

Evaluating the Potential for Marine and Hydrokinetic Devices to become Artificial Reefs or Fish Aggregating Devices based on the Analysis of Surrogates in Tropical, Subtropical, and Temperate US West Coast and Hawaiian Coastal Waters

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LONG-TERM GOALS

Our goal is to evaluate the potential ecosystem interactions that may be associated with marine and hydrokinetic (MHK) devices in coastal waters off the U.S. West Coast and Hawai'i.

OBJECTIVES

Our objective is to evaluate the potential for MHK devices to function as artificial reefs or fish aggregating devices (FADs). We are basing our evaluation on an analysis of surrogate structures located in tropical, subtropical, and temperate coastal waters on the U.S. West Coast and Hawai'i.

APPROACH AND WORK PLAN

- 1) **Approach:** The approach was to review literature and assess the potential for MHK devices to function as FADs and/or artificial reefs, using studies on surrogate structures within four subregions: Southern California Bight; Central California to Cape Flattery, Washington; Puget Sound; and Hawai'i . Where information was lacking, guided discussions with resource managers and subject matter experts were conducted to obtain their personal direct observations and/or unpublished data to assist in the analysis.
- 2) **Key individuals:** Sharon Kramer is the PI on this project, with ecologists Christine Hamilton and Greg Spencer assisting with the analysis, and Heather Ogston as technical editor. Dr. Peter Nelson (Collaborative Fisheries Research West) and David Itano (consultant) are serving as the science advisors. Guided discussions were conducted with the following resource managers/experts: Dr. Kim Holland (Hawaii Institute of Marine Biology), Michael Prall (California Department of Fish and Wildlife), Gavin Keys and Neil Sims (Kampachi Farms, LLC), Robert Pacunski (Washington Department of Fish and Wildlife), Dr. Robert Hannah (Oregon Department of Fish and Wildlife), Dr. Brian Tissot (Humboldt State University), Franklin Parker (U.S. Coast Guard), Eric Pedersen (Pacifco Aquaculture), Dr. Larry Allen (California State University, Northridge), Dick Stevenson (Retired commercial fisherman), Dr. David Ainley (H. T. Harvey & Associates), Alan Everson (National Marine Fisheries Service), and Dr. John Childers (NOAA Fisheries).
- 3) **Work plans for the upcoming year:** We will be completing the final report documenting the findings of our analysis, and submitting a version of the final report to a scientific journal for potential publication.

WORK COMPLETED

We completed **Task 1.0**, and **Milestones 1.1 and 1.2**.

- **Task 1.0 Review and Evaluate Literature:** We reviewed a large body of literature (350+ reports and papers) and assessed the potential for MHK devices to function as FADs and/or artificial reefs using studies on surrogate structures within the four subregions: Southern California Bight; Central California to Cape Flattery, Washington; Puget Sound; and Hawai'i. We also conducted guided discussions or email communications with 15 resource managers/experts to assist in our analysis.
- **Milestone 1.1.** A memorandum documenting the bibliography for the literature review and evaluation, and the resource managers/experts to be contacted.
- **Milestone 1.2.** A memorandum documenting the draft findings of the literature review and evaluation, and guided discussion and email communication logs.

RESULTS

Surrogate structures we reviewed included bottom-oriented surrogate structures (natural reefs, artificial reefs, and marine debris), combined bottom and midwater/surface-oriented structures (oil and gas platforms, kelp beds/rocky reefs, mariculture facilities, purpose-built FADs, piers and marinas), and midwater/surface-oriented structures (floating drift kelp and floating debris). For each of the surrogate structures, we described the fish assemblages, ecological interactions, and sensitive fish species that may occur at MHK devices with similar key features. We created maps showing the locations of each surrogate structure in each subregion to identify the general areas covered by studies of surrogate structures as well as the general areas for which relevant information was still lacking. We summarized, in table format, the following information for each surrogate structure:

- Morphological characteristics of each surrogate structure (e.g., type, structural complexity, size, and position within the water column)
- The depth of the surrogate structure
- Duration of the structure in the water at the time of the study
- The sensitive fish species and fish assemblages reported to occur at the surrogate structure
- Other organisms and physical factors relevant to the structure that may affect assemblages and ecological interactions, such as the presence of invertebrate colonization, and physical factors like water quality, temperature, and inputs

RELATED PROJECTS

Closely-related projects that H.T. Harvey & Associates have been involved in include:

For Bureau of Ocean Energy Management: West Coast Environmental Protocols Framework: Baseline and Monitoring Studies (Klure et al. 2012). <http://tethys.pnnl.gov/publications/west-coast-environmental-protocols-framework>

For U.S. Department of Energy: Deployment Effects of Marine Renewable Energy Technologies - Framework for Identifying Key Environmental Concerns in Marine Renewable Energy Projects (Kramer et al. 2010) <http://tethys.pnnl.gov/publications/framework-identifying-key-environmental-concerns-marine-renewable-energy-projects>

Research and knowledge gained from these projects on the potential effects of MHK devices on fish was applied to the current project.

REFERENCES (*Delete this section if there are none*)

- Adams, T. P., R. G. Miller, D. Aleynik, and M. T. Burrows. 2014. Offshore marine renewable energy devices as stepping stones across biogeographical boundaries. *Journal of Applied Ecology* 51:330–338.
- Ainley, D., D. W. Anderson, and P. R. Kelly. 1981. Feeding ecology of marine cormorants in southwestern North America. *Condor* 83:120–131.
- Ainley, D. G., K. D. Dugger, R. G. Ford, S. D. Pierce, D. C. Reese, R. D. Brodeur, C. T. Tynan, J. A. Barth. 2009. Association of predators and prey at frontal features in the California Current: competition, facilitation, and co-occurrence. *Marine Ecology Progress Series* 389:271–294.
- Allen, L. G., and J. N. Cross. 2006. Surface waters. Pages 320–341 *in* L. G. Allen, D. J. Pondella II, and M. H. Horn (Editors), *The Ecology of Marine Fishes, California and Adjacent Waters*. University of California Press, Berkeley and Los Angeles, California.
- Allen, L. G., and D. J. Pondella II. 2006. Ecological classification. Pages 81–113 *in* L. G. Allen, D. J. Pondella II, and M. H. Horn (Editors), *The Ecology of Marine Fishes, California and Adjacent Waters*. University of California Press, Berkeley and Los Angeles, California.
- Allen, L. G., D. J. Pondella II, and M. H. Horn, Editors. 2006. *The Ecology of Marine Fishes, California and Adjacent Waters*. University of California Press, Berkeley and Los Angeles, California.
- Ambrose, R. F., and S. L. Swarbrick. 1989. Comparison of fish assemblages on artificial and natural reefs off the coast of southern California. *Bulletin of Marine Science* 44:718–733.
- Anderson, T. W., E. E. DeMartini, and D. A. Roberts. 1989. The relationship between habitat structure, body size and distribution of fishes at a temperate artificial reef. *Bulletin of Marine Science* 44:681–697.
- Anderson, D. W., F. Gress, K. F. Mais, and P. R. Kelly. 1980. Brown pelicans as anchovy stock indicators and their relationships to commercial fishing. *California Cooperative Oceanic Fisheries Investigations Reports* 21:54–61.
- Anthony, K. M., C. G. Lowe, and M. S. Love. 2009. Translocation, homing behavior, and habitat utilization of groundfishes around offshore oil platforms in the East Santa Barbara Channel. MMS OCS Study 2009-033. MMS Cooperative Agreement Number 1435-01-06-CA-39796. California State University Long Beach, Long Beach, California.
- Antonelis, G. A., and C. H. Fiscus. 1980. The pinnipeds of the California Current. *California Cooperative Oceanic Fisheries Investigations Reports* 21:68–78.
- Bailey-Brock, J. H. 1989. Fouling community development on an artificial reef in Hawaiian waters. *Bulletin of Marine Science* 44:580–591.
- Baine, M. 2001. Artificial reefs: A review of their design, application, management and performance. *Ocean and Coastal Management* 44:241–259.
- Beamish, R. J., G. A. McFarland, and J. R. King. 2005. Migratory patterns of pelagic fishes and possible linkages between open ocean and coastal ecosystems off the Pacific coast of North America. *Deep-Sea Research II* 52:739–755.

- Beets, J. 1989. Experimental evaluation of fish recruitment to combinations of fish aggregating devices and benthic artificial reefs. *Bulletin of Marine Science* 44:973–983.
- Bergstrom, L., F. Sundqvist, and U. Bergstrom. 2013. Effects of an offshore wind farm on temporal and spatial patterns in the demersal fish community. *Marine Ecology Progress Series* 485:199–210.
- Bergstrom, L., L. Kautsky, T. Malm, R. Rosenberg, M. Wahlberg, N. A. Capetillo, and D. Wilhelmsson. 2014. Effects of offshore wind farms on marine wildlife—a generalized impact assessment. *Environmental Research Letters* 9:1–12.
- Bi, H., R. E. Ruppel, W. T. Peterson, and E. Casillas. 2008. Spatial distribution of ocean habitat of yearling chinook (*Oncorhynchus tshawytscha*) and coho (*Oncorhynchus kisutch*) salmon off Washington and Oregon, USA. *Fisheries Oceanography* 17:463–476.
- Bodkin, J. L. 1986. Fish assemblages in *Macrocystis* and *Nereocystis* kelp forests off central California. *Fishery Bulletin* 84:799–808.
- Boehlert, G. W. 1977. Timing of surface-to-benthic migration in juvenile rockfish, *Sebastes diploproa*, off southern California. *Fishery Bulletin* 75:887–890.
- Boehlert, G. W., and A. B. Gill. 2010. Environmental and ecological effects of ocean renewable energy development: A current synthesis. *Oceanography* 23:68–81.
- Boehlert, G., C. Braby, A. S. Bull, M. E. Helix, S. Henkel, P. Klarin, and D. Schroeder. 2013. Oregon Marine Renewable Energy Environmental Science Conference Proceedings. OCS Study BOEM 2013-0113. U.S. Department of the Interior, Bureau of Ocean Energy Management. Cooperative Agreement with Oregon State University M12AC00012.
- Bograd, S. J., I. Schroeder, N. Sarkar, X. Qiu, W. J. Sydeman, and F. B. Schwing. 2009. Phenology of coastal upwelling in the California Current. *Geophysical Research Letters* 36: L01602. DOI 10.1029/2008GL035933.
- Bond, A. B., J. S. Stephens, Jr., D. J. Pondella II, M. J. Allen, and M. Helvey. 1999. A method for estimating marine habitat values based on fish guilds, with comparisons between sites in the Southern California Bight. *Bulletin of Marine Science* 64:219–242.
- Broadhurst, M., and D. L. Orme. 2014. Spatial and temporal benthic species assemblage responses with a deployed marine tidal energy device: A small scaled study. *Marine Environmental Research* 99:76–84.
- Broadhurst, M., S. Barr, and D. L. Orme. 2014. In-situ ecological interactions with a deployed tidal energy device; an observational pilot study. *Ocean & Coastal Management* 99:31–38.
- Brock, R. E., and J. E. Norris. 1989. An analysis of the efficacy of four artificial reef designs in tropical waters. *Bulletin of Marine Science* 44:934–941.
- Brodeur, R. D., J. P. Fisher, R. L. Emmett, C. A. Morgan, and E. Casillas. 2005. Species composition and community structure of pelagic nekton off Oregon and Washington under variable oceanographic conditions. *Marine Ecology Progress Series* 298:41–57.
- Broughton, K. 2012. Office of National Marine Sanctuaries Science Review of Artificial Reefs. Marine Sanctuaries Conservation Series ONMS-12-05. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries, Silver Spring, Maryland.

- Buckley, R. M., and G. J. Hueckel. 1985. Biological processes and ecological development on an artificial reef in Puget Sound, Washington. *Bulletin of Marine Science* 37:50–69.
- Burton, E., and L. Lundsten. 2006. Biological Characterization at the USS Macon Wreck Site. Monterey Bay National Marine Sanctuary and Monterey Bay Aquarium Research Institute, Monterey, California.
- Cartamil, D. P., and C. G. Lowe. 2004. Diel movement patterns of ocean sunfish *Mola mola* off southern California. *Marine Ecology Progress Series* 266:245–253.
- Carter, J. W., A. L. Carpenter, M. S. Foster, and W. N. Jessee. 1985a. Benthic succession on an artificial reef designed to support a kelp-reef community. *Bulletin of Marine Science* 37:86–113.
- Carter, J. W., W. N. Jessee, M. S. Foster, and A. L. Carpenter. 1985b. Management of artificial reefs designed to support natural communities. *Bulletin of Marine Science* 37:114–128.
- Castro, J. J., J. A. Santiago, and A. T. Santana-Ortega. 2002. A general theory on fish aggregation to floating objects: An alternative to the meeting point hypothesis. *Reviews in Fish Biology and Fisheries* 11:255–277.
- Claisse, J. T., D. J. Pondella II, M. Love, L. A. Zahn, C. M. Williams, J. P. Williams, and A. S. Bull. 2014. Oil platforms off California are among the most productive marine fish habitats globally. *Proceedings of the National Academy of Sciences* 111:1–6.
- Cross, J. N., and L. G. Allen. 1993. Fishes. Pages 459–540 in M. D. Dailey, D. J. Reish, and J. W. Anderson (Editors), *Ecology of the Southern California Bight: A Synthesis and Interpretation*. University of California Press, Berkeley and Los Angeles, California.
- Dagorn, L., K. N. Holland, and D. G. Itano. 2007. Behavior of yellowfin (*Thunnus albacares*) and bigeye (*T. obesus*) tuna in a network of fish aggregating devices (FADs). *Marine Biology* 151:595–606.
- Dailey, M. D., J. W. Anderson, D. J. Reish, and D. S. Gorsline. 1993. The Southern California Bight: background and setting. Pages 1–18 in M. D. Dailey, D. J. Reish, and J. W. Anderson (Editors), *Ecology of the Southern California Bight: A Synthesis and Interpretation*. University of California Press, Los Angeles, California.
- Daly, E. A., R. D. Brodeur, and L. A. Weitkamp. 2009. Ontogenetic shifts in diets of juvenile and subadult coho and Chinook salmon in coastal marine waters: Important for marine survival? *Transactions of the American Fisheries Society* 138:1420–1438.
- Danner, E. M., T. C. Wilson, and R. E. Schlotterbeck. 1994. Comparison of rockfish recruitment of nearshore artificial and natural reefs off the coast of central California. *Bulletin of Marine Science* 55:333–343.
- Degraer, S., R. Brabant, and B. Rumes. 2010. Offshore Wind Farms in the Belgian Part of the North Sea: Early Environmental Impact Assessment and Spatio-temporal Variability. Royal Belgian Institute for Natural Sciences, Management Unit of the North Sea Mathematical Models, Marine Ecosystem Management Section, Brussels, Belgium.
- DeMartini, E. E., and D. A. Roberts. 1990. Effects of giant kelp (*Macrocystis*) on the density and abundance of fishes in a cobble-bottom kelp forest. *Bulletin of Marine Science* 46:287–300.
- DeMartini, E. E., D. A. Roberts, and T. W. Anderson. 1989. Contrasting patterns of fish density and abundance at an artificial rock reef and a cobble-bottom kelp forest. *Bulletin of Marine Science* 44:881–892.
- Dempster, T. 2004. Biology of fish associated with moored fish aggregation devices (FADs): Implications of the development of a FAD fishery in New South Wales, Australia. *Fisheries Research* 68:189–201.

- Dempster, T., and M. Taquet. 2004. Fish aggregation device (FAD) research: Gaps in current knowledge and future directions for ecological studies. *Reviews in Fish Biology and Fisheries* 14:21–42.
- Dempster, T., P. Sanchez-Jerez, J. Bayle-Sempere, and M. Kingsford. 2004. Extensive aggregations of wild fish at coastal sea-cage fish farms. *Hydrobiologia* 525:245–248.
- Dempster, T., P. Sanchez-Jerez, I. Uglem, and P.-A. Bjorn. 2010. Species-specific patterns of aggregation of wild fish around fish farms. *Estuarine, Coastal and Shelf Science* 86:271–275.
- [DOE] U.S. Department of Energy. 2009. Report to Congress on the Potential Environmental Effects of Marine and Hydrokinetic Energy Technologies. Wind and Hydropower Technologies Program.
- [DOE] U.S. Department of Energy, Oregon State University, and Northwest National Marine Renewable Energy Center. 2012a. Wave Energy Test Project—Final Environmental Assessment. DOE/EA-1917.
- [DOE] U.S. Department of Energy, University of Washington, HDR-DTA, Sound & Sea Technology, OpenHydro Group Limited, and Pacific Northwest National Laboratory. 2012b. Admiralty Inlet Pilot Tidal Project (FERC Project No. 12690), Application for a New Pilot Project License (Minor Water Power Project): Volume II, Exhibit E. Snohomish County Public Utility District No. 1, Everett, Washington.
- Easton, R. R. 2012. Video on the Rocks: Use of a Video Lander Platform as a Survey Tool for a High-relief Nearshore Temperate Rocky Reef. Master's Thesis. Oregon State University, Corvallis, Oregon.
- Ebeling, A. W., R. J. Larson, and W. S. Alevizon. 1980. Habitat groups and island-mainland distribution of kelp-bed fishes off Santa Barbara, California. Pages 403–429 in *Multidisciplinary Symposium on the Channel Islands*. Santa Barbara Museum of Natural History, Santa Barbara, California.
- Emery, B. M., L. Washburn, M. S. Love, M. M. Nishimoto, and J. C. Ohlmann. 2006. Do oil and gas platforms off California reduce recruitment of bocaccio (*Sebastes paucispinis*) to natural habitat? An analysis based on trajectories derived from high-frequency radar. *Fishery Bulletin* 104:391–400.
- Emmett, R. L., R. D. Brodeur, and P. M. Orton. 2004. The vertical distribution of juvenile salmon (*Oncorhynchus* spp.) and associated fishes in the Columbia River plume. *Fisheries Oceanography* 13:392–402.
- Erickson, D. L., and J. E. Hightower. 2007. Oceanic distribution and behavior of green sturgeon. *American Fisheries Society Symposium* 56:197–211.
- Freon, P., and L. Dagorn. 2000. Review of fish associative behaviour: Toward a generalisation of the meeting point hypothesis. *Reviews in Fish Biology and Fisheries* 10:183–207.
- Fresh, K. L. 2006. Juvenile Pacific Salmon in Puget Sound. Puget Sound Nearshore Partnership Report No. 2006-06. Published by Seattle District, U.S. Army Corps of Engineers, Seattle, Washington.
- Frid, C., E. Andonegi, J. Depestele, A. Judd, D. Rihan, S. I. Rogers, and E. Kenchington. 2012. The environmental interactions of tidal and wave energy generation devices. *Environmental Impact Assessment Review* 32:133–139.
- Gallagher, M. B., and S. S. Heppell. 2010. Essential habitat identification for age-0 rockfish along the central Oregon coast. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 2:60–72.

- Gelfenbaum, G., T. Mumford, J. Brennan, H. Case, M. Dethier, K. Fresh, F. Goetz, M. van Heeswijk, T. M. Leschine, M. Logsdon, et al. 2006. Coastal Habitats in Puget Sound: A Research Plan in Support of the Puget Sound Nearshore Partnership. Puget Sound Nearshore Partnership Report No. 2006-1. U.S. Geological Survey, Seattle, Washington.
- Grant, J. J., K. C. Wilson, A. Grover, and H. A. Togstad. 1982. Early development of Pendleton Artificial Reef. *Marine Fisheries Review* 44:53–60.
- Grimmer, K., and S. de Beukelaer. 2011. NOAA's Monterey Bay National Marine Sanctuary Lost Fishing Gear Removal Project: 2011 Cruise Report—Research Vessel FULMAR October 24–November 2, 2011. National Oceanic and Atmospheric Administration, Monterey Bay National Marine Sanctuary, Monterey, California.
- Grimmer, K., J. de Marignac, L. de Marignac, and S. de Beukelaer. 2009. Monterey Bay National Marine Sanctuary Lost Fishing Gear Project Cruise Report: October 18, 2009–October 30, 2009. National Oceanic and Atmospheric Administration, Monterey Bay National Marine Sanctuary, Monterey, California.
- Grimmer, K., L. de Marignac, and S. de Beukelaer. 2010. Monterey Bay National Marine Sanctuary Lost Fishing Gear Removal Project Final Cruise Report: September 15, 2010–September 29, 2010. National Oceanic and Atmospheric Administration, Monterey Bay National Marine Sanctuary, Monterey, California.
- Grossman, G. D., G. P. Jones, and W. J. Seaman, Jr. 1997. Do artificial reefs increase regional fish production? A review of existing data. *Fisheries* 22:17–23.
- Hair, C., J. Bell, and M. J. Kingsford. 1994. Effects of position in the water column, vertical movement and shade on settlement to artificial habitats. *Bulletin of Marine Science* 55:434–444.
- Hallier, J. P., and D. Gaertner. 2008. Drifting fish aggregation devices could act as an ecological trap for tropical tuna species. *Marine Ecology Progress Series* 353:255–264.
- Hammar, L. 2014. Power from the Brave New Ocean: Marine Renewable Energy and Ecological Risks. Ph.D. Dissertation. Chalmers University of Technology, Gothenburg, Sweden.
- Hanan, D. A., and B. E. Curry. 2012. Long-term movement patterns and habitat use of nearshore groundfish: Tag-recapture in central and southern California waters. *The Open Fish Science Journal* 5:30–43.
- Hannah, R. W., and P. S. Rankin. 2011. Site fidelity and movement of eight species of Pacific rockfish at a high-relief rocky reef on the Oregon coast. *North American Journal of Fisheries Management* 31:483–494.
- Hannah, R. W., and M. T. O. Blume. 2012. Tests of an experimental unbaited video lander as a marine fish survey tool for high-relief deepwater rocky reefs. *Journal of Experimental Marine Biology and Ecology* 430-431:1–9.
- Harding, J. A., A. J. Ammann, and R. B. MacFarlane. 2011. Regional and seasonal patterns of epipelagic fish assemblages from the central California Current. *Fishery Bulletin* 109:261–281.
- Helvey, M., and R. W. Smith. 1985. Influence of habitat structure on the fish assemblages associated with two cooling-water intake structures in southern California. *Bulletin of Marine Science* 37:189–199.
- Higashi, G. R. 1994. Ten years of fish aggregating device (FAD) design development in Hawai'i. *Bulletin of Marine Science* 55:651–666.
- Holland, K. N., R. W. Brill, and R. K. C. Chang. 1990. Horizontal and vertical movements of yellowfin and bigeye tuna associated with fish aggregating devices. *Fishery Bulletin* 88:493–507.

- Horn, M. H., L. G. Allen, and R. N. Lea. 2006. Pages 3–25 in L. G. Allen, D. J. Pondella II, and M. H. Horn (Editors), *The Ecology of Marine Fishes, California and Adjacent Waters*. University of California Press, Berkeley and Los Angeles, California.
- Horne, J. K., D. A. Jacques, S. L. Parker-Stetter, H. L. Linder, and J. M. Nomura. 2013. Evaluating Acoustic Technologies to Monitor Aquatic Organisms at Renewable Energy Sites. BOEM 2014-057. U.S. Department of the Interior, Bureau of Ocean Energy Management.
- Hueckel, G. J., and R. M. Buckley. 1987. The influence of prey communities on fish species assemblages on artificial reefs in Puget Sound, Washington. *Environmental Biology of Fishes* 19:195–214.
- Huff, D. D., S. T. Lindley, P. S. Rankin, and E. A. Mora. 2011. Green sturgeon physical habitat use in the coastal Pacific Ocean. *PLoS ONE* 6:e25156.
- Huff, D. D., S. T. Lindley, B. K. Wells, and F. Chai. 2012. Green sturgeon distribution in the Pacific Ocean estimated from modeled oceanographic features and migration behavior. *PLoS ONE* 7:e45852.
- Hunter, J. R., and C. T. Mitchell. 1968. Field experiments on the attraction of pelagic fish to floating objects. *Journal du Conseil* 31:427–434.
- Hunter, W. R., and M. D. J. Sayer. 2009. The comparative effects of habitat complexity on faunal assemblages of northern temperate artificial and natural reefs. *ICES Journal of Marine Science* 66:691–698.
- Itano, D. G., and K. N. Holland. 2000. Movement and vulnerability of bigeye (*Thunnus obesus*) and yellowfin tuna (*Thunnus albacares*) in relation to FADs and natural aggregation points. *Aquatic Living Resources* 13:213–223.
- Jessee, W. N., A. L. Carpenter, and J. W. Carter. 1985. Distribution patterns and density estimates of fishes on a southern California artificial reef with comparisons to natural kelp-reef habitats. *Bulletin of Marine Science* 37:214–226.
- Johnson, T. D., A. M. Barnett, E. E. DeMartini, L. L. Craft, R. F. Ambrose, and L. J. Purcell. 1994. Fish production and habitat utilization on a southern California artificial reef. *Bulletin of Marine Science* 55:709–723.
- Kaplan, B., C. J. Beegle-Krause, D. French McCay, A. Copping, and S. Geerlofs. 2010. Updated Summary of Knowledge: Selected Areas of the Pacific Coast. OCS Study BOEMRE 2010-014. U.S. Department of the Interior, Bureau of Ocean Energy Management, Regulation, and Enforcement, Pacific OCS Region, Camarillo, California.
- Keller, A. A., E. L. Fruh, M. M. Johnson, V. Simon, and C. McGourty. 2010. Distribution and abundance of anthropogenic marine debris along the shelf and slope of the US West Coast. *Marine Pollution Bulletin* 60:692–700.
- Kjaer, J., J. K. Larsen, C. Boesen, H. H. Corlin, S. Andersen, S. Nielsen, A. G. Ragborg, and K. M. Christensen. 2006. Danish Offshore Wind—Key Environmental Issues. DONG Energy, Vattenfall, The Danish Energy Authority, and The Danish Forest and Nature Agency, Denmark.
- Krone, R., L. Gutow, T. Brey, J. Dannheim, and A. Schroder. 2013. Mobile demersal megafauna at artificial structures in the German Bight—likely effects of offshore wind farm development. *Estuarine, Coastal and Shelf Science* 125:1–9.

- Langhamer, O., and D. Wilhelmsson. 2009. Colonisation of fish and crabs of wave energy foundations and the effects of manufactured holes—a field experiment. *Marine Environmental Research* 68:151–157.
- Langhamer, O., D. Wilhelmsson, and J. Engstrom. 2009. Artificial reef effect and fouling impacts on offshore wave power foundations and buoys—a pilot study. *Estuarine, Coastal and Shelf Science* 82:426–432.
- Laufle, J. C., and G. B. Pauley. 1985. Fish colonization and materials comparisons on a Puget Sound artificial reef. *Bulletin of Marine Science* 37:227–243.
- Leonhard, S. B., C. Stenberg, and J. Stottrup, Editors. 2011. Effect of the Horns Rev 1 Offshore Wind Farm on Fish Communities: Follow-up Seven Years after Construction. DTU Aqua Report No 246-2011. Technical University of Denmark (DTU) Aqua, National Institute of Aquatic Resources, Denmark.
- Leung, D. Y. C., and Y. Yang. 2012. Wind energy development and its environmental impact: A review. *Renewable and Sustainable Energy Reviews* 16:1031–1039.
- Lindeboom, H. J., H. J. Kouwenhoven, M. J. N. Bergman, S. Bouma, S. Brasseur, R. Daan, R. C. Fijn, D. de Haan, S. Dirksen, R. van Hal, et al. 2011. Short-term ecological effects of an offshore wind farm in the Dutch coastal zone; a compilation. *Environmental Research Letters* 6:035101.
- Lindley, S. T., M. L. Moser, D. L. Erickson, M. Belchik, D. W. Welch, E. Rechisky, J. T. Kelly, J. Heublein, and A. P. Klimley. 2008. Marine migration of North American green sturgeon. *Transactions of the American Fisheries Society* 137:182–194.
- Lluch-Belda, D., D. B. Lluch-Cota, S. E. Lluch-Cota. 2003. Scales of interannual variability in the California Current system: associated physical mechanisms and likely ecological impacts. *CalCOFI Report* 44:76–85.
- Love, M. S., and A. York. 2005. A comparison of the fish assemblages associated with an oil/gas pipeline and adjacent seafloor in the Santa Barbara Channel, Southern California Bight. *Bulletin of Marine Science* 77:101–117.
- Love, M. S., and M. Yoklavich. 2006. Deep rock habitats. Pages 253–268 in L. G. Allen, D. J. Pondella II, and M. H. Horn (Editors), *The Ecology of Marine Fishes, California and Adjacent Waters*. University of California Press, Berkeley and Los Angeles, California.
- Love, M. S., and A. York. 2006. The relationships between fish assemblages and the amount of bottom horizontal beam exposed at California oil platforms: Fish habitat preferences at man-made platforms and (by inference) at natural reefs. *Fishery Bulletin* 104:542–549.
- Love, M. S., and D. M. Schroeder. 2006. Ecological Performance of OCS Platforms as Fish Habitat off California. MMS OCS Study 2004-005. MMS Cooperative Agreement No. 1435-01-03-CA-72694. University of California, Santa Barbara, Marine Science Institute, Santa Barbara, California.
- Love, M. S., and M. M. Nishimoto. 2012. Completion of Fish Assemblage Surveys around Manmade Structures and Natural Reefs off California. BOEM OCS Study 2012-020. University of California, Santa Barbara, Marine Science Institute, Santa Barbara, California.
- Love, M. S., M. Yoklavich, and L. Thorsteinson. 2002. *The Rockfishes of the Northeast Pacific*. University of California Press, Berkeley and Los Angeles, California.
- Love, M. S., D. M. Schroeder, and W. H. Lenarz. 2005. Distribution of bocaccio (*Sebastes paucispinis*) and cowcod (*Sebastes levis*) around oil platforms and natural outcrops off California with implications for larval production. *Bulletin of Marine Science* 77:397–408.

- Love, M. S., D. M. Schroeder, W. Lenarz, A. MacCall, A. S. Bull, and L. Thorsteinson. 2006. Potential use of offshore marine structures in rebuilding an overfished rockfish species, bocaccio (*Sebastes paucispinis*). *Fishery Bulletin* 104:383–390.
- Love, M. S., M. M. Nishimoto, and D. M. Schroeder. 2010. Fish Assemblages Associated with Platforms and Natural Reefs in Areas Where Data are Non-existent or Limited. BOEMRE OCS Study 2010-012. Bureau of Ocean Energy Management, Regulation and Enforcement, Camarillo, California.
- Love, M. S., M. Nishimoto, S. Clark, and D. M. Schroeder. 2012. Recruitment of young-of-the-year fishes to natural and artificial offshore structure within central and southern California waters, 2008–2010. *Bulletin of Marine Science* 88:863–882.
- Lowe, C. G., and R. N. Bray. 2006. Movement and activity patterns. Pages 524–553 in L. G. Allen, D. J. Pondella II, and M. H. Horn (Editors), *The Ecology of Marine Fishes, California and Adjacent Waters*. University of California Press, Berkeley and Los Angeles, California.
- Lowe, C. G., K. M. Anthony, E. T. Jarvis, L. F. Bellquist, and M. S. Love. 2009. Site fidelity and movement patterns of groundfish associated with offshore petroleum platforms in the Santa Barbara Channel. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 1:71–89.
- Lyons, D. E., D. D. Roby, and K. Collis. 2007. Foraging patterns of Caspian terns and double-crested cormorants in the Columbia River Estuary. *Northwest Science* 81:91–103.
- Machias, D., M. R. Landry, A. Gershunov, A. J. Miller, and P. J. S. Franks. 2012. Climatic control of upwelling variability along the western North-American coast. *PLoS ONE* 7(1): e30436. DOI 10.1371/journal.pone.0030436.
- Martin, C. J. B., and C. G. Lowe. 2010. Assemblage structure of fish at offshore petroleum platforms on the San Pedro Shelf of southern California. *Marine and Coastal Fisheries: Dynamics, Management, and Ecosystem Science* 2:180–194.
- Matthews, K. R. 1985. Species similarity and movement of fishes on natural and artificial reefs in Monterey Bay, California. *Bulletin of Marine Science* 37:252–270.
- Matthews, K. R. 1990a. An experimental study of the habitat preferences and movement patterns of copper, quillback, and brown rockfishes (*Sebastes* spp.). *Environmental Biology of Fishes* 29:161–178.
- Matthews, K. R. 1990b. A comparative study of habitat use by young-of-the-year, subadult, and adult rockfish on four habitat types in central Puget Sound. *Fishery Bulletin* 88:223–239.
- Miller, D. J., and R. N. Lea. 1972. Guide to the coastal marine fishes of California. California Department of Fish and Game *Fish Bulletin* 157.
- Misa, W. F. X. E., J. C. Drazen, C. D. Kelley, and V. N. Moriwake. 2013. Establishing species-habitat associations for 4 eteline snappers with the use of a baited stereo-video camera system. *Fishery Bulletin* 111:293–308.
- Mitchell, C. T., and J. R. Hunter. 1970. Fishes associated with drifting kelp, *Macrocystis pyrifera*, off the coast of southern California and northern Baja California. *California Fish and Game* 56:288–297.
- Moffitt, R. B., F. A. Parrish, and J. J. Polovina. 1989. Community structure, biomass and productivity of deepwater artificial reefs in Hawai'i. *Bulletin of Marine Science* 44:616–630.

- [MBARI] Monterey Bay Aquarium Research Institute. 2013. Logbook entry December 12, 2013. [online]: <http://www.mbari.org/expeditions/Benthic2013-Winter/logbook/day2.htm>. Accessed 4 December 2014.
- [NAVFAC] Naval Facilities Engineering Command. 2014. Wave Energy Test Site—Final Environmental Assessment. Marine Corps Base, Hawai'i.
- [NDBC] National Data Buoy Center. 2014. Map of National Data Buoy Center moored buoys. [online]: <http://www.ndbc.noaa.gov/obs.shtml>. Accessed 2 December 2014.
- [NMFS] National Marine Fisheries Service. 2013. Status of Stocks 2013—Annual Report to Congress on the Status of U.S. Fisheries.
- Nelson, P. A., D. Behrens, J. Castle, G. Crawford, R. N. Gaddam, S. C. Hackett, J. Largier, D. P. Lohse, K. L. Mills, P. T. Raimondi, et al. 2008. Developing Wave Energy in Coastal California: Potential Socio-economic and Environmental Effects. CEC-500-2008-083. California Energy Commission, PIER Energy-Related Environmental Research Program & California Ocean Protection Council, Sacramento, California.
- Nishimoto, M. M., and M. S. Love. 2011. Spatial and Seasonal Variation in the Biomass and Size Distribution of Juvenile Fishes Associated with a Petroleum Platform off the California Coast, 2008–2010. BOEMRE OCS Study 2011-08. MMS Cooperative Agreement No.: M08AX12732. University of California, Santa Barbara, Marine Science Institute, Santa Barbara, California.
- Norton, J. G. 1999. Apparent habitat extensions of dolphinfish (*Coryphaena hippurus*) in response to climate transients in the California Current. *Scientia Marina* 63:239–260.
- Nur, N., J. Jahncke, M. P. Herzog, J. Howar, K. D. Hyrenbach, J. E. Zamon, D. G. Ainley, J. A. Wiens, K. Morgan, L. T. Balance, et al. 2011. Where the wild things are: Predicting hotspots of seabird aggregations in the California Current System. *Ecological Applications* 21:2241–2257.
- Oakes, C. T., and D. J. Pondella II. 2009. The value of a net-cage as a fish aggregating device in southern California. *Journal of the World Aquaculture Society* 40:1–21.
- [ODFW] Oregon Department of Fish and Wildlife. 2006. The Oregon Nearshore Strategy. Marine Resources Program, Newport, Oregon.
- Pacific Gas & Electric Company and H. T. Harvey & Associates. 2010. Humboldt WaveConnect™ Project Draft Marine Hydrokinetic Pilot Project License Application - Monitoring and Adaptive Management Plan: Fish and Invertebrates. Appendix E-5.3.3.
- Pacunski, R. E., W. A. Palsson, and H. G. Greene. 2013. Estimating Fish Abundance and Community Composition on Rocky Habitats in the San Juan Islands Using a Small Remotely Operated Vehicle. Washington Department of Fish and Wildlife, Fish Program, Fish Management Division, Olympia, Washington.
- Page, H. M., J. Dugan, and J. Childress. 2005. Role of Food Subsidies and Habitat Structure in Influencing Benthic Communities of Shell Mounds at Sites of Existing and Former Offshore Oil Platforms. MMS OCS Study 2005-001. University of California, Santa Barbara, Coastal Research Center, Marine Science Institute, Santa Barbara, California.
- Page, H. M., J. E. Dugan, D. M. Schroeder, M. M. Nishimoto, M. S. Love, and J. C. Hoesterey. 2007. Trophic links and condition of a temperate reef fish: Comparisons among offshore oil platform and natural reef habitats. *Marine Ecology Progress Series* 344:245–256.

- Palacios, D. M., S. J. Bograd, D. G. Foley, and F. B. Schwing. 2006. Oceanographic characteristics of biological hot spots in the North Pacific: A remote sensing perspective. *Deep-Sea Research II* 53:250–269.
- Palsson, W., T. Tsou, G. G. Bargmann, R. M. Buckley, J. E. West, M. L. Mills, Y. W. Cheng, and R. E. Pacunski. 2009. The Biology and Assessment of Rockfishes in Puget Sound. Washington Department of Fish and Wildlife, Fish Program, Fish Management Division, Olympia, Washington.
- Parnel, M. M., R. L. Emmett, and R. D. Brodeur. 2008. Ichthyoplankton community in the Columbia River plume off Oregon: Effects of fluctuating oceanographic conditions. *Fishery Bulletin* 106:161–173.
- Patton, M. L., R. S. Grove, and R. F. Harman. 1985. What do natural reefs tell us about designing artificial reefs in southern California? *Bulletin of Marine Science* 37:279–298.
- Pearcy, W. G. 1992. Ocean Ecology of North Pacific Salmonids. Washington Sea Grant Program, Seattle, Washington.
- Pearcy, W. G., D. L. Stein, M. A. Hixon, E. K. Pikitch, W. H. Barss, and R. M. Starr. 1989. Submersible observations of deep-reef fishes of Heceta Bank, Oregon. *Fishery Bulletin* 87:955–965.
- Pearcy, W. G., R. D. Brodeur, and J. P. Fisher. 1990. Distribution and biology of juvenile cutthroat trout (*Oncorhynchus clarki clarki*) and steelhead (*O. mykiss*) in coastal waters off Oregon and Washington. *Fishery Bulletin* 88:697–711.
- Peterson, W. T., C. A. Morgan, J. P. Fisher, and E. Casillas. 2010. Ocean distribution and habitat associations of yearling coho (*Oncorhynchus kisutch*) and Chinook (*O. tshawytscha*) salmon in the northern California Current. *Fisheries Oceanography* 19:508–525.
- Pickering, H., and D. Whitmarsh. 1997. Artificial reefs and fisheries exploitation: A review of the ‘attraction versus production’ debate, the influence of design and its significance for policy. *Fisheries Research* 31:39–59.
- Polagye B., and M. Previsic. 2010. Deployment Effects of Marine Renewable Energy Technologies—Tidal Energy Scenarios. RE Vision DE-002. U.S. Department of Energy, Advanced Water Power Program, Washington, D. C.
- Pondella, D. J., II, L. G. Allen, M. T. Craig, and B. Gintert. 2006. Evaluation of eelgrass mitigation and fishery enhancement structures in San Diego Bay, California. *Bulletin of Marine Science* 78:115–131.
- Pool, S. S., D. C. Reese, and R. D. Brodeur. 2012. Defining marine habitat of juvenile Chinook salmon, *Oncorhynchus tshawytscha*, and coho salmon, *O. kisutch*, in the northern California Current system. *Environmental Biology of Fishes* 93:233–243.
- Previsic M. 2010. Deployment Effects of Marine Renewable Energy Technologies—Wave Energy Scenarios. RE Vision DE-001. U.S. Department of Energy, Advanced Water Power Program, Washington D. C.
- Quinn, T. P., and K. W. Myers. 2004. Anadromy and the marine migrations of Pacific salmon and trout: Rounsefell revisited. *Reviews in Fish Biology and Fisheries* 14:421–442.
- Ratte, L. D., and E. O. Salo. 1985. Under-pier Ecology of Juvenile Pacific Salmon (*Oncorhynchus* spp.) in Commencement Bay, Washington. FRI-UW-8508. Report to the Port of Tacoma.
- Reed, D. C., S. C. Schroeter, D. Huang, T. W. Anderson, and R. F. Ambrose. 2006. Quantitative assessment of different artificial reef designs in mitigating losses to kelp forest fishes. *Bulletin of Marine Science* 78:133–150.

- Reedsport OPT Wave Park. 2010. Reedsport OPT Wave Park Settlement Agreement. 28 July, 2010. FERC No. 12713. Prepared in cooperation with U.S. Fish and Wildlife Service, National Marine Fisheries Service, U.S. Forest Service, Oregon Department of State Lands, Oregon Department of Environmental Quality, Oregon Department of Land Conservation and Development, Oregon Water Resources Department, Oregon Department of Fish and Wildlife, Oregon Parks and Recreation Department, Oregon Department of Energy, Oregon State Marine Board, Oregon Shores Conservation Coalition, Surfrider Foundation, and Southern Oregon Ocean Resource Coalition.
- Reese, D. C., and R. D. Brodeur. 2006. Identifying and characterizing biological hotspots in the northern California Current. *Deep-Sea Research II* 53:291–314.
- Relini, G., M. Relini, and M. Montanari. 2000. An offshore buoy as a small artificial island and a fish-aggregating device (FAD) in the Mediterranean. *Hydrobiologia* 440:65–80.
- Rensel, J. E., and J. R. M. Forster. 2007. Beneficial Environmental Effects of Marine Finfish Mariculture. Final Report. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, National Sea Grant College Program, Office of Oceanic and Atmospheric Research, Washington, D.C.
- Reubens, J. T., S. Degraer, and M. Vincx. 2014. The ecology of benthopelagic fishes at offshore wind farms: A synthesis of 4 years of research. *Hydrobiologia* 727:121–136.
- Riera, R., P. Sanchez-Jerez, M. Rodriguez, and O. Monterroso. 2014. Artificial marine habitats favour a single fish species on a long-term scale: The dominance of *Boops boops* around off-shore fish cages. *Scientia Marina* 78(4):505–510.
- Rountree, R. A. 1989. Association of fishes with fish aggregation devices: Effects of structure size on fish abundance. *Bulletin of Marine Science* 44:960–972.
- Rountree, R. A. 1990. Community structure of fishes attracted to shallow water fish aggregation devices off South Carolina, U.S.A. *Environmental Biology of Fishes* 29:241–262.
- [Royal Haskoning] Royal Haskoning Enhancing Society. 2011. SeaGen Environmental Monitoring Programme—Final Report. 16 January. 9S8562/R/303719/Edin. Prepared for Marine Current Turbines. Haskoning UK, Ltd., Industry & Energy, Edinburgh, United Kingdom.
- Russell, D. J. F., S. M. J. M. Brasseur, D. Thompson, G. D. Hastie, V. M. Janik, G. Aarts, B. T. McClintock, J. Matthiopoulos, S. E. W. Moss, and B. McConnell. 2014. Marine mammals trace anthropogenic structures at sea. *Current Biology* 24:R638–R639.
- Sanchez-Jerez, P., D. Fernandez-Jover, I. Uglem, P. Arechavala-Lopez, T. Dempster, J. T. Bayle-Sempere, C. Valle Perez, D. Izquierdo, P.-A. Bjorn, and R. Nilsen. 2011. Coastal fish farms as fish aggregation devices (FADs). Pages 187–208 in S. A. Bortone, F. Pereira Brandini, G. Fabi, and S. Otake (Editors), *Artificial Reefs in Fisheries Management*. CRC Press, Boca Raton, Florida.
- Santora, J. A., J. C. Field, I. D. Schroeder, K. M. Sakuma, B. K. Wells, and W. J. Sydeman. 2012. Spatial ecology of krill, micronekton and top predators in the central California Current: Implications for defining ecologically important areas. *Progress in Oceanography* 106:154–174.
- Schlining, K., S. von Thun, L. Kuhn, B. Schlining, L. Lundsten, N. Jacobsen Stout, L. Chaney, and J. Connor. 2013. Debris in the deep: Using a 22-year video annotation database to survey marine litter in Monterey Canyon, central California, USA. *Deep-Sea Research I* 79:96–105.

- Seki, M. P. 1983. Summary of Pertinent Information on the Attractive Effects of Artificial Structures in Tropical and Subtropical Waters. Administrative Report H-83-12. National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Southwest Fisheries Center, Honolulu Laboratory, Honolulu, Hawai'i.
- Seki, M. P., J. J. Polovina, R. E. Brainard, R. R. Bidigare, C. L. Leonard, and D. G. Foley. 2001. Biological enhancement at cyclonic eddies tracked with GOES thermal imagery in Hawaiian waters. *Geophysical Research Letters* 28:1583–1586.
- Shaffer, J. A. 2002. Nearshore Habitat Mapping of the Central and Western Strait of Juan de Fuca II. Preferential Use of Nearshore Kelp Habitats by Juvenile Salmon and Forage Fish. Washington Department of Fish and Wildlife, Olympia, Washington, and Clallam County Marine Resources Committee, Port Angeles, Washington.
- Shaffer, J. A., D. C. Doty, R. M. Buckley, and J. E. West. 1995. Crustacean community composition and trophic use of the drift vegetation habitat by juvenile splitnose rockfish *Sebastes diploproa*. *Marine Ecology Progress Series* 123:13–21.
- Shipp, R. L., and S. A. Bortone. 2009. A perspective of the importance of artificial habitat on the management of red snapper in the Gulf of Mexico. *Reviews in Fisheries Science* 17:41–47.
- Simenstad, C. A., B. J. Nightingale, R. M. Thom, and D. K. Shreffler. 1999. Impacts of Ferry Terminals on Juvenile Salmon Migrating along Puget Sound Shorelines Phase I: Synthesis of State of Knowledge. WA-RD 472.1. Washington State Transportation Commission, Olympia, Washington.
- Solonsky, A. C. 1985. Fish colonization and the effect of fishing activities on two artificial reefs in Monterey Bay, California. *Bulletin of Marine Science* 37:336–347.
- Stenberg, C., G. E. Dinesen, M. van Deurs, C. W. Berg, H. Mosegaard, and S. Leonhard. Offshore wind farms and their impact on fish abundance and community structure. Paper presented at the Theme Session O—How Does Renewable Energy Production Affect Aquatic Life? ICES CM 2012/O:09.
- Stephens, J. S., Jr., P. A. Morris, K. Zerba, and M. Love. 1984. Factors affecting fish diversity on a temperate reef: The fish assemblage of Palos Verdes Point, 1974–1981. *Environmental Biology of Fishes* 2:259–275.
- Stephens, J. S., Jr., P. A. Morris, D. J. Pondella, T. A. Koonce, and G. A. Jordan. 1994. Overview of the dynamics of an urban artificial reef fish assemblage at King Harbor, California, USA, 1974–1991: A recruitment driven system. *Bulletin of Marine Science* 55:1224–1239.
- Stephens, J. S., Jr., R. J. Larson, and D. J. Pondella. 2006. Rocky reefs and kelp beds. Pages 227–252 in L. G. Allen, D. J. Pondella II, and M. H. Horn (Editors), *The Ecology of Marine Fishes, California and Adjacent Waters*. University of California Press, Berkeley and Los Angeles, California.
- Taylor, J. R., A. P. DeVogelaere, E. J. Burton, O. Frey, L. Lundsten, L. A. Kuhnz, P. J. Whaling, C. Lovera, K. R. Buck, and J. P. Barry. 2014. Deep-sea faunal communities associated with a lost intermodal shipping container in the Monterey Bay National Marine Sanctuary, CA. *Marine Pollution Bulletin*: 83:92–106.
- Thorpe, S. A. 2012. On the biological connectivity of oil and gas platforms in the North Sea. *Marine Pollution Bulletin* 64:2770–2781.
- Tissot, B. N., M. A. Hixon, and D. L. Stein. 2007. Habitat-based submersible assessment of macro-invertebrate and groundfish assemblages at Heceta Bank, Oregon, from 1988 to 1990. *Journal of Experimental Marine Biology and Ecology* 352:50–64.

- Tissot, B. N., W. W. Wakefield, M. A. Hixon, and J. E. R. Clemons. 2008. Twenty years of fish-habitat studies on Heceta Bank, Oregon. Pages 203–217 in J. R. Reynolds and H. G. Greene (Editors), *Marine Habitat Mapping Technology for Alaska*. University of Fairbanks, Alaska, Alaska Sea Grant College Program, Fairbanks, Alaska.
- Toft, J. D., J. R. Cordell, C. A. Simenstad, and L. A. Stamatou. 2007. Fish distribution, abundance, and behavior along city shoreline types in Puget Sound. *North American Journal of Fisheries Management* 27:465–480.
- Tucker, S., M. Trudel, D. W. Welch, J. R. Candy, J. F. T. Morris, M. E. Thiess, C. Wallace, and T. D. Beacham. 2011. Life history and seasonal stock-specific ocean migration of juvenile Chinook salmon. *Transactions of the American Fisheries Society* 140:1101–1119.
- Tuya, F., P. Sanchez-Jerez, T. Dempster, A. Boyra, and R. J. Haroun. 2006. Changes in demersal wild fish aggregations beneath a sea-cage fish farm after the cessation of farming. *Journal of Fish Biology* 69:682–697.
- [USEPA] U.S. Environmental Protection Agency. 1975. A Survey of the Farallon Islands 500-Fathom Radioactive Waste Disposal Site. Technical Note ORP-75-1. Office of Radiation Programs and Office of Water Program Operations, Washington, D.C.
- Viehman, H. A., and G. B. Zydlewski. 2014. Fish interactions with a commercial-scale tidal energy device in the natural environment. *Estuaries and Coasts*: DOI 10.1007/s12237-014-9767-8.
- Walsh, W. J. 1985. Reef fish community dynamics on small artificial reefs: The influence of isolation, habitat structure, and biogeography. *Bulletin of Marine Science* 36:357–376.
- Wang, S. S. 2005. Groundfish Habitat Associations from Video Survey with a Submersible off the Washington State Coast. Master's Thesis. University of Washington, Seattle, Washington.
- Wang, Z., Y. Chen, S. Zhang, K. Wang, J. Zhao, and Q. Xu. 2015. A comparative study of fish assemblages near aquaculture, artificial and natural habitats. *Journal of Ocean University of China*, Science Press, and Springer-Verlag Berlin Heidelberg: in press. DOI 10.1007/s11802-015-2455-x.
- Ware, D. M., and R. E. Thomson. 2005. Bottom-up ecosystem trophic dynamics determine fish production in the northeast Pacific. *Science* 308:1280–1284.
- West, J. E., R. M. Buckley, and D. C. Doty. 1994. Ecology and habitat use of juvenile rockfishes (*Sebastes* spp.) associated with artificial reefs in Puget Sound, Washington. *Bulletin of Marine Science* 55:344–350.
- Wilhelmsson, D., and O. Langhamer. 2014. The influence of fisheries exclusion and addition of hard substrate on fish and crustaceans. Pages 49–60 in M. A. Shields and A. I. L. Payne (Editors), *Marine Renewable Energy Technology and Environmental Interactions*. Springer, New York, New York.
- Wilhelmsson, D., T. Malm, and M. C. Ohman. 2006. The influence of offshore windpower on demersal fish. *ICES Journal of Marine Science* 63:775–784.
- Wilson, C. A., A. Pierce, and M. W. Miller. 2003. Rigs and Reefs: A Comparison of the Fish Communities at Two Artificial Reefs, a Production Platform, and a Natural Reef in the Northern Gulf of Mexico. OCS Study MMS 2003-009. Coastal Fisheries Institute, School of the Coast and Environment, Louisiana State University, Baton Rouge, Louisiana, and U.S. Department of the Interior, Minerals Management Service, Gulf of Mexico OCS Region, New Orleans, Louisiana.

- Witt, M. J., E. V. Sheehan, S. Bearhop, A. C. Broderick, D. C. Conley, S. P. Cotterell, E. Crow, W. J. Grecian, C. Halsband, D. J. Hodgson, et al. 2012. Assessing wave energy effects on biodiversity: The Wave Hub experience. *Philosophical Transactions of the Royal Society (A)*370:502–529.
- Yoklavich, M. M., H. G. Greene, G. M. Cailliet, D. E. Sullivan, R. N. Lea, and M. S. Love. 2000. Habitat associations of deep-water rockfishes in a submarine canyon: An example of a natural refuge. *Fishery Bulletin* 98:625–641.
- Yoklavich, M., G. Cailliet, R. N. Lea, H. G. Greene, R. Starr, J. de Marignac, and J. Field. 2002. Deepwater habitat and fish resources associated with the Big Creek Marine Ecological Reserve. *California Cooperative Oceanic Fisheries Investigations Reports* 43:120–140.
- Zárate-Villafranco, A., and S. Ortega-García. 2000. Spatial and seasonal distribution of the tuna catch on floating objects in the eastern Pacific Ocean during 1992–1993. *Marine and Freshwater Behaviour and Physiology* 34(1):53–72.