

Farallon Institute Annual Report 2016

Research for Healthy Ocean Ecosystems



As the new year begins, Farallon Institute is entering our 10th year of existence. In that time, we have grown into a multi-disciplinary team of scientists who work together towards one goal: **better ocean management and conservation through research**. Understanding ocean ecosystems cannot be done in isolation by a scientist in a single discipline and that is what makes Farallon Institute such a unique organization. We have climate scientists, oceanographers, ecologists, and fishery biologists all under one roof. We provide a space for collaboration, which allows Farallon Institute to take on challenges in ways that other organizations cannot. As we move into our second decade, we are charting a course to ensure that Farallon Institute continues to be a vibrant and thriving interdisciplinary organization working to ensure healthy ocean ecosystems for California and the world's oceans.



Dr. Jeffrey Dorman
Executive Director

During the past year, Farallon Institute scientists have continued to publish in top scientific journals (*Science*, *Nature*, etc.) and have been invited to speak at conferences around the world. In 2016, we published (or have in press) over 10 peer-reviewed manuscripts, and offered testimony on the state of the coastal ocean before the California State Senate and committees of the Pacific Fisheries Management Council. While our research is mostly focused on the West Coast of the United States, we are doing work around the world including in Antarctica, South Africa, Tanzania, British Columbia, Mexico, and Alaska. The ocean is a global entity that does not adhere to political boundaries and our work rarely does as well.



Organizationally, Farallon Institute continues to grow. Our offices in Petaluma have expanded to accommodate our 11 staff members and 3 dogs. This past year we made a major push to reach out to our community for support. We have a re-designed website that is more easily navigated, are finalizing

some print materials that highlight our organization, and have given community talks on the state of the California Ocean. We have also launched (or re-launched in some cases) profiles on Facebook, Twitter, and Instagram and would love to have you connect with us and stay current with Farallon Institute.

Please come and visit us if you are ever in Petaluma. We are looking forward to 2017 and the challenges and successes it will surely bring.

FARALLON INSTITUTE TEAM 2016

Jeffrey Dorman, Ph.D., Executive Director

William Sydeman, Ph.D., President

Marisol Garcia-Reyes, Ph.D., Scientist

Emily Klein, Ph.D., Scientist

Mike Litzow, Ph.D., Scientist

Marcel Losekoot, M.Sc., Programmer/Analyst

Heather Robinson, M.Sc., Scientist

Maryanne Romanowski, M.Sc., Financial Administrator

Amber Szoboszlai, M.Sc., Scientist

Julie Thayer, Ph.D., Scientist

Sarah Ann Thompson, M.Sc., Scientist

Ramona Zeno, M.Sc., Scientist

Canine Office Assistants Keshi, Charlie, Lucy, and Kenai (awarded Emeritus in 2016)

HIGHLIGHTS



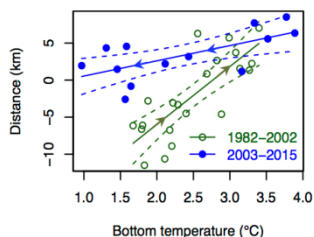
Forage Fish

- studies continued for ecosystem-based fisheries management of anchovies
- updating population estimates and work to establish new harvest control guidelines



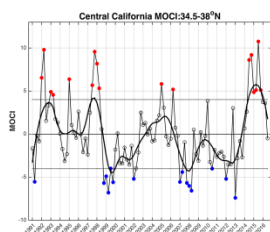
California-South Africa Upwelling

- upwelling modes were described for the Benguela Upwelling Ecosystem
- first project papers were submitted to a peer-review journal



Subarctic Ecosystems

- non-stationarity in biophysical relationships are being studied in Alaska by Litzow et al.
- funding was provided by NSF and NOAA



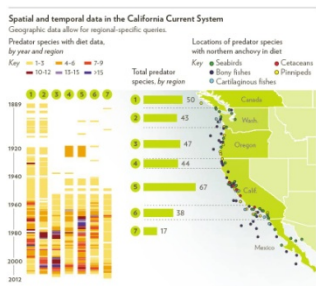
Ocean Condition Indicator (MOCI)

- MOCI is published online quarterly; manuscript was published in a peer-reviewed journal
- latest MOCI updates show the return to normal nearshore ocean conditions and reduction of the recent marine heatwave



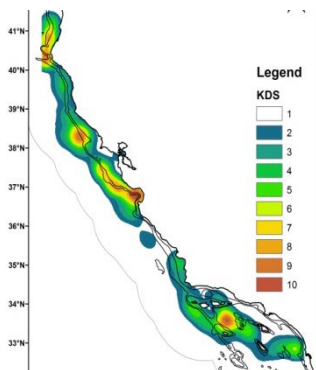
Seabird Monitoring

- 301 seabird nests on Alcatraz Island were monitored from March-September
- approximately 90 days at sea were logged during CalCOFI and NMFS juvenile rockfish surveys; over 30,000 individual seabirds from ~55 species were tallied



California Current Predator Diet Database (CCPDD)

- The CCPDD was utilized in a workshop at the PICES Annual Meeting to highlight a) gaps in information about marine predator forage needs, b) the need for data standardization, c) the loss of important details when data are averaged, and d) the importance of better understanding of prey-switching



Krill

- summary of 15 years of krill hydroacoustic surveys (n = 29) encompassing over 61,000 miles surveyed and 447 significant krill hotspots identified on the US West Coast
- in 2016, 4,983 miles were surveyed and 8 krill hotspots were identified in California



State Senate Science Testimony

- On April 28, 2016, Dr. Bill Sydeman testified to the California Joint Sub-Committee on Fisheries and Aquaculture in a hearing titled "Crab Season and Domoic Acid: Lessons Learned". Bill spoke about ocean conditions that may have affected the production of domoic acid which was found in Dungeness crabs and is toxic to people.

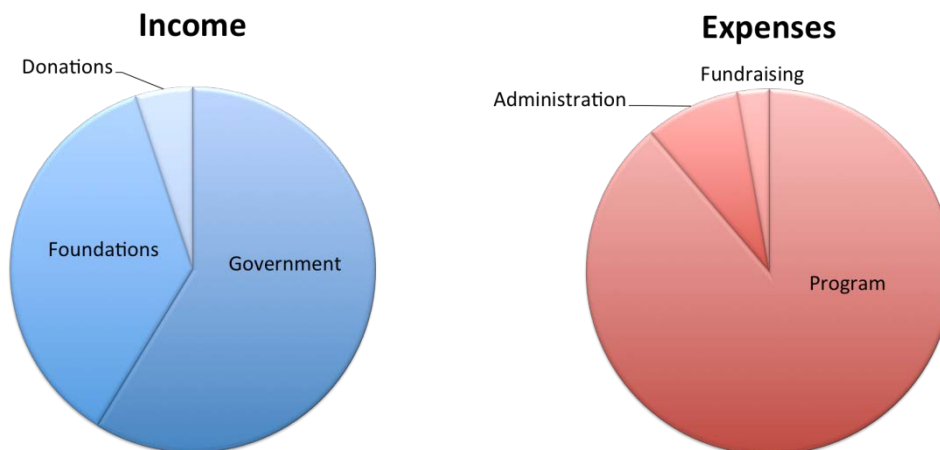
ACCOMPLISHMENTS BY THE NUMBERS

- 9 papers published in the peer-reviewed literature
- 2 Farallon Institute reports published
- 6 papers in press
- 7 conferences or symposia attended
- 5 invited presentations given, and Bill Sydeman presented to the California Joint Sub-Committee on Fisheries and Aquaculture
- 8 oral presentations given
- 3 posters presented
- 2 workshops organized

*A full list of publications is shown on page 7, and a full list of presentations is shown on page 10.

FINANCIALS: JANUARY-DECEMBER, 2016

Farallon Institute continued to experience steady growth in 2016. Income and Expenses both came in around \$750,000; we have 11 members on our team, 8 of whom are full-time employees, and all of them have advanced degrees. Our support sources and expenditures break-down have essentially stayed similar to previous years.



FUNDERS

We could not accomplish our research without the support of government agencies, private foundations, and individuals committed to work. Thank you.

Agencies

National Park Service
National Science Foundation
National Oceanic and Atmospheric Administration
Southern California Ocean Observing System

Office of Naval Research
United States Geological Survey

Foundations

Marisla Foundation
National Fish and Wildlife Foundation

Google.org
The Pew Charitable Trusts

Individual Donors

California Current Level > \$1000

Chelle Gentemann
Hope Millholland

Mike Litzow
Richard Thayer

Gulf of the Farallons Level > \$500

Adam Bauserman
Courtney & Jeff Dorman

John & Traci Botsford
Bahman Rabii

Cordell Bank Level > \$100

Tom Baudendistel & Lisa Kinoshita
Glen Boehm & Mozghan Mizban
Bill & Kia Conn
Bob & Kathleen Dinetz
Sylvia Gillpatrick
Richard & Janis Kinoshita
John Raff

George Bierzychydu
Jeff Cole & Deborah Mandelsberg
Ruth Dietrich
Tony Freicas & Sandy Profeta
John & Gala Haskins
Chad Olcott & Laura Pochop

Volunteers and Supporters

Tanner Boeger
Chris Carney
Kate Ciungan
Rick Johnston
Ron LeValley
Emma Roach

Laura Burgess
Tien Chang
Leah Drapkin
Joey Kolasinsky
Sherie Michaile

PUBLICATIONS

- Davison, P., W.J. Sydeman, and J.A. Thayer. Are there temporal or spatial gaps in recent estimates of anchovy off California? *CalCOFI Reports*, in press.
- Dorman, J.G., F.S. Castruccio, E.N. Curchitser, J.A. Kleypas, and T.M. Powell. Modeled connectivity of *Acropora millepora* populations from reefs of the Spratly Islands and the greater South China Sea. *Coral Reefs* 35:169-179.
- Garcia-Reyes, M., and W.J. Sydeman. California Multivariate Ocean Climate Indicator (MOCI) and marine ecosystem dynamics. *Ecological Indicators* 72:521-529.
- Gentemann, C.L., M.R. Fewings, and M. Garcia-Reyes. Satellite sea-surface temperatures along the west coast of the United States during the 2014-2016 northeast Pacific marine heat wave. *Geophysical Research Letters*, in press.
- Hassrick, J., M.J. Henderson, D.D. Huff, W.J. Sydeman, M.C. Sabal, J.A. Harding, A.J. Ammann, E.D. Crandall, E. Bjorkstedt, J.C. Garza, and S.A. Hayes. Early ocean distribution of juvenile Chinook salmon in an upwelling ecosystem. *Fisheries Oceanography* 25:133-146.
- Koehn, L.E., T.E. Essington, K.N. Marshall, I.C. Kaplan, W.J. Sydeman, A.I. Szoboszlai, and J.A. Thayer. Developing a high taxonomic resolution food web model to assess the functional role of forage fish in the California Current Ecosystem. *Ecological Modelling* 335:87-100.
- Koslow, J.A, and P.C. Davison. Productivity and biomass of fishes in the California Current Large Marine Ecosystem: Comparison of fishery-dependent and independent time series. *Environmental Development* 17:23-32.
- Lamont, T., M. Garcia-Reyes, S.J. Bograd, C.D. van der Lingen, and W.J. Sydeman. Upwelling indices for comparative ecosystem studies: variability in the Benguela Upwelling System. *Journal of Marine Systems*, submitted.
- Litzow, M., and M.E. Hunsicker. Early warning signals, nonlinearity, and signs of hysteresis in real ecosystems. *Ecosphere* 7:e01614.
- MacCall, A.D., W.J. Sydeman, P.C. Davison, and J.A. Thayer. Recent collapse of northern anchovy biomass off California. *Fisheries Research* 175:87-94.
- Poloczanska, E.S., M.T. Burrows, C.J. Brown, J. Garcia Molinos, B. Halpern, O. Hoegh-Guldberg, C. Kappel, P.J. Moore, C. Parmesan, A.J. Richardson, D.S. Schoeman, and W.J. Sydeman. Responses of marine organisms to climate change across oceans. *Frontiers of Marine Science* 3:62.

- Punt, A.E., A.D. MacCall, T.E. Essington, T.B. Francis, F. Hurtado-Ferro, K.F. Johnson, I.C. Kaplan, L.E. Koehn, P.S. Levin, and W.J. Sydeman. Exploring the implications of the harvest control rule for Pacific sardine, accounting for predator dynamics: A MICE model. *Ecological Modelling* 337:79-95.
- Robinson, H.J., J. Thayer, V. Seher, and W. Merkle. 2016. Breeding ecology of Brandt's cormorants and western gulls on Alcatraz Island, 2016. Final Report to the Golden Gate National Recreation Area (GGNRA) National Park Service (NPS).
- Santora, J.A., J.G. Dorman, and W.J. Sydeman. Modeling spatiotemporal dynamics of krill aggregations: size, intensity, persistence, and coherence with seabirds. *Ecography*, in press.
- Santora, J.A., W.J. Sydeman, I.D. Schroeder, J.C. Field, R.R. Miller, and B.K. Wells. Persistence of trophic hotspots and relation to human impacts within an upwelling marine ecosystem. *Ecological Applications*, in press.
- Silber, G.K., M. Lettrich, and P.O. Thomas (eds). 2016. Report of a Workshop* on Best Approaches and Needs for Projecting Marine Mammal Distributions in a Changing Climate. 12-14 January 2016, Santa Cruz, California, USA. U.S. Dep. Commer., NOAA Tech. Memo. NMFS-OPR-54. *Workshop participants: J. Baker, M. Baumgartner, E. Becker, P. Boveng, D. Dick, J. Fiechter, J. Forcada, K. Forney, R. Griffis, J. Hare, A. Hobday, D. Howell, K. Laidre, N. Mantua, L. Quakenbush, J. Santora, P. Spencer, C. Stock, K. Stafford, W. Sydeman, K. Van Houtan, and R. Waples.
- Sydeman, W.J., S.A. Thompson, J.F. Piatt, M. García-Reyes, S. Zador, J. Williams, M. Romano, and H. Renner. Regionalizing indicators for marine ecosystems: Bering Sea - Aleutian Island seabirds, climate, and competitors. *Ecological Indicators*, in revision.
- Sydeman, W.J., J.F. Piatt, S.A. Thompson, M. García-Reyes, S. Hatch, M. Arimitsu, L. Slater, J. Williams, N. Rojek, S. Zador, and H. Renner. Puffins reveal contrasting relationships between forage fish and ocean climate in the North Pacific. *Fisheries Oceanography*, in press.
- Thayer, J.A., A.D. MacCall, P.C. Davison, and W.J. Sydeman. California anchovy population remains low, 2012-2016. *CalCOFI Reports*, in revision.
- Thompson, S.A., W.J. Sydeman, A. Weinstein, K. Krieger, J.A. Thayer, and D. Hay. Trends in Pacific herring (*Clupea pallasii*) in the California Current Ecosystem. *CalCOFI Reports*, in revision.
- Wells, B.K., J.A. Santora, I.D. Schroeder, N. Mantua, W.J. Sydeman, D.D. Huff, and J.C. Field. Marine ecosystem perspectives on Chinook salmon recruitment: a synthesis of empirical and modeling studies from a California upwelling system. *Marine Ecology Progress Series* 552:271-284.

MANUSCRIPTS IN PREPARATION

Garcia-Reyes, M., T. Lamont, W.J. Sydeman, B.A. Black, R.R. Rykaczewski, S.A. Thompson, and S.J. Bograd. A comparison of modes of upwelling variability in the Benguela and California current ecosystems. *Journal of Marine Systems*.

Koehn, L.E., T.E. Essington, K.N. Marshall, W.J. Sydeman, A.I. Szoboszlai, and J.A. Thayer. Trade-offs between forage fish fisheries and their predators in the California Current. *ICES Journal of Marine Science*.

Piatt, J.F., M. Arimitsu, W.J. Sydeman, S.A. Thompson, H. Renner, S. Hatch, J. Williams, A. Kettle, and S. Zador. Geographic structure of coastal marine food webs in the Alaskan North Pacific. *Marine Ecology Progress Series*.

Robinson, H.J., J.A. Thayer, V. Seher, and W.J. Sydeman. Variable responses of breeding seabirds to fireworks disturbance. *Condor*.

Robinson, H.J., J. Thayer, V. Seher, and W. Merkle. 2016. Brandt's cormorant diet analyses: Filling a gap in trophic links of climate versus human disturbance effects on productivity. Report to the Golden Gate National Recreation Area (GGNRA) National Park Service (NPS).

Sydeman, W.J., J.A. Santora, R. Zeno, J. Hassrick, M. Losekoot, S.A. Thompson, P. Davison, J.C. Field, S. Hayes, and W.T. Peterson. Sensing and mapping krill distribution and abundance in the California Current. *Progress in Oceanography*.

Sydeman, W.J., S.A. Thompson, M. Arimitsu, A. Bennison, P. Boersch-Supan, C. Boyd, R.J.M. Crawford, F. Daunt, R. Furness, D. Gianuca, A. Gladics, L. Koehn, E. Logerwell, T. Morris, E.M. Phillips, J. Provencher, A. Punt, C. Saraux, L. Shannon, R. Sherley, A. Simeone, R. Wanless, S. Wanless, S. Zador. Documenting seabird-fisheries competition: Review, synthesis and best practices. *Fisheries Research*.

Szoboszlai, A.I., J.A. Thayer, W.J. Sydeman, and L.E. Koehn. Synthesis of anchovy and sardine consumption by seabirds, fish, and mammals in the California Current. *ICES Journal of Marine Science*.

Thayer, J., J. Hassrick, H. Robinson, K. Hernandez, P. Morris, and M. Weise. Temporal variation in central California sea lion food habits: 2013-16 in comparison with 1998-99. Farallon Institute Report.

Thayer, J.A., and W. Sydeman. "One-third for the (sea)birds," marine mammals and fish? Forage thresholds for productivity of marine vertebrates in the California Current. *Ecosphere*.

Thayer, J.A., A.I. Szoboszlai, and W.J. Sydeman. California Current predator forage needs for applications to allowable fisheries catch: Model comparisons and synthesis.

PRESENTATIONS

Davison, P., A. MacCall, W.J. Sydeman, and J.A. Thayer. California anchovy population remains low. Oral presentation, CalCOFI Conference. San Diego, CA. December, 2016.

Garcia-Reyes, M., T. Lamont, S.J. Bograd, B. Black, R.J.M. Crawford, C. van der Lingen, S.A. Thompson, R.R. Rykaczewski, and W.J. Sydeman. Modes of upwelling variability in the Benguela Current System and how they relate to ecosystem productivity. Oral presentation, Ocean Sciences Annual Meeting. New Orleans, LA. February, 2016.

Garcia-Reyes, M. Under pressure: Climate change, upwelling and Eastern Boundary Upwelling Ecosystems. Invited presentation seminar at Romberg Tiburon Center. Tiburon, CA. March, 2016.

Garcia-Reyes, M., and W.J. Sydeman. Ecosystem indicators. Oral presentation, meeting for Forecasting ENSO Impacts on Marine Ecosystems of the U.S. West Coast. San Diego, CA. August, 2016.

Garcia-Reyes, M., T. Lamont, W.J. Sydeman, S.J. Bograd, R.R. Rykaczewski, S.A. Thompson, and B.A. Black. Eastern boundary upwelling systems: Seasonal modes of upwelling variability in the California and Benguela Systems. Poster presentation, CLIVAR Open Science Conference. Qingdao, China. August, 2016. Also presented at the Benguela Symposium. Cape Town, South Africa. November, 2016.

Garcia-Reyes, M., S.A. Thompson, and W.J. Sydeman. Multivariate Ocean Climate Indicator (MOCI): The case of California. Poster presentation, PICES North Pacific Marine Science Organization Annual Meeting. San Diego, CA. November, 2016.

Garcia-Reyes, M. Careers: What an oceanographer does for a living. Invited presentation to science students at Tomales High School. Tomales, CA. November, 2016.

Sydeman, W.J. New tricks, old dogs, no-analog ecosystems and seabird resilience. Plenary presentation, Pacific Seabird Group Annual Meeting. Oahu, HI. February, 2016.

Sydeman, W.J., M. Garcia-Reyes, S.A. Thompson, G. Humphries, H. Renner, D. Dragoo, D.W. Anderson, F. Gress, E. Velarde, J.F. Piatt, Y. Watanuki, and J.K. Parrish. Seabird responses to unusual oceanographic conditions in the northeast Pacific, 2014-2015: Mass mortality and regional-scale breeding success. Oral presentation, Ocean Sciences Annual Meeting. New Orleans, LA. February, 2016.

Sydeman, W.J., M. Garcia-Reyes, S.A. Thompson, R. Suryan, H. Renner, E. Velarde, D. Anderson, and Y. Watanuki. Variable responses of seabirds to North Pacific warming, 2014. Poster presentation, Ocean Sciences Annual Meeting. New Orleans, LA. February, 2016.

- Sydeman, W.J., and M. Garcia-Reyes. State of the Ocean: 2014-2016: Persistent marine heat wave takes hold. Oral presentation to the Joint Sub-Committee on Fisheries and Aquaculture. Sacramento, CA. April, 2016.
- Sydeman, W.J., J.G. Dorman, and M. Garcia-Reyes. State of the ocean. Invited presentation, Noyo Center for Marine Science. Fort Bragg, CA. May, 2016.
- Sydeman, W.J. Marine climate impacts: Re-distributions, die-offs, and toxicity along the U.S. West Coast. Oral presentation, GFNMS Climate Change Summit. San Francisco, CA. May, 2016.
- Sydeman, W.J. Forage, predators, upwelling, climate. Invited presentation, Monterey Bay Aquarium Research Institute (MBARI). Moss Landing, CA. September, 2016.
- Sydeman, W.J. (and the village). Climate change and upwelling ecosystems. Oral presentation, Benguela Symposium. Cape Town, South Africa. November, 2016.
- Sydeman, W.J., G.L. Hunt, Jr., D. Bertram, Y. Watanuki, R.R. Ream, K. Hattori, H. Kato, and K. Morgan. Marine birds, mammals, and PICES: Brief history and roadmap for the future. Oral presentation, PICES North Pacific Marine Science Organization Annual Meeting. San Diego, CA. November, 2016.
- Thayer, J.A., A.I. Szoboszlai, and W.J. Sydeman. Predator consumption of forage species in the California Current. Invited oral presentation, PICES North Pacific Marine Science Organization Annual Meeting. San Diego, CA. November, 2016.