutral ocean conditions, squid have spawned earlier in the year in southern California and landings have shifted spatially toward Monterey, potentially because of warming El Niño-like ocean conditions and reduced ocean productivity. Future work will focus on growing a collaborative relationship between CWPA, SWFSC, and CDFW in order to investigate squid abundance fluctuations, statolith ageing for growth and mortality assessments, as well as stable isotope and microchemistry work that assess natal habitats of market squid landed in the fishery.

P-16. Relating otolith growth parameters to somatic growth from laboratory-reared Pacific mackerel (*Scomber japonicus*)

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Pacific mackerel support one of the most important commercial fisheries in the California Current Ecosystem. This species is distributed from southeastern Alaska to Banderas Bay (Mexico) and within the Gulf of California. The Pacific mackerel stock is exploited commercially throughout its range and is assessed using an age-structured model. Thus, parameters such as recruitment and biomass for this stock are critically dependent on the accuracy and precision of age estimates. Various studies have attempted to use weight and length of otoliths as proxies of age or as auxiliary parameters to improve ageing precision in assessment models. However, otolith growth does not always correlate with somatic growth, therefore it is important to demonstrate a strong relationship between these two parameters before weight or length can be used for age determination. For this study, juvenile Pacific mackerel were collected at the Everingham Mission Bay Bait Barge in October and November of 2013. The fish were acclimated for two months, then tagged and reared for nine months in three tanks at temperatures of 13˚C, 17˚C and 21˚C. Preliminary results showed that otolith weight significantly increased with fish body weight regardless of temperature. However, the relationship between otolith weight and length with body length for fish of similar ages varied with temperature. These data suggested that otolith weight and length were determined more by environment than age. Likewise, these parameters may not be reliable proxies for estimating age and growth of Pacific mackerel.

P-17. Developing Improved Spatial Maps of the Distribution of Rebuilding Stocks in the Rockfish Conservation Area (RCA) To Inform Fishing and Management

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A handful of federally-declared overfished species (OFS, e.g. Yelloweye Rockfish, Canary Rockfish, Darkblotched Rockfish, Cowcod, Bocaccio, and Pacific Ocean Perch) constrain the West Coast Groundfish fishery. The Rockfish Conservation Areas (RCAs) are depth-based closures that were implemented in 2002 with the aims of minimizing the potential catch of OFS and supporting rebuilding these depleted stocks. However, the recent transition of the trawl sector of the groundfish fishery to an Individual Fishing Quota (IFQ) management system, and the associated hard caps for these rebuilding species, has created strong new incentives for fishermen to avoid these species on their own. In addition, there are target species, such as Lingcod, Yellowtail Rockfish, and Chilipepper Rockfish that could be more fully utilized if fishermen could fish "cleaner" by avoiding areas where there is a high risk of bycatch of rebuilding species. These factors drive a growing interest in developing better spatial maps of the distribution of OFS to inform fishing activities (i.e. bycatch avoidance plans, risk pools, etc.) and management efforts (including potentially a re-examination of the role and configuration of the trawl RCA). As a proof of concept for better understanding the distribution and abundance of OFS, we have developed a repository of spatially-referenced observations and catch data for OFS from a broad array of publicly available and willing partner sources in central California. The repository includes a geodatabase from which map products of positive sightings or catch of overfished species in Central California are derived. This required the compilation of data - currently widely distributed and collected using a variety of survey tools, at different spatial scales, and for different purposes - into one geodatabase to be able to create a "best available map" of OFS locational information. In addition to creating the geodatabase from existing sources, we are actively using both visual survey tools and research fishing to assess whether compiling this accessible, authoritative, and up-to-date source of information on OFS observations is helpful to inform fishing and management decisions.

P-18. Aerial survey of small pelagic species in the Southern California Bight

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Current survey indices used in annual stock assessments to manage the federal Pacific sardine (*Sardinops sagax*) fishery do not include nearshore sardine biomass in southern California waters. The California Department of Fish and Wildlife, in collaboration with the California Wetfish Producers Association, has conducted aerial surveys using direct observer estimates of sardine biomass within the Southern California Bight since the summer of 2012. Both island and mainland coastal areas, as well as open water areas, were surveyed during spring and summer seasons. Beginning in summer 2013, additional small pelagic species, including Pacific mackerel (*Scomber japonicus*), northern anchovy (*Engraulis mordax*), and jack mackerel (*Trachurus symmetricus*), have been included in the survey protocol. Aerial identifications of fish school species have been validated using boat sampling of aerial sightings, and demographic information obtained from collected samples. Additionally, habitat analyses have compared sardine distribution with environmental variables (sea-surface temperature and chlorophyll a concentrations) from satellite data. We observed fish primarily along coastal areas; most notably, large aggregations were seen in nearshore waters off Ventura and Santa Monica. We found significant relationships between mainland coastal and island coastal areas with northern anchovy and Pacific mackerel abundance, respectively. Summer seasons accounted for higher amounts of observed sardine (estimated tons) than spring seasons, and total tonnage each season has declined since 2012. With continued efforts, this work will provide information on sardine and other small pelagic fish species abundance and distribution to account for areas not covered in present surveys. Further data collection on sampled fish and habitat associations can add to understanding of population and stock structure.

P-19. NOAA CalCOFI Genomics Project (NCOG): Microbial 'Omics in the Southern California Bight

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Microbial diversity and function represent one of the great data gaps in marine observations, despite their large diversity and prominent role in biogeochemical cycling. Additionally, increasing evidence indicates that viruses, bacteria and protists are crucial biological components of coastal and pelagic ecosystems. In particular, microbial activity is largely responsible for regulating marine food web dynamics and associated carbon, nitrogen, silica and other key ocean ecosystem nutrient cycles. In early 2014, we initiated the quarterly collection of samples suitable for DNA and RNA analyses to examine the diversity, biogeography, and activity of planktonic microbes in the CalCOFI Southern California Bight grid. Samples are collected at the primary productivity and cardinal stations at the mixed layer chlorophyll max and at 515 m, as well as at two bathypelagic samples (3500m) from the northern and southern regions of the grid, and filtered onto 0.22 µm Sterivex filters. High-throughput sequencing of 16S & 18S rDNA (Illumina MiSeq) and mRNA (Illumina HiSeq) with automated laboratory protocols and the associated bioinformatics will allow us to extensively survey the diversity and functional activity of microbes within the rich context of physical, biological and chemical data collected by CalCOFI. The continued collection of these types of samples will provide an important perspective on microbial interactions and dynamics in space and time and may unearth critical information regarding ocean response to large-scale pressures, enabling us to better predict tipping points and augment our understanding of factors that enable or dampen ecosystem resiliency.

P-20. Coherence, variability, and potential predictability of mid-shelf copepod assemblages of the northern California Current

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We applied non-metric, multidimensional scaling (NMDS) to characterize temporal and taxonomic variability within copepod assemblages at mid-shelf stations along the Newport Hydrographic Line (NHL; 44.63°N) and the Trinidad Head Line (THL; 41.06°N), and use results from this analysis as the basis for examining patterns and variation in these assemblages in the context of local and regional forcing, hydrographic conditions and indices of transport. From 2008 through early 2014, taxa with offshore and southern (warm) biogeographic affinities have been consistently more prevalent off northern California than off Oregon, and this latitudinal contrast persists over the course of typically coherent seasonal shifts in the copepod assemblages throughout the region over the course of the year. Moreover, the composition of copepod assemblages off northern California appears to be more variable during summer months, than the predominantly cold-water assemblage observed during the upwelling season off Oregon, yet, thh copepod assemblage off Oregon appears to be more variable during winter—particularly from year to year—than the assemblage off northern California. Copepod assemblages in both areas exhibited responses to the 2009-2010 El Niño, but recovery of northern taxa off northern California from the 2009-2010 El Niño lagged well behind that observed off Oregon. To explore the potential role of transport in driving this variability, we extracted indices of the heading from which waters are arriving in the vicinity of each station from data-assimilative ROMS circulation models for the California Current, and developed a simple model to relate the dominant axis of variability in copepod community structure (NMDS1) to these transport indices. For the NHL time series, this model achieved a good fit ($R \sim 0.7$). For the THL, prediction of NMDS1 was not as strong ($R \sim 0.45$), but major departures appear to be related to differences in transport during the decay phase of the 2009-10 El Niño.

- taxon-specific shifts in abundance e.g. *Tortanus discudatus, Acartia tonsa, Corycaeus anglicus, Microcalanus pusillus*