Climate change and the recovery of Endangered Black Abalone

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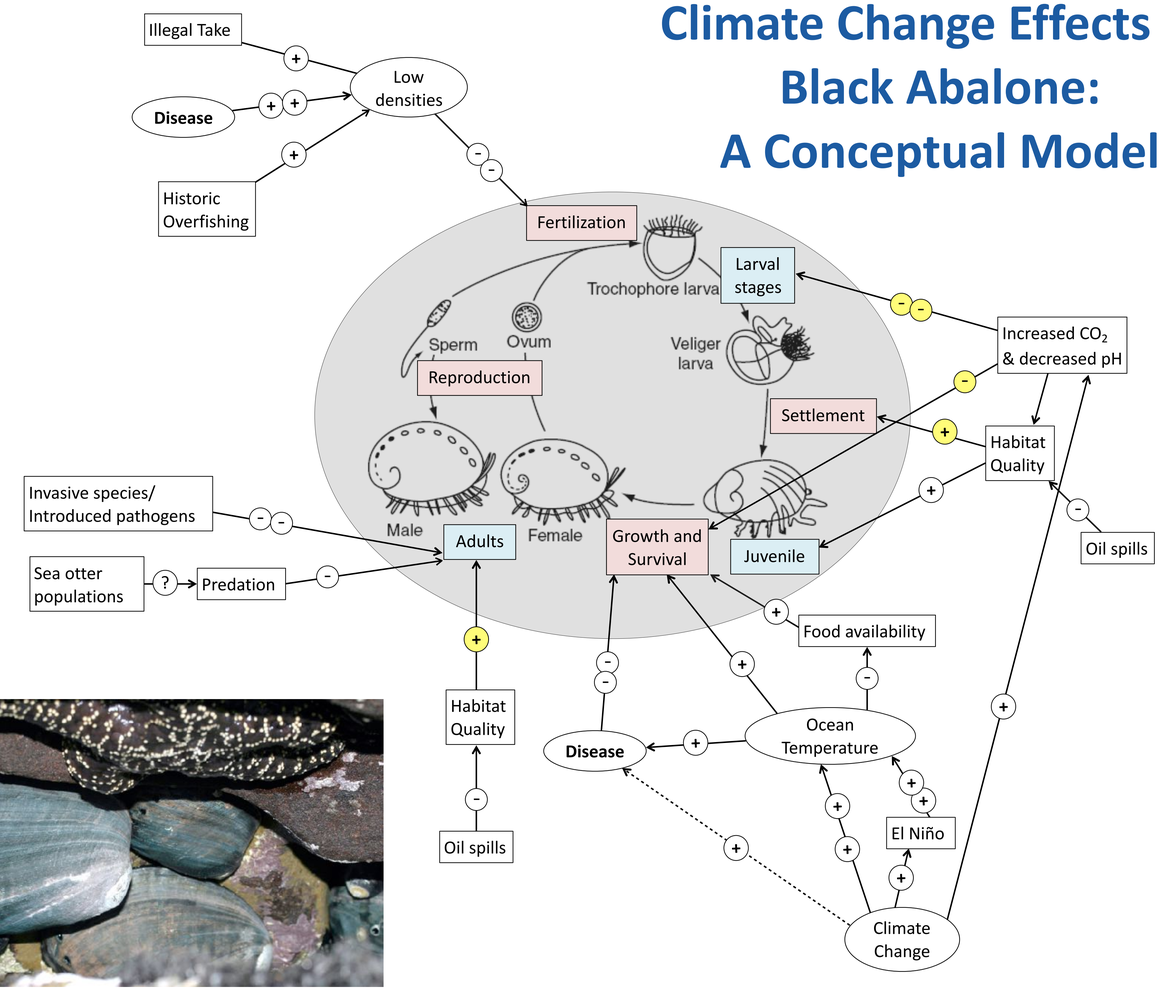
- Black abalone are marine snails that live in intertidal rocky shores along the west coast of the US and Mexico
- They were once extremely abundant and sustained a large fishery
- Overfishing depressed all CA populations of black abalone
- A particularly strong El Niño during 1982-3 brought with it a new disease called withering syndrome (WS)
- WS resulted in significant losses of remaining abalone, and was the largest contributor to listing black abalone as an Endangered Species

Why consider climate change in recovery?

- Recovery plans usually focus on concrete threats, such as disease, overfishing, or habitat degradation
- Climate change can be an indirect threat if it modifies other threats. For example, if a species requires a narrow temperature range, habitats may become scarce as a result of climate change
- Recovery plans are used to manage threats to species, assess proposed projects that may impact a species or its habitat, and bring species back from the brink of extinction
- Without considering climate change, we could miss otherwise predictable shifts in habitat or other conditions threatening an endangered species

We created a conceptual model to visualize the impacts of climate change on black abalone, as well as the synergistic effects of other threats to black abalone.

Climate Change Effects on Black Abalone: A Conceptual Model



A conceptual model of the anthropogenic, climate, and natural threats to black abalone (*Haliotis cracherodii*), differentiated by life stage. Ovals signify large-scale changes, temporally and spatially. Squares signify localized or short-term changes. The direction/nature of an effect is denoted by a plus (increase) or minus (decrease). For example, Climate Change will likely increase the proliferation of diseases, which decrease the growth and survival of black abalone. Unlabeled arrows indicate that the effect can be an increase or decrease, depending on the magnitude or direction of the change in the threat. Yellow directions indicate limited data - this may be because all data is from small samples or on other abalone species. Dotted lines represent indirect effects. For example, Climate Change does not necessarily directly change the number or type of pathogens in the water, but may change an abalone's immune function, and ability to resist disease and disease-related death.

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References: Conceptual model based on McClure, M.M., et al.,(2013) Incorporating Climate Science in Applications of the U.S. Endangered Species Act for Aquatic Species. Conservation Biology, 27: 1222–1233. doi:10.1111/cobi.12166. Threats based on Morash, A. J. and Alter, K. (2015), Effects of environmental and farm stress on abalone physiology: perspectives for abalone aquaculture in the face of global climate change. Reviews in Aquaculture. doi: 10.1111/raq.12097; and based on the Black Abalone Recovery Outline (Sept 2016) http://www.westcoast.fisheries.noaa.gov/publications/protected_species/other/abalone_species/Black%20Abalone%20critical%20habitat/20160922_black_abalone_recovery_outline_final.pdf. Photos from NMFS, right photo Dave Witting.