CalCOFI Conference

2-3 December 2019

NOAA Southwest Fisheries Science Center
La Jolla, CA

Hosted by:

Scripps Institution of Oceanography
and Southwest Fisheries Science Center

CalCOFI Coordinator: John Heine
Symposium Conveners: Brice Semmens and Andrew Thompson

In association with:
California Department of Fish and Wildlife

CalCOFI Conference 2019

Southwest Fisheries Science Center
La Jolla, CA
Dec. 2-3

Monday, 2 December

9:00-10:00 Registration – Southwest Fisheries Science Center

10:00-10:10 **Opening of the Conference**
Welcome: Cisco Werner, NOAA NMFS

10:10-10:55 **Session I: State of the California Current 2018-19: a new anchovy regime and marine heatwave?** Andrew R. Thompson[1], I. D. Schroeder[2], S. J. Bograd[2], E. L. Hazen[2], M. G. Jacox[2], A. L. Leising[2], B. K. Wells[3], J. L. Fisher[4], K. Jacobson[4], J.S. Zeman[4], E. P. Bjorkstedt[3], R. R. Robertson[5], M. Kahru[6], R. Goericke[6], C. E. Peabody[1], T. R. Baumgartner[7], B. E. Lavaniego[7]s, L. E. Miranda[7], E. Gomez-Ocampo[7], J. Gomez-Valdes[7], T. R. Ault[8], E. A. Daly[4], C. A. Morgan[4], B. J. Burke[9], J. C. Field[3], K. M. Sakuma[3], E. D. Weber[1], W. Watson[1], J. M. Porquez[10], J. Dolliver[10], D. Lyons[10], R. A. Orben[10], J. E. Zamon[11], P. Warzybok[12], J. Jahncke[12], J. A. Santora[3], S. A. Thompson[13], B. Hoover[13], W. Sydeman[13], and S. R. Melin[13] (see abstracts section for all affiliations).

10:55 **Session II: Contributed Papers (15 minutes with 5 minutes for discussion).** Chair: Julia Coates, California Dept. of Fish and Wildlife

10:55-11:15 C-1. **The small pelagic fishery of temperate affinity in Mexico, 2018 season.** Concepción Enciso Enciso[1], **Martín E. Hernández Rivas[2]**, María de los Ángeles Martínez Zavala[3], Manuel O. Nevárez Martínez[3] and Casimiro Quiñonez Velázquez[2] and [4]Reginaldo Durazo, [1]CRIAP-ENSENADA, [2]CICIMAR-IPN, [3]CRIAP GUAYMAS and [4]UABC.

11:15-11:35 C-2. **First Results from the Catalina Dynamic Ocean Chemistry Program.** Craig G. Gelpi, Catalina Marine Society, Lake Balboa, CA.

11:35-11:55 C-3. **Investigating Patterns of Larval Fish Community Dynamics Over the Past Two Decades Using a Novel Application of Environmental DNA Metabarcoding.** Zachary Gold[1], Dovi Kacev[2], Paul H. Barber[1], Kelly D. Goodwin[3], Luke Thompson[3], Andrew Thompson[4], [1] Department of Ecology and Evolutionary Biology, UCLA, Los Angeles, [2] Scripps Institution of Oceanography, UCSD[3], Atlantic Oceanographic and Meteorological Lab, Miami, [4] Southwest Fisheries Science Center, NMFS/NOAA, La Jolla.

11:55-12:45 Lunch

12:45-1:05 C-4. **Position of the North Pacific Current & Northeast Pacific Ocean Circulation Modes**. Marisol García-Reyes[1], William Sydeman[1], Chelle Genteman[1,2], Sonia Batten[3], & Kathleen Dohan[2], [1] Farallon Institute, Petaluma, CA, [2] Earth and Space Research, Seattle, WA, [3] Marine Biological Association, UK.

1:05-1:25 C-5. **Increase in Surface Temperature and Deep Layer Nitrate in the California Current: A Spatiotemporal Analysis of Four-Dimensional Hydrographic Data.** Lindsay Hennes, University of Southern California.

1:25-1:45 C-6. **Status of the Market Squid Fishery.** Katie O Grady, California Department of Fish and Wildlife.

1:45-2:05 C-7. ***Zooglider*** – **Autonomous and concurrent acoustic, optical, and physical recordings for novel insights into the structure of marine systems.** Sven Gastauer[1], Mark D. Ohman[1], [1]Scripps Institution of Oceanography.

2:05-2:25 C-8. **Trophic ecology of Northern Anchovy and Pacific Sardine in the California Current Ecosystem from 1960 to 2011.** Rasmus Swalethorp[1,2,3], Michael R. Landry[1], Mark D. Ohman[1], Lihini Aluwihare[1], Dereka Chargualaf[2], Andrew R. Thompson[2], [1]Scripps Institution of Oceanography, La Jolla, [2]Southwest Fisheries Science Center, NOAA Fisheries, La Jolla, [3]DTU Aqua, Technical University of Denmark.

2:25-2:50 Break

2:50 Session III: **Contributed Papers (15 minutes with 5 minutes for discussion).** Chair: TBA

2:50-3:10 C-9. **Observing the regional effects of climate variability with the California Underwater Glider Network.** Daniel L. Rudnick, Scripps Institution of Oceanography, La Jolla, CA.

3:10-3:30 C-10. **Characterizing secular trends of warming and deoxygenation in the CalCOFI time series and ecological implications for fisheries species.** Natalya D. Gallo[1,2], Gavin L. Simpson[3], Nick C. Wegner[2], Lisa A. Levin[1], Andrew Thompson[2], Russ Vetter[2], Brice X. Semmens[1], [1]Scripps Institution of Oceanography, University of California San Diego, [2]NOAA Southwest Fisheries Science Center, La Jolla, CA, [3]Institute of Environmental Change and Society, University of Regina, Saskatchewan, Canada.

3:30-3:50 C-11. **Implementing Ecosystem Considerations in Forage Fisheries: Use of Ecosystem Monitoring Data in a San Francisco Bay Herring Case Study.** Julie A. Thayer[a,], Elliott Hazen[b], Marisol García-Reyes[a], Amber Szoboszlai[a], William.J. Sydeman[a], [a] Farallon Institute, Petaluma. CA, [b] NOAA Southwest Fisheries Science Center, Environmental Research Division, Pacific Grove, CA.

3:50-4:10 C-12. **Inter-annual variability in forage fish population size structure: selectivity of traditional vs. non-traditional monitoring data.** Julie A. Thayer[1,2], Zofia Burr[1], Ryan Carle[3], John Field[4], Peter Warzybok[5], [1] Farallon Institute, Petaluma, CA, [2] Institute of Marine Sciences, University of California, Santa Cruz, [3] Oikonos Ecosystem Knowledge, Santa Cruz, CA, [4] Fish Ecology Division, Southwest Fisheries Science Center, National Marine Fisheries Service, Santa Cruz, CA, [5] Point Blue Conservation Science, Petaluma, CA.

Reception

5:00-7:00 Martin Johnson House (T-29), Scripps Institution of Oceanography. Beer, wine, and non-alcoholic beverages, hors d'oeuvres, desert.

Tuesday, 3 December

8:00-8:30 Registration – Southwest Fisheries Science Center

8:30 **Session IV: The Symposium of the Conference: Putting Ocean Ecosystem Monitoring Data To Use**

Chair: Andrew Thompson, SWFSC, NOAA/NMFS, and Brice Semmens, Scripps Institution of Oceanography

8:30-8:40 Introduction and overview. Brice Semmens, Scripps Institution of Oceanography

8:40-9:00 S-1. **Trawling for data: A Fisheries Independent West Coast Groundfish Bottom Trawl Survey (1998 – 2019).** Aimee A. Keller[1], Keith L. Bosley[1], Aaron C. Chappell[2], John C. Buchanan[2], Douglas Draper[2], Peter Frey[1], John H. Harms[1], Melissa A. Head[1], Dan Kamikawa[2], Laurel S. Lam[3], and Victor H. Simon[1], [1]Northwest Fisheries Science Center, NMFS/NOAA, Seattle, WA, [2]Northwest Fisheries Science Center, NMFS/NOAA, Newport, OR, [3]Northwest Fisheries Science Center, PSMFC, Seattle, WA.

9:00-9:20 S-2. **NOAA Fisheries' shelf rockfish hook and line survey: An industry-scientist research partnership for long-term resource sustainability.**

John H. Harms[1], Jim A. Benante[2], Laurel S. Lam[2], Victor H. Simon[1], Aaron C. Chappell[3], Aimee A. Keller[1], [1]Northwest Fisheries Science Center, NMFS/NOAA, Seattle, WA, [2]Northwest Fisheries Science Center, PSMFC, Seattle, WA, [3]Northwest Fisheries Science Center, NMFS/NOAA, Newport, OR.

9:20-9:40 S-3. **The Joint U.S.-Canada Integrated Ecosystem and Pacific Hake Acoustic-Trawl Survey: Growing beyond a single-species focus**. Sandra Parker-Stetter[1], Stéphane Gauthier[2], Julia Clemons[3], Michael Malick[1], Elizabeth Phillips[1], Alicia Billings[3], Dezhang Chu[1], Steve de Blois[1], Jackie Detering[4], John Pohl[1], Ben Snow[4], Chelsea Stanley[2], Rebecca Thomas[1], [1]Northwest Fisheries Science Center, NMFS/NOAA, Seattle, WA, [2]Institute of Ocean Sciences, DFO, Sidney, BC, [3]Northwest Fisheries Science Center, NMFS/NOAA, Newport, OR, [4]Pacific Biological Station, DFO, Nanaimo, BC.

9:40-10:00 S-4. **NOAA-Northwest Fisheries Science Center's Juvenile Salmon & Ocean Ecosystem Surveys**. Kym Jacobson[1], Brian Burke[2], Cheryl Morgan[3], [1] Fish Ecology Division, Northwest Fisheries Science Center, NMFS/NOAA, Seattle, WA, [2] Fish Ecology Division, NOAA/Fisheries, Northwest Fisheries Science Center, NMFS/NOAA, Newport, OR, [3] Cooperative Institute for Marine Resources Studies, Oregon State University, Newport, OR.

10:00-10:20 Break.

10:20-10:40 S-5. **The Applied California Current Ecosystem Studies (ACCESS)**. Meredith Elliott[1], Danielle Lipski[2], Jan Roletto[3], Jaime Jahncke[1], [1]Point Blue Conservation Science, Petaluma, [2]Cordell Bank National Marine Sanctuary, Point Reyes, [3]Greater Farallones National Marine Sanctuary, San Francisco.

10:40-11:00 S-6. **Newport Hydrographic Line and Broadscale Northern California Current Ecosystem Surveys**. Kym C. Jacobson[1], Jennifer L. Fisher[2], Samantha Zeman[2], [1] Fish Ecology Division, NOAA/Fisheries, Northwest Fisheries Science Center, NMFS/NOAA, Newport, OR, [2] Cooperative Institute for Marine Resources Studies, Oregon State University, Newport, OR.

11:00-11:20 S-7. **Larval fish as a predictor of available prey fields for and marine survival of juvenile salmon: new approaches for salmon management**. Richard D. Brodeur[1] Elizabeth A. Daly[2], Toby D. Auth[3], [1]Estuarine and Ocean Ecology Program, Northwest Fisheries Science Center, National Oceanic and Atmospheric Administration, [2]Cooperative Institute for Marine Resources Studies, Oregon State University, Hatfield Marine Science Center, [3]Pacific States Marine Fisheries Commission, Hatfield Marine Science Center.

11:20-11:40 S-8. **The Trinidad Head Line: zooplankton indicators of ecosystem responses to climate forcing in the northern California Current**. Eric P. Bjorkstedt[1], Roxanne Robertson[2], Blair Winnacott[2], Raphe Kudela[3], Clarissa Anderson[4], [1]Southwest Fisheries Science Center NMFS/NOAA, Humboldt State University, Trinidad, CA, [2]CIMEC at Humboldt State University, Trinidad, CA, [2]University of California, Santa Cruz, CA, [4]SCCOOS, SIO, La Jolla, CA

11:40-12:00 S-9. **Farallon Institute: 30 Years of Monitoring the California Current.** Jeffrey G. Dorman[1], William J. Sydeman[1], Marisol García-Reyes[1], Julie A. Thayer[1], [1]Farallon Institute, Petaluma, CA.

12:00-12:40 Lunch

12:40-1:00 S-10. **MBARI contributions to ocean observing of the California Current System.** Francisco Chavez and MBARI collaborators, Monterey Bay Aquarium Research Institute (MBARI).

1:00-1:20 S-11. **The Rockfish Recruitment and Ecosystem Assessment Survey: Thirty-seven years of epipelagic micronekton collections in the California Current**. John C. Field[1], Jarrod A. Santora[1], Rebecca R. Miller[2], Brian K. Wells[1], Keith M. Sakuma[1]. [1] Fisheries Ecology Division, Southwest Fisheries Science Center, National Marine Fisheries Service, National Oceanic and Atmospheric Administration, Santa Cruz, CA, [2] Cooperative Institute for Marine Ecosystems and Climate, Institute for Marine Sciences, University of California Santa Cruz.

1:20-1:40 S-12. **The California Collaborative Fisheries Research Program: implementation and expansion of a statewide marine protected area monitoring program.** Ruttenberg, B.I.[1], Waltz, G.T.[1], Bellquist, L.[2], Caselle, J.[3], Chiu, J.[4], Dibble, C.[5], Fields, R.[4], Honeyman, C.[3], Kelmartin, I.[6], Mason, E.[2], Morgan, S.[5], Mulligan, T.[6], Satterthwaite, E.[5], Semmens, B.[2], Starr, R.[4], Staton, J.[6], Tyburczy, J.[7], Wendt, D.E.[1], [1]Center for Coastal Marine Sciences, Cal Poly San Luis Obispo, [2]Scripps Institution of Oceanography, UC San Diego, [3]Marine Science Institute, UC Santa Barbara, [4]Moss Landing Marine Laboratories, [5]Department of Environmental Science and Policy, UC Davis, [6]Department of Fisheries Biology, Humboldt State University, [7]California SeaGrant, Humboldt State University.

1:40-2:00 S-13. **Twenty years of monitoring coastal ecosystems by PISCO: linking ecological theory and data to inform management and policy**. J. Wilson White[1], Jennifer E. Caselle[2], Mark H. Carr[3], Daniel P. Malone[3], John A. Barth[1], Carol A. Blanchette[2], Francis Chan[1], Bruce A. Menge[1], Peter T. Raimondi[3], Libe Washburn[2]. [1]Oregon State University, Corvallis/Newport

[2]University of California, Santa Barbara, [3]University of California, Santa Cruz.

2:00-2:20 S-14. **The Santa Barbara Channel Marine Biodiversity Observation Network**. Robert Miller[1], David Siegel[1], Craig Carlson[1], Dan Reed[1], Andrew Rassweiler[2], Milton Love[1], Andrew Thompson[3], Deborah Iglesias-Rodriguez[1], Margaret O'Brien[1], [1]Marine Science Institute, University of California Santa Barbara, [2]Florida State University, Tallahassee, [3]NMFS Southwest Fisheries Science Center.

2:20-2:40 Break

2:40-3:00 S-15. **Streamlining Ecosystem Assessments: New Tools to Quickly Generate Management Information from Ocean Monitoring Data**. Jennifer A Brown[1,2,3], Chris Caldow[2], Andrew DeVogelaere[3], Greg Williams[4,5], Benjamin D Best[6], Gabrielle Canonico[7], [1]ECOS Consulting, [2]Channel Islands National Marine Sanctuary, National Ocean Service, NOAA, [3]Monterey Bay National Marine Sanctuary, National Ocean Service, NOAA, [4]Pacific States Marine Fisheries Commission, [5]Northwest Fisheries Science Center, NOAA Fisheries, [6]EcoQuants LLC, [7]US Integrated Ocean Observing System (IOOS), National Ocean Service, NOAA.

3:00-3:20 S-16. **Extending the relevance of the Southern California Coastal Ocean Observing System through Collaborations with Ecosystem and Fisheries Science.** Clarissa Anderson[1] and many partners, [1]Scripps Institution of Oceanography, SCCOOS La Jolla.

3:20-3:40 S-17. **Regional Monitoring for Sediment and Water Quality in the Urban Ocean of the Southern California Bight.** Karen McLaughlin[1], Kenneth Schiff[1], Nina Bednarsek[1], Dario Diel[1], Bowen Du[1], David Gillet[1], John Griffith[1], Darrin Greenstein[1], Ashely Parks[1], Jayme Smith[1], Stephen Weisberg[1], [1]Southern California Coastal Water Research Project, 3535 Harbor Blvd., Suite 110, Costa Mesa CA.

3:40-4:00 S-18. **Acoustic-Trawl Method Surveys inform Precautionary, Ecosystem Approaches to Management of Forage Fishes in the California Current**. David A. Demer[1], Kevin Stierhoff[1], Juan P. Zwolinski[2], [1]Southwest Fisheries Science Center, NMFS/NOAA, La Jolla, [2]Institute of Marine Sciences, University of California Santa Cruz.

4:00-4:20 S-19. **The California Current Ecosystem Long-Term Ecological Research site.** Mark D. Ohman (on behalf of the CCE group).

4:20-4:40 S-20. **IMECOCAL: Mexican Research Program of the California Current. More than 20 ears monitoring the southern CC.** Sylvia P. A. Jiménez-

Rosenberg, Instituto Politécnico Nacional, CICIMAR, Depto. de Plancton y Ecología Marina.

4:40-5:00 S-21. **The California Cooperative Oceanic Fisheries Investigation: Monitoring the California Current Ecosystem since 1949.** Andrew R. Thompson, Brice X. Semmens and Briana C. Brady.

Poster Session

5:15-7:15 **Martin Johnson House (T-29), Scripps Institution of Oceanography.** Beer, wine, and non-alcoholic beverages, hors d'oeuvres, and dessert.

P-1. **Aerial Survey of Small Pelagic Species in Nearshore California Waters**. Kirk Lynn[1], Emmanis Dorval[2], Dianna Porzio[3], Trung Nguyen[3], [1]California Department of Fish and Wildlife, La Jolla, [2]NOAA Affiliate OAI/Southwest Fisheries Science Center, [3]California Department of Fish and Wildlife, Los Alamitos.

P-2. **An Overview of the California Live Bait Marine Fishery.** Dianna Porzio[1], Kirk Lynn[2], Trung Nguyen[1], [1]California Department of Fish and Wildlife, Los Alamitos, [2]California Department of Fish and Wildlife, La Jolla.

P-3. **Predicting spatio-temporal shifts in larval fish abundance in the eastern Pacific using Bayesian hierarchical modeling.** Katherine E. Dale[1], Rita S. Mehta[1], M. Timothy Tinker[1], [1]University of California, Santa Cruz 130 McAllister Way, Santa Cruz, CA 95060.

P-4. **Gauging Environmental Effects on Larval Rockfish Condition and Recruitment within the Southern California Bight.** Noah Ben-Aderet[1], Andrew Thompson[1], [1] Fisheries Resources Division, NOAA – Southwest Fisheries Research Center, La Jolla, California.

P-5. **Robust and Simple Classifications Quantify Ecological Responses to Marine Heatwaves.** Ryan Freedman[1,2,3], Jennifer A. Brown[1,4], Chris Caldow[1], and Jennifer E. Caselle[5], [1] NOAA Channel Islands National Marine Sanctuary, [2]Ecology Evolution and Marine Biology Department, University of California Santa Barbara, [3]Cardinal Point Captains, [4]ECOS Consulting, LLC, [5]Marine Science Institute, University of California Santa Barbara.

P-6. **The SIO Pelagic Invertebrate Collection: An unparalleled resource for the Ocean Sciences.** Mark D. Ohman, Linsey M. Sala, Scripps Institution of Oceanography, UC San Diego.

Conference adjourned.

Session I

State of the California Current 2018-19: a new anchovy regime and marine heatwave?

Andrew R. Thompson[1], I. D. Schroeder[2], S. J. Bograd[2], E. L. Hazen[2], M. G. Jacox[2], A. L. Leising[2], B. K. Wells[3], J. L. Fisher[4], K. Jacobson[4], J.S. Zeman[4], E. P. Bjorkstedt[3], R. R. Robertson[5], M. Kahru[6], R. Goericke[6], C. E. Peabody[1], T. R. Baumgartner[7], B. E. Lavaniego[7]s, L. E. Miranda[7], E. Gomez-Ocampo[7], J. Gomez-Valdes[7], T. R. Ault[8], E. A. Daly[4], C. A. Morgan[4], B. J. Burke[9], J. C. Field[3], K. M. Sakuma[3], E. D. Weber[1], W. Watson[1], J. M. Porquez[10], J. Dolliver[10], D. Lyons[10], R. A. Orben[10], J. E. Zamon[11], P. Warzybok[12], J. Jahncke[12], J. A. Santora[3], S. A. Thompson[13], B. Hoover[13], W. Sydeman[13], and S. R. Melin[13]

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[8]Pacific States Marine Fisheries Commission, Hatfield Marine Science Center, Newport, Oregon
[9]Fish Ecology Division, Northwest Fisheries Science Center, Seattle, WA
[10]Oregon State University, Hatfield Marine Science Center, Newport, Oregon
[11]Northwest Fisheries Science Center, Point Adams Research Station, Hammond OR
[12]Point Blue Conservation Science, Petaluma, CA
[13]Farallon Institute for Advanced Ecosystem Research, Petaluma, CA 94952
[13]National Marine Fisheries Service, Alaska Fisheries Science Center, Seattle, WA

The California Current Ecosystem (CCE) has been in a primarily warm state since 2014, and this pattern largely continued into 2019. The CCE experienced a mild El Niño from late 2018 into 2019, and basin-scale indicators reflected this condition (elevated Oceanic Niño Index and Pacific Decadal Oscillation). Despite the El Niño, spring upwelling was above average between southern California and Washington (but below average in Baja California). Sea surface temperature (SST) was mostly near the long-term average between Washington and southern California, while surface chlorophyll *a* was above average in Oregon/Washington and slightly below average in most of California in spring/early summer 2019. SST changed dramatically by fall 2019, however, as a marine heatwave (MHW) that formed in May 2019 in the Gulf of Alaska impinged upon the West Coast of the United States. The expansion of the 2019 MHW followed a similar pattern to the 2014-2015 MHW.

Off Oregon, the zooplankton assemblage was in a mixed state as both southern and northern copepod abundances were positively anomalous in 2019. Off northern California *Euphausia pacifica* body size was smaller than average. Euphausid abundances were well below average in both central and southern California in 2019.
In the north, winter 2019 larval fish abundances were high and dominated by offshore taxa that are associated with warm conditions; spring larval and post-larval biomass were close to average. The single most important finding in 2019 was that Northern Anchovy (*Engraulis mordax*) adult and larvae were at record-high abundances in central and southern California. In central California, Market Squid (*Doriteuthis opalescens*) and Pacific Sardine (*Sardinops sagax*) were also abundant. In southern California warm-water mesopelagic fishes have been very abundant since 2014, and this trend continued into 2019.

Indicators for future salmon returns were mixed in 2019. The abundance of northern copepods, which correlate positively with returns, was high. However, abundances of yearling Chinook Salmon (*Oncorhynchus tshawytscha*) and Coho Salmon (*O. kisutch*), which also correlate positively with returns, were slightly below average. Winter ichthyoplankton was comprised mostly of southern or offshore taxa, which bodes poorly for salmon returns.

Seabird (Common Murre [*Uria aalge*]; Brandt's Cormorant [*Phalacrocorax penicillatus]*; and Pelagic Cormorant [*Phalacrocorax pelagicus*]) productivity off Oregon was the highest in years in both 2018 and 2019. Common Murre chicks consumed large amounts of young of the year flatfish in Oregon, a prey item known to be conducive to chick survival. Despite the prevalence of Northern Anchovy in central California, Common Murre and Brand's Cormorant production was low in Southeast Farallon Island as these birds were unable to feed optimally on Northern Anchovy, and there was a scarcity of more appropriate prey such as young of the year flatfishes or rockfishes.
California Sea Lions (*Zalophus californianus*), by contrast, benefitted greatly from the large Northern Anchovy forage base. In 2018, live pup count, weight, and growth rate were anomalously high, and Northern Anchovy remains occurred in >85% of scat samples. Humpback Whale (*Megaptera novaeangliae*) sightings were also very high in 2019, likely because Humpback Whale congregated near shore to feed on Northern Anchovy.

Session II: Contributed Papers

(C-1 to C-8)

C-1. The small pelagic fishery of temperate affinity in Mexico, 2018 season

Concepción Enciso Enciso[1], **Martín E. Hernández Rivas[2]**, María de los Ángeles Martínez Zavala[3], Manuel O. Nevárez Martínez[3] and Casimiro Quiñonez Velázquez[2] and [4]Reginaldo Durazo

[1]CRIAP-ENSENADA, [2]CICIMAR-IPN, [3]CRIAP GUAYMAS and [4]UABC

According to Official Mexican Norm NOM-003-SAG / PESC-2018, small pelagic fishing vessels along the Mexican coast must operate within a specific region related to their base port, which is defined in the corresponding Fishing Permit. Fleet movement between regions is not allowed. Movement of vessels will be allowed for a specific time and by express authorization of the fishing authority only, when for operational and maintenance reasons some fishing units cease to operate, and other units can occupy the unused effort. For the above, three regions are established for the fishing of small pelagics off the Pacific Ocean coast, including the Gulf of California: Zone A, Pacific coast of the Baja California peninsula, with 34 vessels; Zone B, Gulf of California and the coast of Sinaloa-Nayarit and northern Jalisco, with 60 vessels and Zone C, from northern Jalisco to Chiapas with three vessels.

Although the NOM identifies 12 species for exploitation, only five of these are of temperate affinity and the rest are tropical. The fishery is mainly aimed at four species since the catch of jack mackerel is generally low.

During 2018, the total catch in the NW of Mexico was 595,716 t. Specifically, and in order of importance according to fishing volumes, the Pacific sardine was the most captured species (338,768 t), followed by the northern anchovy (149,101 t), the chub mackerel (94,770 t) and the round herring (13,077 t).

In Ensenada, B.C., the total catch was 135,243 t, of which 73,031 t were from Pacific sardine, 12,172 t from chub mackerel and 50,040 t from northern anchovy; in Bahía Magdalena, B.C.S., a total of 79,800 t were captured, of which 78,850 t were from Pacific sardine and 950 t from chub mackerel; in the north and center of the Gulf of California (Guaymas and Yavaros, Sonora) a total of 380,673 t were captured, of which 186,887 t corresponded to Pacific sardine, 99,061 t to northern anchovy, 81,648 t to chub mackerel and 13,077 t to round herring sardine. The total catch of Pacific sardine for the western coast of the Mexican Pacific was 151,881 t, 19% lower than the catches from the Gulf of California.

* Authors in alphabetical order.

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C-2. First Results from the Catalina Dynamic Ocean Chemistry Program

Craig G. Gelpi[1]

[1]Catalina Marine Society, Lake Balboa, CA

Islands offer the possibility of being refugia from ocean acidification. Oceanic conditions may produce different mean pH values for islands relative to nearby mainland, while large natural variations in pH may influence how marine fauna tolerate increasingly acidifying waters. The Catalina Dynamic Ocean Chemistry (CDOC) program is designed to investigate natural variations in ocean chemical parameters found at Santa Catalina Island, California. There are two measurement protocols, including depth profiling from a boat, and measurements from a fixed 18.3-m depth on a mooring chain. The average pH value amongst the mooring deployments was 8.18, significantly larger than measurements reported from the mainland coast in the Southern California Bight. We find that during regimes of strong stratification and internal waves (i.e., summer conditions), pH is modulated significantly at internal wave frequencies and is highly correlated with temperature. The internal wave activity enabled an estimate of nominal parameter values as a function of depth. Strong episodic upwelling events occurring in less stratified conditions (i.e., winter conditions) are also attended by more acidic water. We find the largest modulation in pH for either summer or winter conditions to be greater than 0.1 pH unit. Results obtained from the depth-profiling protocol are in general agreement with those from the mooring, including an average pH of 8.12 at 18.3 m.

C-3. Investigating Patterns of Larval Fish Community Dynamics Over the Past Two Decades Using a Novel Application of Environmental DNA Metabarcoding

Zachary Gold[1], Dovi Kacev[2], Paul H. Barber[1], Kelly D. Goodwin[3], Luke Thompson[3], Andrew Thompson[4]

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Plankton samples track stock biomass and ecosystem dynamics worldwide and are a critical component for monitoring and managing U.S. fisheries and marine ecosystems. Ichthyoplankton collected by the California Cooperative Oceanic Fisheries Investigations (CalCOFI) program helps inform rockfish and clupeoids stock assessments and fish ecosystem status within the California Current Ecosystem. However, traditional methods for identifying plankton are time and labor intensive, resulting in a backlog of samples that need to be processed. A promising new technique for efficiently quantifying species from plankton samples is high throughput sequencing of dissociated DNA from the ethanol-preservation buffer. This cost-effective and non-destructive technique utilizes DNA shed from plankton into the preservation buffer, thus allowing researchers to extract, amplify, sequence, identify, and potentially quantify DNA abundance of species without damaging archived samples. We use novel environmental DNA (eDNA) techniques to identify larval fish and zooplankton species from ethanol-preserved plankton samples collected by the CalCOFI program at 4 stations likely exposed to different oceanographic water masses between 1996 and 2019. Our aims are to 1) evaluate the efficacy of eDNA to accurately identify larval fishes by comparing genetic and morphologically identified samples; and 2) investigate the long-term dynamics of Southern California ichthyoplankton and zooplankton communities in response to climate forcing. We successfully amplified DNA from all stations and time points in triplicate using 4 metabarcodes targeting fish (*12S*), Sebastes (*CytB*), and zooplankton (*CO1* and *16S*). We test how fish and zooplankton biodiversity and assemblage structure respond to oceanographic dynamics including the 1997-98 El Niño and record-warm 2014-2016 marine heatwave. This project has the potential to greatly augment traditional ichthyoplankton processing and provide critical information on key ecosystem component dynamics in near real-time.

C-4. Position of the North Pacific Current & Northeast Pacific Ocean Circulation Modes

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Flow rates of the California Current (CAC) and the Alaska Current (AKC) are expected and known to covary, as they have a common source in the North Pacific Current (NPC). Two modes of variability for the CAC and AKC have been described: an in-phase or breathing mode (both increasing/decreasing at the same time) and a bifurcation mode (alternating in strength). Changes in the strength and position of the NPC itself has been proposed as a mechanism for this covariability, but only the strength has been analyzed. In this study, we test the hypothesis that the latitudinal position of the NPC is associated with the variability in the CAC and AKC flow rates. We test this hypothesis by performing a Principal Component Analysis of the latitudinal position of the NPC bifurcation streamline - the line dividing the water that flows south into the CAC or north into the AKC - and the meridional currents in strategic regions of the northern CAC and AKC. We used 19 years (2000-2018) of satellite-derived SSH and geostrophic currents data to conduct this analysis. Our results indicate that for this period, the position of the NPC is associated with the alternating strength of the CAC and AKC (bifurcation mode), and that the relationship between the coastal currents and the NPC varies with season. The leading winter and fall principal component (PC) associated poleward shifts of the NPC with increasing (decreasing) strength of the CAC (AKC). In contrast, the spring and summer leading and second PCs explained almost equal portions of the variability. In these two seasons, one mode represents the variability of CAC and the NPC near the coast (bifurcation area), while the other represents the AKC and the position of the NPC offshore. The coastal mode associates poleward shifts in the NPC with stronger CAC, similar to winter/fall leading PCs, while the offshore mode associates poleward shifts in NPC with stronger AKC instead. This analysis supports the idea that the CAC and AKC co-vary in an alternating mode, while demonstrating that the position of the NPC is associated to this variability. Furthermore, we show that this circulation, associated with the PDO, is predominant in winter and fall, but spring and summer are more complex with important variability near the coast that impacts mostly the CAC.

C-5. Increase in Surface Temperature and Deep Layer Nitrate in the California Current: A Spatiotemporal Analysis of Four-Dimensional Hydrographic Data

Lindsay Hennes

University of Southern California

The California Current System (CCS) off the coast of southern California has been surveyed for 70 years by California Cooperative Oceanic Fisheries Investigation (CalCOFI). Past research associated increase in sea surface temperature (SST) with decrease in primary productivity in the CCS due to a stronger thermocline, which prevented nitrate moving from the deep layer to the surface. However, recent research indicates that primary productivity is increasing in the CCS despite SST warming. This project shed further light on this unexpected trend and explored whether the data record showed if surface temperature and deep layer nitrate concentration are increasing. A unique workflow using Empirical Bayesian Kriging 3D and the Space Time Cube toolset in ArcGIS Pro was created to analyze spatial and temporal patterns in temperature and nitrate in the long time-series hydrographic dataset using both vertical and horizontal cross-sections. Results show that SST and deep layer nitrate offshore are increasing in the CCS, and spatial patterns suggest the increased nitrate may be delivered by the California Current, perhaps due to changes to circulation in the Pacific.

C-6. Status of the Market Squid Fishery

Katie O Grady

California Department of Fish and Wildlife

Market Squid is routinely one of California's largest commercial fisheries in terms of volume and value. Landings and ex-vessel value averaged over 107,000 short tons and $65 million from 2009 to 2015, with a particularly productive period in Northern California during the 2014 to 2016 El Niño-Southern Oscillation. The fishery is managed under a limited entry program and monitored by evaluating egg escapement (reproductive output). Biological information comes from the California Department of Fish and Wildlife's dockside sampling program, which includes a multi-decadal dataset. Within the past two decades the average dorsal mantle length (DML) of Market Squid caught by the fishery in Southern California (south of Point Conception) decreased ($p < .0001$) whereas the average DML of individuals caught in Northern California (north of Point Conception) increased ($p < .0001$). Long-term data streams could provide insight into changes in distribution, catch per unit effort, spawning patterns, or morphology and the extent to which these changes are driven by fishery dynamics or environmental factors.

C-7. *Zooglider* – Autonomous and concurrent acoustic, optical, and physical recordings for novel insights into the structure of marine systems

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Zooglider, a new generation of autonomous ocean glider equipped with optical, acoustic and physical sensors presents is a truly cross-disciplinary sampling platform. Through high resolution optical shadowgraph imaging, *Zooglider* can characterize the structure of relatively undisturbed zooplankton communities. Such optical images provide novel insights into the community structure, prey-predator interactions, 3-dimensional orientation and abundance of zooplankton communities. As such, *Zooglider* derived information can help us to improve trait-based models and contribute to our understanding of marine food web complexity. Multi-frequency acoustic recordings (200 and 1000 kHz) in combination with simultaneous physical recordings of ambient fluorescence, temperature and salinity allow the quantification of biological or physical boundaries zones and relative biomass. The concurrent nature of these three datasets make *Zooglider* a promising tool, to work towards a better understanding of physical-biological coupling within the zooplankton environment and an improved description of resulting gradient regions. During the 2019 CCE-LTER process cruise (Aug.-Sept. 2019), *Zooglider* was launched at sea and navigated remotely to cross the Pt. Sur coastal upwelling filament, which was concurrently sampled during the Lagrangian ship-based survey. Crossing through prominent features, *Zooglider* was able to deliver high resolution information on the biological and physical properties of the ecosystem structure inside and outside of the targeted ocean features. *Zooglider* proved to be a useful tool to complement ship-based sampling and to support Lagrangian measurements of cross-shore fluxes.

C-8. Trophic ecology of Northern Anchovy and Pacific Sardine in the California Current Ecosystem from 1960 to 2011

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Over the centuries, Northern Anchovy (*Engraulis mordax*) and Pacific Sardine (*Sardinops sagax*) stocks experienced large fluctuations in size and recruitment even before the impact of fisheries, likely in response to oceanographic changes. Although the underlying mechanisms for these fluctuations are still poorly understood, changing environmental conditions such as temperature, explain some of the variation in population size and recruitment. However, these physical factors likely affect anchovy and sardine indirectly through changes in plankton community composition and abundance, which then dictates prey availability for larvae and juveniles. We explore the linkages between larval trophic ecology and population variability using nitrogen isotopic analyses of formalin-preserved tissues and specific amino acids from larvae collected off California by the CalCOFI program over the period of 1960 to 2011. We use a new Compound Specific Isotopic Analysis method using High Pressure Liquid Chromatography coupled with offline Isotope Ratio Mass Spectrometry generating high precision $\delta^{15}N$ measurements on individual 15-23 mm (SL) larvae. Towards the ends of their respective regimes in the late 1980s and late 2000s, larval anchovy and sardine both show substantial changes in trophic levels. Food chain length to anchovy larvae increased (higher trophic position) as zooplankton biovolume declined, indicating possible food limitation or less efficient energy transfer to the larvae. Trophic positions of sardine larvae showed enhanced interannual variability suggesting substantial fluctuations in plankton community structure within their habitat. These findings illustrate the potential importance of planktonic food web structure supporting larval development in regulating temporal dynamics in population indices of these two clupeid species.

Session III: Contributed Papers

(C-9 to C-12)

C-9. Observing the regional effects of climate variability with the California Underwater Glider Network

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The overarching goal of the California Underwater Glider Network (CUGN) is to sustain baseline observations of climate variability in the California Current System (CCS). The CUGN uses Spray underwater gliders making repeated dives from the surface to 500 m and back, repeating the cycle every 3 hours, and traveling 3 km in the horizontal during that time. The CUGN includes gliders on three of the traditional cross-shore CalCOFI lines: 66.7, 80.0 and line 90.0. The glider missions typically last 100 days, and cover over 2000 km, thus providing 4-6 sections on lines extending 350-500 km offshore. Since 2005 the CUGN has covered 310,000 km over ground in 40 glider-years, while doing 135,000 dives. Measured variables include temperature, salinity, velocity, chlorophyll fluorescence, dissolved oxygen, and acoustic backscatter. These data are used to produce a regularly gridded climatology whose products are, for each observed variable, a mean field, an annual cycle, and the anomaly from the annual cycle. A striking biannual cycle is apparent in the California undercurrent and in chlorophyll fluorescence, likely reflecting forcing further equatorward. The interannual anomalies are examined with an emphasis on climate events of the last ten years including the ongoing warm anomalies that started in 2014 and a salinity anomaly that began in 2018. Dissolved oxygen is the most recently added observation, with the times series now longer than two years. Initial results suggest offshore transport of low oxygen water in eddies, especially on line 66.7.

C-10. **Characterizing secular trends of warming and deoxygenation in the CalCOFI time series and ecological implications for fisheries species**

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Temperature and oxygen conditions on upwelling margins vary at both shorter (semidiurnal, diurnal, event-based, and seasonal), and longer timescales (interannual and multidecadal). Considering the magnitude and characteristics of variability is important for understanding when climate-driven changes, such as ocean warming and ocean deoxygenation, become discernible and ecologically relevant. The California Cooperative Oceanic Fisheries Investigations (CalCOFI) is a long-term ecosystem monitoring program that is now in its 70th year. This time series provides an opportunity to characterize the natural variability of temperature and oxygen, test for the presence of statistically significant secular trends, and examine how warming and deoxygenation trends vary from inshore to offshore and through the upper 500 m of the water column. We use generalized additive models (GAMs) to quantify how oxygen and temperature variability are explained by different modes of variability: seasonal, interannual, multidecadal, and secular. We find a significant warming signal throughout the water column, significant increases in oxygen within the mixed layer, and significant decreases in oxygen at all depths below the mixed layer. To consider the ecological relevance of combined changes in temperature and oxygen, we use laboratory physiological measurements to determine the critical oxygen level (P_{crit}) for an important rockfish species, the Bocaccio (*Sebastes paucispinis*), and use this to calculate the metabolic index for this species. We then use GAMs to examine how the metabolic index of the habitat for Bocaccio changes through time across the CalCOFI time series. Changes in the metabolic habitat due to secular trends are compared to changes in the metabolic habitat due to natural climate forcing phenomena, to contextualize different timescales of habitat impact for this important fisheries species.

C-11. Implementing Ecosystem Considerations in Forage Fisheries: Use of Ecosystem Monitoring Data in a San Francisco Bay Herring Case Study

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Ecosystem based fisheries management is a priority nationally and beyond, yet lack of robust approaches has hampered its implementation. Even though forage fishes are critically important in trophic relationships in marine ecosystems, few examples of applied ecosystem-based information exist. We created a multi-pronged approach to ecosystem considerations in fisheries management and applied it to the small San Francisco Bay Pacific herring *Clupea pallasii fishery as a case history for use in other forage fisheries. The first step of our work used environmental parameters and recruitment indices to predict stock status for use in setting fishing quotas. The second step developed a qualitative predator indicator to potentially adjust quotas which consisted of (1) the status of alternative forage species in the ecosystem, (2) predator population "health" and mortality events. This indicator, with "stoplight" management recommendations, is framed* in relation to herring population cycles and climatic influences on population dynamics, and can inform potential predator mortality levels on herring. *We present a method to apply these metrics to fishing quotas and adjustments, geared toward the annual management cycle, and leveraging existing ecosystem monitoring data for simplicity and cost-effectiveness.* The resulting indicator matrix is flexible to incorporating environmental and ecosystem change; indeed future research on trophic interactions and climate effects on the herring-based ecosystem is warranted.

C-12. Inter-annual variability in forage fish population size structure: selectivity of traditional vs. non-traditional monitoring data

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Despite the crucial role of forage fish in ecosystem functioning, data on population demographic structure is often not readily available for many forage fish stocks. Data to characterize variability in population size structure can be highly informative for population monitoring and management, as such data are a reflection of cohort strength, variable growth rates, and for body-size dependent broadcast spawners such as anchovy, also represent variable reproductive capacity. In this study, Anchovy Length Indices (ALI) were developed for the central California portion of the Northern anchovy central stock using two types of existing ecosystem monitoring data, predator and midwater trawl samples, for years during which fishery sampling was not conducted. Seabird and trawl sampling methods differed somewhat in their selectivity, yet both methods appeared to sample all age classes of anchovy and reflected similar patterns of inter-annual variability in length frequency. The predator-based ALI was therefore further used to characterize anchovy size structure for years when trawl data on anchovy length was not available.

Session IV: The Symposium of the Conference

Putting Ocean Ecosystem Monitoring Data To Use

SYMPOSIUM ABSTRACTS

S-1. Trawling for data: A Fisheries Independent West Coast Groundfish Bottom Trawl Survey (1998 – 2019)

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The Northwest Fisheries Science Center conducts an annual bottom trawl survey along the upper continental slope and shelf of the U.S. west coast. Since 1998, the survey has occurred in conjunction with the commercial fishing industry aboard chartered west coast bottom trawlers. The survey targets groundfish resources in trawlable habitats at depths of 55-1280 m from U.S.-Canada to U.S.-Mexico and is the primary source of fisheries-independent data used in the majority of stock assessments for commercially important west coast species. We describe the history, methods, and design for the trawl survey and summarize our monitoring efforts. We collect an ongoing time series of species composition, relative abundance, distribution, weight, size, age, diet, maturity, and DNA. We additionally sample environmental (near bottom temperature, salinity, dissolved oxygen, chlorophyll fluorescence, turbidity and bottom depth) and habitat data. We present a case study from a time series of oxygen measurements collected across a range of depths and conditions from the upper to the lower limit of the oxygen minimum zone and shoreward across the continental shelf. Our research revealed significant positive relationships between catch and oxygen levels for 19 of 34 groundfish species within hypoxic bottom waters using generalized additive models. We saw an apparent threshold effect at lower oxygen levels, where small changes in oxygen produced large changes in catch for several species, information of value to future ecosystem-based management in the face of changing oceanographic conditions.

S-2. NOAA Fisheries' shelf rockfish hook and line survey: An industry-scientist research partnership for long-term resource sustainability

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NOAA Fisheries' Northwest Fisheries Science Center has conducted a hook and line survey for shelf rockfish in the Southern California Bight annually since 2003. This survey uses rod and reel gear to sample 201 fixed sites to generate a long-term time series of abundance and biological data for important species of shelf rockfish and other groundfish species that inhabit rocky, untrawlable seafloor. The survey began in the aftermath of the designation of the west coast groundfish fishery as a federal disaster in 2000 and subsequent coastwide bans on sport and commercial fishing for many groundfish species. At that time, fishery-independent survey coverage ended at Pt. Conception and did not target the rocky, high-relief habitats that support dozens of groundfish species including several key species that had recently been declared overfished. In response to concerns raised by the sport and commercial fishing sectors about the paucity of relevant data needed to monitor these species, NOAA Fisheries and industry partnered to develop an at-sea research program that would improve the information available for stock assessments. After an initial pilot cruise in 2003, the hook and line survey has provided an unbroken time series of data for use in stock assessments for important groundfish species including cowcod, bocaccio, yellowtail rockfish, greenspotted rockfish, lingcod, and others. Survey operations also generate a full water column profile of oceanographic data after each sampling event which includes temperature, salinity, dissolved oxygen, chlorophyll, and turbidity. Our long-term goals include continuing this time series of information, expanding its spatial scope where appropriate, and responding to the evolving data needs for sustainably managing this vital fishery.

S-3. The Joint U.S.-Canada Integrated Ecosystem and Pacific Hake Acoustic-Trawl Survey: Growing beyond a single-species focus

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The Integrated Ecosystem and Pacific Hake Acoustic-Trawl Survey has been conducted along the coasts of California, Oregon, Washington, and British Columbia since 1992. Beginning in 2003, the Survey has been a biennial partnership between the Northwest Fisheries Science Center (NWFSC) and Fisheries and Oceans Canada (DFO), including a 3-year shared effort with Southwest Fisheries Science Center (2012, 2013, 2015). The joint NWFSC-DFO survey supports the Pacific Hake (*Merluccius productus*) stock assessment under the U.S.-Canada Pacific Hake/Whiting Treaty. The original survey goal was simple: use acoustic data and midwater trawling to estimate age-2+ Hake biomass and provide biological information for the age-based stock assessment. Over time, survey sampling and data products have expanded in response to changing capabilities and needs. Acoustic analyses now include age-1 Hake and euphausiids/krill (a key prey item for Hake), with anticipated future inclusions of pelagic rockfish and mesopelagic fish. Oceanographic data, once limited to temperature-depth measurements during midwater trawls, now include continuous day/night Acoustic Doppler Current Profiler (ADCP) data, nighttime Conductivity-Temperature-Depth (CTD) rosette casts, and daytime Underway CTD casts. Many of these data have been processed and are becoming publicly available. Environmental data are being used to groundtruth forecasts of Hake horizontal distribution, integrated into models of Hake and euphausiid habitat use, and as inputs to bioenergetics models of Hake growth. Upcoming projects will evaluate the potential role of dissolved oxygen in Hake and euphausiid vertical distributions. From a biological standpoint, the Survey supports a host of regular and on-demand joint and partner projects, including studies of maturity, physiology, tagging, stable isotopes, and genetic studies. With its large spatial coverage, the Survey is the platform for the coast-wide Harmful Algal Bloom (HAB) sampling and also completes 5-6 sampling lines for zooplankton between CA and BC. In 2019, the Survey's CTD rosettes provided water samples for the eDNA Strategic Initiative, and the NOAA Ship *Bell M. Shimada*'s flow-through system was used to evaluate potential utility of a continuous phytoplankton sampler (CytoBot). While the Survey maintains its strong ties to fisheries management, it continues to evolve to efficiently meet broader acoustic, biological, oceanographic, and ecosystem data and sampling needs.

S-4. NOAA-Northwest Fisheries Science Center's Juvenile Salmon & Ocean Ecosystem Surveys

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Our efforts have been designed to study juvenile salmon as they enter the ocean and during their first months of marine residence, as well as to monitor the ocean conditions affecting these fish. Our primary foci are to determine the physical, biological, and ecological mechanisms that influence survival of salmon during their early marine life and to produce information that can inform management within the Columbia River Basin for improved returns of Columbia River salmon. Over the past 22 years, we have sampled the continental shelf off Oregon and Washington in June and monitored climate conditions, hydrography, zooplankton, the abundance and distribution of juvenile salmon and associated nekton, as well as metrics of salmon growth and condition. Given the complexity of the climate, ocean, and Columbia River plume conditions, each year of data has provided a unique suite of conditions that significantly contributes to a more comprehensive understanding of the ocean ecosystem processes affecting salmon. We have developed a suite of indicators of ocean conditions, ecosystem productivity, and juvenile salmon early marine survival that, when incorporated into qualitative and quantitative decision support tools, represent an "ecosystem approach" to providing management advice.

S-5. The Applied California Current Ecosystem Studies (ACCESS)

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The Applied California Current Ecosystem Studies (ACCESS, www.accessoceans.org) is a public/private partnership founded in 2004 that supports marine wildlife conservation and healthy marine ecosystems in north-central California by conducting ocean research to inform resource managers, policy makers, and conservation partners. ACCESS focuses on the oceanic habitats in Federal and State waters of northern and central California (from Point Arena in the north to Pacific Grove in the south), encompassing Cordell Bank, Greater Farallones and Monterey Bay National Marine Sanctuaries.

Most at-sea surveys are conducted on the R/V Fulmar, although other vessels have been employed (e.g., R/V Bell M. Shimada, R/V McArthur II, R/V Martin). We collect data on oceanography, low/mid-trophic levels, and top marine predators. For oceanography, we collect data continuously (TSG) and at predetermined stations (CTD, surface water samples for nutrient analysis, and Niskin bottle for water samples at depth for ocean acidification and nutrients monitoring). For low and mid-trophic levels, we collect phytoplankton (by net), zooplankton (by hoop and Tucker trawls) at predetermined stations, as well as continuous sampling of krill and fish (through hydroacoustics). For top marine predators, we collect data on birds and mammals through standardized strip and line transects.

The main research topics and management issues we aim to address include: 1) Saving whales from ship strikes, 2) Reducing whale entanglements, 3) Protecting wildlife hotspots, 4) Developing ecosystem indicators, and 5) Tracking ocean acidification.

We produce an annual ‘Ocean Climate Indicators Report’ that provides information about the status and trends of physical and biological climate change indicators in the region. We are working towards making our data available in the Central and Northern California Ocean Observing System (CeNCOOS) Data Portal.

S-6. Newport Hydrographic Line and Broadscale Northern California Current Ecosystem Surveys

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In an effort to understand climate variability and lower trophic level response in the Northern California Current, biophysical sampling along the Newport Hydrographic (NH) Line has been conducted twice weekly to monthly, year-round, since 1996. Sampling occurs at 7 stations evenly spaced across the continental shelf to slope from 1 to 25 nautical miles from shore. At each station, temperature, salinity, dissolved oxygen, and chlorophyll fluorescence are measured throughout the water column; surface water is collected to quantify nutrients, chlorophyll, phytoplankton species composition and abundance, and particulate and dissolved domoic acid; and plankton nets are deployed to collect mesozooplankton, krill, and fish and invertebrate (e.g., Dungeness crabs) larvae. Physical data and zooplankton species composition and abundance from the NH Line are available on a near real-time basis to managers and researchers. Data are also distilled into ocean ecosystem indicators used to characterize the habitat and survival of juvenile salmonids, and have also shown promise for other stocks such as sablefish, rockfish, and sardine. Transects that cover a broader spatial scale in both latitude and longitude have also been sampled for 20+ years two to three times a year, when NOAA ships are available. These surveys provide a platform for collaborations with other NOAA programs, tribal science staff, and academic scientists, and they place our understanding of lower trophic level responses to environmental variability into a broader geographic context.

S-7. Larval fish as a predictor of available prey fields for and marine survival of juvenile salmon: new approaches for salmon management

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Late spring and summer diets of juvenile coho and Chinook salmon are primarily made up of late-larval and early-juvenile winter-spawning taxa such as rockfishes, sand lance, sculpins, and smelts. Plankton and large trawl nets under-sample these salmon prey in the marine environment, so we investigated whether estimates of fish larval abundance or biomass in the winter and early spring could be used as a proxy of food available to young salmon. We have used winter (January-March) ichthyoplankton biomass estimates from the Newport Oregon Hydrographic line off the Central Oregon Coast (latitude 44°40' N) from 1998-2019 as a potential indicator of future feeding conditions for young salmon when they inhabit the marine environment several months later. The relationship between this biomass estimate and salmon survival was relatively strong until recent years, when phenological and distributional shifts in spawning of some species occurred due to unusually warm ocean conditions associated with a large marine heatwave. We developed a new index based upon the community composition of only the nearshore prey which provided better predictions for coho, steelhead, and Chinook salmon survival than the earlier indices. Larval fishes, through changes in abundance and community structure, have been shown to be a good indicator of ocean conditions and we believe they can be a useful and cost-effective performance indicator of future fish trophic dynamics for juvenile salmon, and can provide an early warning of major shifts in the availability of food resources and subsequent effects on survival and returns of adult salmon.

S-8. The Trinidad Head Line: zooplankton indicators of ecosystem responses to climate forcing in the northern California Current

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Sampling along the Trinidad Head Line is conducted at approximately monthly intervals throughout the year to provide information on the state of the coastal plankton ecosystem off northern California in the context of hydrographic variability and climate forcing. The resulting time series of data resolves seasonal patterns in several assemblages, as well as cross-shelf structure in those taxa analyzed across the entire transect. Seasonal patterns in the euphausiid assemblage reflect combined effects of variability in reproductive output and advection-driven cross-shelf distributions. Moreover, tthe euphausiid assemblage exhibited strong, persistent changes in response to the marine heatwave of 2014-2016, including the detection of warm-water taxa not previously reported in our record. Similar shifts have been detected in assemblages of larval fish and larval cephalopods across the transect, and in the copepod assemblage sampled at our mid-shelf station. Coincident with these changes in diverse plankton assemblages, we have observed a persistent shift in the mean size of adult *Euphausia pacifica* towards smaller individuals. Complementary analysis is documenting the presence and distribution of domoic acid in a recently identified HAB hotspot off northern California. Collectively, these time series provide strong evidence of changes in the plankton community off northern California in response to climate forcing, including shifts with potentially important implications for productivity throughout the broader ecosystem.

S-9. Farallon Institute: 30 Years of Monitoring the California Current

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Farallon Institute has been participating in monitoring and understand California's coastal ocean since its inception in 2007. These efforts include making use of previously unused datasets, collecting data in the field to continue long standing monitoring efforts, and the derivation of new products that synthesize ecosystem states in easy to understand terms. These products span the physical and biological ecosystem and include physical mechanisms, lower-trophic level products (krill, anchovy), and upper trophic level (seabirds). We will present on the multivariate ocean climate index (MOCI), 20 years of acoustic data that has been processed for krill, and 30+ year seabird surveys from rookeries and at-sea surveys. The results of these efforts have elevated our understanding of how upwelling forces structure the coastal ecosystem and the trophic implications to top predators. Further, these monitoring efforts have been used in management of coastal resources by inclusion in the California Current Integrated Ecosystem Assessment, PICES Ecosystem Status Report, and in the California Marine Protected Area planning process.

S-10. MBARI contributions to ocean observing of the California Current System

Francisco Chavez and MBARI collaborators

Monterey Bay Aquarium Research Institute (MBARI)

Since its inception in 1987 MBARI has focused on the development of technology for improved observation and understanding of the marine environment. MBARI has utilized Monterey Bay and contiguous waters of the California Current System as a natural laboratory for their technology development. A byproduct has been continually updated time series from a variety of perspectives and from the surface to the deep ocean. This presentation provides a brief review of a subset of MBARI's observations and future directions.

S-11. The Rockfish Recruitment and Ecosystem Assessment Survey: Thirty-seven years of epipelagic micronekton collections in the California Current

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Since 1983, the Fisheries Ecology Division of the Southwest Fisheries Science Center (SWFSC) has conducted a midwater trawl survey off central California waters, with survey effort transitioning to a coastwide effort (in collaboration with the Northwest Fisheries Science Center) since 2001. The original research objective was to develop pre-recruit indices abundance for pelagic young-of-the-year (YOY) rockfish (Sebastes spp.) that would inform stock assessments of incoming year class strength for these long-lived species that are characterized by high recruitment variability. A secondary research objective was to inform process studies that relate to the physical and biological factors and covariates that are associated with the development of these strong year classes. Since the earliest days of the survey, such process studies have been inclusive of improving our understanding of the role of juvenile groundfish and other forage species for salmon, seabirds and other top predators. Survey data have continued to inform quantitative and conceptual models that link the physical drivers and ecological consequences of changes in the abundance of epipelagic micronekton to the dynamics and distribution of higher trophic level predators throughout the California Current. This talk will briefly describe the temporal and spatial history of the survey, highlight key findings and challenges with respect to both the original and more recent survey objectives, and provide thoughts and ideas regarding how the future of this survey may better inform both single species and ecosystem based management in the context of a dynamic and changing climate.

S-12. The California Collaborative Fisheries Research Program: implementation and expansion of a statewide marine protected area monitoring program

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The State of California mandated a statewide network of marine protected areas (MPAs) along the coast of California in 1999 by passing the Marine Life Protection Act. The State legislation included a mandate for monitoring the performance of the MPA network. The California Collaborative Fisheries Research Program (CCFRP) was designed by a consortium of academic scientists, resource managers, commercial and recreational fishers, and local stakeholders to monitor the performance of the MPAs. The study design utilized local fisher knowledge and standardized hook and line methods to monitor MPAs. The first suite of MPAs was established along the central coast of California in 2007 and primarily regulated extractive activities. CCFRP was initially implemented by Moss Landing Marine Laboratories and Cal Poly, San Luis Obispo in 2007 to monitoring 4 MPAs along the central coast of California. In 2017, CCFRP expanded to include all of the MPA network regions: North, North Central, Central, and South. CCFRP now includes six academic institutions monitoring 14 MPAs across the entire State MPA network. To date, CCFRP has caught and released more than 130,000 fishes from more than 35 species. These data have been and will continue to be distributed to state and federal resource managers, and they have been used in several stock assessments. In addition, CCRFP researchers are using these data for ongoing evaluations of the effectiveness of the California MPA network, to examine the relationship between fishery dependent and fishery independent data, and to explore the impacts of major climatic events such marine heat waves. In addition to the biological data CCFRP has collected, CCFRP science crews continually interact with commercial and recreational fishers across the state, resulting in stronger working relationships between scientists and local stakeholders.

S-13. Twenty years of monitoring coastal ecosystems by PISCO: linking ecological theory and data to inform management and policy

J. Wilson White[1], Jennifer E. Caselle[2], Mark H. Carr[3], Daniel P. Malone[3], John A. Barth[1], Carol A. Blanchette[2], Francis Chan[1], Bruce A. Menge[1], Peter T. Raimondi[3], Libe Washburn[2]

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For the past 20 years, the Partnership for Interdisciplinary Study of Coastal Oceans (PISCO) has conducted long-term, large-scale monitoring of hard-substrate intertidal and subtidal ecosystems and inner-shelf oceanography on the U.S. Pacific coast. The scale of this dataset, along with coordinated coast-wide experiments, has provided new insights into the biophysical factors structuring coastal ecosystems at multiple scales, and afforded opportunistic observations of the ecosystem responses to climate variability, invasive species, and epizootic diseases. Focusing on the subtidal kelp-forest fish observations in central and southern California, the 20-year monitoring program spanned the implementation of the world's second-largest marine protected area (MPA) network. The subtidal monitoring data have thus allowed before:after comparisons of fish populations, essential to the adaptive management of the MPA network. Moreover, the richness of the dataset has allowed us to confront theoretical predictions from the science of population dynamics with empirical data. This has allowed PISCO scientists to set expectations for population trends and data needs, directly guiding the management of nearshore ecosystems.

S-14. The Santa Barbara Channel Marine Biodiversity Observation Network

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The concept of Marine Biodiversity Observation Networks (MBONs) originated from the realization that little was known about the status of most marine species, particularly those that are not fished or charismatic. In response, the US, through the National Ocean Partnership Program, funded three prototype MBON projects. Our project, the Santa Barbara Channel MBON, has two main goals: to integrate existing biodiversity-relevant data for the region, and to explore new and underutilized methods for assessing biodiversity in the coastal ocean. The three methods we have focused on are image analysis, acoustics, and genomics. Ultimately the goal is to assess marine communities at spatial scales that are relevant to management and environmental change. Our main users and partners have been the BOEM Pacific region and the Channel Islands National Marine Sanctuary. We will discuss progress on these goals from the past five years of SBC MBON and directions moving forward including expanding to the Southern California Bight as a whole.

S-15. Streamlining Ecosystem Assessments: New Tools to Quickly Generate Management Information from Ocean Monitoring Data

Jennifer A Brown[1,2,3], Chris Caldow[2], Andrew DeVogelaere[3], Greg Williams[4,5], Benjamin D Best[6], Gabrielle Canonico[7]

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NOAA's Office of National Marine Sanctuaries produces standard condition reports as a tool to periodically assess a sanctuary's "state," specifically as the current status and recent trends of driving forces, human pressures, water quality, habitats, and living resources. Completion of a full assessment for a site involves compilation of monitoring data and synthetic data products from a wide variety of monitoring programs that overlap geographically with a sanctuary. Compiling this information is time consuming and has resulted in infrequent updates to condition reports roughly every decade. On-going collaborations between west coast sanctuaries and the California Current Integrated Ecosystem Assessment Program (CCIEA), Marine Biological Observation Network (MBON) demonstration projects, and the US Integrated Ocean Observing System (IOOS) are resulting in substantial progress towards streamlining the generation of condition reports and delivering more timely assessment information. We will share examples of these improvements including: an inventory of priority datasets such as those provided by the CalCOFI surveys, cross-walked with sanctuary habitats and management targets; improved data accessibility for near real-time status reporting; upscaled/downscaled data products for better alignment with the scale of the management unit; and suites of data products (e.g., interactive infographics, curated data views) to facilitate use by different stakeholders.

S-16. Extending the relevance of the Southern California Coastal Ocean Observing System through Collaborations with Ecosystem and Fisheries Science

Clarissa Anderson[1] and many partners

[1]Scripps Institution of Oceanography, SCCOOS La Jolla

The principal goal of the Southern California Coastal Ocean Observing System (SCCOOS) is to provide observations and value-added products to a diverse stakeholder community of managers and planners, scientists, and the general public. As one of eleven regional associations of the U.S. Integrated Ocean Observing System (IOOS), SCCOOS has developed the capability to support operational decision-making and long-term assessment by implementing and leveraging observations from high-frequency radar, autonomous underwater gliders, shipboard surveys through partnership with CalCOFI, automated shore stations, and output from a suite of operational and research models, many of which are available in near real-time. SCCOOS advocates for sustained and enhanced observations while supporting technology and product development through regional partnerships, such as with the Coastal Data Information Program (CDIP). To this end, participation in a federally certified framework ensures that data products are useful and accessible, while preserving the necessary detail to support the scientific and educational communities. SCCOOS strives to balance the priorities of the IOOS enterprise with emerging advances in data science and technology in order to enhance regional capacity and relevance to ecosystem science. To this end, we are actively collaborating with SWFSC, the IOOS MBON program, the National Marine Sanctuaries, and California MPA Monitoring programs. A renewed emphasis at SCCOOS on integrating biological observations into national and global databases is strengthening our role in ecosystem science. This talk will highlight SCCOOS collaborations and future potential in the areas of ecosystems, water quality, harmful algal blooms, and fisheries.

S-17. Regional Monitoring for Sediment and Water Quality in the Urban Ocean of the Southern California Bight

Karen McLaughlin[1], Kenneth Schiff[1], Nina Bednarsek[1], Dario Diel[1], Bowen Du[1], David Gillet[1], John Griffith[1], Darrin Greenstein[1], Ashely Parks[1], Jayme Smith[1], Stephen Weisberg[1]

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The Southern California Bight (SCB) is host to one of some of the most productive ecosystems in the world, providing economic, cultural and recreational services to large populations living along the coast. However, it is also subject to significant pollutant inputs due to a highly urbanized coastland. Historically, environmental monitoring of this urban coastal environment has been temporally intensive, but spatially focused on narrow areas closest to regulated discharges, providing a potentially biased perspective of overall coastal sediment and water quality. Beginning in 1994 and conducted every five years since, nearly 100 regulated, regulatory, non-governmental and academic organizations have joined forces to implement the SCB Regional Marine Monitoring Program (the Bight Program). The Bight Program has affected management actions in the region by focusing management effort on habitats most impacted by poor sediment and water quality, highlighting improvements from previous management actions, and characterizing emerging threats to the coastal zone, such as ocean acidification. The most recent Bight program sampled nearly 400 locations, from brackish estuaries to offshore basins >1000m depth, using a probabilistic survey design and measuring multiple indicators of sediment quality including chemistry, toxicity, and infauna, water quality indicators including nutrients, harmful algal bloom toxins, dissolved oxygen, pH and aragonite saturation state, biological indicators of impairment, and indicators of human pathogens. Here we will highlight several key findings and trends from the Bight Program's 25-year history and propose some strategies to better link the program with other marine monitoring efforts in Southern California.

S-18. Acoustic-Trawl Method Surveys inform Precautionary, Ecosystem Approaches to Management of Forage Fishes in the California Current

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In 2006, during a cooling trend indicated by the Pacific Decadal Oscillation Index (PDO), the Southwest Fisheries Science Center revived acoustic-trawl method (ATM) surveys to directly assess the distributions, abundances and lengths of Pacific sardine, Northern Anchovy, Pacific Herring, Pacific Mackerel, and Jack Mackerel in the California Current. Since then, data have been collected during spring, summer, or both, using multi-frequency echosounders, surface trawls, a continuous underway fish-egg sampler (CUFES), and conductivity-temperature-depth probes (CTDs). The resulting time series have served to characterize: dynamics in potential sardine habitat; a halt to seasonal sardine migration; a persisting environmental correlation with sardine recruitment; a reduction in cohorts comprising the stock, variations in rates of growth and natural mortality; a precipitous decline in sardine biomass; and transitions in the dominant forage-fish species from sardine to mackerels and now anchovy. These and more results of the ATM surveys are critical to the prediction of climate-driven fish stock productivity that might be used to manage fisheries with precautionary and ecosystem approaches.

S-19. The California Current Ecosystem Long-Term Ecological Research site

Mark D. Ohman (on behalf of the CCE group)

From its inception in 2004, the NFS-supported *California Current Ecosystem* Long-Term Ecological Research site (CCE-LTER) has been built upon a close partnership with CalCOFI. The data sources that provide much of the foundation for CCE's hypotheses emanate from the CalCOFI time series, particularly the holozooplankton, ichthyoplankton, and hydrographic data that extend back to the beginning of CalCOFI, but also the systematic nutrient, primary production, and Chl-*a* measurements made since 1984. With the advent of CCE, we were able to add a series of measurements to CalCOFI, including flow cytometry assessments of picoplankton, HPLC characterizations of phytoplankton community composition, fine mesh (202 μm) zooplankton measurements of zooplankton community structure by Zooscan, particulate organic nitrogen and carbon, and, more recently, continuous flow through assessments of phytoplankton pigments and physiology (by ALF) and the key ocean acidification variables pH and pCO_2. CCE and CalCOFI have emerged as synergistic entities, with complementary contributions to documenting and understanding the longer-term sources of forcing in the CCE and their consequences for the pelagic food web. CCE has several program elements in addition to our partnership with CalCOFI (including Process Cruises; other Time Series measurements; Modeling; Information Management; and Education, Outreach, and Capacity Building), but the linkage with CalCOFI is foundational. This presentation will briefly introduce the guiding hypotheses for the CCE-LTER program and illustrate many of the points of complementarity between our research and outreach activities and those of the CalCOFI time series.

S-20. IMECOCAL: Mexican Research Program of the California Current. More than 20 Years monitoring the southern CC

Sylvia P. A. Jiménez-Rosenberg

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The California Current System has been referred as the most intensively studied oceanic system in the world. Since 1997, in the southern California Current region, the IMECOCAL Program has conducted quarterly oceanographic cruises with an average of 80 stations following the original CalCOFI Program sampling grid. This program was designed to provide quantitative descriptions of physical and biological processes that contribute to broadening our understanding of the role they play in the dynamics of the California Current ecosystem, particularly in the Mexican area off the Baja California Peninsula. In each station CTD casts are made in order to obtain temperature, conductivity and pressure of seawater. In addition, surface fluorescence and speed of marine currents are continuously recorded. Bongo-net hauls are carried out to determine biomass and structure of the zooplankton community and water samples are taken for the determination of nutrients and dissolved oxygen. Also in most cruises, in selected stations, primary production experiments are carried out. Although the program has had some changes due financial struggling, in total 63 cruises have been conducted, accomplishing 15 fall cruises, 17 winter cruises, 16 spring cruises and 15 summer cruises. As a direct result from IMECOCAL research, oceanographic structure has been characterized, as a transitional zone where the relatively cold and low-salinity water of the California Current meets warmer and more saline tropical and subtropical waters. Distribution of the correspondent biota from these different types of water masses are affected mostly by seasonal and interannual variability. According to this, fish larvae communities divide the region in three mayor zones: ENSENADA, between Ensenada, BC and Punta Baja (CalCOFI lines 97 to 110), defined by a lower larval diversity of mostly subartic and temperate taxa; VIZCAINO BAY, and the adjacent oceanic region (CalCOFI lines 113 to 127), with the highest larval diversity in the region, where biota of northern and southern taxa coincide, and SOUTH PUNTA EUGENIA, which is the less sampled area, but most of the time includes sampling stations in the Gulf of Ulloa and north Bahía Magdalena (CalCOFI lines 130 to 137). Fish larvae of tropical and subtropical taxa are dominant in this area.

S-21. The California Cooperative Oceanic Fisheries Investigation: Monitoring the California Current Ecosystem since 1949

Andrew R. Thompson, Brice X. Semmens and Briana C. Brady

California Cooperative Oceanic Fisheries Investigations (CalCOFI), a partnership between Scripps Institution of Oceanography, California Department of Fish and Wildlife and the National Oceanic and Atmospheric Administration, is one of the world's longest-running marine ecosystem monitoring programs. CalCOFI began systematically sampling the California Current in 1949 to determine causes of the collapse of the Pacific Sardine (*Sardinops sagax*) fishery. At its inception, CalCOFI was far ahead of its time. In 1949, the term 'ecosystem' was coined only 15 years prior, but CalCOFI founders had the foresight to initiate a full ecosystem-monitoring program that collected both biological (from plankton nets) and hydrographic samples. In addition, although the initial focus was on Pacific Sardine, a decision was made early on to identify all larval fishes, and CalCOFI therefore currently tracks spawning of hundreds of fishes. Effort was monumental from 1949-1961 when samples were collected nearly monthly throughout California, Baja California, and the Sea of Cortez. Effort eventually settled to current standards with quarterly sampling from San Francisco to San Diego in winter and spring and San Louis Obispo to San Diego in summer and fall. The scope of sampling also evolved since 1949. Physical oceanographic sampling has become ever more sophisticated with the advent and integration of new instruments such as underway spray gliders. From a biological perspective, plankton samples are still collected with obliquely towed nets that are similar to those from 1949, but additional plankton sampling methods were added over the years (e.g., manta nets, pairovet nets, Continuous Underway Fish Egg Sampler). Further, CalCOFI now monitors higher trophic level birds and marine mammals. Most recently, CalCOFI began collecting environmental DNA that genetically provides information on bacterial, phytoplankton and zooplankton communities. Looking towards the future, CalCOFI will sample ecosystem components ranging from bacterial to whales with a suite of physical measurements that can contextualize biological changes. The long CalCOFI time-series will enable us to contextualize ecosystem dynamics in an era of rapid climate change, and continued integration of technological advancements will provide a more nuanced, detailed, and mechanistic understanding of ecosystem drivers. Information from CalCOFI will therefore continue to help guide marine management decisions under climate change.

POSTER TITLES AND ABSTRACTS

P-1. Aerial Survey of Small Pelagic Species in Nearshore California Waters

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Pacific Sardine (*Sardinops sagax*) and Northern Anchovy (*Engraulis mordax*) are important West Coast fisheries managed within the Coastal Pelagic Species (CPS) complex by the Pacific Fishery Management Council (PFMC) and the National Marine Fisheries Service. Current survey indices used in annual stock assessments to manage the Pacific Sardine fishery do not include nearshore biomass, and thus do not provide a complete picture of overall stock status. The California Department of Fish and Wildlife and the California Wetfish Producers Association have collaborated in conducting an aerial survey of nearshore Pacific Sardine biomass within the Southern California Bight since the summer of 2012, and Northern Anchovy since 2013. In 2017, the survey was extended to include nearshore abundance in Northern California. The PFMC conditionally approved the aerial survey methodology for use in future CPS stock assessments in June 2017. A nearshore cooperative survey project began in late 2018 to develop a variance estimator and further refine an observer bias correction factor. Analysis of within- and among-transect variance has shown that parallel surveys across transects can provide reasonable variance estimates. Survey data indicate observer estimates are negatively biased, underestimating Pacific Sardine biomass by approximately 14%. Pacific Sardine and Northern Anchovy biomass estimates for Northern California surveys in 2017 have been large relative to those from ship surveys restricted to waters outside of a few miles from the coast, comprising more than 146% and 35%, respectively, of offshore estimates.

P-2. An Overview of the California Live Bait Marine Fishery

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The California live bait fishery is a unique and extremely valuable component of the state's recreational fishing community and economy. Originally introduced in 1910, fishing for live bait quickly became specialized with the introduction of lampara and purse seine nets in 1912 to provide the rapidly expanding sport fishing industry with live Northern Anchovy (*Engraulis mordax,* anchovy) and Pacific Sardine (*Sardinops sagax*, sardine). Live bait is used by recreational anglers targeting a variety of gamefish such as tunas and bass on commercial passenger fishing vessels (CPFVs), private boats, and kayaks predominantly in Southern California. Demand for live bait shifts throughout the year depending on location and the target species. The live bait fishery seeks pure schools of anchovy and sardine, which have the highest demand by sportfishing boats and anglers. The ability to capture anchovy or sardine depends on the species' availability and behavior. The live bait fleet currently consists of approximately 15 vessels along the California coast. Since 2000 the fishery has averaged an annual total catch of approximately 3,000 metric tons, of which 75 percent was sardine. The first system for determining the amount of live bait taken was instituted by the California Department of Fish and Wildlife (CDFW) (then Division of Fish and Game, Bureau of Marine Fisheries) in 1938 and a voluntary logbook program began in 1939. Since 2000, live bait has been federally managed within the Coastal Pelagic Species (CPS) complex by the Pacific Fishery Management Council (PFMC) and the National Marine Fisheries Service under the CPS Fishery Management Plan (CPS FMP). Catch data from a CDFW monitoring program are used in stock assessments and for determining annual catch limits. Due to recent estimates of low sardine biomass levels, the directed large-scale sardine fishery has been closed since 2015 and the stock was declared overfished in 2019. In June 2019, Amendment 17 to the CPS FMP was adopted allowing directed live bait fishing when a stock is overfished. Concurrently, the live bait industry is now submitting electronic landing receipts to the Department to ensure take is accounted for and within sustainable levels.

P-3. Predicting spatio-temporal shifts in larval fish abundance in the eastern Pacific using Bayesian hierarchical modeling

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For many marine fishes, dispersal occurs via a planktonic larval form that resides in the surface layer of the ocean for a period of days to months before moving to juvenile habitats. Dispersal of larvae is influenced by environmental factors (e.g., climate oscillations, temperature, and currents) as well as biotic factors (e.g., pelagic larval duration time, feeding behavior, and swimming ability). The Eastern Pacific is oceanographically complex and home to many targeted fish species.

Few studies have utilized long-term, spatially-explicit models to examine factors driving larval distributions across years. Yet developing predictive frameworks and integrating multiple stressors in a spatial context has been cited as an important area for future research. Spatial data in the form of larval fish catch data presents additional sources of sampling error, observation error, and spatial autocorrelation that can be difficult to account for in traditional analytical approaches. However, Bayesian methods can easily incorporate error and correct for autocorrelation while still providing estimates on actual parameter values that can be used for predicting larval abundances at a specific point in space and time.

Here, we present preliminary results from a hierarchical, Eulerian-framed Bayesian model that combines long-term empirical CalCOFI and IMECOCAL catch data with environmental and biotic data to identify how larval distributions vary in space and time from southern Baja to southern California from 1951-2019. We focus our efforts on a few target species which vary in pelagic larval duration time, adult habitat, and spawning season.

P-4. Gauging Environmental Effects on Larval Rockfish Condition and Recruitment within the Southern California Bight

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Management plans and stock rebuilding goals are dependent on robust recruitment, life-history and environmental data. Unfortunately, our knowledge is incomplete as to how environmental conditions, especially those that oscillate on varying timescales, affect larval health and subsequent recruitment to the adult population. Our study evaluates whether maternal investment and larval growth rate predict recruitment success for multiple species of rockfishes and whether these factors are influenced by intra- and inter-annual environmental conditions. Because small changes in larval condition can generate order-of-magnitude differences in year-class strength for many marine fishes, understanding the underlying cause of recruitment variation is integral to the success of these rebuilding programs and has important applications to the California Current Integrated Ecosystem Assessment (CCIEA) program. This study addresses key data-gaps of CCIEA groundfish risk assessments, specifically environmental and climate change impacts.

We quantified maternal investment and larval growth rates for 8 rockfishes (5 targeted by fishing and 3 unfished, abundant species) by analyzing otoliths from larvae collected from 1998 to 2013 on winter CalCOFI cruises. We recorded larval and otolith morphometrics and quantified daily growth rate as well as overall age at capture. Additionally, we evaluated potential environmental effects modeling mean MI and RG per year against mean temperature, salinity and chlorophyll in the upper 100m in the summer/fall prior to spawning and at the time of sampling, respectively. Preliminary results indicate that significant variability exists within individual species between years as well as across all species for a given year. These differences are likely driven by a combination of local (SST, primary productivity) and large-scale (PDO, ENSO) environmental conditions. This integrative approach facilitates a better understanding of how increasing variability in local and regional marine conditions affect not only larval growth rate, but eventual recruitment to the juvenile and adult populations.

P-5. Robust and Simple Classifications Quantify Ecological Responses to Marine Heatwaves

Ryan Freedman[1,2,3], Jennifer A. Brown[1,4], Chris Caldow[1], and Jennifer E. Caselle[5]

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Efficiently quantifying ecological shifts from acute climate events is challenging, leading to a disconnect between real-time community composition and management action. Our study classified thermal affinities of kelp forest fish species using biogeographic data and expert opinion to create a simplified method to track differential responses to climatic events. We used this newly developed classification scheme to track multiple fish community metrics' response to the 2014 marine heatwave that occurred off the US West Coast. Abundance, diversity and recruitment of 'warm species' during the marine heatwave (2014-2017) were significantly higher compared with years prior (2002-2013). 'Cold water' species did not experience significant parallel declines. Marine Protected Areas (MPAs) did not appear to buffer these community shifts as responses were similar both inside and outside MPAs. Non-fished species were more responsive to environmental drivers compared to targeted species which means managers looking to preserve ecosystem structure in response to acute climate disturbance should utilize additional conservation strategies.

P-6. The SIO Pelagic Invertebrate Collection: An unparalleled resource for the Ocean Sciences

Mark D. Ohman, Linsey M. Sala
Scripps Institution of Oceanography, UC San Diego

The SIO Pelagic Invertebrate Collection (PIC) is the repository for not only ~ 80,000 CalCOFI zooplankton samples, but for an additional ~60,000 samples from around the world ocean. This archive is unparalleled in the U.S museum and collections community, and perhaps beyond, in part for the exceptional CalCOFI time series and in part for the extensive geographic coverage and sampling into the deep sea. The PIC has repeatedly demonstrated the value of archiving physical specimens for diverse and sometimes unanticipated studies. These include reconstructing the effects of climate forcing on pelagic populations, stable isotope analyses of changes in food web structure, metabarcoding of metazoans, evolutionary dynamics of zooplankton, pelagic biogeography, consequences of ocean acidification, Trait-based Analyses of plankton communities, and other topics. The PIC has also served as a key resource permitting the development of fishery-independent metrics of market squid, California spiny lobster, and Dungeness crab. The physical plankton samples and reference specimens also provide a critical reference for validating the development of new technologies. We will provide a few examples of topical studies facilitated by the PIC.