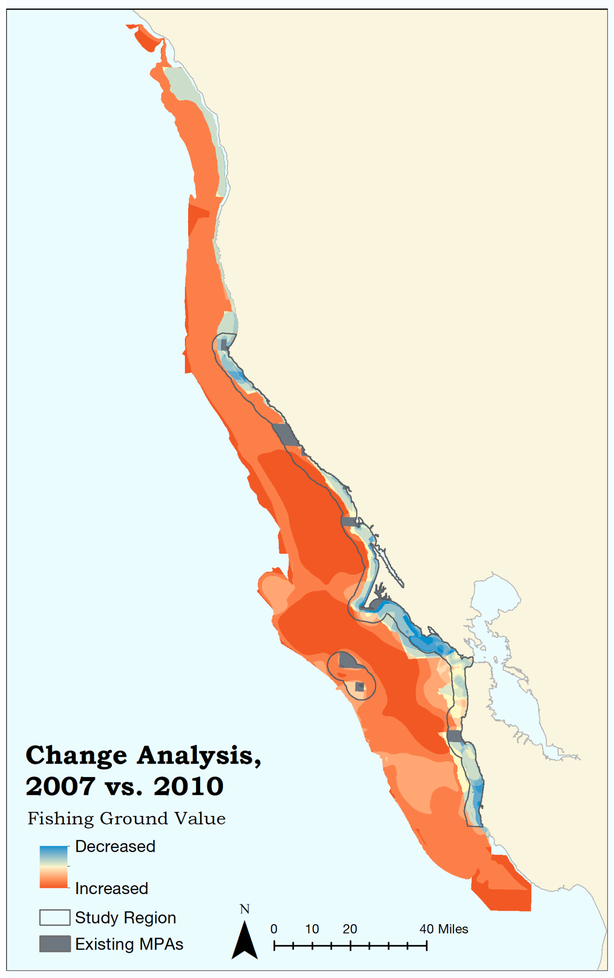
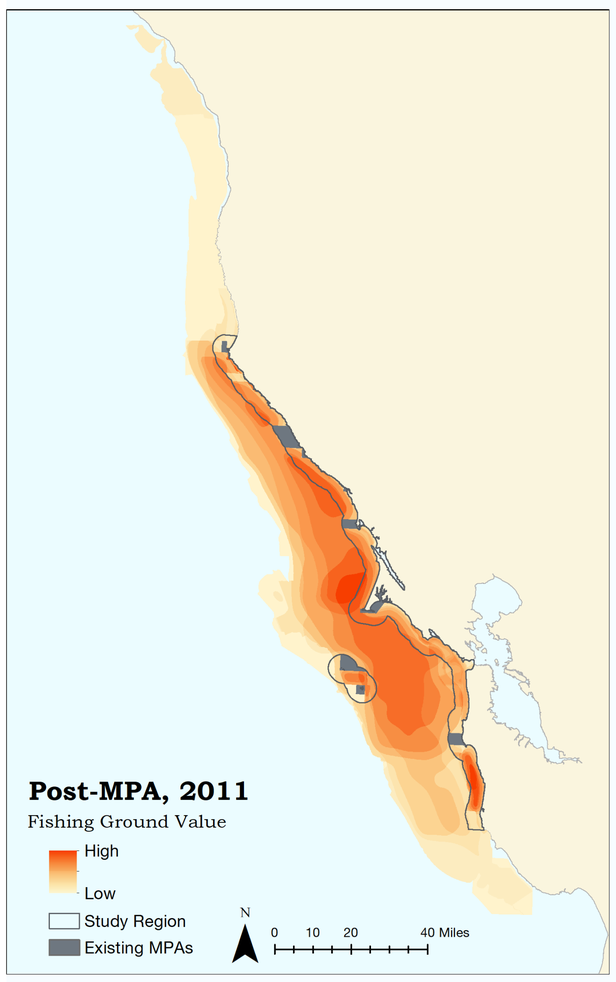
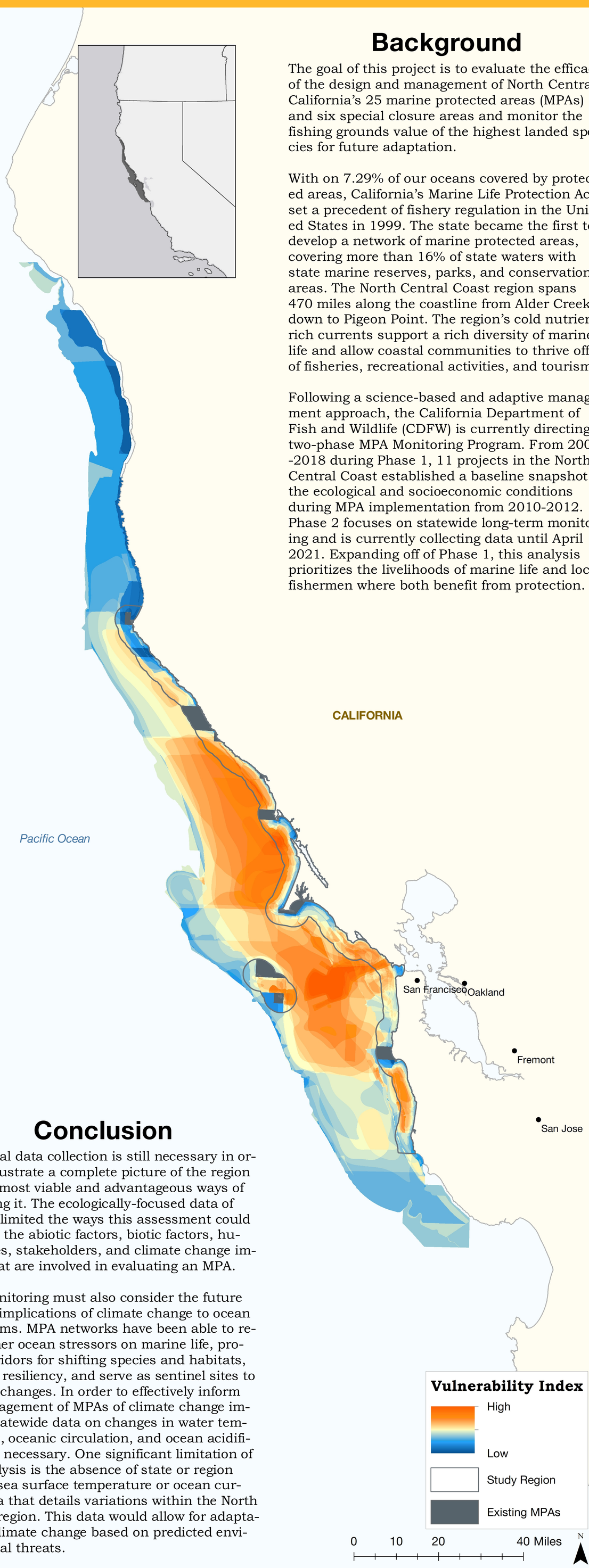
Monitoring California's Marine Protected Area Network:

A Vulnerability Analysis of North Central Coast Fisheries

Commercial Fisheries







Background

The goal of this project is to evaluate the efficacy of the design and management of North Central California's 25 marine protected areas (MPAs) and six special closure areas and monitor the fishing grounds value of the highest landed species for future adaptation.

With on 7.29% of our oceans covered by protected areas, California's Marine Life Protection Act set a precedent of fishery regulation in the United States in 1999. The state became the first to develop a network of marine protected areas, covering more than 16% of state waters with state marine reserves, parks, and conservation areas. The North Central Coast region spans 470 miles along the coastline from Alder Creek down to Pigeon Point. The region's cold nutrient-rich currents support a rich diversity of marine life and allow coastal communities to thrive off of fisheries, recreational activities, and tourism.

Following a science-based and adaptive management approach, the California Department of Fish and Wildlife (CDFW) is currently directing a two-phase MPA Monitoring Program. From 2007 -2018 during Phase 1, 11 projects in the North Central Coast established a baseline snapshot of the ecological and socioeconomic conditions during MPA implementation from 2010-2012. Phase 2 focuses on statewide long-term monitoring and is currently collecting data until April 2021. Expanding off of Phase 1, this analysis prioritizes the livelihoods of marine life and local fishermen where both benefit from protection.

Methods

A Raster Calculator was used to determine the areas with the highest vulnerability to overfishing based off of the value that fishermen place on various fishing grounds of five of the most landed species.

To determine vulnerability, three factors were quantified. Using the relative values that local fishermen put on Dungeness crab, halibut, salmon, sea urchin, and rockfish fishing grounds, each raster file was reclassified in order to create three variables. For commercial fisheries, two variables were used: the difference in relative fishing ground value between pre and post-MPA (2007 vs. 2010) and the relative fishing ground values post-MPA (2011). For the commercial passenger fishing vessel (CPFV) recreational fisheries, one variable was used: the relative fishing ground values post-MPA (2010). Since the commercial fishery change analysis subtracted the newer values from the old, the change analysis variable was subtracted in the equation to accurately account for the negative values that indicated an increase in fishing ground value. The equation put into the Raster Calculator is as follows:

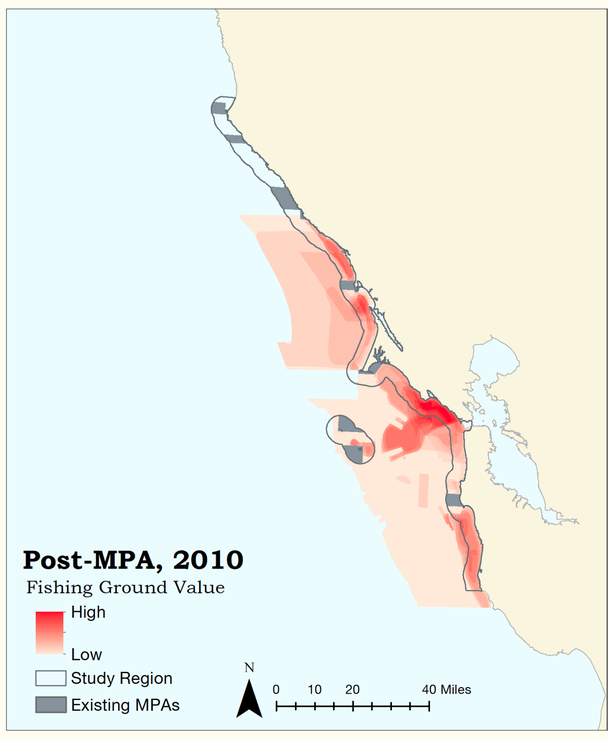
(Commercial_PostMPA) + (CPFV_PostMPA) - (Commercial_ChangeAnalysis)

The data for all three variables was retrieved from the CDFW through interviews conducted with local fishermen in the North Central Coast. Fishermen were asked to map their fishing grounds and determine the relative importance of each fishing ground by allocating 100 pennies across the grounds. Spatial data collected from these interviews was then combined through an aggregation process that weighted these values with the ex-vessel revenue from the fishery during that year.

Each variable contains five different raster datasets of the fishing ground values of five of the most commonly fished species in the region. These five datasets were reclassified, weighted, and added together in the Raster Calculator. These weights reflect the average pounds landed of each species. In order to generate the three vulnerability variables, these five species variables were added up in the Raster Calculator with the following weights:

(Dungeness_Crab * .3) + (Rockfish * .3) + (Salmon * .2) + (Halibut * .15) + (Sea_Urchin * .05)

Commercial Passenger Fishing Vessel (CPFV) Fisheries



Results

Initial evaluation of the final vulnerability map indicates an overwhelming area of high vulnerability that spans much of the North Central coastline. Looking closer within the outlined study region that hugs the coast, a majority of this sliver is made up of areas that are valued highly and moderately by fishermen as indicated by darker orange and yellow areas. These are the areas where fish populations are vulnerable to overfishing, and there is an opportunity for regulation through expansions of existing MPAs or new protected areas. While the orange areas valued highly by fishermen outside the study region may also be prone to overfishing, they also may indicate overspill. As MPAs provide the protection to revitalize fish populations, this abundance can have a ripple effect and allow fishermen to benefit from highly valued fishing grounds just outside the protected areas.

Additionally, this analysis indicates a certain level of effectiveness that MPAs have had in discouraging fisheries from exercising consumptive behaviors when they are deemed illegal. The areas around the existing MPAs generally indicate low vulnerability to fish populations due to fishermen's lowered fishing ground values in these areas. Due to the vast regions of high fishing ground value outside of MPAs, fishermen have more incentive to comply with no-take regulations inside of MPAs without needing to rely of their protected and revitalized fish populations.

Conclusion

Additional data collection is still necessary in order to illustrate a complete picture of the region and the most viable and advantageous ways of protecting it. The ecologically-focused data of Phase 1 limited the ways this assessment could consider the abiotic factors, biotic factors, human uses, stakeholders, and climate change impacts that are involved in evaluating an MPA.

MPA monitoring must also consider the future and the implications of climate change to ocean ecosystems. MPA networks have been able to reduce other ocean stressors on marine life, provide corridors for shifting species and habitats, promote resiliency, and serve as sentinel sites to monitor changes. In order to effectively inform the management of MPAs of climate change impacts, statewide data on changes in water temperature, oceanic circulation, and ocean acidification is necessary. One significant limitation of this analysis is the absence of state or region specific sea surface temperature or ocean current data that details variations within the North Central region. This data would allow for adaptation to climate change based on predicted environmental threats.

The monitoring and management of these MPAs must be collaborative and multi-faceted in order to attend to the interdependent nature of fisheries, ensure the compliance of all stakeholders, and build resilience in marine ecosystems.

Cartographer: Robyn Lee
Class: Intro to GIS, Spring 2019

Projection: NAD 1983 StatePlane California V FIPS 0405 Ft
Data sources: CDFW, OceanSpaces, TuftsGIS, ESRI

Tufts UNIVERSITY