Understanding the impact of changing ocean conditions on Dungeness crab (*Cancer magister*) megalopae recruitment and the commercial crab fishing industry through the coupled human-natural systems lens.

Faculty Mentors:

* Kathleen O’Malley ([kathleen.omalley@oregonstate.edu](mailto:kathleen.omalley@oregonstate.edu)) – Big Data Dimension
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* Francis Chan ([chanfr@science.oregonstate.edu](mailto:chanfr@science.oregonstate.edu)) – Natural Science Dimension
* Su Sponaugle ([su.sponaugle@oregonstate.edu](mailto:su.sponaugle@oregonstate.edu)) – Big Data/Natural Science Dimensions

Prospective Students:

* Elizabeth Lee, M.S., Fisheries and Wildlife, Genomics (Genomics)
* Astrea Strawn, M.S., Marine Resource Management (Social Science)
* Caitlin Magel, Ph.D., Integrative Biology (Ecology)
* Kelsey Swieca, Ph.D., Integrative Biology (Big Data, Natural Science)

Background:

Over the past six decades, there have been large fluctuations in commercial landings of Dungeness crab off the west coast of the United States. Because this is one of the most economically valuable fisheries in the region, gaps in our understanding of the causes and consequences of volatility and uncertainty in catch represent an exemplar challenge for coupled human-natural system research along our coast. The impacts of recent domoic acid-induced closures on coastal communities and the emerging understanding of the fishery threats posed by the progression of ocean acidification (Marshall et al. 2017) have further highlighted the need for new science to inform management under increasingly uncertain future ocean changes.

While the challenges are great, the dynamics of the Dungeness crab fishery and the populations and ecosystems that support it also represent a valuable opportunity for engaging students in the study of complex systems and training in risk and uncertainty quantification. Dungeness crabs have a complex, bipartite life-cycle where females mate in the spring and store sperm until eggs are fertilized and released in the fall. Egg development takes 3-4 mo. with hatching occurring near the coast in the winter (Strathmann 1987). The larval period, which consists of five zoeal stages and a final megalopal stage, ranges from 3-4 mo. As larvae develop, they are found progressively farther from shore (reviewed in Rasmuson 2013). By the megalopal stage, larvae are typically found in seaward of the continental shelf in the California Current, and often >100 km from shore. To survive to the adult stage, megalopae must migrate from offshore back to the coast to settle in shallow water in nursery habitats (Wild and Tasto 1983). In Oregon, megalopae begin returning to shore, on average, in April and settlement can last into the fall, suggesting that, in some years, southward currents transport larvae that hatched in Canadian waters (Shanks 2013). Recruitment to the fishery occurs typically in year 4 when winter ocean conditions further influence the profitability and safety of the commercial fleet.

The dynamics of the fishery can thus reflect the influences of biological, environmental, and social variability that are linked over multiple temporal and spatial scales. Understanding this and other systems of cross-scale interplay between ecological and social variability will require students who are trained to engage across multiple disciplines, and employ multiple modes of inquiry and problem-solving. We envision convening a team of students who can bring diverse knowledge and perspectives to bear on questions of risk and uncertainty in the crab fishery. Students of this candidate team have research foci in:

1. Intra- and inter-annual genomic diversity of megalopae recruits
2. The role risk and uncertainty play in decision making regarding safety, business planning, and marketing
3. Comparative dynamics of oxygen and carbonate chemistry across coastal ecosystems and ecosystem service functions of seagrass habitats
4. High resolution vertical and horizontal distributions of crab zoea and megalope in association with oceanographic variables

This team will further have access to extensive datasets including those on population genetics from over 5,000 crab individuals; high resolution continuous optical surveys of crab pelagic stages and associated zooplankton community distribution across continental shelf waters; oxygen, carbonate chemistry, and seagrass habitat measurements for Pacific NW estuaries; and oral history records from the commercial crab fishery. Although the ultimate direction of the team project will be defined by the students, the diverse knowledge base available to them can enable research that: 1) compares and contrasts the treatment of variability and uncertainty from respective fields, 2) explores approaches for cross-scale and cross-discipline integration of risk and uncertainty, and 3) evaluates the marginal value of new information in system science.

Desired Area(s) of Expertise for Additional Prospective Students:

Computer Science, Statistics, Geospatial science

**References**

Marshall KN, Kaplan IC, Hodgson EE, Hermann A, Busch DS, McElhany P, Essington

TE, Harvey CJ and Fulton EA, (2017). Risks of ocean acidification in the California

Current food web and fisheries: ecosystem model projections. Global Change

Biology. doi: 10.1111/gcb.13594

Rasmuson L (2013) The biology, ecology and fishery of the Dungeness crab, *Cancer*

*magister*. Advances in Marine Biology 65: 95-148.

Shanks AL (2013) Atmospheric forcing drives recruitment variation in the Dungeness crab

(*Cancer magister*), revisited. Fisheries Oceanography 22: 263-272.

Strathmann MF (1987) Reproduction and Development of Marine Invertebrates of the

Northern Pacific Coast. University of Washington, Seattle.

Wild PW, Tasto RN (1983) Life history, environment, and mariculture studies of Dungeness

crab with emphasis on the central California fishery resource. California Department

of Fish and Game, Fish Bulletin 172: 1-352.