
# CalCOFI Conference

3-5 December 2012

Asilomar Conference Center
Pacific Grove, CA

Hosted by:

California Department of Fish and Game

CalCOFI Coordinator: John Heine
Symposium Convener: Laura Rogers-Bennett

In association with:
Southwest Fisheries Science Center, NOAA Fisheries
Scripps Institution of Oceanography

# CalCOFI Conference 2012

Asilomar Conference Center
Pacific Grove, CA
Dec. 3-5

**Monday, 3 December**

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|---|---|
| 12:30-1:30 | Registration – Fred Farr Forum |
| 1:30-1:45 | **Opening of the Conference**<br>Welcome: Laura Rogers-Bennett, California Department of Fish and Game |
| 1:45-2:45 | **Session I: Status of the California Current**<br>Eric Bjorkstedt, Southwest Fisheries Science Center, NOAA |
| 2:45-3:15 | Break. Registration continues. Check-in to rooms. |
| 3:15-5:45 | **Session II: Status of the Fisheries**<br>Chair: Dianna Porzio, California Department of Fish and Game |
| 3:15-4:00 | Coastal pelagic species, Chelsea Protasio |
| 4:00-4:15 | Market squid, Chelsea Protasio |
| 4:15-4:30 | Ocean salmon, Barry Miller |
| 4:30-4:45 | California sheephead, Kerri Loke |
| 4:45-5:00 | California halibut, Travis Tanaka |
| 5:00-5:15 | Groundfish, Melanie Parker |
| 5:15-5:30 | Dungeness crab, Christy Juhasz |
| 5:30-5:45 | Sea cucumber, Carlos Mireles |
| **6:00-7:00** | **Dinner, Crocker Dining Hall** |
| **Reception** | |
| 7:00-9:00 | Fred Farr Forum. Beer, wine, and non-alcoholic beverages, hors d'oeuvres |

**Tuesday, 4 December**

**7:30-8:30** **Breakfast, Crocker Dining Hall**

8:00-8:30 Registration – Fred Farr Forum

8:30 **Session III: The Symposium of the Conference: Harmful Algal Blooms in the California Current**
Chair: Laura Rogers-Bennett, California Department of Fish and Game

8:30-8:40 Introduction and overview. Laura Rogers-Bennett, California Department of Fish and Game

8:40-9:15 S-1. **Harmful Algal Blooms in the U.S.** Quay Dortch, Center for Sponsored Coastal Ocean Research, National Centers for Coastal Ocean Science, National Ocean Service, National Oceanographic and Atmospheric Administration

9:15-9:50 S-2. **Shellfish aquaculture, restoration, and harmful algal blooms: A reality check**. Sandra E. Shumway, Department of Marine Sciences, University of Connecticut

9:50-10:10 BREAK

10:10-10:45 S-3. **Strategies for early warning of harmful algal blooms.** Vera L. Trainer, NOAA Northwest Fisheries Science Center

10:45-11:20 S-4. **A southern California perspective on Harmful Algal Blooms: Collaborations, findings and prediction**. Melissa Carter[1], Carolynn Culver[2], Mary Hilbern[1], Fernanda Mazzillo[3], Gregg Langlois[4], and John McGowan[1].
[1] Scripps Institution of Oceanography, University of California, San Diego, [2]California Sea Grant Extension Program, [3]University of California, Santa Cruz, [4]California Department of Public Health

11:20-11:55 S-5. **Shifting patterns and emerging Harmful Algal Bloom issues in the California Current.** Raphael M. Kudela, Ocean Sciences Department and Institute for Marine Sciences, University of California Santa Cruz

12:00-1:00 **Lunch, Crocker Dining Hall**

1:00-1:35 S-6. **Forensic transcriptomic scan suggests Yessotoxin as cause of invertebrate mass mortality following Harmful Algal Bloom in northern California.** Pierre De Wit[1*], Stephen R. Palumbi[1], Laura Rogers-Bennett[2],
[1]Department of Biology, Hopkins Marine Station, Stanford University, [2]Bodega Marine Lab, California Department of Fish and Game

1:35-2:10 S-7. **The *Gonyaulax* shell game: Deducing the identity of a putative emergent HAB along the central California coast**. Charles J. O'Kelly[1], Geneva J. Mottet[1], Adele Paquin[2], Karina J. Nielsen[2], [1] Friday Harbor Laboratories, University of Washington, Friday Harbor, WA, [2] Department of Biology, Sonoma State University, Rohnert Park, CA

2:10-2:45 S-8. **Harmful algal blooms affecting coastal California wildlife: Review of evidence for coastal pollution and biomagnification as contributors, and challenges of assessing the broader impacts on marine mammals and birds.** Melissa A. Miller, DVM, Ph.D., MS[1,2], Frances M. Gulland, VetMB, MRCVS, Ph.D.[3,] Corrine M. Gibble, MS[4], Stori C. Oates, MS[1,2], Hannah M. Nevins, MS[1,2], and Raphael M. Kudela, Ph.D.[4], [1]Marine Wildlife Veterinary Care and Research Center, California Department of Fish and Game, Office of Spill Prevention and Response, Santa Cruz, CA, [2]Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, CA, [3]The Marine Mammal Center, Marin, CA, [4]Ocean Sciences Department, University of California, Santa Cruz, CA

2:45-3:05 BREAK

3:05 **Session IV: Contributed Papers (15 minutes with 5 minutes for discussion).** Chair: Tony Koslow, Scripps Institution of Oceanography

3:05 -3:25 C-1. **Physiological studies of *Gymnodinium catenatum* a paralytic toxin producer in the Mexican Pacific: A Review.** Christine J. Band-Schmidt[1]*, José J. Bustillos-Guzmán[2], David J. López-Cortés[2], Ismael Gárate-Lizárraga[1], Erick J. Núñez-Vázquez[2], Francisco E. Hernández-Sandoval[2] and Lorena Durán-Riveroll[1]. [1]Departamento de Plancton y Ecología Marina, Centro Interdisciplinario de Ciencias Marinas-Instituto Politécnico Nacional, [2]Centro de Investigaciones Biológicas del Noroeste.

3:25-3:45 C-2. **Fish assemblages in the southern California Current: relationships with climate, 1951–2008.** J. Anthony Koslow[1], Ralf Goericke[1], William Watson[2]. [1] Scripps Institution of Oceanography, University of California, S.D., [2] Southwest Fisheries Science Center, NMFS/NOAA.

3:45-4:05 C-3. **Examination of young-of-the-year rockfish (*Sebastes* spp.) catches in relation to hydrographic conditions, in particular thermal fronts, at two adjacent areas off central California.** Keith M. Sakuma, Stephen Ralston, and Eric P. Bjorkstedt, NOAA Fisheries, Southwest Fisheries Science Center, Fisheries Ecology Division.

4:05-4:25 C-4. **Distributional patterns of pelagic juvenile rockfish on the U.S. west coast – what happened in 2005?** Stephen Ralston[1] and Ian J. Stewart[2,3].

[1]Southwest Fisheries Science Center, NMFS, Santa Cruz, CA. [2]Northwest Fisheries Science Center, NMFS, Seattle, WA. [3]current affiliation: International Pacific Halibut Commission, Seattle, WA.

4:25-4:45 C-5. **The response of Monterey Bay to the Great Tohoku Tsunami.** Larry Breaker, Moss Landing Marine Laboratories.

4:45-5:05 C-6. **Spatial and temporal patterns of variability in Scyphomedusae in the central California coastal marine ecosystem**. John C. Field,[1] Jarrod Santora,[2] Keith Sakuma,[1] Amber Payne[1] and Baldo Marinovic[3]. [1]SWFSC, NOAA Fisheries Ecology Division, Santa Cruz, California, [2]Farallon Institute for Advanced Ecosystem Research, Petaluma, California, [3]Long Marine Laboratory, University of California at Santa Cruz.

5:05-5:25 C-7. **Spatial patterns of fisheries development and groundfish landings in California.** Rebecca Miller[1], John Field[1], Jarrod Santora[2], Meisha Key[3], Don Pearson[1] and Alec MacCall[1]. [1]National Marine Fisheries Service, Southwest Fisheries Science Center. [2]Farralon Institute of Advanced Ecosystems Research. [3]California Department of Fish and Game.

6:00-7:00 **Dinner, Crocker Dining Hall**

**Tuesday, 4 December (cont)** 7:00-9:00
**Poster Session - Fred Farr Forum**

Beer, wine, and non-alcoholic beverages, hors d'oeuvres

P-1. **Chlorophyll dynamics at Santa Catalina Island.** C. Gelpi, Catalina Marine Society.

P-2. **Organic carbon concentrations in the CalCOFI survey region during 2009 and 2010.** Stephens, BM, Porrachia M, Aluwihare, LI, Dovel, S, Roadman, MJ, Georicke, R.

P-3. **Influence of California Current in HABs at Mexican Central Pacific Ocean.** Alejandro Morales-Blake[1], Sofía A. Barón-Campis[2], J. Gerardo A. Ceballos-Corona[3], Mónica C. Rodríguez-Palacio[4], Rosalba Alonso-Rodríguez[5] & David U. Hernández-Becerril[5]. [1]Facultad de Ciencias Marinas, Universidad de Colima, Manzanillo, Colima, México. [2]Instituto Nacional de Pesca, SAGARPA, Pitágoras #1320, México, D.F. [3]Facultad de Biología, Universidad Michoacana de San Nicolás de Hidalgo, Cd. Universitaria, Morelia, Michoacán. [4]Depto. Hidrobiología, Universidad Autónoma Metropolitana Iztapalapa (UAM-I), México, D.F. [5]Instituto de Ciencias del Mar y Limnología,

Universidad Nacional Autónoma de México, Cd. Universitaria, México, D.F.

P-4. **Preliminary analysis of age, length, and maturity of Pacific mackerel *(Scomber japonicus)* collected 2009-2012 off of San Diego, CA**. Erin Reed, Coastal Pelagic Species Group, Southwest Fisheries Science Center, NOAA.

P-5. **Breaking the cycle: anomalies in the ovarian development of blackgill rockfish, *Sebastes melanostomus***. Lyndsey Lefebvre, John Field, Fisheries Ecology Division, Southwest Fisheries Science Center, NMFS/NOAA.

P-6. **Diet variability of forage fish in the northern California Current ecosystem.** Andrew Hill[1], Ric Brodeur[2], Elizabeth Daly[3]. [1]Portland Community College, Hatfield Marine Science Center, [2]NOAA, NWFSC, Fisheries Ecology Division, [3]Oregon State University, CMIRS.

P-7. **Dungeness crab die-off at Pt. Reyes MPA cluster July 2011: precursor to Sonoma County invertebrate die-off?** Donna Kline[1], James Lindholm[1], Dirk Rosen[2], Elizabeth Ramsay[1]. [1]Institute for Applied Marine Ecology, California State University, Monterey Bay, [2]Marine Applied Research and Exploration.

P-8. **Large California Current-wide salp bloom in spring 2012.** Ohman, M.D. and L. Sala, Pelagic Invertebrates Collection, Scripps Institution of Oceanography, U.C San Diego.

**Wednesday, 5 December**

**7:30-8:30 Breakfast, Crocker Dining Hall**

8:30 **Session V: Contributed Papers (15 minutes with 5 minutes for discussion)**
Chair: Russ Vetter, Southwest Fisheries Science Center

8:30-8:50 C-8. **Unexpected directionality, forcing variable, and time scales affect Pacific Sardine (*Sardinops sagax*) spawning distribution under climate change**. Sam McClatchie, NOAA Southwest Fisheries Science Center.

8:50-9:10 C-9. **Advection of Anchovy *Engraulis mordax*, Jack Mackerel *Trachurus symmetricus*, and Sardine *Sardinops sagax* eggs and larvae off southern California by hydrodynamic models**. Edward D. Weber[1], Mathew R. Mazloff[2], Bruce D. Cornuelle[3], Yi Chao[3], Hajoon Song[4], Arthur J. Miller[2], and Sam McClatchie[1]. [1]NOAA Southwest Fisheries Science Center, [2]Scripps Institution of Oceanography, University of California San Diego, [3]Remote

Sensing Solutions, Inc, [4]Ocean Sciences Department, University of California Santa Cruz.

9:10-9:30 C-10. **Ichthyoplankton dynamics throughout the California Current system: a comparative analysis of fish assemblages in Oregon, California, and Baja California.** Andrew R. Thompson[1], Toby D. Auth[2], Martín E. Hernández Rivas[3], Noelle M. Bowlin[1], Richard D. Brodeur[4], Sam McClatchie[1], Sylvia Patricia A. Jiménez Rosenberg[3], Alejandro T. Hinojosa Medina[3], and William Watson[1]. [1] Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, CA, USA, [2] Pacific States Marine Fisheries Commission, Newport, OR, USA, [3] Centro Interdisciplinario de Ciencias Marinas-Instituto Politécnico Nacional, La Paz, BCS, MEX, [4] Northwest Fisheries Science Center, NOAA Fisheries, Newport, OR, USA.

9:30-9:50 C-11. **Seasonal and annual trends in cetacean density and abundance on the southern CalCOFI lines.** Gregory S. Campbell[1], Katherine Whitacker[1], Len Thomas[2] and John A. Hildebrand[1]. [1]Marine Physical Laboratory, Scripps Institution of Oceanography, University of California San Diego, La Jolla, CA. [2]School of Mathematics and Statistics, University of St Andrews, St Andrews, UK.

9:50-10:10 C-12. **Tools for improved interpretation of acoustic marks: What's the catch?** Stéphane Gauthier[1] and George Cronkite[2]; presented by Ken Cooke[2]. Fisheries and Oceans Canada, [1] Institute of Ocean Sciences, Sidney, BC; [2]Pacific Biological Station, Nanaimo, BC.

10:10-10:30 BREAK

10:30 **Session VI: Contributed Papers (15 minutes with 5 minutes for discussion)**
Chair: Sam McClatchie, Southwest Fisheries Science Center

10:30-10:50 C-13. **Increasing *Pseudo-nitzschia* abundance and domoic acid toxicity of sinking particles in the Santa Barbara Basin associated with changes in nutrient source waters.** Claudia Benitez-Nelson[1,2] , Clarissa Anderson[1,3], Robert Thunell[1,2], Emily Sekula-Wood[2], David Siegel[4]. [1]Marine Science Program, University of South Carolina, [2]Department of Earth and Ocean Sciences, University of South Carolina, [3]Ocean Sciences Department, UC Santa Cruz, [4]Earth Research Institute and Department of Geography, UC Santa Barbara, Santa Barbara, CA 93106

10:50-11:10 C-14.

11:10-11:30 C-15. **Gelatinous plankton in the California Current.** John McGowan, Scripps Institution of Oceanography, UC San Diego.

11:30-11:50 C-16.
11:50-12:10 C-17.

12:00-1:00 **Lunch, Crocker Dining Hall**

Conference adjourned.

# SYMPOSIUM ABSTRACTS

## S-1. Harmful Algal Blooms in the U.S.

Quay Dortch

Center for Sponsored Coastal Ocean Research, National Centers for Coastal Ocean Science, National Ocean Service, National Oceanographic and Atmospheric Administration

Harmful Algal Blooms (HABs), which comprise many different species and impacts, have increased worldwide. In the U.S. the frequency and ranges of many known HABs have increased and new HAB species have emerged, so that all U.S. states now experience HABs. Although some HABs are localized, others can affect large geographic areas (Gulf of Maine, Gulf of Mexico, Greater Caribbean, Pacific coast) or have spread from one location to another (for example, *Karenia brevis*, the Florida red tide, and *Alexandrium monilatum* spreading from the Gulf of Mexico up the east coast of the U.S.). Thus, the occurrence of HABs is dependent both on large scale oceanographic processes as well as the biology and ecology of the organisms. The NOAA Ecology and Oceanography of Harmful Algal Blooms (ECOHAB) program is taking a regional ecosystems approach to understanding the causes and impacts of HABs in order to develop improved monitoring and forecasting for early warning as well as new approaches to minimize or prevent blooms and their impacts.

## S-2. Shellfish aquaculture, restoration, and harmful algal blooms: A reality check

Sandra E. Shumway

Department of Marine Sciences, University of Connecticut, Groton, CT 06340

Shellfish aquaculture and restoration continue to expand globally, as do eutrophication and harmful algal blooms. Molluscan shellfish are among the most important of ecosystem engineers and providers of ecosystem services. As such, restoration and aquaculture are both increasingly touted as means of habitat restoration, and as potential sources of mitigation for coastal degradation including eutrophication and erosion. At some scales, shellfish restoration and establishment of sustainable molluscan shellfish aquaculture operations can mitigate effects of coastal development and eutrophication; however, the expectations and publicity are reaching unrealistic levels. Harmful algal blooms impact coastal resources globally and their impacts can be devastating to local economies and environments. In addition, the impacts of harmful algae on shellfish are highly species-specific and critical data regarding impacts of these toxic algae on critical life stages of the shellfish, and which will impact the potential for success of any restoration effort in the long term, are lacking. There is a clear need for studies to assess the impacts of toxic algae on the reproductive effort, sperm and egg viability, and long-term sustainability of bivalve molluscs used in aquaculture and restoration efforts. This presentation will open a discussion of the realistic expectations that could result from exploitation of bivalve molluscs, whether in restored reefs or in aquaculture farms, as long-term ecosystem engineers and mitigators of coastal degradation, and discuss the importance of strong and meaningful collaboration between scientists and industry.

## S-3. Strategies for early warning of harmful algal blooms

Vera L. Trainer

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Seattle, WA 98112. Email: vera.l.trainer@noaa.gov

Partnerships of federal, state, tribal government agencies, and private groups have banded together to monitor and provide early warning of toxins in shellfish, including diarrhetic shellfish toxins that have caused recent illnesses in Washington State. The ORHAB (Olympic Region Harmful Algal Bloom), SoundToxins (Puget Sound) and AHAB (Alaska Harmful Algal Bloom) partnerships use highly trained human eyes combined with cutting edge technology to provide the managers of important shellfish fisheries advance notice of pending harmful algal blooms (HAB) events. These warnings have had significant management implications by allowing state and tribal fishery managers to provide timely information on pending harvest disruptions to thousands of recreational harvesters, tourist business operators and tribal subsistence and commercial harvesters. In addition, regular monitoring of surf zone plankton assemblages have allowed fishery and health managers to reduce the level of shellfish tissues tested for the presence of marine biotoxins, during periods when harmful algal species are not blooming. These US west coast monitoring partnerships have formed the template for training programs for HABs and seafood safety in developing nations that have been implemented in the Republic of the Philippines, Guatemala, and Indonesia. In all cases, these programs are tailored to the needs of the regions using unique, community-based training approaches that have proven to be highly effective and sustainable.

## S-4. A southern California perspective on harmful algal blooms: Collaborations, findings and prediction

Melissa Carter[1], Carolynn Culver[2], Mary Hilbern[1], Fernanda Mazzillo[3], Gregg Langlois[4], and John McGowan[1]

[1] Scripps Institution of Oceanography, University of California, San Diego
[2]California Sea Grant Extension Program
[3]University of California, Santa Cruz
[4]California Department of Public Health

Understanding the complexity of harmful algal blooms (HABs) and their impacts on marine resources requires collaborations that overlap a variety of fields, agencies, and regions. California is leading the way in trans-regional collaborations on HABs with the data sharing efforts of SCCOOS (Southern California Coastal Ocean Observing Systems), CeNCOOS (Central and Northern Coastal Ocean Observing Systems), HABMAP (Harmful Algal Bloom Monitoring Alert Program) and CDPH (California Department of Public Health). Ongoing monitoring efforts provide the basis for evaluating and assessing the potential of algal toxins within important California fisheries. With the increased prevalence and persistence of offshore blooms, particularly of domoic acid, these and additional efforts are critical for informing seafood advisories in the state. Finding opportunities to collaborate with CalCOFI can help assess the potential risks to our marine resources and seafood consumers, and provide novel opportunities for data collection and sharing.

## S-5. Shifting patterns and emerging harmful algal bloom issues in the California Current

Raphael M. Kudela

Ocean Sciences Department and Institute for Marine Sciences
University of California Santa Cruz
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Blooms of harmful and toxic algae have increased in frequency and severity along this coast during the past few decades. Spring blooms of toxic *Pseudo-nitzschia* are now a recurring problem first reported in central California during the 1990s and on an annual basis in southern California since 2003. Many explanations have been proposed and investigated vis-à-vis the possible environmental driving forces for the observed patterns of harmful blooms in the CCS. The possibilities include hydrographic features that affect macro- and micronutrient availability (coastal upwelling, the proximity to canyons, the existence of retention/incubation areas, river and sewage effluent discharge) and biological aspects of the algae (e.g. light and nutrient competition, vertical migration, mixotrophy). While progress has been made, particularly regarding the annual occurrence of *Pseudo-nitzschia* blooms, the emergence of several new HAB problems in the last decade has raised new concerns. Dinoflagellates in particular have become an emerging, and increasing, issue. In addition to *Alexandrium*, California is susceptible to *Lingulodinium*, *Cochlodinium*, *Gonyaulax,* and *Dinophysis*. Preliminary evidence suggests that this shift in HAB problems within the CCS may be caused by a combination of decadal scale oscillations, coastal eutrophication, and possibly establishment of seed populations in new geographic regions. Using examples from several recent large-scale HAB events, these patterns and mechanisms are explored with an aim towards establishing both an ecological understanding of bloom dynamics and developing an effective monitoring and management approach towards HAB event prediction and response.

## S-6. Forensic transcriptomic scan suggests Yessotoxin as cause of invertebrate mass mortality following Harmful Algal Bloom in northern California

Pierre De Wit[1*], Stephen R. Palumbi[1], Laura Rogers-Bennett[2]

[1]Department of Biology, Hopkins Marine Station, Stanford University, 120 Ocean View Blvd., Pacific Grove, CA 93950, USA
[2]Bodega Marine Lab, California Department of Fish and Game, 2099 Westside Rd., Bodega Bay, CA 94923-0247, USA

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Sven Lovén Centre for Marine Sciences, Kristineberg 566, 451 78 Fiskebäckskil, Sweden

Dead red abalone (*Haliotis rufescens*) and gumboot chitons (*Cryptochiton stelleri*), washed ashore following an intense algal bloom along the Sonoma County coast in August 2011. Subtidal Scuba surveys immediately following the event revealed that an average of 23% of all the red abalone surveyed (N=4096) and 25% of all the red sea urchins (*Strongylocentrotus franciscanus*) surveyed (N=5275) were dead. Purple sea urchins (*S. purpuratus*) as well as sea stars and other invertebrates were also killed. In shallow water (<5m) mortalities were much greater with more than 50% of the red abalone and 93% of the red sea urchins dead. We investigated the genetic changes following this mortality event hypothesizing that microalgae produced a toxin which caused the mortality and shifts in allele frequencies in the survivors. We sequenced mantle transcriptomes of 24 red abalone individuals before and after the event and detected 46,000 SNPs for which all individuals were genotyped. Through an $F_{ST}$ outlier approach, we were able to identify 42 SNPs in 36 genes that changed markedly during the event. This list includes genes involved in cytoskeleton organization (particularly Cadherin), mitochondrial function, immune response, apoptosis and Calcium binding. A functional enrichment analysis for high $F_{ST}$ SNPs identified several functional categories that have been affected by the mortality event, including electron transport chain, cytoskeleton organization and response to organic cyclic compound. All of these changes are consistent with Yessotoxin being the cause of the event. In contrast, no protein phosphatases had changed during the event, which would have been a signature of Domoic or Okadaic acid toxicity. Nor had genes related to hypoxia tolerance changed during the event. In addition, we found several genes involved in glycolysis that had changed during the event, suggesting an additional target of Yessotoxin; we also implicate Glutathione-S-transferase as a potential detoxification enzyme. To our knowledge, this is the first time transcriptomic scans have been used to forensically identify the impacts of invertebrate mortalities. This study shows the potential of this approach to further our understanding of harmful algal blooms and the mechanisms of poorly known toxins in wild populations.

## S-7. The *Gonyaulax* shell game: Deducing the identity of a putative emergent HAB along the central California coast

Charles J. O'Kelly[1], Geneva J. Mottet[1], Adele Paquin[2], Karina J. Nielsen[2]

[1] Friday Harbor Laboratories, University of Washington, Friday Harbor, WA 98250
[2] Department of Biology, Sonoma State University, Rohnert Park, CA 94928

During the mid- to late summer of 2011, extraordinarily dense single-species blooms of dinoflagellates occurred in Sonoma and Marin Counties, California, and in Washington waters of the Salish Sea, particularly Puget Sound and the eastern end of the Strait of Juan de Fuca. Although the algae in both locations were initially assigned to the same species, *Gonyaulax spinifera* (Claparède & Lachmann, 1859) Diesing, 1866, the California bloom was associated with brilliant bioluminescence and severe losses of abalone and other marine invertebrates, while the Washington bloom lacked visible bioluminescence and was not associated with dieoffs of marine life. There were also subtle differences between the algae in the two blooms in the structure of the thecal plates (the "shell") covering the vegetative cells. Both algae reappeared in their respective locations in 2012, though at much lower densities and, to date, without impact on marine life.

Morphological and molecular analyses indicate that algae heretofore placed in *G. spinifera* actually belong to an as-yet incompletely characterized species complex. The California alga most nearly resembles the species *G. membranacea* (Rossignol, 1964) Ellegaard et al., 2003, though its bright bioluminescence does not occur in a cultured strain of this species. Also, if this alga is the source of the toxin that killed the abalone in Sonoma County, its mode of action is inconsistent with yessotoxin, a known product of *G. membranacea*, or of any other known dinoflagellate exochemical. The Washington dinoflagellate represents a previously-undescribed member of the *G. spinifera* complex, and is not closely related to *G. membranacea.*

The ability to distinguish among the cryptic species in the *G. spinifera* complex is an important first step towards assessing variations in types (including potential new types) and amounts of toxin produced in blooms, as is being demonstrated for other HAB species, in particular the ciguatera-associated species of *Gambierdiscus*.

## S-8. Harmful algal blooms affecting coastal California wildlife: Review of evidence for coastal pollution and biomagnification as contributors, and challenges of assessing the broader impacts on marine mammals and birds

Melissa A. Miller, DVM, Ph.D., MS[1,2], Frances M. Gulland, VetMB, MRCVS, Ph.D.[3,] Corrine M. Gibble, MS[4], Stori C. Oates, MS[1,2], Hannah M. Nevins, MS[1,2], and Raphael M. Kudela, Ph.D.[4]

[1]Marine Wildlife Veterinary Care and Research Center, California Department of Fish and Game, Office of Spill Prevention and Response, Santa Cruz, CA
[2]Wildlife Health Center, School of Veterinary Medicine, University of California, Davis, CA
[3]The Marine Mammal Center, Marin, CA
[4]Ocean Sciences Department, University of California, Santa Cruz, CA

Over the past 20 years, Harmful Algal Blooms (HABs) have been increasingly identified as important health risks for humans, domestic animals and wildlife along the land-sea interface. We are also beginning to identify anthropogenic factors that could be contributing to HAB severity and frequency on both local and broader scales, including coastal urbanization, watershed degradation and nutrient loading. A range of HABs have been confirmed as important sources of wildlife mortality in California, and numerous reports document the spectacular mass-mortality events that often accompany these blooms. Unfortunately, smaller events and impacts on offshore species like cetaceans often go unrecognized. In addition, the sublethal, chronic and/or synergistic impacts of HAB toxins could be important causes of wildlife morbidity and mortality, but are more difficult to assess. Finally, due to limited funding and availability of cost-effective, validated and standardized assays to facilitate diagnostic testing, estimating population and regional or watershed-level HAB impacts is challenging. Fortunately, attempts to synergize effort between health professionals, phycologists, oceanographers, statisticians, and ocean and coastal water policy managers are on the rise. This synergistic approach has the greatest potential to enhance awareness of the severity of worldwide health risks from HABs by the public and policymakers, and will optimize efforts to identify and mitigate anthropogenic drivers of coastal HABs.

# CONTRIBUTED ABSTRACTS

## C-1. Physiological Studies of *Gymnodinium catenatum* a paralytic toxin producer in the Mexican Pacific: A Review

Christine J. Band-Schmidt[1]*, José J. Bustillos-Guzmán[2], David J. López-Cortés[2], Ismael Gárate-Lizárraga[1], Erick J. Núñez-Vázquez[2], Francisco E. Hernández-Sandoval[2] and Lorena Durán-Riveroll[1]

[1]Departamento de Plancton y Ecología Marina, Centro Interdisciplinario de Ciencias Marinas-Instituto Politécnico Nacional, A. P. 592, La Paz, B.C.S. 23000, Mexico.
[2]Centro de Investigaciones Biológicas del Noroeste, A. P. 128, La Paz, B.C.S. 23000, Mexico.

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This review presents a detailed analysis of the state of knowledge of physiological studies done in strains of the dinoflagellate *Gymnodinium catenatum*, a paralytic toxin producer. *In vitro* studies of *G. catenatum* strains from different localities along the Pacific coast of Mexico show that this species can tolerate wide temperatures from11° to 33 °C, with optimal growth between 21° and 29 °C; a wide salinity range, from 25 to 40, with optimal growth between 28 and 38, and a wide range of N:P ratios from 5.4 to 74.3, with an optimal growth at a N:P ratio of 23.5. Variations in toxin cell quota and toxin composition have been related with latitudinal differences, culture media, growth rate, and temperature, but the presence of dcSTX, GTX 2-3, dcGTX2-3, C1, and C2 are usual components. Recently, benzoate type toxins have been described as an important component in the toxicity of *G. catenatum* cells of the Mexican Pacific. We can conclude that this species tolerates wide environmental conditions, which probably has allowed its distribution along the Mexican Pacific. Despite the toxicity of *G. catenatum* and its wide distribution, there has been low monitoring effort, and probably many events in the Mexican Pacific have gone unnoticed. In spite of being one of the most studied toxic dinoflagellate species in Mexico, there are still many research areas that have not been addressed, such as a finer monitoring design, definitions and quantification of physical-biological cell interactions, interactions between species, cyst studies, diverse toxic effects on a wider number of taxa, toxin metabolism, among others.

## C-2. Fish assemblages in the southern California Current: relationships with climate, 1951–2008

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We examined the dominant patterns of temporal variability in the fish fauna of the southern California Current based on a principal component (PC) analysis of the CalCOFI ichthyoplankton data set, 1951-2008. Eighty-six taxa were analyzed, including all ecologically dominant fish species, both exploited and unexploited. The first three PCs accounted for 20.5, 12.4 and 6.8% of the variance of the data, respectively (total: 39.7%). Each was dominated by taxa from particular adult or larval habitats. PC 1 predominantly represented the coherent response of 24 mesopelagic taxa from 10 families and was most highly correlated with long-term trends in midwater oxygen levels. PC 2 was dominated by six of the seven most abundant ichthyoplankton taxa in the region, predominantly California Current endemics including key pelagic species (northern anchovy, Pacific sardine, and Pacific hake), rockfishes (genus *Sebastes*), and two midwater taxa with cool-water affinities (*Stenobrachius leucopsarus, Leuroglossus stilbius*). PC 2 exhibited a significant declining trend and when detrended was negatively correlated with both sea surface temperature (SST) and, at a lag of one year, with sea level (SL) anomalies at San Francisco, indicating a positive correlation with advection of the California Current. PC 3 was dominated by coastal and reef-associated fishes with predominantly southerly affinities. It was positively correlated with SST and SL, indicating a positive relationship with diminished flow of the California Current. The taxa dominating PCs 2 and 3 mostly co-occur as broad spatially-defined ichthyoplankton assemblages. The ocean environment thus appears to drive common patterns of temporal variability within diverse fish assemblages in the California Current. These assemblages are defined primarily by the water masses or ocean habitats the taxa share as adults and larvae, rather than their taxonomic affinity.

## C-3. Examination of young-of-the-year rockfish (*Sebastes* spp.) catches in relation to hydrographic conditions, in particular thermal fronts, at two adjacent areas off central California

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We examined the relationship between catches of young-of-the-year (YOY) rockfish (*Sebastes* spp.) and hydrography by analyzing midwater trawl and conductivity, temperature, depth (CTD) data collected from 1987 – 2003 at two adjacent areas off central California, Pescadero ( ~37$^{o}$ 16.5'N) and Davenport (~36$^{o}$ 59'N). Annual trends in mean log-transformed catch were similar between the two areas even though hydrographic conditions differed. Large catches of YOY rockfish occurred off Pescadero coincident with cold, saline conditions indicative of upwelling. In contrast larger catches were observed off Davenport under warmer, less saline conditions with reduced catches occurring during strong upwelling. An analysis of covariance (ANCOVA) incorporating temperature gradients from CTD data showed no significant effect on log-transformed catches off Pescadero, but there was a significant effect observed for Davenport. Examination of temperature contour maps showed no clear relationship between large catches of YOY rockfish (> 200/trawl) with thermal fronts. Ongoing work includes developing more spatially explicit analysis to better evaluate cases where YOY rockfish are associated with fronts.

## C-4. Distributional patterns of pelagic juvenile rockfish on the U.S. west coast – what happened in 2005?

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The National Marine Fisheries Service conducts an annual survey of the distribution and abundance of pelagic juvenile rockfish along the U.S. west coast. The survey is a joint effort of the Southwest and Northwest Fisheries Science Centers and is designed to estimate variation in the reproductive success of exploited groundfish stocks and to generate fishery-independent recruitment indices for use in stock assessment. Survey results from 2001-2009 indicate that the latitudinal centers of distribution of most species typically occur in central California (36-39° N). An unusual pattern occurred in 2005, however, wherein species with northern affinities (subgenus *Sebastosomus*) were encountered well to the north and species with southern affinities (subgenus *Sebastodes*) were taken well to the south of their normal range; in central California very few fish were encountered. An analysis of oceanographic factors to explain this anomaly indicates that in central California: (1) poleward flow during the winter spawning season was much stronger than normal, (2) cumulative upwelling/downwelling through February and March was weakly developed and more spatially homogeneous than normal, and (3) February zonal wind stress was offshore. The affect of these conditions relative to the anomalous distribution of pelagic juvenile rockfish is considered.

## C-5. The Response of Monterey Bay to the Great Tohoku Tsunami

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The response of Monterey Bay to the Great Tohoku earthquake of 2011 is examined. From a practical standpoint, although the resulting tsunami did not cause any damage to the open harbors at Monterey and Moss Landing, it caused extensive damage to boats and infrastructure in Santa Cruz Harbor which is closed to surrounding waters. From a scientific standpoint, the observed and predicted amplitudes of the tsunami at 1 km from the source were 21.3 and 22.5 m based on the primary arrival from one DART bottom pressure recorder located 986 km ENE of the epicenter. The predicted and observed travel times for the tsunami to reach Monterey Bay agreed within 3%. The predicted and observed periods of the tsunami-generated wave before it entered the bay yielded values that approached 2 hours. Once the tsunami entered Monterey Bay it was transformed into a seiche with a primary period of 36-37 minutes, corresponding to quarter-wave resonance. Finally, in an effort to predict impact at the coast a transfer function model was constructed based on data from the bottom-mounted MARS array outside the bay, and the Monterey tide gauge inside the bay.

## C-6. Spatial and temporal patterns of variability in Scyphomedusae in the central California coastal marine ecosystem

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Elements of the pelagic community, including Scyphomedusae, have been quantitatively surveyed along the Central California coast during late spring (May, June) since 1983. Although the survey has traditionally focused on pelagic stages of juvenile rockfish, in order to develop indices of year class strength for stock assessments, recent efforts have included efforts to characterize the broader micronektonic community both spatially and temporally, and to improve our understanding of inter-annual variability and population dynamics, among-species associations, and relationships between the spatial structure of communities and physical oceanographic variables. Data on the abundance of Scyphomedusa (primarily *Chrysaora fuscescens* and *Aurelia aurita*) have been quantified for most of the time period between 1990 and 2012, and these show large annual fluctuations that track each other in some years, but are mismatched in others. These two species have generally different habitats, and preliminary investigations into the distribution of these species over time suggest interesting spatial relationships between large jellies and other important elements of the ecosystem (such as krill and juvenile salmon). We present these results, and discuss the dynamics of jellyfish relative to physical factors as well as the trends in abundance and productivity of other pelagic micronekton in the central California pelagic ecosystem.

## C-7. Spatial patterns of fisheries development and groundfish landings in California

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A unique set of spatially referenced, long-term commercial and recreational catch data are currently available for an extended period for California fisheries landings, following a substantial data recovery effort to digitize commercial catch data from the 1930s through the 1960s. Using this dataset we examine spatial development patterns for California groundfish in order to evaluate whether there is evidence for sequential, or serial, depletion of biomass across space, and whether implicit stock assessment model assumptions of relative homogeneity in the distribution of fishing effort and catches over time and space are reasonable. Landings are recorded by California Department of Fish and Game spatial blocks at a 10' latitude x 10' longitude grid resolution, and extend the entire length of coastal California ranging approximately 140 kilometers from shore. We focus initial investigations on rockfish (Sebastes spp.), for which we stratified block area by depth with 200 m for the recreational fishery and 600 m for the commercial fishery. For each gridded-block, we calculated the mean legacy rockfish catches as a function of available habitat, conduct geostatistical analyses, and evaluate the results relative to a suite of variables. Generalized linear model (GLM) results indicate an increasing distance between catch locations and ports, movement towards deeper habitat, and fishing in increasingly inclement weather through time. Long-term catch datasets are of great importance to estimates of historical catches for use in stock assessments, and are generally very informative for species where spatial and temporal information is lacking. The results are also informative for spatially explicit fisheries management, marine spatial planning efforts, and general understanding of the historical development of these fisheries.

## C-8. Unexpected directionality, forcing variable, and time scales affect Pacific Sardine (*Sardinops sagax*) spawning distribution under climate change

Sam McClatchie

NOAA Southwest Fisheries Science Center

The key results from this study are three. First, the currently emerging paradigm leads us to expect that fish populations in the northern hemisphere will shift their distributions northward with secular trends in climate. In contrast to this expectation, we found that the Pacific sardine spawning population first shifted south, and subsequently moved further offshore, rather than further north. Second, the general assumption is that changes in fish populations will be driven by changes in temperature, and especially by warming temperatures. Instead, we found that sardine spawning habitat appears to have shifted offshore in response to changes in the wind field, so the proximal forcing variable was unexpected. Although the ultimate forcing variable is likely temperature driven changes in the pressure fields that in turn drive the winds, the proximal variable was wind stress over the ocean rather than warming of surface waters affecting the temperature tolerances of the sardine. Third we detected what superficially appeared to be a secular trend in the distribution of the spawning sardine operating over a time-scale of ~25 years, but on closer inspection we discovered that the trend was driven by the more intense southward winds generated by La Niña conditions. The actual time-scale for the forcing is the ENSO time scale of order 4–7 years, rather than the longer time secular scale. Our results provide an example of how embedded shorter time scales must be considered when evaluating possible secular climatic trends on the distributions of fish.

## C-9. Advection of Anchovy *Engraulis mordax*, Jack Mackerel *Trachurus symmetricus*, and Sardine *Sardinops sagax* eggs and larvae off southern California by hydrodynamic models

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We modeled probable advection patterns of eggs of three small pelagic species captured in the continuous underway fish egg sampler during spring 2001-2012 to test the hypothesis that eggs and larvae aggregate in the Southern California Bight, where they are likely to rear. Three types of circulation models with different resolutions and spatiotemporal domains (two Regional Ocean Modeling System models and the MIT General Circulation Model) provided similar results. Most anchovy eggs, which were assumed to hatch into larvae within a few days, were retained in the Southern California Bight. However, most eggs and larvae of sardine and Jack mackerel were advected far offshore, where they began moving south with the California Current during summer. These results suggest that environmental conditions in the California Current during late spring and summer should play an important role in recruitment of sardine and Jack mackerel. This area is not regularly sampled as part of the CalCOFI program or any other regular survey.

## C-10. Ichthyoplankton dynamics throughout the California Current system: a comparative analysis of fish assemblages in Oregon, California, and Baja California

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Understanding how fish assemblages are affected by environmental fluctuation is critical to ecosystem and fisheries management. A factor that makes accurate characterization of assemblage dynamics difficult is that fishes often move large distances though time, and static, regional sampling regimes typically encompass only a fraction of the biogeographic range of most taxa. To provide a more synoptic view of fish assemblage dynamics in the California Current system (CCS), we analyzed ichthyoplankton samples collected between 1997 and 2011 from northern (Oregon), central (California), and southern (Baja California) regions of the CCS. Redundancy analysis (RDA) showed that assemblages differed significantly by season and region, and pairwise comparisons indicated that the magnitude of difference was greater between Oregon and California or Mexico than between California and Baja California. Variance partitioning of RDA models revealed that local environmental conditions (temperature and salinity) explained more of the variation in assemblage structure than regional (upwelling) or basin-scale (MEI) indices for each combination of region by season. However, upwelling and MEI were important in Oregon and Baja California in spring. In addition, temperature and salinity were much more effective in explaining assemblage structure in deep (> 2000 m) than shallow waters in California, but the opposite was true in Mexico. Comparison of the interannual dynamics in presence/absence for taxa found in multiple regions showed that several oceanic (e.g., Mexican lampfish, Panama lightfish) and coastal-oceanic (e.g., Pacific sardine, northern anchovy) taxa fluctuated in synchrony in Baja California and California. By contrast, there were no strong correlations in the interannual dynamics of taxa found in both California and Oregon. Logistic regression analyses modeling the presence of individual taxa against temperature and salinity identified notable regional differences in the sign and degree of correlation for taxa with different habitat affinities (oceanic, coastal-oceanic, coastal). These results demonstrate that the response of fishes to environmental change can differ greatly at different latitudes and highlight the need for broad-scale sampling to characterize ecosystem variability in the ocean.

## C-11. Seasonal and annual trends in cetacean density and abundance on the southern CalCOFI lines

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Seasonal and annual patterns of cetacean density, abundance and distribution on the southern CalCOFI lines were assessed through visual line-transect surveys during thirty-two CalCOFI cruises from July 2004 – July 2012. From 1,482 sightings of 20 cetacean species, a series of abundance estimates were calculated for the 11 most frequently encountered species. Fin whales and blue whales were the most abundant large baleen whales with overall abundances of ~700 and ~400 respectively. Seasonally, blue and fin whales exhibited the highest abundance in summer while humpbacks were more numerous during fall surveys. Annually, blue and fin whales exhibited the lowest abundance during the La Niña period of 2007/2008 followed by peaks in abundance during the warmer water period in 2009/2010, whereas humpback whale abundance showed a decreasing trend from 2008-2012. Short-beaked common, long-beaked common and Pacific white-sided dolphins were the most abundant small cetaceans with overall abundances of ~123,000, ~ 17,000 and ~5,500 respectively. Seasonally, short-beaked common, long-beaked common and bottlenose dolphins exhibited the highest abundance in summer and fall whereas Pacific white-sided, Risso's dolphins and Dall's porpoise were more numerous during winter and spring surveys. Variations in species-specific spatial distribution patterns were also apparent and indicative of known species habitat preferences within the California Current ecosystem. Observed variations in cetacean abundance and distribution will be discussed in the context of fluctuations in measured ecosystem parameters, particularly cetacean prey species density and distribution. Cetacean surveys on CalCOFI cruises provide an avenue to investigate seasonal and inter-annual patterns in abundance and distribution on a longer continuous time scale with a higher rate of sampling than previous cetacean surveys off the California coast. The insight gained from these analyses provides data needed to evaluate potential anthropogenic perturbations to cetacean populations in southern California and sets the foundation for development of comprehensive management protocols.

## C-12. Tools for improved interpretation of acoustic marks: What's the catch?

Stéphane Gauthier[1] and George Cronkite[2]; presented by Ken Cooke[2]

Fisheries and Oceans Canada, [1] Institute of Ocean Sciences, Sidney, BC; [2]Pacific Biological Station, Nanaimo, BC

The interpretation of acoustic marks has traditionally relied on catch composition from targeted trawls. This approach has several limitations, as it often assumes equal catchability and availability among aquatic organisms. In cases of catches with mixed species, it is often difficult (if not impossible) to determine if these species were naturally found in mixed aggregations or if they were spatially segregated but captured within the same trawl. To address these issues, we have combined a net camera, underwater lights, and a pressure-temperature sensor on a midwater trawl used for acoustic target identification. These instruments were secured a few sections in front of the codend, with the camera pointed towards the rear of the net. By synchronizing all instruments we could determine when and at what depth particular marks were captured, identify smaller animals that went through the net but were not retained by the codend, and quantify behavioural responses of animals within the net, including residency time. Results using this instrument configuration highlighted the shortcomings of traditional trawl interpretation. Using an array of different interpretive scenarios (e.g. using trawl catch solely or in combination with video) we demonstrate the potential bias this can have on estimating fish biomass. Development, application, and future directions for such combinations of instruments will be discussed.

## C-13. Increasing *Pseudo-nitzschia* abundance and domoic acid toxicity of sinking particles in the Santa Barbara Basin associated with changes in nutrient source waters

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Since the early to mid 1990's, the Santa Barbara Basin (SBB) has been the site of intensive time-series water column sampling and sediment trapping. Chlorophyll concentrations have increased significantly over the past several years, consistent with observations of more intense diatom blooms during the spring and summer and fewer, large dinoflagellate blooms beginning in 2001. Sediment trap fluxes confirm these changes with evidence of an abrupt shift upwards in bloom frequency and abundance of the neurotoxin (domoic acid) producing, lightly silicified diatom, *Pseudo-nitzschia* beginning in 2000. We hypothesize that these shifts are exacerbated by increasing nutrient concentrations in SBB surface waters coupled with a decrease in Si/N and an increase in N/P. Such changes explain the seeming discrepancy between increasing diatom abundance and the transition to less silicified diatom species. Furthermore, silicate and phosphate limitation, combined with increasing acidity, have been shown to facilitate domoic acid production. Given the limited evidence for changes in upwelling in the SBB, we hypothesize that increasing HABs are due to changes in the upwelled properties of the source waters. Time series data from the SBB that include CalCOFI measurements, Plumes and Blooms water column sampling, and long term sediment trap records are crucial to testing these hypotheses and elucidating secular changes in the phytoplankton community.

**C-14.**

## C-15. Gelatinous Plankton in the California Current

John McGowan

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We have used the entire 60 year time-series of "Total minus Large" zooplankton biomass measurements in the California Current to test the conjecture that the removal of top predators and other perturbations have led to a major change in the structure of the planktonic food web and an increase in the abundance of gelatinous plankton and in the frequency of their blooms. We found no increase in either variable. There was an increase in the per cent of gelatinous plankton in the mesozooplankton biomass due mostly to the decline in the crustacean fraction.

# POSTER TITLES AND ABSTRACTS

## P-1. Chlorophyll dynamics at Santa Catalina Island

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Santa Catalina Island is expected to be an insignificant source of nutrients for algal blooms as the island has little agriculture, no rivers and few streams that reach the ocean. However, it experiences episodic blooms and two mechanisms, one local and the other regional, have been suggested as sources. Locally, the island is a site of intense internal waves that can promote mixing and diffusion of nutrients from depth. Regionally, nutrients and phytoplankton may also drift to the island from more productive areas. This study quantifies the frequency of blooms, using chlorophyll products obtained from MODIS on the Aqua satellite mission and in situ chlorophyll measurements made at the Wrigley Institute of Environmental Studies located near Two Harbors. Regional chlorophyll dynamics are examined using the satellite data, while local dynamics are investigated using the mooring data.

## P-2. Organic carbon concentrations in the CalCOFI survey region during 2009 and 2010

Stephens, BM, Porrachia M, Aluwihare, LI, Dovel, S, Roadman, MJ, Georicke, R

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The 2009-2010 El Niño and 2010-2011 La Niña events in the CalCOFI survey region have led to increased anomalies in nitrate, decreased salinity and oxygen at the $\delta_t$ 26.4 isopycnal, and decreases in the surface mixed-layer temperature. Here we explore seasonal trends of organic carbon stocks within the context of the hydrographic anomalies observed during the weak El Niño of 2009-2010 and strong La Niña of 2010-2011. Further, we seek to draw correlations between organic carbon concentrations and hydrographic values in order to better evaluate the role of carbon within the CalCOFI system and explore the possibility of extending the predictive capability of our organic carbon time series, which was initiated in 2004.

## P-3. Influence of California Current in HABs at Mexican Central Pacific Ocean

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In order to record and recognize the oceanographic conditions that allow HABs development, discrete sampling have been carried out from 1999 until summer 2012 at Manzanillo bays in Colima, Mexico, and four oceanographic cruises were carried out along Mexican Central Pacific coasts (Jalisco, Colima, Michoacán and Guerrero) during 2009 to 2012 springs. Based on these studies we have recorded 24 phytoplankton species and one ciliate that generate red tides. These events show very high spatio-temporal variability also with high interannual fluctuations, and can be associated to the hydrodynamic of the region. From CTD casts, t-s diagrams were made to identify water masses of the zone during HABs development, mainly in winter and spring. HABs events produced by *Akashiwo sanguinea, Lingulodinium polyedrum, Cochlodinium polykrikoides, Alexandrium sp.* are associated to the California Current Water, as well as high *Pseudo-nitzschia spp.* cell densities. Thus, California Current transports phytoplankton species which may produce HABs at Mexican Central Pacific Ocean. On the other hand, during oceanographic cruises HABs were recorded offshore at a range of 5-10 nm from the coastal line at upwelling borders. Geostrophic currents maps provided by NOAA/CoastWatch were used to confirm the presence of the California Current that flows southward from Baja California, Mexico during winter and spring and sometimes flows parallel to Mexican Central Pacific coast. HABs development, spreading and permanence have been studied using satellite imagery provided by the OceanColor Web (NASA).

## P-4. Preliminary analysis of age, length, and maturity of Pacific mackerel *(Scomber japonicus)* collected 2009-2012 off of San Diego, CA

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## P-5. Breaking the cycle: anomalies in the ovarian development of blackgill rockfish, *Sebastes melanostomus*

Lyndsey Lefebvre, John Field

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Southwest Fisheries Science Center, NMFS/NOAA

There is increasing evidence for exceptions to the traditional view of annual spawning cycles in iteroparous fishes, including multi-year oocyte development, abortive maturation in first-time spawning females, and skipped spawning events in adult females. Such anomalies are typically missed when ovaries are macroscopically staged, yet recognition of these events is important when estimating maturity curves and spawning stock biomass for stock assessment purposes as they can have a significant effect on lifetime fecundity of females. Blackgill rockfish (*Sebastes melanostomus*) are among the longest-lived and slowest-growing *Sebastes* species in the California Current region. Unusual patterns of macroscopic maturity stages of females examined for the 2011 stock assessment and occurrence of "prolonged adolescence" in other *Sebastes* species prompted an ongoing histological study of blackgill rockfish ovaries in order to assess reproductive patterns and potential anomalies. Since June 2010 ovarian samples have been collected from commercial fishermen out of Morro Bay, California from 12 (monthly) time periods. Phases of ovarian development are described, initial findings are discussed, and comparisons between macroscopic and microscopic ovarian staging are made from samples collected between June 2010 and January 2012. After histological examination of 173 ovaries, oocyte development appears to take at least one year, with pre-vitellogenic secondary growth oocytes present in regenerating ovaries as well as those in the early developing phase. After histological examination, several fish below the estimated size at first maturity (29 cm) were found to be "biologically" mature (with pre-vitellogenic secondary growth oocytes present), further suggesting oocyte development is a multi-year process; however, it is unlikely these fish were "functionally" mature (i.e. contributing to production). Four cases of abortive maturation were found in fish smaller than 40 cm. The ovaries undergoing abortive maturation, as well as some ovaries in the regressing and regenerating phases, were macroscopically classified as developing. Findings of this study will be of direct relevance for future stock assessments of this species, and may provide additional evidence of the complexity of reproductive ecology for long-lived species.

## P-6. Diet variability of forage fish in the northern California Current ecosystem

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As fisheries management shifts to an ecosystem-based approach, understanding energy pathways and trophic relationships in the Northern California Current (NCC) will become increasingly important for predictive modeling and understanding ecosystem response to changing ocean conditions. In the NCC, pelagic forage fishes are a critical link between seasonal and interannual variation in primary production and upper trophic groups. We compared diets among dominant forage fish (sardines, anchovies, herring, smelts, mackerels, and sablefish juveniles) in the NCC collected in May and June of 2011 and 2012, and found high diet variability between and within species on seasonal and annual time scales, and also on decadal scales when compared to results of past studies. Prey composition for most forage fish in 2012 were principally composed of copepods, which differed from a preponderance of euphausiids found in previous studies for cold-water ocean conditions. Forage fish that show plasticity in diet may be more adapted to ocean conditions of low productivity or anomalous prey fields. These findings highlight the variable and not well-understood connections between ocean conditions and energy pathways within the NCC.

## P-7. Dungeness crab die-off at Pt. Reyes MPA cluster July 2011: precursor to Sonoma County invertebrate die-off?

Donna Kline[1], James Lindholm[1], Dirk Rosen[2], Elizabeth Ramsay[1]

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In August 2011 an unprecedented die-off of marine invertebrates occurred along the Sonoma County coastline that coincided with a large algae bloom. Large numbers of dead red abalone and sea urchins were observed from south of Bodega Bay to Anchor Bay in the north, impacting at least 50 miles of shoreline and reducing abalone populations by as much as 30 percent. Mortality rates were even higher for red sea urchin, ranging from 40 to 45 percent. Other invertebrates affected by the event included chitons, sea stars, rock crab, kelp crab, mussels, and other mollusks, echinoderms and crustaceans. Approximately four weeks earlier, July 19, while conducting MPA Baseline ROV surveys in the Pt. Reyes MPA cluster, we observed hundreds of dead Dungeness crabs piled on rocks inside the SMCA. Though Dungeness crabs were not a species significantly affected in Sonoma County, we hypothesize that the two events may be connected and propose that the origin of the event may have been farther south. Prevalent seasonal current patterns for the region, in coincidence with relaxation in upwelling observed prior to and during the algae bloom could have caused accumulation of dead Dungeness in the retention cell just below Pt. Reyes where dead Dungeness were observed. This event may have influenced the reduced Dungeness landings reported from 2011-2012 and, though effects on juvenile crabs were not directly observed, may impact landings in upcoming years.

## P-8. Large California Current-wide salp bloom in spring 2012

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In spring of 2012 the widespread occurrence of gelatinous suspension-feeding salps was first noted across a broad region of the California Current System, extending at least 350 km offshore. Pyrosomes were also relatively common. We analyzed the spatial extent and species composition of the salp bloom from the spring, 2012 CalCOFI cruise and related Coastwide survey cruises conducted by SWFSC/NMFS, focusing on two geographic regions: the Southern and Central California sectors of the CCS. We will present analyses of geographic patterns of distribution and C biomass of the salp assemblage in these two regions, and compare them to previous salp outbreaks over the past 6 decades. Salp blooms are of considerable interest, both for their disproportionate impact on ocean biogeochemistry via enhanced vertical fluxes of C and other elements, and for their role as potential competitors with other suspension-feeding zooplankton and planktivorous fishes.