

Ecological Carrying Capacity for South Puget Sound Ecopath with Ecosim

Ecological carrying capacity is the maximum extractive pressure that does not cause unacceptable change in the ecosystem. The Ecopath with Ecosim (EwE) modeling framework provides a way to visualize the biomass of a suite of species groups over time, using mortality rates or 'production' of species groups, food intake and diet composition.

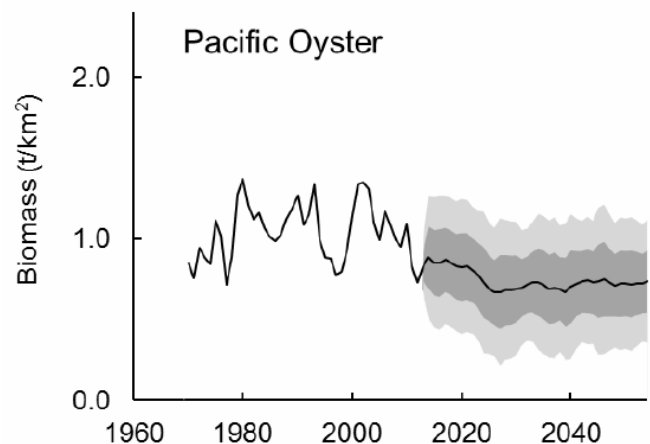
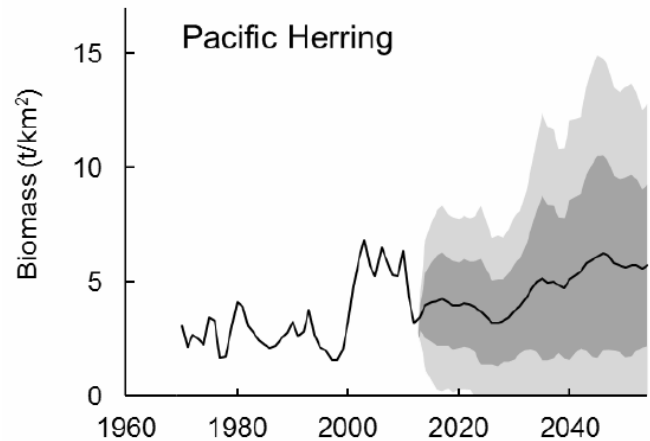
Our EwE model simulates known historic changes for 1970-2012, and forecasts potential changes through 2054 for 12 key species of marine mammals, marine birds, salmon, game fish and bivalves. We selected 12 focal species groups to analyze in detail. Geoduck clam, Pacific oyster and Olympia oyster, adult Chinook salmon, adult Coho salmon, adult Chum salmon, rockfish, Pacific herring, sea lions, harbor seals, Great Blue heron, and marine birds were selected because we were interested in exploring the effect of population changes, and/or their populations would have consequences on fisheries or managed species.

Because assessment of regional carrying capacity could inform current and future management decisions, our EwE was performed in conjunction with a diverse stakeholder working group. Representatives included Puget Sound county planners, shellfish growers, and staff from state natural resource agencies, tribes and conservation non-governmental organizations. Stakeholder inclusion facilitated the best population/biomass data to be gathered, and ensured relevant scenarios were modeled.

The model we built is focused on several lower trophic level components of the food web. A key aspect of our approach is the unique application to multi-species shellfish aquaculture and harvest. Simulations forecast potential future ecosystem configurations under a variety of population changes and fishing and aquaculture management policies.

Analyses of the 1970 and 2012 mass balance models suggest that the rapid expansion of shellfish aquaculture would not likely have significantly influenced the biomasses of other species. Therefore

it was not surprising that, in all our scenarios of future marine production, there were few trophic effects on the South Puget Sound ecosystem when maintaining or significantly increasing shellfish aquaculture production.



The graphs above show biomass trajectories for two of our focal species, Pacific herring and Pacific oyster, in one scenario. This scenario simulated responses when the biomass of farmed geoduck is increased 10 times (the 2012 biomass) by 2025, and the annual phytoplankton production is 25% less than it was in 1970-2012. This scenario revealed moderate biomass increases for herring and a slight decrease for Pacific oyster. (Dark gray is one and light gray is two standard deviations from the mean of 100 simulations.) Funding for this work was provided through Washington Sea Grant, pursuant to NOAA award #NA14OAR4170078.

