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**THE NET CONSEQUENCE:**

Impacts of Set Gillnets on  
California Ocean Biodiversity

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Photo, right: A female sheephead and other fish swim through a giant kelp forest off Santa Barbara Island. © David Fleetham, Alamy  
Photo, top right: Humpback whale. © Shutterstock, Wildest Animal

# Executive Summary

*Despite nearshore bans on the use of set gillnet fishing gear, these nets designed for catching California halibut and white seabass are still used offshore and around islands in Southern California ocean waters causing immense damage to wildlife and threatening marine biodiversity.*



Off the U.S. West Coast, Southern California's ocean waters are some of the most productive and diverse in the world. Marine mammals, sharks, rays, skates, fish, and seabirds that migrate, feed, and reproduce in the dynamic ocean waters of this region all share a common threat: the risk of becoming entangled in set gillnet fishing gear. These nearly invisible monofilament nets indiscriminately catch more than 125 species of ocean animals—the majority of which are thrown overboard already dead or dying—raising significant concerns over the fishery's impacts on California's marine biodiversity.

With glaring gaps in management oversight and little public visibility, set gillnets are still allowed in federal waters (3-200 miles) off Southern California and around nearshore islands. Management tools are available to reduce bycatch to sustainable levels and a more selective hook and line fishing method is already well-established. The California Fish and Game Commission that manages this fishery must address the needless waste set gillnets inflict on California's marine environment, to ensure that the unique ocean ecosystem off California can continue to thrive, while bolstering sustainable fishing communities.



# An Ocean Ecosystem at Risk

*Stretching from Point Conception to the U.S. Mexico border, the Southern California Bight is a globally important haven for biodiversity. The complex network of seamounts, ridges, canyons and banks extends more than 100 miles from the coast and is home to some of the richest and most diverse deep-sea corals on the U.S. West Coast.<sup>1</sup>*

The Channel Islands are sometimes referred to as the “Galapagos of North America.” Here, nutrient rich waters from the north converge with warm sub-tropical waters from the south, making the ocean region surrounding the Channel Islands among the most diverse and productive in the world. Wind-driven upwelling brings nutrient rich waters to the surface, sparking large blooms of microscopic plant-like organisms called phytoplankton.<sup>2,3</sup>

These blooms support tiny krill, anchovy, herring and other forage species that in turn create the base of the food web for more than 150 species of breeding and migrating seabirds, 32 species of marine mammals, four different species of sea turtles, and more than 700 fish species.

The Southern California Bight boasts the largest density of dolphins on Earth,<sup>4</sup> is an important migratory highway for whales,<sup>5</sup> and one of the most important nursery grounds for sharks in the Pacific Ocean — including great white sharks, blue sharks, and mako sharks.

The Channel Islands are also home to giant kelp forests, which support more than 1,000 marine species beneath their canopies.<sup>6</sup> Kelp forests are teeming with fish, sharks, invertebrates, and a variety of underwater algae species, providing food and protection within their understory. Many species of juvenile fish that support commercial and recreational fisheries rely upon kelp forests as their nursery habitats.

The numerous offshore banks and islands of the Southern California Bight also support world-renowned sportfishing opportunities for groundfish and migratory gamefish, maintaining a multibillion-dollar recreational fishing industry. Coveted sites like Cortes and Tanner banks have some of the best saltwater angling on earth. This area is also critical for California economies, supporting commercial fisheries for rockfish, black cod, California halibut, white seabass, and lobster, which all support coastal fishing markets, harbors, and marinas.

Marine mammals, sharks, rays, skates, fish, and seabirds that migrate, feed, and reproduce in the dynamic ocean waters off California all share a common threat: the risk of becoming entangled in set gillnet fishing gear used to target California halibut and white seabass. California set gillnets catch more than 125 species of ocean animals,<sup>7</sup> raising conservation concerns for both threatened and endangered species as well as many other animals for which the population status is unknown.

In many respects, California is a global leader when it comes to ocean conservation. The state has one of the most extensive networks of marine protected areas in the country and furthered its conservation commitments at the 2022 United Nations Biodiversity Conference by pledging to be a world leader on conserving ocean biodiversity.<sup>8</sup> Yet California continues to allow one of the dirtiest and most destructive fishing methods in the Southern California Bight, one of the world’s ecological treasures.

# Southern California: A Haven For Marine Biodiversity

Off the coast of Southern California lies an ocean ecosystem teeming with life. Ancient shoreline terraces, rocky reefs, seamounts and deep-sea basins create complex and diverse seafloor habitat which supports abundant marine life. Shallow banks like (1) Tanner and (2) Cortes banks create important habitat which supports world renowned recreational sport fishing and scuba diving opportunities. The unique convergence of ocean currents here produces incredible ocean productivity. Cold polar water (3-California Current) from the north converges with warm subtropical waters (Southern California Countercurrent), generating a mixing zone of rotating water (4-Southern California Eddy). This mixing zone of nutrient-rich water supports abundant biodiversity of marine mammals, seabirds, sharks, fish, corals, and kelp forests, making the region one of the most productive ecosystems in the world.



**California Sea Lion**  
 (5) San Miguel Island is home to one of the largest California sea lion rookeries in the U.S. Northern fur seals, harbor seals, and elephant seals also frequent the island. In the breeding and pupping season, more than 70,000 California sea lions can be found here.

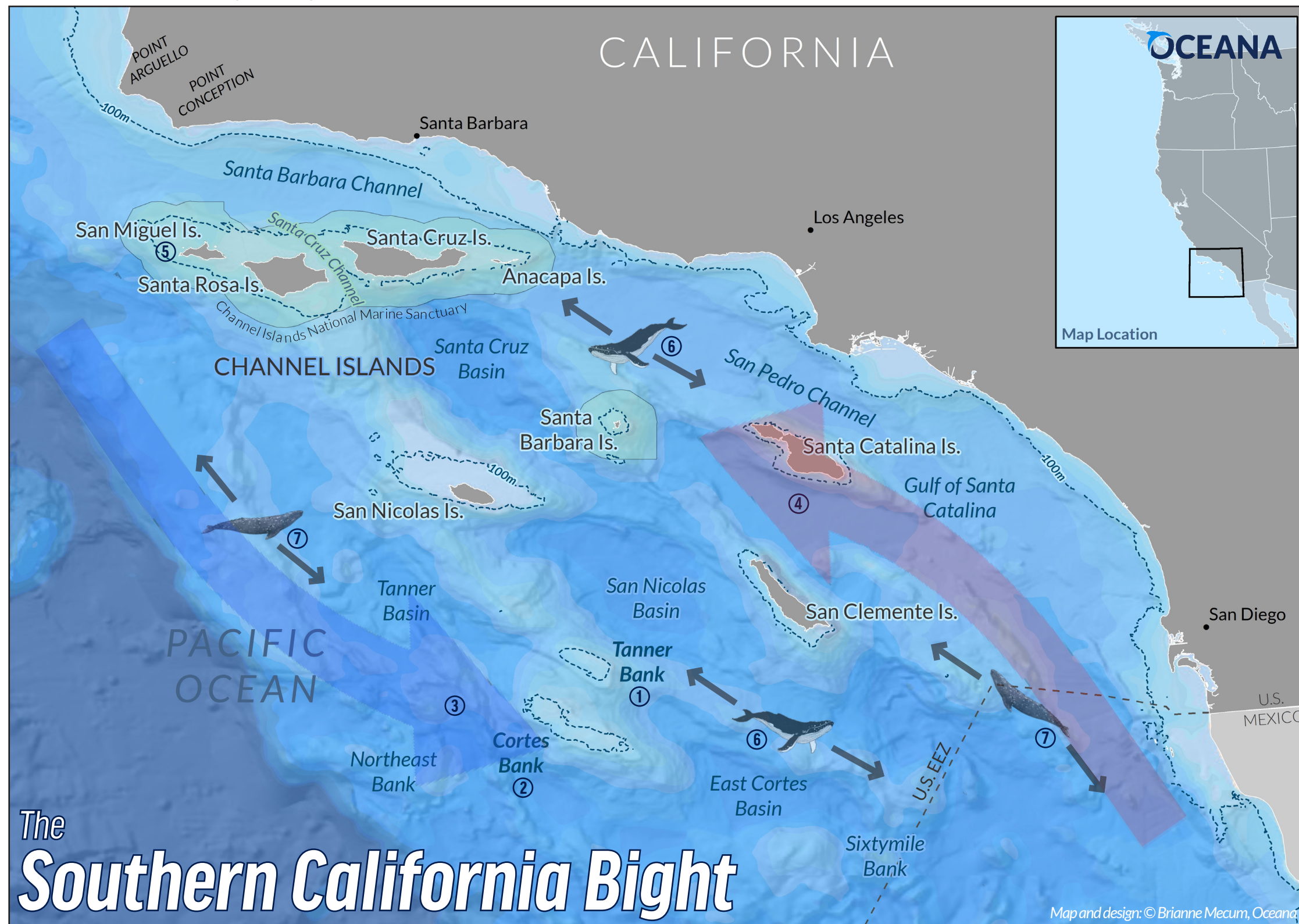
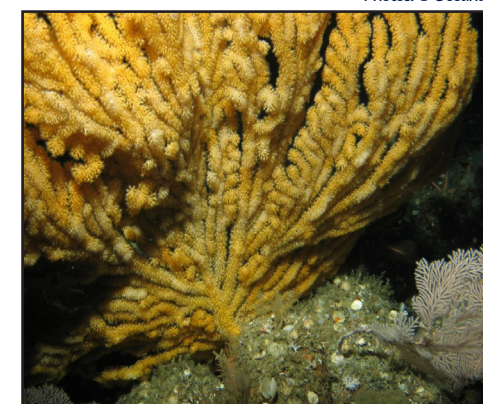
Photo: © Nat'l Park Service



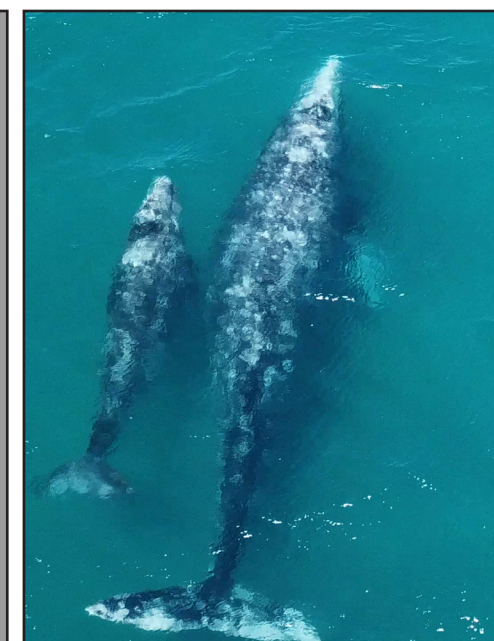
## Deep Sea Corals

The Southern California Bight boasts some of the most abundant and diverse deep sea corals and sponge communities off the North American West Coast. These communities serve as essential fish habitats for commercial and recreational fish species by providing shelter and nursery habitat, and are hotspots for marine biodiversity.

Photos: © Oceana



Map and design: © Brianne Mecum, Oceana



## Whale Feeding and Migration Areas

Inshore and offshore areas of the Southern California Bight are an important feeding destination and (6) migration route for humpback whales that breed in Mexico and Central America. Gray whales swim through on their (7) migration from Mexico to the Arctic, the longest migration of any animal in the world.<sup>5</sup>

Photos: © Gray Whale Gin (above) © Tory Kallman, Shutterstock (below)



# California Set Gillnets in Context

*Many commercially targeted fish such as California halibut and white seabass can be caught with different types of fishing gear, yet the choice of fishing gear can have economic and ecological costs.*

California set gillnets target California halibut and white seabass, yet the non-selective design of the nets entangles many other species — some are legal to keep and marketable, but the majority are not. Many non-target species are thrown overboard as waste. This bycatch includes marine mammals, seabirds, sharks and rays, invertebrates, and non-marketable fish.

Set gillnets catch and discard a variety of fish species important to recreational fishermen, including barred sandbass, giant seabass, lingcod, cabezon, and California barracuda.

The once iconic recreational and commercial giant seabass fishery has been closed for

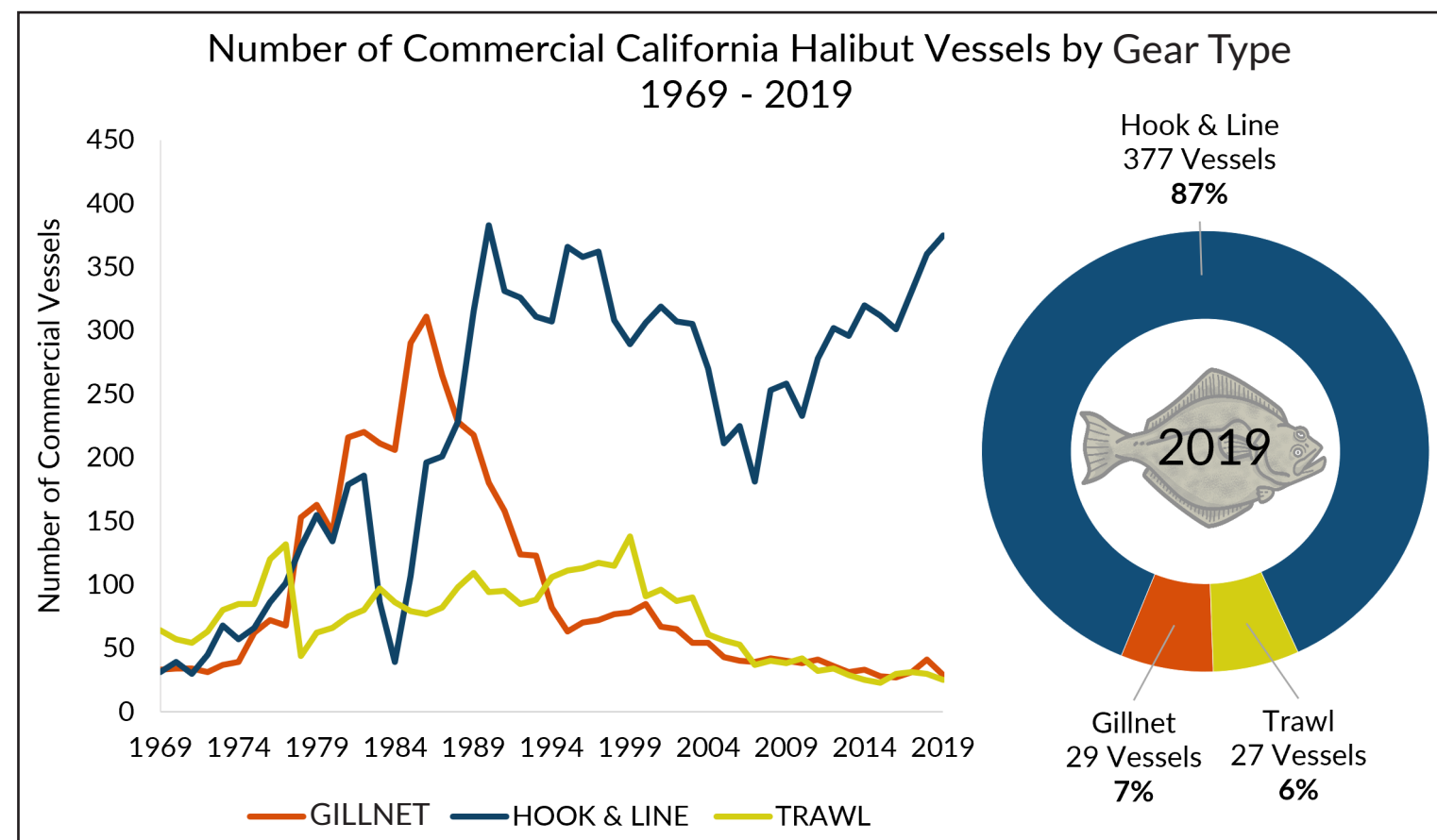
decades due to population depletion, yet set gillnets remain the only commercial fishery still allowed to incidentally catch and sell giant seabass.<sup>9</sup>

In set gillnets, even the target species of California halibut is caught as bycatch. Twelve percent of California halibut are discarded as undersized or damaged.<sup>7</sup> The observed mortality of discarded halibut is 40 percent, not accounting for fish that die after being thrown back.<sup>7</sup>

California Department of Fish and Wildlife (CDFW) population assessments indicate the California halibut population in Southern California may be declining due to high harvest rates and environmental impacts.<sup>10</sup> California halibut is an economically important fish for several commercial fisheries in California, including bottom trawls and hook and line gear types. The last assessment for white seabass indicated the population has been in decline and is at relatively low levels — approximately 27 percent of unfished levels.<sup>11</sup>

Hook and line fishing is a selective fishing method that has significantly less bycatch and typically yields higher prices for fish considered better quality seafood. From 2007-2022, halibut and white seabass caught with hook and line gear garnered approximately 30 percent more per pound compared to set gillnets.<sup>12</sup> In the current landscape of the state's California halibut fishery, there are ten times more hook and line vessels than set gillnet vessels (Figure 1), and set gillnets catch 15 percent of the state's California halibut by weight. In 2019, there were 29 active set gillnet fishing vessels in California.<sup>13</sup>

Bycatch rates in non-selective fishing gears, such as set gillnets, pose sustainability threats for wildlife and other recreational and commercial opportunities. These fishing methods must be responsibly managed to reduce bycatch to protect sensitive ecosystems and wildlife, and ensure the long-term sustainability of fisheries in California.



**Figure 1.** Commercial California Halibut Vessel Distribution by Gear type in 2019. Hook & Line vessels make up 87% of total vessels fishing for California halibut in 2019, while set gillnet vessels make up only 7%.



# The Problem: Bycatch in California Set Gillnets

*Set gillnets may be an efficient method of catching fish; however, the gear type is notorious for its high bycatch rates and impacts to wildlife. These nearly invisible monofilament net panels – like underwater fencing – can be up to thirteen feet tall and extend for more than a mile.<sup>14</sup> The six-to-eight-inch mesh nets are weighted to the seafloor and designed to trap halibut, white sea bass, and other marketable commercial fish by their gills; however, the nets also entangle many other ocean animals.*

Studies evaluating set gillnets have concluded that this gear has among the greatest impacts on marine ecosystems and at-risk species.<sup>15,16,17,18</sup> Set gillnets are routinely set and left alone to fish and remain underwater anywhere from seven to 50 hours.<sup>19</sup> While these nets are “soaking” underwater, marine animals swimming or diving in the area can become entangled.

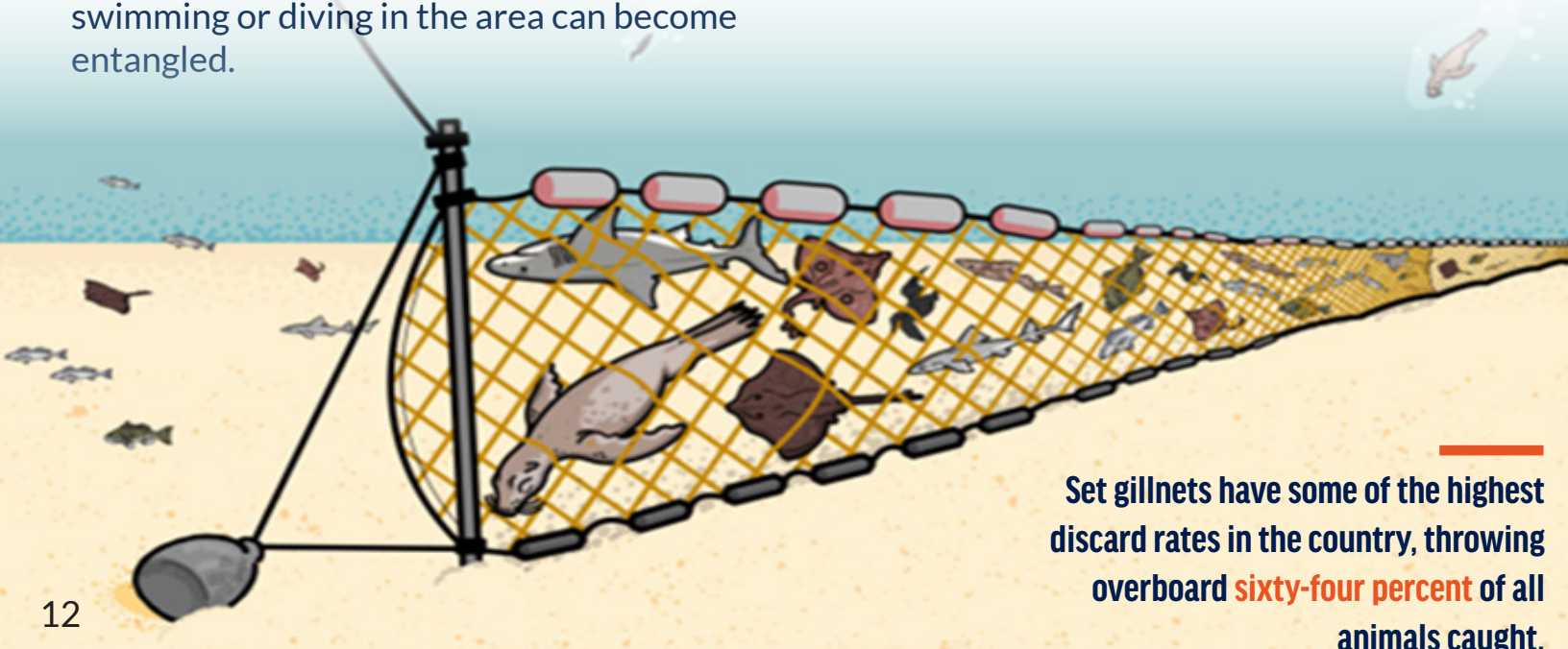
Once the nets are retrieved, legal and marketable catch is kept, such as California halibut and white seabass for which the mesh netting is designed, as well as barracuda, yellowtail, leopard shark, and others. The rest is thrown back to sea.

According to federal fishery observers and entanglement reports, more than 125 species of ocean animals are caught including ecologically important sharks and rays, sea lions, dolphins, endangered sea turtles and whales, and seabirds.<sup>5,7,20,21,22,23</sup> Set gillnets have some of the highest discard rates in the country, throwing overboard as waste 64 percent of all animals caught. Fifty-five percent of discarded animals are already dead,<sup>7</sup> and the number of animals discarded alive that then die after being tossed overboard could be significant but is not known or quantified. Ultimately, nearly two out of three animals caught are thrown overboard, the majority already dead.<sup>7</sup>

Entangled marine mammals that require air to breathe drown when they are unable to surface, and sharks, rays, skates, and finfish suffer similar fates when they are not able to swim and pass oxygen over their gills. Large animals such as sea lions and whales may escape with the gillnets still entangled around their necks, mouths, flukes, and fins.

Over the last 15 years conservative estimates indicate more than 230,000 animals in total have been discarded in the fishery;<sup>7,24</sup> however, using commercial fish landings data to estimate total catch, the number of discarded animals could be as high as two million.<sup>25</sup> Due to the lack of consistent tracking methods by state and federal managers, the magnitude of catch and dead discarded bycatch is unknown.

Most of the discarded species do not have population assessments or management safeguards like catch limits, catch seasons, or size limits to ensure sustainability. Out of 97 finfish, shark, ray, and skate species caught in the fishery, 68 have no population assessment and have unknown population levels. Furthermore, 56 of these species are not managed in state or federal Fishery Management Plans, standard management tools used to manage for sustainability and prevent overfishing and species depletion. This raises significant concerns over the fishery’s impacts on California’s marine ecosystem, and is particularly concerning for many species of sharks, rays, and skates – species which tend to grow slowly, have few young, and play an important role in a healthy ocean ecosystem.



**Set gillnets have some of the highest discard rates in the country, throwing overboard sixty-four percent of all animals caught.**

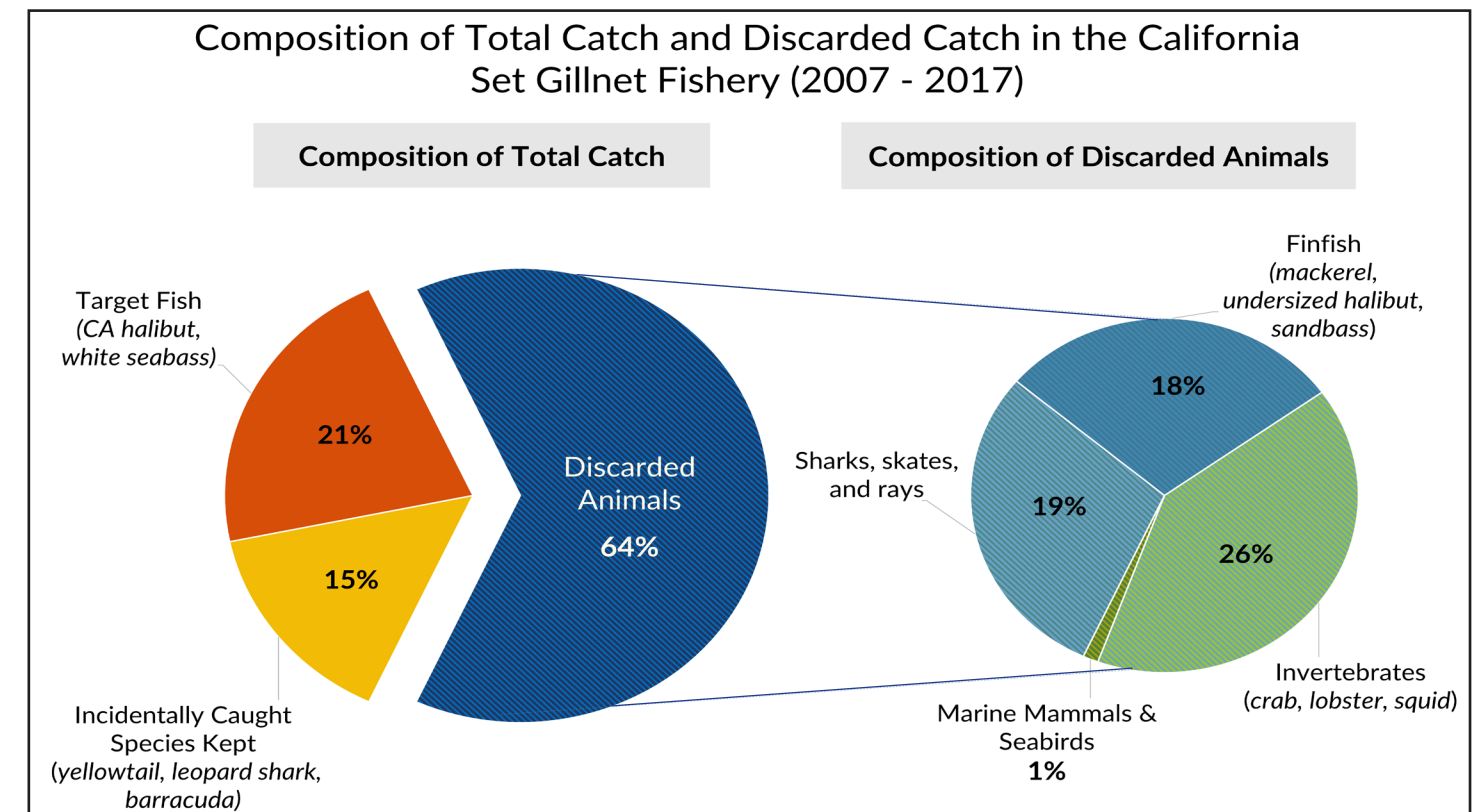


Figure 2. Composition of total animals caught and discarded in the California set gillnet fishery based on federal observer data 2007 – 2017.<sup>7</sup> Observer data is reported in number of animals caught, kept, discarded, and discarded mortality.

# Sharks and Rays at Risk

*Sharks, skates, and rays — collectively known as elasmobranchs — are important components of marine ecosystems and are particularly vulnerable to the pressures of overfishing. Set gillnets entangle more than 28 different species of elasmobranchs.*



Sharks, skates, and rays are integral to maintaining a healthy marine ecosystem. As apex predators, sharks feed on animals below them in the food chain — a mechanism called predator top-down control — regulating and maintaining the balance of marine ecosystems. They help remove weak and sick animals in the ecosystem as well as provide balance between competitors to ensure species diversity. As predators, they also shift their prey's spatial habitat, which alters the feeding strategy and diets of other species.

Through these spatial controls and abundance, sharks indirectly maintain seagrass and corals, critically important habitat for many marine species.<sup>26</sup> The skeleton of elasmobranchs consists of cartilage, not bone, which means they are easily bruised and injured, and are particularly vulnerable to overfishing due to their low reproductive rates and high age of maturity. The loss of sharks has led to the decline in coral reefs, seagrass beds, and the loss of commercial fisheries.

Decades of ecological research have demonstrated that shifts in predator abundance, such as declines of shark populations, can have cascading consequences for the structure, function, and resilience of marine ecosystems.<sup>27</sup> Declines in predator populations caused by overfishing may have sweeping consequences for the broader ocean ecosystem of the Southern California Bight.

Nearly three out of every four sharks, rays, and skates caught are tossed overboard in the set gillnet fishery and we estimate a minimum of 62,000 sharks alone have been tossed overboard by the fishery within the last 15 years.<sup>7,25</sup> The Southern California Bight is a critical nursery area for many species of sharks — including great white sharks, thresher sharks, and tope sharks.<sup>28,29,30,31,32</sup> Of the 28 elasmobranch species caught in the set gillnet fishery, 22 of them have no population assessment and health of the populations is unknown. Of the handful of species that are assessed, some are in serious trouble.

## Tope Sharks

Tope sharks, also known as soupfin sharks because of their highly sought after fins used in sharkfin soup, are a candidate species for Endangered Species Act (ESA) listing as of 2022.<sup>33</sup> Minimum estimates indicate more than 1,700 tope sharks have been discarded from 2007–2021 in the set gillnet fishery and more than half of those thrown overboard were already dead.<sup>7,25</sup> The overall status of California's tope shark population is unknown and has not been evaluated in more than 70 years, though all available data points to a population struggling to recover from being targeted in both the shark fin trade and historic vitamin-A fishery of the mid-1900s.<sup>34</sup>

## Juvenile Great White Sharks

Waters off southern California where the set net fishery operates serve as a critical nursery for young white sharks.<sup>20,35</sup> Set gillnets are the largest threat to juvenile great white sharks off the West Coast. These nets are responsible for more than 90 percent of the juvenile great white sharks caught and discarded in California fisheries, estimated by the National Marine Fisheries Service (NMFS) to be 25 white sharks per year.<sup>36</sup> Each adult female typically produces a single white shark pup every two years, and the pups have high rates of natural mortality.<sup>37</sup>

Despite indications that the Northeast Pacific population of white sharks has increased in recent years,<sup>38</sup> the number of sub-adult and adult white sharks on the West Coast is estimated to be in the low hundreds.<sup>39</sup> While the take of white sharks is prohibited in most other fisheries, state law allows set gillnet fishermen to incidentally catch and land white sharks with no limits in place.

## Bat Rays

Bat rays are the most discarded of all rays caught in set gillnets. We estimate that at least 7,400 bat rays were tossed overboard from 2007 to 2021.<sup>7,25</sup> Aptly named, the bat ray glides gracefully by flapping its bat-like wings over sandy-bottomed bays and through the kelp forests it calls home. Several bays and wetland areas along the California coast are essential nurseries and feeding areas for these rays.





# Marine Mammals at Risk

*In addition to the bycatch of sharks and rays, California set gillnets are also capable of entangling other marine wildlife such as humpback whales, gray whales and California sea lions.*



## Humpback and Gray Whales

California set gillnets are a threat to gray and humpback whales that swim, feed, and migrate with their new babies in waters off California. Of the three populations of humpback whales that migrate through California waters, one is federally endangered and one is threatened. Entangled whales can continue to swim, dragging the fishing gear with them. Over time the gear slowly weighs whales down and can lead to death months later from infection or starvation.

According to NOAA Fisheries, roughly 75 percent of reported whale entanglements are fatal. From documented reports, unidentified gillnets have entangled 38 whales from 2000-2022, including 12 humpbacks and 26 grays.<sup>21</sup> In contrast to trap fisheries for crab and lobster, fishery managers do not require distinguishing gear marking on gillnets, so the fishery of origin involved in these gillnet entanglements remains unidentified.



## California sea lions

Set gillnets kill more California sea lions annually than all other observed West Coast fisheries combined.<sup>40</sup> Sea lions are attracted to the many fish entangled in the nets and can become entangled themselves. Once entangled, sea lions can drown on site or break away with netting wrapped around their necks or flippers, which can lead to soft tissue injury and death from infections and trauma if the net is not removed.

The Pacific Marine Mammal Center, a marine mammal rehabilitation and marine veterinary center located in Southern California, reports the majority of the entanglement events they respond to are California sea lions entangled in 8-inch pink monofilament netting, which are often used for California set gillnets..

A California sea lion suffers from monofilament net wrapped around its neck, the same type of mesh netting used in the California set gillnet fishery.  
© Roxy Grant



Photo, top left: Humpback whale mother and calf. © Ed Lyman, NOAA  
Photo, left: Gray whale calf. © Robert Harding, Alamy  
Photo, top right: California sea lions. © Robert Schwemmer, NOAA

# Management Gaps

*Currently managed by the California Fish and Game Commission, the California set gillnet fishery has a prolonged history of needing management measures to reduce deadly impacts to wildlife.*

After southern California sport fishermen noticed major declines in fish populations in the 1980's, fishermen, environmental organizations, and elected officials worked together to address wildlife impacts caused by set gillnets.

In a major victory for anglers and the marine ecosystem, California voters passed Proposition 132 in 1990, which prohibited the use of set gillnets within state waters off Southern California (0-3 nautical miles) with exceptions that allowed fishing within one nautical mile of the Channel Islands.

In the late 1990s, scientists discovered set gillnets were also killing an alarming number of federally protected marine mammals and seabirds. In response, the California Fish and Game Commission banned the use of these nets off the Central Coast in 2002.

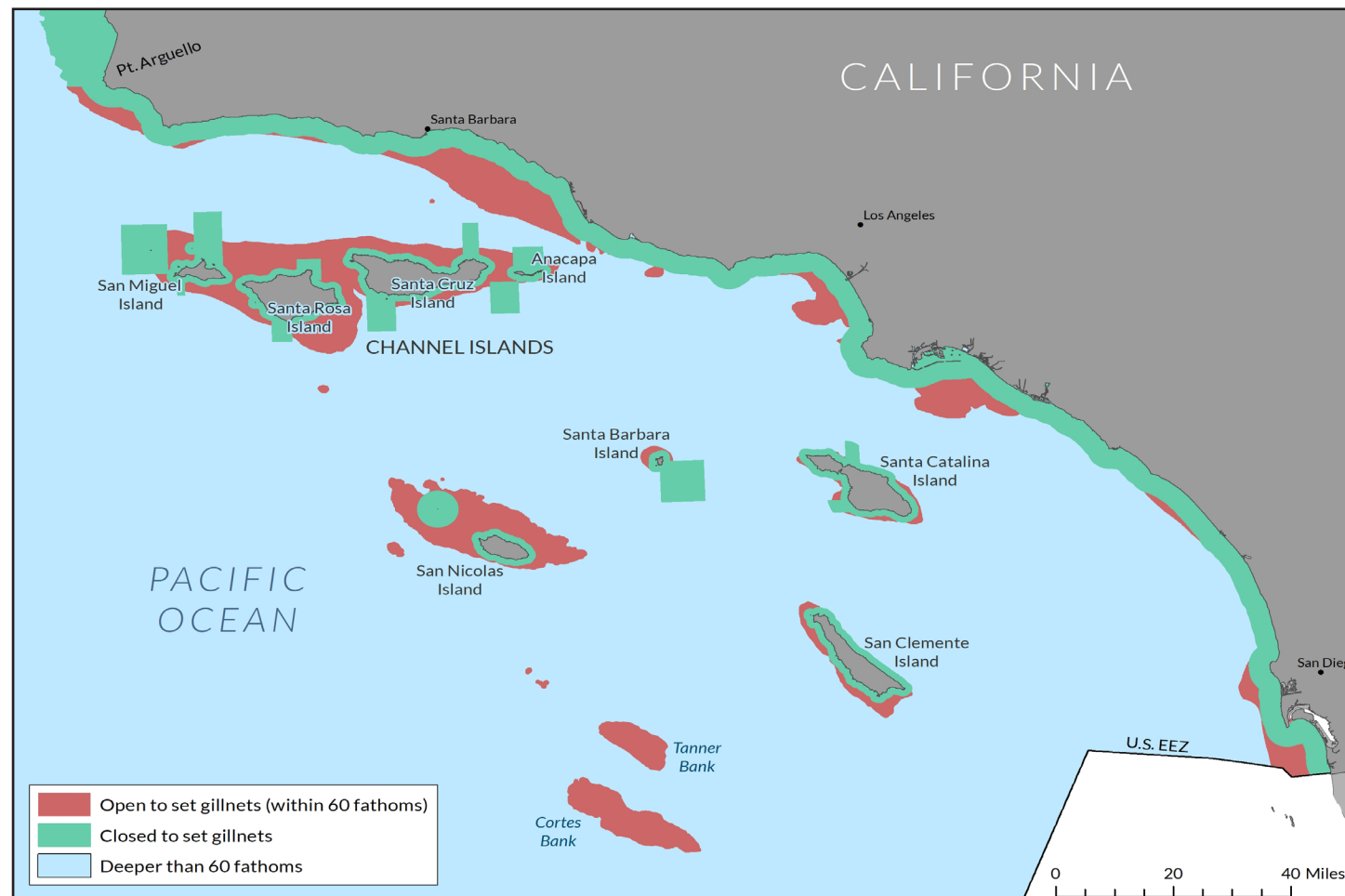
In areas where set gillnets have been banned, regional populations of vulnerable species have been able to recover towards healthy population levels. Scientists have documented the dramatic recovery of harbor porpoise, giant seabass, leopard shark, and tope shark populations that were depleted prior to the ban on set gillnets in California state waters.<sup>41,42</sup>

Due to the complexities of these various management actions most Californians are unaware that set gillnets are still being used offshore and around islands in Southern California federal waters (3-200 nautical miles), causing immense damage to wildlife.

Of the 45 state-managed fisheries analyzed in 2017 by CDFW, set gillnets rose to the top of the priority list in the state's Ecological Risk Assessment. This Assessment identifies fisheries that pose the most risk to species and ecosystems, and should therefore be a priority for managers and management resources.

Fisheries that regularly kill marine mammals are required to have federal fishery observers onboard to monitor and document marine mammal catch under the Marine Mammal Protection Act. Despite this legal mandate, the set gillnet fishery has operated with no observers during nine of the last 15 years. In the six years the fishery was observed, NMFS only observed 12.5 percent of fishing effort.<sup>12</sup> This is despite NMFS' own scientists recommending at least 20 percent year-round observer coverage more than a decade ago.<sup>43</sup> Without adequate observer coverage the true toll on wildlife is unknown.

The California Fish and Game Commission must implement measures to reduce bycatch to "acceptable types and amounts" under California's Marine Life Management Act.<sup>44</sup> The determination of what is and isn't "acceptable" represents a legal threshold in state law to initiate a process to address unacceptable bycatch through conservation and management measures.



**Figure 3.** In the above map, areas in red are open to the set gillnet fishery. Areas in green are where the fishery is banned. The remaining area in blue is technically open to the fishery, though most effort occurs within 60 fathoms (360 feet) depth.



A gray whale with a gillnet wrapped around its fluke.  
 © NOAA, MMHSRP Permit # 18766-06



Gillnet cut off gray whale.  
 © SeaWorld San Diego, NOAA Permit #18786-06

# Potential Management Solutions

*Below are a variety of management approaches used across other U.S. fisheries to reduce bycatch. These approaches represent a suite of potential management options that could be applied to the California halibut and white seabass set gillnet fishery.*



## **Time and Area Closures**

Time and area closures prohibit fishing with certain gear types in specific areas and/or seasons to protect vulnerable or endangered species.

## **Hard Caps on Bycatch**

Hard caps put limits on the number of a certain species that can be caught as bycatch and generally require ceasing fishing activity in an area for a pre-determined period once a hard cap is reached or exceeded.

## **Decreased soak times**

Limiting the duration of time that set gillnets can be in the water — referred to as the soak time — can reduce the associated injury and mortality for animals.<sup>20</sup>

## **Fishing gear transition program**

Transition programs can be established whereby fishermen receive financial compensation and/or priority access to permits for use of cleaner fishing gear. The programs can also be accompanied by limiting transferability of permits and/or a mandatory phase-out of permits for use of the higher bycatch gear type.

## **Bycatch Monitoring and Gear Marking**

To accurately detect the entanglement of rare or endangered species such as sea turtles or whales, 100 percent monitoring and bycatch reporting is required,<sup>45</sup> along with easily identifiable gear marking. For endangered species with extremely low population sizes — such as the leatherback sea turtle — current observer coverage of the set gillnet fishery is insufficient.



*The tools are available to reduce bycatch in California's set gillnet fishery. The California Fish and Game Commission is required under state law to find solutions to minimize bycatch, ensuring the unique ocean ecosystem off California can continue to thrive and support vibrant and sustainable fishing communities.*

Pacific leatherback sea turtles were documented entangled in set gillnets prior to the nearshore ban off central California.<sup>24</sup> Current observer coverage of the fishery is insufficient to evaluate its impacts on endangered species such as the leatherback. Scientists warn that just one leatherback death per year along the West Coast will impact the recovery of the species.<sup>46</sup>

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24. Total catch estimates are based upon federal observer data of set gillnet fishing sets conducted from 2007 to 2017 and total fishing trips (landing days) provided by the California Department of Fish and Wildlife (CDFW) 2007 to 2021. In the absence of total number of fishing sets to compare to sets recorded by federal observers, we assumed a 1:1 sets to trips ratio, assuming 1 set occurred per 1 trip for the 2007-2021 period. Multiple sets typically occur during each fishing trip, although the data is unavailable to quantify how many sets occur during each trip. This estimation method of total effort and total catch provides the absolute minimum estimate of total catch that is possible given the available data from 2007 – 2021.
25. Based upon landings data of California halibut sourced from PacFin – current minimum total catch estimates are unable to account for the amount of California halibut landed per year in set gillnets, indicating the total effort estimates using the 1 set to 1 trip extrapolation method are underestimating total effort of the set gillnet fishery.
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