Student Handout: Sustainably managing a Hawaiian nearshore marine resource

"*Mālama i ke kai, a mālama ke kai iā ʻoe*"
(Care for the ocean, and the ocean will care for you)

Introduction to Ecosystem & Stakeholders
Pre-class readings:
Tissot BN (2005) Integral marine ecology: community-based fishery management in Hawaiʻi. World Futures 61: 79-95.
Jokiel PL, KS Rodgers, WJ Walsh, DA Polhemus, TA Wilhelm (2011) Marine resource management in the Hawaiian Archipelago: the traditional Hawaiian system in relation to the western approach. Journal of Marine Biology. doi: 10.1155/2011/151682.

Introduction:
"*Mālama i ke kai, a mālama ke kai iā ʻoe*" (Care for the ocean, and the ocean will care for you)

Coral reef ecosystems are exceptionally valuable. Ecologically coral reefs have high species diversity; economically they support tourism, fisheries, and shoreline protective services; and culturally they have high value for the native Hawaiian and other island communities through community engagement in traditional fishing practices, as a source of extracted resources, and as a component of spiritual practices.

Yet, these ecosystems face many challenges including over fishing, sedimentation, nutrient input, direct harvest of coral, destructive fishing practices, warming water, increased frequency and intensity of bleaching events, increased frequency and intensity of storm events, and ocean acidification.

Within the Hawaiian Department of Land and Natural Resources is the Division of Aquatic Resources. From their website, "The mission of the Division of Aquatic Resources is to work with the people of Hawaiʻi to manage, conserve, and restore the state's unique aquatic resources and ecosystems for present and future generations." More specifically, as part of the Aloha Challenge, https://dashboard.hawaii.gov/aloha-challenge, a goal has been set of sustainably managing 30% of nearshore resources by 2030.

For this case study, you will grapple with what it means to sustainably manage a resource. Students will (1) be introduced to needs of various stakeholders, (2) integrate multiple data streams to characterize a nearshore reef fishery, (3) describe feedbacks between the relevant social and environmental systems, (4) will propose a management plan, and (5) will peer-review the feasibility of policy proposals. While you are encouraged to consider the full nearshore marine ecosystem of Hawaiʻi, this case study is focused on *Acanthurus triostegus*, a small surgeonfish commonly referred to as the convict tang by visitors to the islands or as manini by people more familiar with local culture. As part of this case study, you will study the socio-environmental system of manini along the windward coast of Oʻahu to develop key skills that can be applied to various other socio-environmental systems.

Class Discussion on Sustainable Management:

- What does it mean to sustainably manage a fishery?
- What are the ecological dynamics?
    - for a singular species
    - for an ecosystem
- What are the social dynamics?
- Who are all the stakeholders?
    - consider the full capture to consumption pathway for a reef fish

Activity 1a:
Working in groups of two, construct a concept map of nearshore fishery system dynamics for manini along the windward coastline of O‘ahu. Concept maps need to include at least four social and four ecological elements.

Activity 1b:
Add directionally explicit connections between elements on your concept map. Pair with another group and explain your connections to each other.

Integrating Multiple Data Streams
Pre-class readings:

McCoy KS, ID Williams, AM Friedlander, H Ma, L Teneva, JN Kittinger (2018) Estimating nearshore coral reef-associated fisheries production from the main Hawaiian Islands. PLoS ONE 13(4): e0195840. https://doi.org/10.1371/journal.pone.0195840.

Williamson DH, DM Ceccarelli, RD Evans, GP Jones, GR Russ (2014) Habitat dynamics, marine reserve status, and the decline and recovery of coral reef fish communities. Ecology and Evolution 4(4): 337-354.

We are currently at a time when we can use information from the natural sciences to reveal the spatial and temporal dynamics of a fish from spawning through larval stages to juvenile and adult life stages. These data can be paired with information from fisheries and social sciences to reveal the spatial and temporal dynamics of the capture and sharing of food resources. When considered in the context of the socio-environmental system in which the fishery occurs, this suite of data enables a holistic understanding of the system to guide effective management strategies. In this part of the case study, you will integrate information across multiple data streams to characterize a reef fish sustenance fishery (focused on manini along the windward coast of O‘ahu). Discuss with a neighbor what types of data would you want to characterize the dynamics of, and ultimately to suggest management strategies for this socio-environmental system.

Activity 2a:
Working in groups of 2-4, find, obtain, and review relevant datasets. Keep a clear record of each finding that includes the general type of data, the source location / data provider, and key takeaways from that dataset.

Activity 2b:
Create storyboards of your expected connections between these datasets. Identify specific questions you have for connecting the datasets and predict patterns and relationships among datasets.
Select two data sources that are of most interest to your group and use these to characterize the nearshore fishery system. Add in a few additional data sources and continue to update your characterization of the system.
Pair with another group and share your characterizations. Discuss similarities and differences in your understandings of the system. Work together to blend your understandings and re-characterize the system.

Activity 2c:
Discuss the spatial and temporal extent of each dataset. How do these vary across the datasets? How might this impact the ability to integrate these data streams? Is there a feasible option to make the context of the data streams more consistent?

Activity 2d:
Identify at 1-3 social and 1-3 environmental datasets that your team was not able to find and that would provide useful insights into the system, e.g., create a data wish list.
Create a plan for how you could feasibly access and/or collect these data.

Activity 2e:
Working with your original partner, update your system dynamics concept map and prepare a 1-page memo explaining the cause, directionality, and strength of all linkages.

Adaptive Management Plan
Pre-class readings:
Maui Coral Reef Recovery Team (2015) Ola nā Papa i Mālama ‘ia: A practical plan for the technical and cultural restoration of Maui’s coral reefs. Version 2.0. Maui Nui Marine Resource Council, Kīhei, Maui. https://www.mauireefs.org/
Ke Kukulu Ahu: Aha Moku Advisory Committee Strategic Plan (2013) http://dlnr.hawaii.gov/ahamoku/files/2013/09/Ke-Kukl-Ahu-Strat-Plan-Template-DLNR.docx

Often, policy makers do not have all the data they desire; yet they need to develop policy strategies. Effective management strategies are reasonable given the ecological parameters of the

system, consider the values and needs of various stakeholders, have feasible enforcement strategies, include a plan to monitor key elements of the socio-environmental system, and are able to respond to changes in the socio-environmental system.

Activity 3a:
Working in groups of 2-4, outline the key elements you would want to include in your proposed management plan. Develop these ideas and ensure that your plan incorporates the core components of an effective management plan. Prepare 1-page white memo depicting the details of your group's proposed adaptive management policy. This should include regulations, enforcement, a monitoring plan, a means of responding to shifting dynamics, and a measurement of success.

Activity 3b:
Trade your policy plans with another group. Review the feasibility the other team's policy proposal. Add comments to their proposal noting how feasible their plan is given ecological parameters, stakeholder support, and enforcement capacity. Include evaluation of the ability of the proposed plan to recognize shifts in the system (effective monitoring), to be adjusted given shifts in the system, and to evaluate success of the management strategies. Add initials of each member of your group to the proposal you are reviewing to the document your thoughtful participation in the peer-review process (the thoroughness of your comments will be included your overall assessment).
Form a merged group with the group that you have peer-reviewed the plan for. Taking five minutes to focus on each team's proposal, share your overall feedback and present a few specific recommendations to the other team.
Modify your team's proposed management policy to incorporate the feedback of your classmates and any additional components you would like to add. As the conclusion of this case study, you will hand in your original policy plan with your peer's feedback, a final 1-3 page policy proposal, and a final systems dynamics concept map.