Deadliest Bycatch: Assessing the Removal of Abandoned Fishing Gear off the Coast of California
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OBJECTIVES
The goal of this project is to evaluate the amount and type of abandoned fishing gear off the coast of California that poses the highest entanglement risk to marine wildlife. Our project results will assist Ocean Defenders Alliance (ODA) and guide future gear removal efforts and the eventual implementation of ropeless fishing gear. This project will:

1. Assess the dynamics of past and current abandoned fishing gear by overlaying spatial and temporal distributions of abandoned fishing gear with gear type, species, and number of marine wildlife entanglements.
2. Spatially overlay abandoned fishing gear records and aerial surveys with existing marine wildlife migration patterns, including seasonal migratory patterns, highlighting where entanglements have most often occurred, and are likely to occur to assess biological and economic losses.
3. Provide a verified best-fit model to ODA that identifies future gear abandonment locations and quantities to guide gear removal efforts and future implementation of ropeless fishing gear. Ropeless fishing gear allows anglers to trigger the release of a stowed rope and buoy attached to a trap or pot on the seafloor that brings the gear back to the surface.
4. Craft a short video highlighting ODA’s work in removing abandoned fishing gear and how that has improved ecosystem health and reduced the impacts abandoned fishing gear has on local communities’ economies and ecosystem services.
5. Create educational outreach materials to encourage anglers to avoid abandoning gear, report illegally discarded gear, and to spread awareness on preventing marine life entanglements.

SIGNIFICANCE
Derelict fishing gear costs Californians millions in lost revenue. In 2018, over $182.7 million dollars came from commercial fishery landings, and supported more than 146,000 jobs in California’s seafood industry. Ocean Defenders Alliance (ODA) is targeting abandoned fishing gear because it causes the needless and preventable death of thousands of marine animals leading to large economic losses. Some of the most impacted species include endangered and threatened cetaceans (whales, dolphins), pinnipeds (seals, sea lions), and sea turtles (leatherback)- all of which fund millions in the California economy, including ecotourism (whale/dolphin watching tours, scuba diving, snorkeling), seafood, and jobs.

The dungeness crab fishery off the coast of California has one of the highest rates of gear abandonment. This is in part due to the Dungeness crab fishing season (November 15 to July15) overlapping with winter storms. When anglers are setting crab traps, the traps typically sit on the ocean floor for 2 - 48 hours, with a long vertical rope line attached to a marking buoy that floats on the ocean's surface. When strong winter storms occur, the pots, rope, and buoys are dragged along the surface floor and displaced to another location that the anglers can’t find or retrieve. The abandonment of this gear causes ghost fishing; which is when abandoned fishing gear (such as crab traps) capture animals and are not emptied, leading to marine wildlife deaths. The dead animals then act as bait for other marine species, who enter the trap and become stuck, starting the process over again. This ghost fishing cycle leads to the depletion of the Dungeness crab population and large profit losses (up to $20,000 per abandoned trap) to the Dungeness crab fishery which is one of the largest fisheries in California, with $51 million dollars worth of crab landed in 2019.
Off the Coast of California, entanglements are directly leading to population declines in threatened and endangered species, including humpback whales, blue whales, and the Pacific leatherback sea turtle. The thin vertical rope lines attaching traps to surface buoys are difficult for cetaceans, pinnipeds, and sea turtles to identify and avoid. When caught, animals panic and thrash around causing the rope to cut off circulation and strangle the limbs. Oftentimes, dolphins and sea turtles end up drowning because they can’t get back up to the surface to breathe. Meanwhile, whales’ large size allows them to drag the trap with them, but the rope can cut into the flesh and cause infections or even lead to loss of their fluke, impacting foraging and other behaviors. Caught animals also have restricted movement which can lead to starvation or increased chance of vessel strikes because animals can’t avoid the vessels. Typically, once the ropes have tightened, it is very difficult and dangerous for whales or humans to remove them, and disentanglement efforts have led to casualties on expert whale entanglement response teams.

BACKGROUND
The California coast hosts many commercial and recreational fisheries that have unintentionally caused the abandonment of over one hundred tons of fishing gear. Entanglements and ghost fishing are a growing concern due to their contribution to population declines in many species under the Marine Mammal Protection Act (1972) and the Endangered Species Act (1973), including the humpback whale, blue whale, pacific leatherback sea turtle, and green sea turtle. Though Ocean Defenders Alliance has conducted large-scale removal efforts to reduce the amount of abandoned fishing gear, more fishing gear is being abandoned each year than what can be removed. A potential solution is ropeless fishing gear, however, there are only a few ropeless fishing gear prototypes in development, and none have been approved for large-scale implementation due to still being in the testing phase and their high expense. In 2020, California legislature proposed regulation that would include provisions for ropeless fishing gear use in commercial dungeness crab fisheries, showing the need for action and an assessment for future implementation of ropeless fishing gear.

While ropeless fishing gear offers a good future solution, there is a current need to curb the continued input of abandoned fishing gear off the coast of California. This can be done by developing a model that can predict where abandoned gear is most likely to end up, so that removal efforts and resources can be targeted towards those areas. Further, the model can be used to identify the highest risk areas where gear is lost to help inform policy decisions and the most needed areas for future ropeless gear implementation. By overlaying marine wildlife migration routes with derelict gear graveyards, this can aid policymakers to target specific fishery locations.

Additionally, creating educational and outreach videos and pamphlets will help reduce the amount of abandoned gear entering the ocean. The video and pamphlets will detail how anglers can avoid abandoning their gear, how to report illegally discarded gear, and how to report entangled animals observed on the water.

EQUITY
This project aims to embrace the diversity, equity, and inclusion involved in marine debris removal and prevention efforts, and environmental outreach. Specifically, we will ensure to give full and proper credit to our data sources. We also commit to sharing the results and knowledge from our
project with the organizations who contributed to it. Furthermore, we aim to accomplish our project goals through hard work, respect, honesty, and fairness.

**AVAILABLE DATA**

This project will make use of the following available data:

- **Ocean Defenders Alliance** (Data made available to Bren students)
  - 16 years of SoCal abandoned fishing gear removal. Datasets include gear removal locations, amount of gear removed (pounds), gear type removed (nets, traps, lines, etc.), amount of animals found (alive or dead), and animal species released.
  - 2021 Aerial Surveys by ODA showing >1,000 abandoned traps in areas near Point Conception.

- **National Oceanic and Atmospheric Administration** (Publicly available data)
  - Specific whale and sea turtle population migration routes and patterns as tabular GIS data.
  - Temporal and spatial data of whale entanglements along the West Coast including associated gear types and fisheries (as available).

**POSSIBLE APPROACHES**

1. **A literature review will be conducted** to assemble the wealth of knowledge surrounding fishing gear abandonment and removal efforts.

2. **Creation of a model that will predict the location of current and future abandoned fishing gear.** This task will involve compiling ODA temporal and spatial data, fishery spatial data (particularly dungeness crab), marine wildlife migration patterns (baleen whales, leatherback sea turtles, etc.), and other publicly available data to determine the highest risk areas for entanglements and resource allocation for current and future removal efforts. AICc analysis and K-fold cross validation will then be performed to maximize model parsimony.

3. **A short 5-10 minute video will be crafted** highlighting how ODAs work helps to reduce inequalities in local communities through improving ecosystem health and bolstering ecosystem services for individuals that rely on subsistence fishing or California’s fisheries for food, livelihood, and recreation.

**DELIVERABLES**

- A model that can be used to identify and predict where abandoned fishing gear ‘hot spots’ are and where ropeless fishing gear should eventually be implemented.

- A short video will be crafted to highlight ODAs efforts to remove abandoned fishing gear and increase ecosystem health and reduce the impacts abandoned fishing gear has on local communities’ economies and ecosystem services.

- An informative flier or sticker will be created detailing how anglers can avoid abandoning gear, report illegally discarded gear they see, and spread awareness on preventing marine wildlife entanglements.

**INTERNSHIP**

Ocean Defenders Alliance will commit up to $5,000 in support of an internship position in the summer of 2022, with internship details dependent on COVID restrictions and ODA’s Return to Work policy. However, ODA will still provide a high level of engagement and professional development should the internship be remote.
CITATIONS


BUDGET AND JUSTIFICATION
The budget for this project is not projected to exceed the $1,300 provided by the Bren School of Environmental Science & Management. Expenses will mainly include costs for any student travel, and supplies needed to create outreach materials.

CLIENT LETTER OF SUPPORT
Please see the attached client letter of support from ODA.