PROJECT BRIEF:
Maximizing the Value of Offshore Aquaculture Development in the Context of Multiple Ocean Uses

Funded by: California Sea Grant
Project Team: Marine Science Institute and Bren School of Environmental Science, UC Santa Barbara and Biological Sciences Department, Cal Poly

The Challenge

Demand for seafood in the United States and around the world continues to rise, driven by population growth and escalating per capita consumption. As a result, aquaculture is increasingly proposed as a potentially sustainable option to meet this demand. Given intense competition for space on land and in coastal bays and estuaries, many are looking to open water or offshore aquaculture as an innovative solution. Offshore aquaculture represents an opportunity to bring economic development to coastal communities, decrease our reliance on foreign imports and overharvested wild stocks, overcome potential downsides of other types of aquaculture, and ensure that high quality seafood products reach American consumers. However, offshore aquaculture is not without its own challenges, as aquaculture can interact with other ocean uses like wild fisheries and can result in negative environmental impacts such as nutrient enrichment and spread of disease.

The Solution

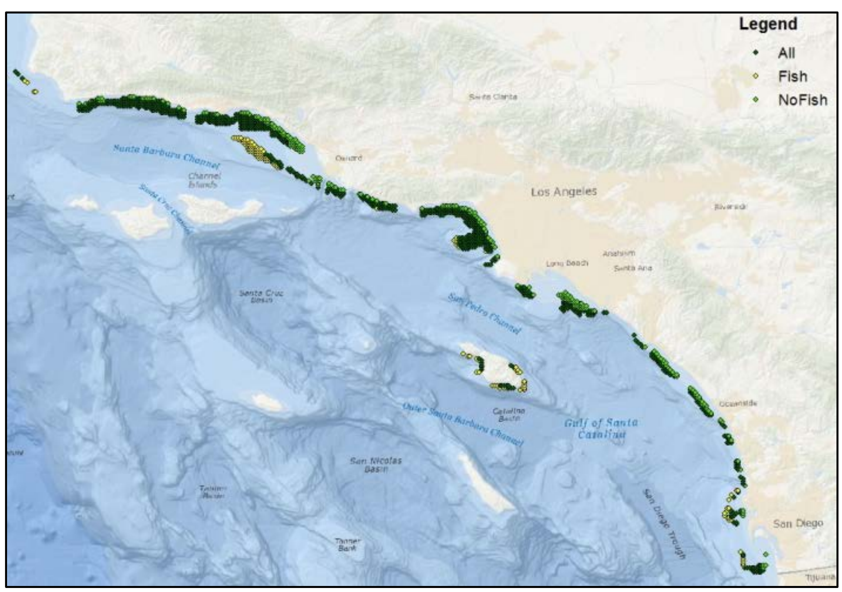
Proactive, scientifically-informed marine spatial planning (MSP) for offshore aquaculture has the potential to minimize undesirable interactions and impacts, while maximizing the benefits provided by increased aquaculture production.

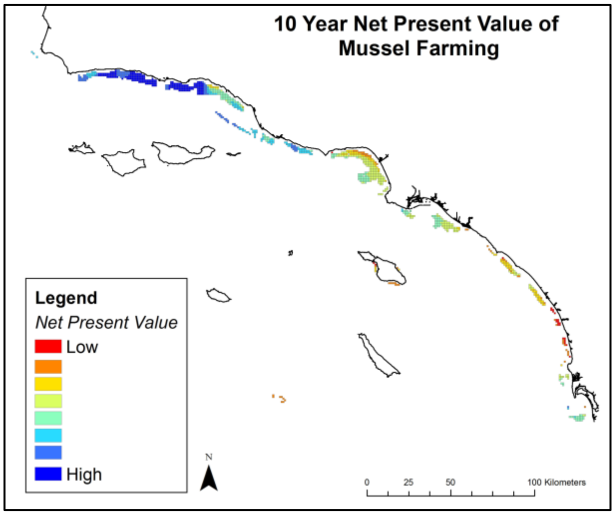
Project Approach

We have developed a new quantitative spatial planning framework that informs offshore aquaculture siting by minimizing the economic and environmental tradeoffs between offshore aquaculture development and other existing and planned marine uses. We applied this framework to a case study of aquaculture development (for finfish, shellfish and seaweed culture) for the Southern California Bight.

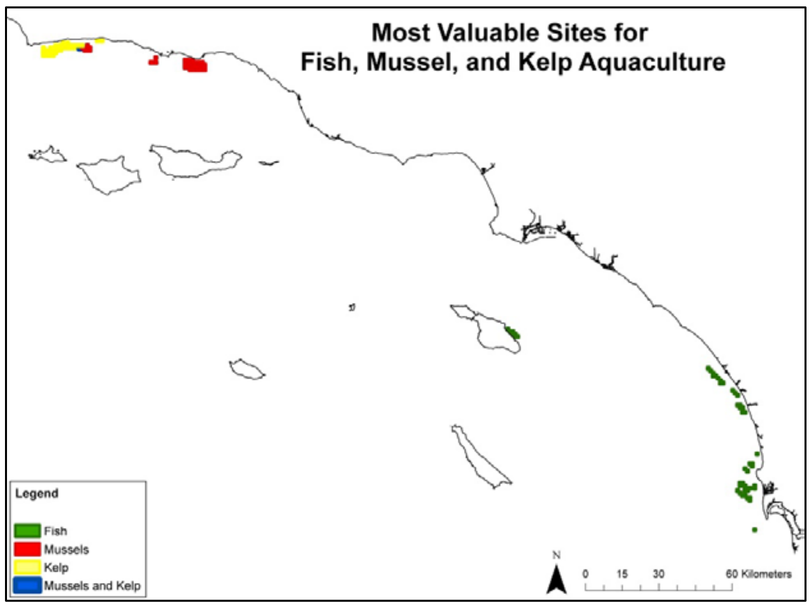
Key Results to Advance Open Ocean Aquaculture Development in California

We began by determining which areas of the Southern California Bight are not suitable for aquaculture development due to environmental factors (such as hard bottom habitat), technological limitations (such as depth), or existing incompatible uses (such as marine protected areas or shipping lanes) and excluded these areas from our study area. This analysis revealed over 1000 locations within the Southern California Bight (at a resolution of 1 km^2) where aquaculture could potentially be developed (figure, right).

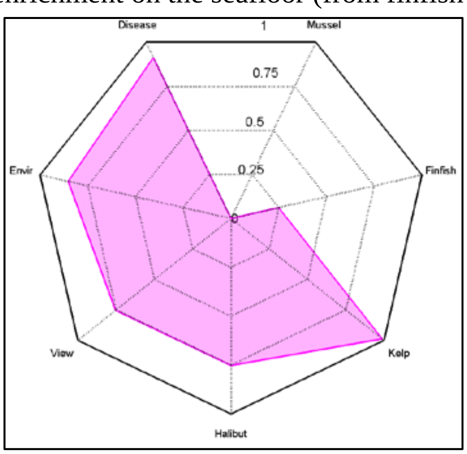




For each of the three aquaculture types (finfish, shellfish, kelp), we have developed production and cost models based on species that could feasibly be grown in southern California. Aquaculture yields (production) will be impacted by environmental conditions that vary over space (e.g. water temperature, currents, productivity, etc.), and economic costs of production will vary based on environmental conditions (e.g., wave height, depth) and geographic location (e.g., distance from port). By putting together a revenue model (based on production and prices) and a cost model, we are able to evaluate the value of each developable cell to the aquaculture industry, represented as a 10 year net present value (figure, left). When examining the most valuable areas for each aquaculture type, we found that the best locations for kelp and mussels were clustered in the north, and the best areas for finfish were clustered in the south (figure, right). However it is important to note that these maps were made based on example species; the most suitable areas could change if different target species are evaluated.



We then examined tradeoffs between these three types of aquaculture and: 1) wild fish populations specifically California halibut, and the associated recreational and commercial fisheries, 2) environmental health, specifically the effects of nutrient enrichment on the seafloor (from finfish aquaculture, 3) viewshed quality given that offshore aquaculture will interrupt the view from coastal locations, and 4) disease risk from aquaculture (both in terms of spread to other farms and to wild populations), focusing on the increased risk resulting from greater connectivity among farms. We then conducted a tradeoff analysis examining the millions of possible permutations of developing these feasible planning areas with the three aquaculture scenarios. For any possible spatial plan, we can examine how that plan performs for the seven objectives (figure, left) and determine where tradeoffs between these objectives can be minimized through spatial planning. Our analysis will identify a range of spatial plans that provide optimal outcomes when planning for aquaculture development in the context of multiple ocean uses.



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