Science, Service, Stewardship

Agenda Item I.1.b
NMFS Report 4 (Electronic Only)
September 2018

NOAA
FISHERIES
SERVICE

Seabird Mortality in U.S. West Coast Groundfish Fisheries (2002-2016)

Jason E. Jannot
Thomas P. Good
Kayleigh Somers
Vanessa Tuttle
Jon McVeigh

Publication date: September 2018

U.S. Department of Commerce | National Oceanic and Atmospheric Administration | National Marine Fisheries Service

This document should be cited as follows:

J.E. Jannot, T. P. Good, K. Somers, V. Tuttle, J. McVeigh. 2018. Seabird Mortality in U.S. West Coast Groundfish Fisheries 2002-2016. NOAA Fisheries, NWFSC Observer Program, 2725 Montlake Blvd E., Seattle, WA 98112.

NWFSC Observer Program
National Marine Fisheries Service
Northwest Fisheries Science Center
Fishery Resource Analysis and Monitoring Division
2725 Montlake Blvd. E.
Seattle, WA 98112

Seabird Mortality in U.S. West Coast Groundfish Fisheries 2002-2016

Jason E. Jannot*[1], Thomas P. Good[2], Kayleigh Somers[1], Vanessa Tuttle[1], Jon McVeigh[1]

NWFSC Observer Program
Fishery Resource Analysis and Monitoring Division[1]
Conservation Biology Division[2]
Northwest Fisheries Science Center
National Marine Fisheries Service
NOAA
Seattle, WA 98112

August 9, 2018

*jason.jannot@noaa.gov

Contents

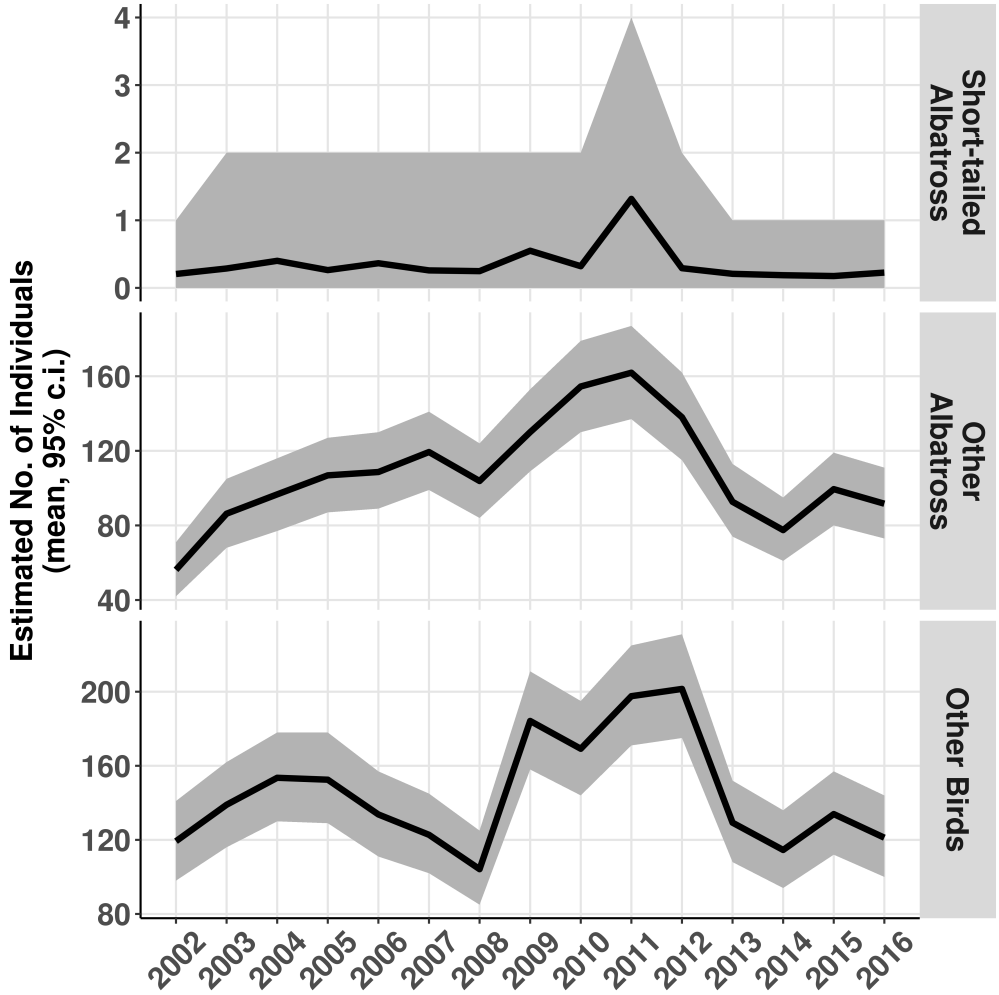
Executive Summary

The California Current marine ecosystem on the United States (US) West Coast (Washington, Oregon, California) supports a diversity of marine organisms, including seabirds. This report summarizes interactions between the US West Coast groundfish fishery and seabirds and presents estimates of fleet-wide bycatch for seabirds based on data from the fishery and federal observer programs for the years 2002-2016.

Lethal and non-lethal interactions, as well as sightings, are presented for five fishery sectors using hook-and-line gear, six sectors using trawl gear, and four sectors using pot gear. A total of 41 species interacted with or were sighted in these fisheries over the 2002-2016 period. Twelve species are considered endangered, threatened, vulnerable, or near threatened by the U.S. Endangered Species Act (ESA) or the International Union for Conservation of Nature. The remaining 28 species are not listed or categorized as "Least Concern" (i.e., not at risk).

The three albatross species interact with these fisheries: black-footed, Laysan, and the ESA-listed short-tailed albatross. To date, only one short-tailed albatross has been observed killed by these fisheries and the mean estimated mortality for most years is less than 1 individual per year (Figure 1. However, black-footed albatross are consistently killed in a number of fishery sectors reported here. Laysan albatross have occasionally been killed by these fisheries, but the mortalities are few and infrequent. The estimated mean of non-short-tailed albatross mortalities ranged from a low of about 60 individuals in 2002 to a high of about 160 individuals in 2011 (see Other albatross in Figure 1). The 2016 mean estimate for of other (non-short-tailed) albatross was about 90 individuals (Figure 1). Other birds (i.e., non-albatross) also showed a peak in mortality during the 2009-2011 period of about 180-200 birds killed (Figure 1). The 2016 mean estimated mortality of other birds was about 120 (Figure 1).

Figure 1: Estimated short-tailed albatross, other albatross and other birds mortality (mean no. individuals $\pm$ 95% c.i.) in US West Coast groundfish fisheries for the period 2002-2016.



Hook-and-line fisheries account for the largest number of albatross taken among the three gear categories (hook-and-line, trawl, pot). Hook-and-line fisheries account for 58-83% of seabird mortality in a given year, followed by trawl fisheries at 13-37% in a given year and pot fisheries at 0-8% of bycatch in a given year (Table 1). The largest number of albatross taken comes from Limited Entry Sablefish vessels fishing hook-and-line gears. This prompted regulations requiring streamer-lines on hook-and-line vessels fishing in U.S. West Coast groundfish fisheries to be implemented in 2015. Bycatch of other species is generally split evenly between hook-and-line and trawl gears. Seabird mortality is likely underestimated on trawl vessels because seabirds can be killed or injured by striking cables that exit aft of the vessel during trawling. These cables are not routinely monitored in these fisheries. Significant levels of bycatch, especially of albatross, have

been recorded in similar trawl fisheries around the globe (Favero, et al. 2011; Maree, et al. 2014; Tamini, et al. 2015). Pot gears appear to catch very few seabirds.

In earlier versions of this report (Jannot et al. 2011) we used ratio estimators to estimate seabird bycatch. In this report we implement an improved method for bycatch estimation. We applied a Bayesian modeling approach to estimate total bycatch and associated error for fisheries sectors with less than 100% observer monitoring. These methods have been used with other rare bycatch species, including cetaceans, delphinids, pinnipeds, sea turtles, and sharks (Martin et al. 2015). The Bayesian method improves uncertainty around estimates and provides fleet-wide estimates even in years when no seabirds were reported killed by fisheries observers. Comparsions between the ratio and Bayesian estimates are provided in an appendix. Given the results of the comparisons, we chose the Bayesian method for seabird bycatch estimates. The estimated bycatch rate θ is assumed constant through time. All uncertainty in the time series originates from fluctuating levels of effort through time (percent observer coverage only affects the expansion). Future investigations will explore the assumption that θ is constant through time.

Table 1: Estimated seabird mortality (numbers of individuals) and the percent of total mortality by gear type and year in U.S. West Coast groundfish fisheries, 2002-2016.

	Hook-and-Line		**Trawl**		**Pot**		
Year	Estimate	Percent	Estimate	Percent	Estimate	Percent	Total
2016	203.78	74%	61.91	22%	12.55	5%	277.24
2015	229.42	68%	95.42	28%	13.65	4%	338.48
2014	194.61	69%	69.49	25%	17.54	6%	281.62
2013	216.37	61%	126.18	35%	12.94	4%	355.46
2012	340.81	83%	54.55	13%	14.14	3%	409.48
2011	343.05	78%	80.82	18%	13.57	3%	439.50
2010	300.12	79%	65.60	17%	11.87	3%	377.60
2009	260.61	72%	85.56	24%	14.00	4%	360.13
2008	201.88	77%	44.46	17%	17.02	6%	263.38
2007	194.19	62%	105.22	34%	11.90	4%	311.32
2006	205.20	73%	64.76	23%	12.66	4%	282.64
2005	192.80	61%	108.43	34%	13.64	4%	314.86
2004	170.23	58%	107.13	37%	15.08	5%	292.46
2003	153.17	59%	87.09	34%	19.50	8%	259.74
2002	119.23	68%	56.43	32%	0.00	0%	175.66
Total	3325.47	70%	1213.05	26%	200.06	4%	4739.57

List of Tables

List of Figures

Introduction

The California Current marine ecosystem on the United States (US) West Coast (Washington, Oregon, California) supports a diversity of marine organisms, including albatross and other seabirds. Managing and conserving marine biodiversity requires accounting for human-induced mortality to marine organisms such as seabirds. Seabirds overlap with commercial fisheries operating within the US Exclusive Economic Zone (EEZ) on the US West Coast, which can cause incidental human-induced mortality of these species, a.k.a., bycatch. This report summarizes interactions between the US West Coast groundfish fishery and seabirds and presents estimates of fleet-wide bycatch for seabirds based on data from the fishery and federal observer programs for the years 2002-2016.

More species of seabirds are threatened or endangered than any other bird group, and seabird populations have declined faster than other bird groups (Croxall et al., 2012; Lascelles et al., 2016). Seabird bycatch is considered a major threat to seabird populations, and, on a relative scale, almost as detrimental as the top threat to seabirds, invasive species (Croxall et al., 2012). Furthermore, bycatch affects a larger proportion of seabird populations than most other human threats to these species. Fishing vessels using longline gear kill 160,000 –320,000 seabirds globally each year (Anderson et al., 2011). Although global estimates are lacking for trawl fisheries, individual studies indicate that global seabird mortality from trawl gear is likely to be of a similar scale (Bartle, 1991; Weimerskirch et al., 2000; González-Zevallos et al., 2007; Watkins et al., 2008; Tamini et al., 2015). Quantifying the lethal and sub-lethal effects of fisheries on seabirds is the first step in understanding the impact of fisheries on seabird populations and developing solutions to minimize seabird bycatch. The US Fish and Wildlife Service (USFWS) manages seabird populations in the US by enforcing laws and regulations pertaining to seabirds and other migratory birds. NOAA's Northwest Fisheries Science Center (NWFSC) and West Coast Regional Office (WCRO) in collaboration with the USFWS gather data on fishery related mortality of seabirds in US West Coast groundfish fisheries to aid USFWS and other agencies in their efforts to quantify and mitigate seabird bycatch.

The US West Coast supports a diversity of seabird species of both national and international importance and which exhibit a wide range of life history characteristics. Seabirds interacting with the US West Coast groundfish fishery include species that breed locally. For example, US West Coast populations of nesting Brandt's cormorants (*Phalacrocorax penicillatus*) and western gulls (*Larus occidentalis*) represent the majority of the global populations of these species (USFWS, 2005). In addition to resident species, the California Current ecosystem hosts millions of seabird migrants including three species of global conservation concern: the short-tailed albatross (Phoebastria albatrus) is listed as endangered under the U.S. Endangered Species Act (ESA) and the black-footed (*Phoebastria nigripes*) and Laysan albatrosses (*Phoebastria immutabilis*) are listed as near-threatened on the IUCN Red List (International Union for Conservation of Nature). Other West Coast

seabirds that are ESA-listed include California least terns (*Sternula antillarum browni*) and the marbled murrelet (*Brachyramphus marmoratus*; Table 2). All three of these species interact or have the potential to interact with commercial fishing vessels in this region. In addition to the species already mentioned, seven others categorized by the IUCN as vulnerable or near threatened also interact with US West Coast groundfish fisheries (Table 2).

All seabirds in the California Current system are highly mobile and require an abundant food source to support their high metabolic rates (Ainley et al., 2005). Thus, oceanic productivity and prey availability drive seabird abundance along the US West Coast (Tyler et al., 1993; Ainley et al., 2005). Coastal upwelling, which delivers nutrient rich water to the surface, determines the seasonal and latitudinal distribution of prey biomass, which seabirds follow (Tyler et al., 1993). On the US West Coast, upwelling is most intense south of Cape Blanco, OR (42°50′ N latitude) (Bakun et al., 1974; Barth et al., 2000), which appears to support a large percentage of the nesting sites of locally breeding seabirds (Tyler et al., 1993). The location of stable nesting sites reflects oceanographic conditions that support long-term food availability (Tyler et al., 1993, Naughton et al. 2007). Transient species to the California Current system are also most abundant in areas of strong upwelling intensity and high productivity (Briggs and Chu, 1986; Hyrenbach et al., 2002).

The US West Coast upwelling not only varies by latitude, but also by season, thereby influencing both the latitudinal and seasonal distribution of seabirds. The US West coast has three distinct oceanic seasons: the Upwelling, Oceanic, and Davidson Current seasons (Ford et al., 2004). The Upwelling season coincides with late spring and summer, when northerly winds transport surface waters southward and away from the coast. The distribution of breeding species in summer largely reflects the location of nesting colonies, which are most prevalent adjacent to the central and northern portion of the California Current system (Tyler et al., 1993; Ford et al., 2004). However, during this time, productivity and prey abundance associated with upwelling bring visiting species to the US West Coast which outnumber the breeding species. Commonly observed visiting species in summer include the sooty shearwater (*Puffinus griseus*), Northern fulmar (*Fulmarus glacialis*), and black-footed albatross (*Phoebastria nigripes*) (Tyler et al., 1993). During the fall Oceanic season, northerly winds and upwelling intensity decrease, and sea surface temperature reaches its annual maximum. Several species that nest further south in Mexico and southern California move northward, including the brown pelican (*Pelecanus occidentalis*) and storm petrels (Hydrobatidae). As winter approaches, southern nesters return south and breeders from boreal nesting colonies become more abundant, particularly along the California coast (Tyler et al., 1993). In winter, warmer water delivered by the Davidson current reduces primary production along the US West Coast (Davidson Current season). Seabird abundance during this time is generally low (Tyler et al., 1993).

Table 2: U.S. Endangered Species Act (ESA) status, International Union for the Conservation of Nature (IUCN) status, number of observed mortalities (takes), number of non-lethal interactions, and number of sightings for all birds recorded by observers on U.S. West Coast Fishing Vessels observed by the Northwest Fisheries Science Center Observer Program, 2002-2016. Estimated fishing mortality by year for each species is given in Table 3

Nominal Identifiers		**Conservation Status**		**Observed**		
Common Name	Species	ESA	IUCN	Takes	Interactions	Sightings
Short-tailed Albatross	*Phoebastria albatrus*	Endangered	Vulnerable	1	43	160
California Least Tern	*Sternula antillarum browni*	Endangered	Not Assessed	0	0	2
Marbled Murrelet	*Brachyramphus marmoratus*	Threatened	Endangered	0	1	154
Pink-footed Shearwater	*Ardenna creatopus*	Not Listed	Vulnerable	5	5	48
Leach's Storm-Petrel	*Hydrobates leucorhous*	Not Listed	Vulnerable	26	10	30
Black-legged Kittiwake	*Rissa tridactyla*	Not Listed	Vulnerable	0	0	1
Sooty Shearwater	*Ardenna grisea*	Not Listed	Near Threatened	40	26	7858
Snowy Plover	*Charadrius nivosus*	Not Listed	Near Threatened	0	1	0
Heermanns Gull	*Larus heermanni*	Not Listed	Near Threatened	0	3	34
Laysan Albatross	*Phoebastria immutabilis*	Not Listed	Near Threatened	3	48	83
Black-footed Albatross	*Phoebastria nigripes*	Not Listed	Near Threatened	333	2527	4318
Cassin's Auklet	*Ptychoramphus aleuticus*	Not Listed	Near Threatened	9	37	3
Green-winged Teal	*Anas crecca carolinensis*	Not Listed	Not Assessed	10	0	0
Short-tailed Shearwater	*Ardenna tenuirostris*	Not Listed	Least Concern	0	1	0
Wilsons Warbler	*Cardellina pusilla*	Not Listed	Least Concern	0	1	0
South Polar Skua	*Catharacta maccormicki*	Not Listed	Least Concern	0	1	0
Pigeon Guillemot	*Cepphus columba*	Not Listed	Least Concern	0	0	99
Rhinoceros Auklet	*Cerorhinca monocerata*	Not Listed	Least Concern	0	2	2
Semipalmated Plover	*Charadrius semipalmatus*	Not Listed	Least Concern	0	1	0
Tufted Puffin	*Fratercula cirrhata*	Not Listed	Least Concern	0	1	16
Northern Fulmar	*Fulmarus glacialis*	Not Listed	Least Concern	263	2558	193
Common Loon	*Gavia immer*	Not Listed	Least Concern	1	1	0
Pacific Loon	*Gavia pacifica*	Not Listed	Least Concern	0	0	2
Fork-tailed Storm-Petrel	*Hydrobates furcatus*	Not Listed	Least Concern	0	101	6
California Gull	*Larus californicus*	Not Listed	Least Concern	2	1	32
Mew Gull	*Larus canus*	Not Listed	Least Concern	1	0	0
Ring-billed Gull	*Larus delawarensis*	Not Listed	Least Concern	1	0	0
Glaucous-winged Gull	*Larus glaucescens*	Not Listed	Least Concern	4	4	7
Western Gull	*Larus occidentalis*	Not Listed	Least Concern	71	7654	157
Arctic Herring Gull	*Larus smithsonianus*	Not Listed	Least Concern	13	0	1
Orange-crowned Warbler	*Leiothlypis celata*	Not Listed	Least Concern	0	3	0
White-winged Scoter	*Melanitta deglandi*	Not Listed	Least Concern	3	0	0
American White Pelican	*Pelecanus erythrorhynchos*	Not Listed	Least Concern	0	0	1
Brown Pelican	*Pelecanus occidentalis*	Not Listed	Least Concern	6	11	101
Double-crested Cormorant	*Phalacrocorax auritus*	Not Listed	Least Concern	2	2	0
Pelagic Cormorant	*Phalacrocorax pelagicus*	Not Listed	Least Concern	0	0	7
Brandts Cormorant	*Phalacrocorax penicillatus*	Not Listed	Least Concern	7	0	0
Lesser Goldfinch	*Spinus psaltria*	Not Listed	Least Concern	0	1	0
Brown Booby	*Sula leucogaster*	Not Listed	Least Concern	0	4	3
Ancient Murrelet	*Synthliboramphus antiquus*	Not Listed	Least Concern	0	0	1
Common Murre	*Uria aalge*	Not Listed	Least Concern	62	6	96

Seabird Management

NOAA's National Marine Fisheries Service is responsible for managing marine ecosystems, including accounting for all fisheries bycatch, including seabirds. NOAA Fisheries works closely with the primary agency responsible for seabird management, USFWS, to assist in seabird management.

Currently, there are multiple U.S. laws, U.S. regulations and NOAA policies that govern seabird bycatch in commercial fisheries, including:

- Migratory Bird Treaty Act of 1918 (MBTA)
- Endangered Species Act (ESA) of 1973
- U.S. National Plan of Action for Reducing the Incidental Catch of Seabirds in Longline Fisheries (NPOA-Seabirds)
- Executive Order 13186 "Responsibilities of Federal Agencies to Protect Migratory Birds"
- NOAA Fisheries' National Bycatch Strategy
- Magnuson-Stevens Act
- National Environmental Policy Act
- Fish and Wildlife Coordination Act
- National Marine Sanctuaries Act
- USFWS's List of Birds of Conservation Concern (USFWS 2008)

The MBTA, passed in 1918, affirms and implements the US's commitment to four international conventions with Canada, Japan, Mexico, and Russia for the protection of a shared migratory bird resource. The MBTA protects all migratory birds and their parts (including eggs, nests, and feathers). Migratory birds live, reproduce, or migrate across international borders at some point during their annual life cycle. In total, 836 bird species are protected under the MBTA. The MBTA applies to the area in US coastal waters extending 3 miles from shore and violations carry criminal penalties.

The purpose of the ESA (1973) is to protect and recover imperiled species and the ecosystems upon which they depend. Currently, there are over 1400 species in the United States listed as threatened or endangered under the ESA. The ESA offers seabirds additional protective measures beyond the MBTA. The ESA protects imperiled species and the ecosystems upon which they depend. The ESA authorizes protective measures for

listed species, which include restrictions on taking, transporting, or selling specimens. The USFWS has jurisdiction over all endangered birds in the US, including the Short-tailed albatross, which is found along the US West Coast and overlaps and interacts with US West Coast groundfish fisheries

U.S. West Coast Fisheries Management

Fishery Descriptions

The west coast groundfish fishery is a multi-species fishery that utilizes a variety of gear types (Appendix apdx:sector). The fishery harvests species designated in the Pacific Coast Groundfish Fishery Management Plan (FMP; PFMC 2016) and is managed by the Pacific Fishery Management Council (PFMC). Over 90 species are listed in the groundfish FMP, including a variety of rockfish, flatfish, roundfish, skates, and sharks. These species are found in both federal (>4.8 km off-shore t the EEZ) and state waters (0-4.8 km). Groundfish are both targeted and caught incidentally by trawl nets, hook-and-line gears, and fish pots. Under the FMP, the groundfish fishery consists of four management components:

- The Limited Entry (LE) component encompasses all commercial fisheries who hold a federal limited entry permit. The total number of limited entry permits available is restricted. Vessels with an LE permit are allocated a larger portion of the total allowable catch for commercially desirable species than vessels without an LE permit.
- The Open Access (OA) component encompasses commercial fishers who do not hold a federal LE permit. Some states require fishers to carry a state issued permit for certain OA sectors.
- The Recreational component includes recreational anglers who target or incidentally catch groundfish species. Estimates of seabird bycatch in recreational fisheries are not covered by this report.
- The Tribal component includes native tribal commercial fishers in Washington state that have treaty rights to fish groundfish. Estimates of seabird bycatch from tribal fisheries are not included in this report.

The LE and OA components can be further subdivided into sectors based on gear type, target species, permits and other regulatory factors. Sectors are described in detail in each of the gear-specific sections. In 2011, the limited entry (LE) bottom trawl sector of the US West Coast groundfish fishery began fishing under an Individual Fishing Quota (IFQ) management program. An IFQ is defined as a federal permit under a limited access system to harvest a quantity of fish, representing a portion of the total allowable catch

of a fishery that can be received or held for exclusive use by a person (MSA 16 UIC 1802(23)). The implementation of the IFQ management program in 2011 resulted in a mandate that vessels must carry NMFS observers on all IFQ fishing trips. Prior to the IFQ program, vessels in this sector could only fish with bottom trawl gear. Since the IFQ implementation, bottom and midwater trawl, as well as hook-and-line and pot gears are allowed to be fished under this permit.

A description of each fishery sector permits, gears, target species, vessel length, fishing depths and management is given in Appendix .

Northwest Fisheries Science Center (NWFSC) Groundfish Observer Program

The NWFSC Groundfish Observer Program places at-sea observers on commercial sectors that target or take groundfish as bycatch in the US West Coast EEZ. At-sea observer data provides critical data for independent estimates of the amount and types of species caught and discarded in these fisheries. The observer program has two units: the At-Sea Hake Observer Program (A-SHOP) and the West Coast Groundfish Observer Program (WCGOP). The WCGOP and A-SHOP observe distinct sectors of the groundfish fishery (Appendix).

The A-SHOP observes the fishery that catches and delivers Pacific hake (a.k.a. Pacific whiting, *Merluccius productus*, henceforth referred to as hake) at-sea including non-tribal catcher-processor and mothership vessels (Appendix). The A-SHOP has conducted observations of the US West Coast at-sea hake fishery since 2001. Prior to 2001, observer coverage of the US West Coast at-sea hake fishery was conducted by the North Pacific Groundfish Observer Program. Curreent A-SHOP program information and documentation on data collection methods can be found in the A-SHOP observer manual (NWFSC, 2017a). The at-sea hake fishery has mandatory observer coverage, with each vessel over 38 meters carrying two observers. Beginning in 2011, under IFQ/Co-op Program management, all catcher vessels that deliver catch to motherships are required to carry observers or use electronic monitoring equipment.

Observers on at-sea hake vessels take a random sample of the total catch, including both the component that will be retained and that which will be discarded. With one or two observers on-board each vessel, nearly 100% of tows are sampled. However, because of the large volume of catch from each tow, it is only possible to sample 30 to 60% of the total tow catch. When a sample is collected, the various species within it are weighed and recorded. The resulting data are expanded to the tow level and used to summarize catch by species in the fleet as a whole.

The WCGOP program was established in May 2001 by NOAA Fisheries (a.k.a., Na-

tional Marine Fisheries Service, NMFS) in accordance with the Pacific Coast Groundfish Fishery Management Plan (50 CFR Part 660) (50 FR 20609). This regulation requires all vessels that catch groundfish in the US EEZ from 4.8-322 km offshore carry an observer when notified to do so by NMFS or its designated agent. Subsequent state rule making has extended NMFS's ability to require vessels fishing in the 0-4.8 km state territorial zone to carry observers.

The NWFSC Groundfish Observer Program collects at-sea data to improve estimates of total catch and discard and inform fisheries management by observing groundfish fisheries along the US West Coast. The WCGOP observes multiple Federal groundfish fisheries, including: IFQ shoreside delivery of groundfish and Pacific hake, LE and OA fixed gear (Appendix). The WCGOP also observes several state-permitted fisheries that incidentally catch groundfish, including the Oregon and California nearshore fixed gear sectors, California halibut trawl and pink shrimp trawl fisheries (Appendix).

Similar to the at-sea hake fleet, shoreside IFQ vessels are required to carry an observer on 100% of fishing trips. In 2015, some vessels obtained an exempted fishing permit (EFP) which allowed them to carry electronic monitoring (EM) equipment for catch monitoring in lieu of an observer and EM continues to be used by a portion of the IFQ fleet. In non-IFQ fishery sectors, there is no mandate for 100% coverage and the amount of observer coverage varies among sectors and within sectors among years (Somers et al., 2017b). In these sectors, permits are selected for observation by the WCGOP using a random sampling design without replacement. First, the WCGOP determines the amount of time (based on available resources) it will take to observe the entire fleet; this is termed the selection cycle. Next, the WCGOP aggregates locations along the US West Coast into port groups. The permits or vessels in each fishery sector are assigned to a port group based on the location of their previous year's landings. Within each port group, the permits or vessels are randomly selected for coverage. The LE bottom trawl prior to the IFQ program (2002-2010), LE sablefish fixed gear non-endorsed (non-primary), OA fixed gear, Oregon and California nearshore, California halibut, and pink shrimp sectors are selected for one or two month periods, which coincide with cumulative trip limit periods used in management. LE fixed gear sablefish endorsed (primary) permits are selected for the entire sablefish season (April 1 through October 31) until their quota is caught. This selection process is designed to produce a logistically feasible sampling plan with a distribution of observations throughout the entire geographic and temporal range of each fishery sector. Once a permit or vessel has been selected for coverage, the WCGOP attempts to observe all trips and sets that vessel makes during the coverage period.

The annual percentage of observer coverage in non-hake fishery sectors ranges from 0 to 30% (Somers et al., 2017b), as defined by the proportion of fishery landings that are observed. Coverage varies among sectors based on priority. Higher priority sectors receive the highest observer coverage (see sector tables in Appendix B). A list of fish-

ery sectors in order of coverage priority can be found in the WCGOP manual (NWFSC, 2017b).

Fisheries observers monitor and record catch data on commercial fishing vessels by following protocols in the WCGOP manual (NWFSC, 2017b). Observer sampling focuses on discarded catch and supplements existing fish ticket landing receipt data to inform weights of retained catch. Observers generally sample 100% of tows/sets made during a trip. On trawlers, the total weight of discarded catch is estimated, and the discarded catch is then sampled for species composition. The species composition sample could represent either a census or a subsample of all discarded catch. On fixed gear vessels (hook-and-line and pot gears), observers sample total catch (similar to at-sea hake observer sampling methodology) and sample anywhere from 30 to 100% of the catch from each set.

Seabird Mortality

Observer Sampling for Seabirds

All observers receive training on seabird data collection and identification, including the three ESA-listed species: short-tailed albatross, California least tern, and marbled murrelet. WCGOP places sampling seabirds and other protected species as the highest priority of observer duties. Observers sample and document seabirds when the following occur:

- Fishing gear catches any seabird, regardless of whether the individual lived or died.
- A seabird interacted with the fishing vessel but was not caught in the gear.
- An ESA-listed seabird is sighted.

Observers identify each bird to species or the lowest possible taxonomic unit, and they count, weigh (if bird in hand), and photograph the bird(s). If the seabird has a tag or band, observers remove (dead birds only) or document tag number(s) and/or band color(s) and note the banding pattern (which leg(s), order of colored bands, etc.). Bird band numbers, colors, and associated information are reported to NWFSC and USFWS staff. Observers must document all sightings of ESA endangered or threatened seabirds (Table 2). When time allows, sightings can be documented on other seabird species.

Observed Fishery Interactions

Observers record a variety of fishery interactions with seabirds. Both observer programs use a system of coded categories to document interactions:

- *Lethal Removal-Not Trailing Gear*: Animal(s) killed by vessel personnel to prevent serious damage to or loss of gear, catch, or human life. No gear attached to animal(s).
- *Lethal Removal-Trailing Gear*: Animal(s) killed by vessel personnel to prevent serious damage to or loss of gear, catch, or human life. Pieces of gear, including parts of net or line, attached to animal(s) when returned to sea.
- *Killed by Gear*
- *Vessel Strike*: Individual is struck by some part of the vessel, including hull, mast, rigging or cables.
- *Rig Strike* (currently only used in A-SHOP): Individual made contact with vessel's rigging, excluding third wire, paravane, or warp cable interactions.
- *Third Wire, Paravane, or Warp Cable Contact* (currently only used in A-SHOP): Individual came in contact with the third wire, paravane, or warp cables.
- *Entangled in Gear - Not Trailing Gear*: Animal(s) entrapped or entangled in fishing gear, but escapes or is released alive. Includes instances where an individual is hooked. No gear attached to animal(s) when returned to sea.
- *Entangled in Gear - Trailing Gear*: Animal(s) entrapped or entangled in fishing gear, but escapes or is released alive. Includes instances where an individual is hooked. Pieces of gear, including parts of net or line, attached to animal(s) when returned to sea.
- *Feeding on Bait - Attached to Hook*
- *Feeding on Bait - Floating Free*
- *Feeding on Discarded Catch*
- *Feeding on Offal*: Animal(s) feeding on the discarded products of fish processing (e.g., fish guts).
- *Feeding on Catch*: Animal(s) feeding on fish prior to the fish being brought on-board vessel.
- *Foraging, Not Bait* (currently only used in A-SHOP): Bird was foraging or feeding near the vessel but not feeding on bait or discards.
- *Deterrence Used*: Vessel personnel attempted to deter interaction with individual(s) using: Firearm, Gaff, Acoustic Device, Yelling, or Other method.
- *Boarded Vessel*: Individual(s) boarded the fishing vessel of own volition.

- *Unknown*: The vessel or vessel personnel interacted with individual(s), but the observer did not directly view the interaction nor ascertain what the interaction was. Observer notes describe interaction details when possible.
- *Other*: Animal(s) involved in interaction(s) with the vessel; however, the interaction(s) type is not included in list of interaction codes. Observer notes describe interaction details when possible.
- *Sighting Only*: Animal did not interact with vessel but individual(s) was within observation distance of vessel and/or observer.

Interactions need to be screened for inclusion (or exclusion) from bycatch estimation, as not all interactions would lead to mortality. To aid this process, in 2015, WCGOP deployed a protocol to record one of five possible outcomes of the interaction:

1. *Alive - No visible signs of injury*: Individual(s) alive and showing no visible signs of injury because of the interaction.
2. *Alive - Visible signs of injury*: Individual(s) alive, but showing signs of injury that might be a result of the interaction.
3. *Dead or Unresponsive Carcass*: Individual(s) dead or unresponsive.
4. *Not Applicable*: Code only used for sightings.
5. *Unknown*: Observer is unsure of outcome. Observer notes describe interaction details when possible.

A-SHOP observers began recording one of six possible interaction outcomes in 2010:

1. *Flew Off*: Individual flew off or left the immediate area of the interaction.
2. *Released Flew Off*: Any bird that was removed from the vessel or gear and flew off upon release.
3. *Released To Water*: Individual was removed from the vessel or gear and returned to the water.
4. *Died*
5. *Carcass Salvaged*: Whole specimen of dead birds was recovered and preserved.
6. *Observer End Observing*: Observer stops recording the event because other duties take priority. Common outcome for sightings.

We defined any interaction that was immediately lethal or thought to lead to mortality, as a mortality, even if the animal was currently alive at the time of the observation. Using language adopted from the ESA, we refer to these lethal interactions as 'takes'. Section 3 of the ESA specifies the term 'take' to mean 'harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct' (16 USC 1532). We identified any ESA-listed seabird species (Table 2) interacting with a vessel consistent with this definition as a take. The combination of the interaction category, interaction outcome, and specific details in observer notes recorded at the time of the interaction informed take designations. For most interactions, the interaction category in combination with the interaction outcome was sufficient to make the determination. In other instances, the observer notes recorded at the time of the interaction indicated that the interaction resulted in, or was likely to result in, the mortality of the animal. Observers typically detail the nature of the injury and changes in the animal's behavior following its release. Noted factors indicating a potential mortality included birds with bleeding, broken bones, lost feathers, and birds that did not fly away or return to normal behavior within a few minutes of the interaction. Not all interactions resulted in a mortality and were thus judged to be non-lethal (i.e., not a take).

For ESA listed seabirds, observers are instructed to collect and freeze the carcass of any dead birds and transfer them to the USFWS. Regulations also require observers to care for any short-tailed albatross (STAL) brought on board injured until USFWS takes possession. The WCGOP (NWFSC, 2017b) and A-SHOP (NWFSC, 2017a) sampling manuals describe protocols for the collection of dead and care of injured ESA-listed seabirds.

Opportunistic Takes For takes to be used in bycatch estimation, they must either be randomly sampled or represent a complete census of the haul. In some cases observers witness seabird interactions that occur outside of the sampled catch (e.g., informed of an interaction by the crew, observed an interaction while on deck, bird struck vessel or rigging, etc.). Observers record these non-random, opportunistic observations of seabird takes whenever they occur. Opportunistic data are excluded from bycatch expansion because they are not randomly sampled. However, opportunistic samples are included in the bycatch estimate, by simply adding the number of opportunistic takes to the expanded take estimate. Tables in Appendix present both the randomly sampled and opportunistically sampled seabird takes by year, fishery sector and gear type. Figure 62 in Appendix presents opportunistic samples as a proportion of all samples across all fishery sectors by year for albatross and other bird species.

Seabird Bycatch

In past reports, we used ratio estimators to estimate bycatch (e.g., Jannot et al. 2011). However, in this report we applied a Bayesian modeling approach to estimate total bycatch and associated error for fisheries sectors with less than 100% observer monitoring. These methods have been used with other rare bycatch species, including cetaceans, delphinids, pinnipeds, sea turtles, and sharks (Martin et al. 2015). We modeled bycatch rate as constant and inferred annual expected mortality, given a specified level of effort. Fleet-wide bycatch for fisheries with less than 100% observer coverage was estimated using observer coverage rate (observed landings/total landings). All estimates reported in the tables are based on the Bayesian estimates ($\pm$95% confidence limits).

Even though ratio estimators have been widely used in discard estimation (Stratoudakis et al., 1999; Borges et al., 2005; Walmsley et al., 2007), including in the U.S. West Coast groundfish fisheries (e.g., Jannot et al., 2011), ratio estimators are known to have some issues, especially when bycatch events are rare(Martin et al. 2015, Carretta and Moore 2014, Rochet and Trenkel, 2005). Ratio estimators rely heavily on the assumption that bycatch is proportional to some metric or proxy of fishing effort, such as fishery landings, an assumption not often supported by data (Rochet and Trenkel, 2005). In some cases, bycatch might vary nonlinearly or even be unrelated to the ratio estimator denominator. Most seabird species reported here are rarely or sporadically caught. The rarity of seabird bycatch combined with less than 100% observer monitoring in many of these fisheries makes it difficult to assess the link between seabird bycatch and fishing effort. Low levels of observer coverage can produce biased estimates when ratio estimators are used to calculate fleet-wide bycatch of protected species (Carretta and Moore 2014, Martin et al. 2015).

As noted above, seabird bycatch can occur by a variety of means. In addition, seabird species vary in susceptibility to fishing mortality. Fishing behavior and methods, gear type, time, and weather all contribute to the probability of seabird mortality. In addition, species-specific characteristics such as feeding locations and times, diet preferences, size, and individual physical condition also play a role in susceptibility. Albatross populations are especially vulnerable to the impact of bycatch mortality because they exhibit delayed maturity, low annual fecundity, and long life spans —life history characteristics that make populations vulnerable to decline from even small increases in mortality. Commercial fisheries have been implicated in the decline of many albatross and petrel species (Weimerskirch et al., 1997; Lewison and Crowder, 2003; Baker et al., 2007). Fifteen of 22 albatross species (Family Diomedeidae) are threatened with extinction, which is one of the highest proportions for any bird family (Butchart et al., 2004; Croxall et al., 2012; Phillips, 2013; IUCN, 2017). Because albatross are one of the most threatened groups of seabirds and the most frequently caught group along the U.S. West Coast (Table 3, Figure 2), we present results for the three albatross species combined and compare those

results with patterns of bycatch for non-albatross birds combined.

Total Fishing Mortality

Total seabird mortality for all species across all fisheries, is shown, by year in Table 3. Estimates in Table 3 are the combined sum of the observed mortality of individuals from 100% observed fisheries, the sum of the opportunistically sampled individuals, and the mortality estimated from randomly sampled individuals in fisheries with less than 100% observer coverage. The 'exact' confidence intervals are given as "lower confidence limit (LCL) –upper confidence limit (UCL)" in the adjacent column of Table 3 and as a grey ribbon around the lines in Figure 2. Details of the confidence interval calculations can be found in the Methods section.

Table 3: Estimated seabird mortality in U.S. West Coast groundfish fisheries 2010-2016. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 17. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	All Sectors, All Gears													
	2010		2011		2012		2013		2014		2015		2016	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	156.93	133.3-183.5	166.32	142-193.6	136.50	114.6-161.4	93.29	75.3-114.2	79.16	62.7-98.6	100.13	81.5-121.8	94.23	76.2-115.3
Laysan Albatross	0.58	0-4.8	0.58	0-4.8	2.51	0.4-8	1.37	0.1-6.2	0.34	0-4.4	0.33	0-4.3	0.41	0-4.5
Short-tailed Albatross	0.32	0-4.3	1.32	0.1-6.1	0.29	0-4.3	0.21	0-4.1	0.19	0-4.1	0.18	0-4	0.23	0-4.1
Storm-Petrel Unid	0.68	0-5	0.00	0-3.7	0.00	0-3.7	2.04	0.3-7.3	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7
Pink-footed Shearwater	5.08	1.7-11.8	7.46	3.1-15	7.92	3.4-15.7	5.27	1.8-12.1	4.84	1.5-11.4	5.62	2-12.5	3.81	1-10
Sooty Shearwater	27.55	18.2-39.9	34.64	24.1-48.3	44.02	32-59.1	56.23	42.5-73	50.97	37.9-67	59.03	44.9-76.1	29.02	19.4-41.7
Shearwater Unid	57.73	43.8-74.7	72.21	56.5-90.9	48.18	35.5-63.8	52.69	39.4-69	48.45	35.8-64.2	54.00	40.6-70.5	46.26	33.9-61.7
Northern Fulmar	20.24	12.4-31.2	31.33	21.3-44.4	14.18	7.8-23.7	53.52	40.2-69.9	5.77	2.1-12.7	14.39	7.9-24	10.77	5.3-19.4
Tubenoses Unid	0.00	0-3.7	4.00	1.1-10.2	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7
Common Murre	13.09	7-22.3	10.26	5-18.7	7.07	2.9-14.5	9.19	4.2-17.3	8.34	3.7-16.2	15.50	8.8-25.4	10.22	5-18.7
Murre Unid	0.00	0	0.00	0-3.7	1.07	0-5.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7
Auklet/Murrelet Unid	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7
Alcid Unid	0.55	0-4.8	2.54	0.4-8.1	0.50	0-4.7	0.35	0-4.4	0.33	0-4.3	0.31	0-4.3	0.40	0-4.5
Brandts Cormorant	8.77	4-16.8	8.03	3.5-15.8	7.38	3.1-14.9	7.75	3.3-15.4	12.48	6.5-21.6	11.22	5.6-20	7.81	3.3-15.5
Double-crested Cormorant	5.98	2.2-13	6.84	2.7-14.2	7.29	3-14.8	5.38	1.8-12.2	5.45	1.9-12.3	5.07	1.7-11.8	4.90	1.6-11.5
Cormorant Unid	14.58	8.1-24.2	13.17	7-22.4	12.13	6.3-21.1	11.53	5.9-20.4	11.73	6-20.6	11.57	5.9-20.4	12.76	6.7-21.9
California Gull	0.31	0-4.3	0.31	0-4.3	1.29	0.1-6.1	0.20	0-4.1	1.21	0.1-5.9	0.18	0-4.1	0.23	0-4.1
Glaucous-winged Gull	3.04	0.6-8.8	1.01	0-5.6	2.92	0.6-8.6	0.64	0-4.9	0.59	0-4.8	0.59	0-4.8	0.74	0-5.1
Mew Gull	0.00	0	1.00	0-5.6	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7
Ring-billed Gull	0.33	0-4.3	0.33	0-4.3	1.30	0.1-6.1	0.22	0-4.1	0.20	0-4.1	0.18	0-4.1	0.24	0-4.2
Western Gull	16.16	9.3-26.2	23.59	15.1-35.2	64.72	49.9-82.5	13.53	7.3-22.9	13.13	7-22.4	16.03	9.2-26	13.82	7.5-23.3
Gull Unid	20.17	12.3-31.1	29.52	19.8-42.3	22.98	14.6-34.5	15.38	8.7-25.2	18.08	10.7-28.5	22.31	14-33.7	17.93	10.6-28.4
Brown Pelican	12.92	6.9-22.1	13.80	7.5-23.2	11.78	6-20.7	11.57	5.9-20.4	10.36	5-18.9	11.17	5.6-19.9	10.17	4.9-18.6
Common Loon	2.01	0.2-7.2	2.90	0.6-8.6	1.61	0.1-6.6	1.83	0.2-7	2.06	0.3-7.3	2.74	0.5-8.4	2.13	0.3-7.4
Green-winged Teal	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
White-winged Scoter	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Red-necked Phalarope	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	1.00	0-5.6
Bird Unid	3.81	1-10	5.32	1.8-12.1	3.07	0.6-8.9	4.02	1.1-10.3	4.78	1.5-11.4	4.78	1.5-11.4	2.71	0.5-8.3
Arctic Herring Gull	2.01	0.2-7.2	3.02	0.6-8.8	9.77	4.6-18.1	5.25	1.8-12	1.16	0-5.8	1.15	0-5.8	1.45	0.1-6.3
Cassin's Auklet	1.00	0-5.6	0.00	0-3.7	0.00	0-3.7	2.00	0.2-7.2	2.00	0.2-7.2	0.00	0-3.7	1.00	0-5.6
Leach's Storm-Petrel	3.76	1-9.9	0.00	0-3.7	0.00	0-3.7	2.00	0.2-7.2	0.00	0-3.7	2.00	0.2-7.2	5.00	1.6-11.7

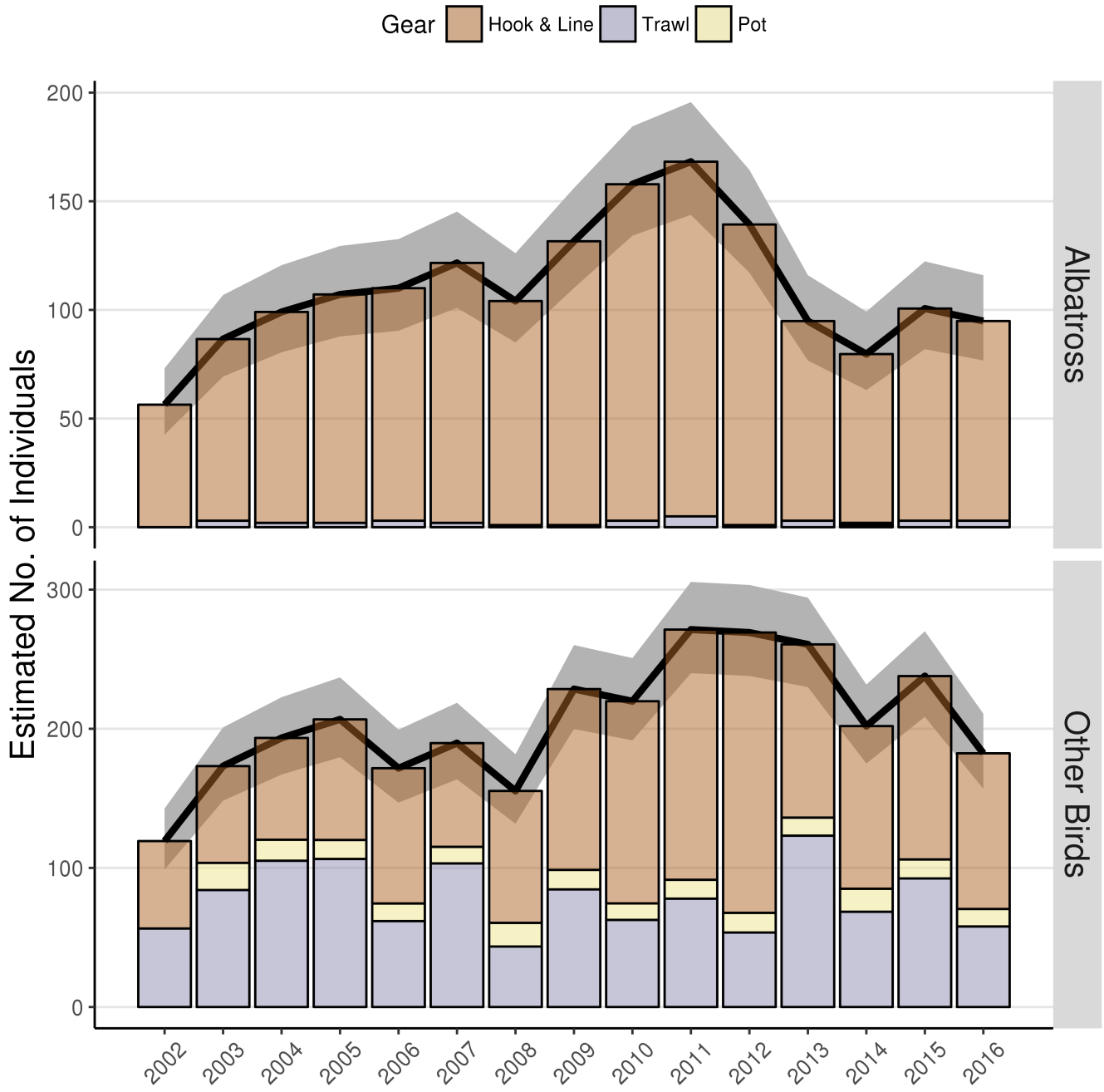


Figure 2: Total estimated seabird mortality (no. individuals = black line; grey ribbon = 95% confidence limits) from all sectors by gear type observed by the NWFSC Groundfish Observer Program. Values are reported in Table 3.

Black-footed albatross (BFAL) are the single most frequently caught species (Table 3). Across the time series, black-footed albatross mortality increased from a low of 56 black-footed albatross in 2002 to a high of 166 birds in 2011 with an annual average of 110 BFALs killed (LCL = 90.41, UCL = 132.58). Bycatch estimates of Laysan and short-tailed albatross were much smaller than black-footed estimates, an average of less than one per year of each species. Shearwaters, followed by gulls, northern fulmars, and murres make up the second, third, and fourth most common bird bycatch in these fisheries. In all, a total of 30 species or taxa have been observed as bycatch in at least one year during the 15 year period from 2002-2016 (Table 3).

Seabird Bycatch in Hook-and-Line Fisheries

Groundfish fisheries using hook-and-line gear on the US West Coast account for the majority of seabird bycatch among US groundfish fisheries. Hook-and-line fisheries were responsible for almost all of the albatross bycatch, which is largely black-footed albatross, as is shown by the overlapping lines and the bars touching the line in the top panel of Figure 2. Albatross mortality steadily increased from about 55 albatross in 2002 to a peak in 2011 of about 160 albatross, followed by a steady decline across years to a low of about 77 albatross killed in 2014. Ninety-seven and 91 albatross were killed in 2015 and 2016 respectively.

Hook-and-line vessels also contribute to a large fraction of the non-albatross mortality (Figure 2). Non-albatross seabirds also show a similar increase from about 60 non-albatross birds killed in 2002 rising to about 210 non-albatross seabirds killed in 2012. Non-albatross bird deaths decline from roughly 210 in 2012 to about 125 in 2013 and hovered between 125 to 150 birds per year for 2013 to 2016.

After black-footed albatross, annual bird bycatch on hook-and-line vessels was largely comprised of, in decreasing order, shearwaters, gulls, and cormorants (Tables 4 & 18). A smaller number of other species are killed annually with a total of 22 species or taxa observed as bycatch in these hook-and-line fisheries over the 15-year period (Tables 4 & 18).

Observed bycatch rates in hook-and-line fisheries are shown in Figure 4. These rates are calculated from the observed data and are not extrapolated to the fleet. Hook-and-line vessels fishing on the US West Coast are not required to maintain or submit logbooks and therefore hook counts for these fleets is not available. The international standard for reporting seabird bycatch on hook-and-line vessels is dead birds per 1000 hooks. To provide comparision of bycatch rates in our fisheries to global fisheries, we present the observed bycatch rates based on observed number of hooks as well as observed landed catch. Landed catch is the only measure available as a fleet-wide effort metric in these

fisheries (Somers et al. 2018) and as such, landed catch is used to expand the number of observed seabird takes to the fleet-wide estimate.

Table 4: Estimated seabird mortality in U.S. West Coast groundfish fishery sectors 2010-2016 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 18. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	All Sectors, Hook-and-Line Gears													
	2010		2011		2012		2013		2014		2015		2016	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	153.93	130.6-180.3	161.32	137.4-188.2	135.50	113.7-160.3	91.29	73.5-112	77.16	60.9-96.4	97.13	78.8-118.5	91.23	73.5-112
Laysan Albatross	0.58	0-4.8	0.58	0-4.8	2.51	0.4-8	0.37	0-4.4	0.34	0-4.4	0.33	0-4.3	0.41	0-4.5
Short-tailed Albatross	0.32	0-4.3	1.32	0.1-6.1	0.29	0-4.3	0.21	0-4.1	0.19	0-4.1	0.18	0-4	0.23	0-4.1
Pink-footed Shearwater	4.35	1.3-10.7	5.10	1.7-11.8	6.77	2.7-14.1	3.61	0.9-9.7	3.34	0.8-9.3	4.15	1.2-10.5	3.33	0.8-9.3
Sooty Shearwater	10.13	4.9-18.6	13.43	7.2-22.8	8.49	3.8-16.4	13.54	7.3-22.9	7.95	3.4-15.7	7.55	3.2-15.2	7.78	3.3-15.5
Shearwater Unid	56.21	42.5-73	69.95	54.5-88.4	45.88	33.6-61.2	47.37	34.8-62.9	43.90	31.9-58.9	51.36	38.3-67.5	42.60	30.8-57.5
Northern Fulmar	2.46	0.4-8	2.33	0.4-7.7	9.15	4.2-17.3	1.52	0.1-6.5	3.77	1-9.9	2.39	0.4-7.8	1.76	0.2-6.8
Common Murre	4.38	1.3-10.8	5.34	1.8-12.1	3.91	1-10.1	5.35	1.8-12.2	4.69	1.5-11.2	6.94	2.8-14.3	4.62	1.4-11.1
Alcid Unid	0.55	0-4.8	2.54	0.4-8.1	0.50	0-4.7	0.35	0-4.4	0.33	0-4.3	0.31	0-4.3	0.40	0-4.5
Brandts Cormorant	2.07	0.3-7.3	1.98	0.2-7.2	1.69	0.2-6.7	1.94	0.2-7.1	2.13	0.3-7.4	3.89	1-10.1	2.26	0.3-7.6
Double-crested Cormorant	3.82	1-10	4.73	1.5-11.3	4.29	1.2-10.7	3.40	0.8-9.4	3.20	0.7-9.1	2.88	0.6-8.6	3.01	0.6-8.8
Cormorant Unid	4.21	1.2-10.5	5.08	1.7-11.8	3.62	0.9-9.7	3.67	0.9-9.8	3.37	0.8-9.3	3.16	0.7-9	3.28	0.7-9.2
California Gull	0.31	0-4.3	0.31	0-4.3	1.29	0.1-6.1	0.20	0-4.1	0.18	0-4.1	0.18	0-4.1	0.23	0-4.1
Glaucous-winged Gull	3.04	0.6-8.8	1.01	0-5.6	2.92	0.6-8.6	0.64	0-4.9	0.59	0-4.8	0.59	0-4.8	0.74	0-5.1
Mew Gull	0.00	0	1.00	0-5.6	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Ring-billed Gull	0.33	0-4.3	0.33	0-4.3	1.30	0.1-6.1	0.22	0-4.1	0.20	0-4.1	0.18	0-4.1	0.24	0-4.2
Western Gull	14.77	8.2-24.5	22.80	14.4-34.3	63.99	49.3-81.7	12.70	6.7-21.9	12.40	6.5-21.5	15.34	8.6-25.2	12.12	6.3-21.1
Gull Unid	19.26	11.6-30	20.70	12.8-31.7	22.16	13.9-33.5	13.13	7-22.4	14.21	7.8-23.7	14.68	8.2-24.3	12.75	6.7-21.9
Brown Pelican	12.92	6.9-22.1	13.80	7.5-23.2	11.78	6-20.7	11.57	5.9-20.4	10.36	5-18.9	11.17	5.6-19.9	10.17	4.9-18.6
Common Loon	2.01	0.2-7.2	2.90	0.6-8.6	1.61	0.1-6.6	1.83	0.2-7	2.06	0.3-7.3	2.74	0.5-8.4	2.13	0.3-7.4
Red-necked Phalarope	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	1.00	0-5.6
Bird Unid	2.46	0.4-8	4.55	1.4-11	2.39	0.4-7.8	2.21	0.3-7.6	3.08	0.7-8.9	3.12	0.7-9	2.04	0.3-7.3
Arctic Herring Gull	2.01	0.2-7.2	1.95	0.2-7.1	9.77	4.6-18.1	1.25	0.1-6	1.16	0-5.8	1.15	0-5.8	1.45	0.1-6.3

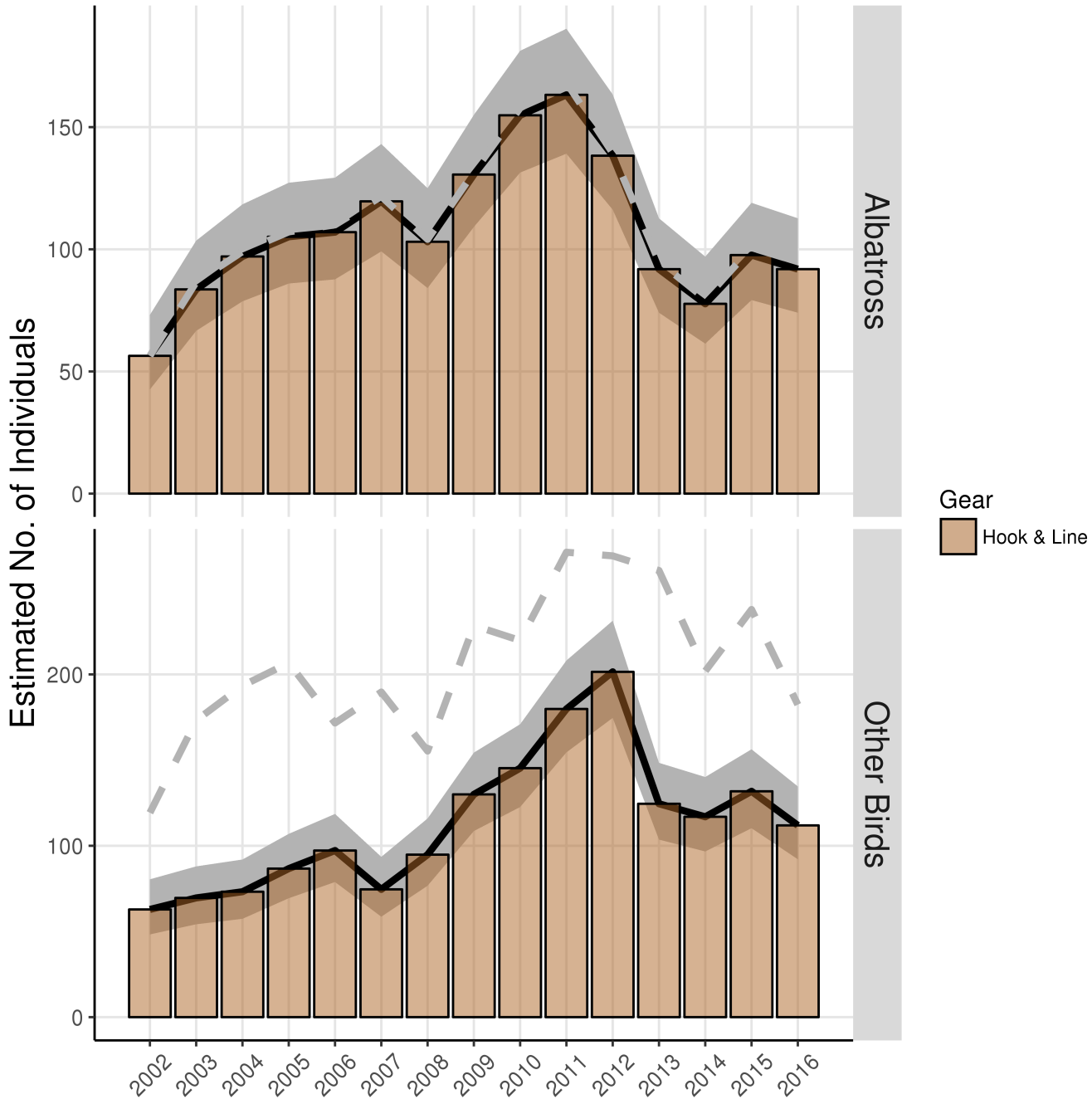


Figure 3: Total estimated seabird mortality from vessels using hook-and-line gear observed by the NWFSC Groundfish Observer Program. Dashed grey lines represent total bird mortality from all gear types and are the same as those shown in Figure 3. Solid black lines represent mortality from hook-and-line gears. Table 4 reports the values plotted in Figure 3.

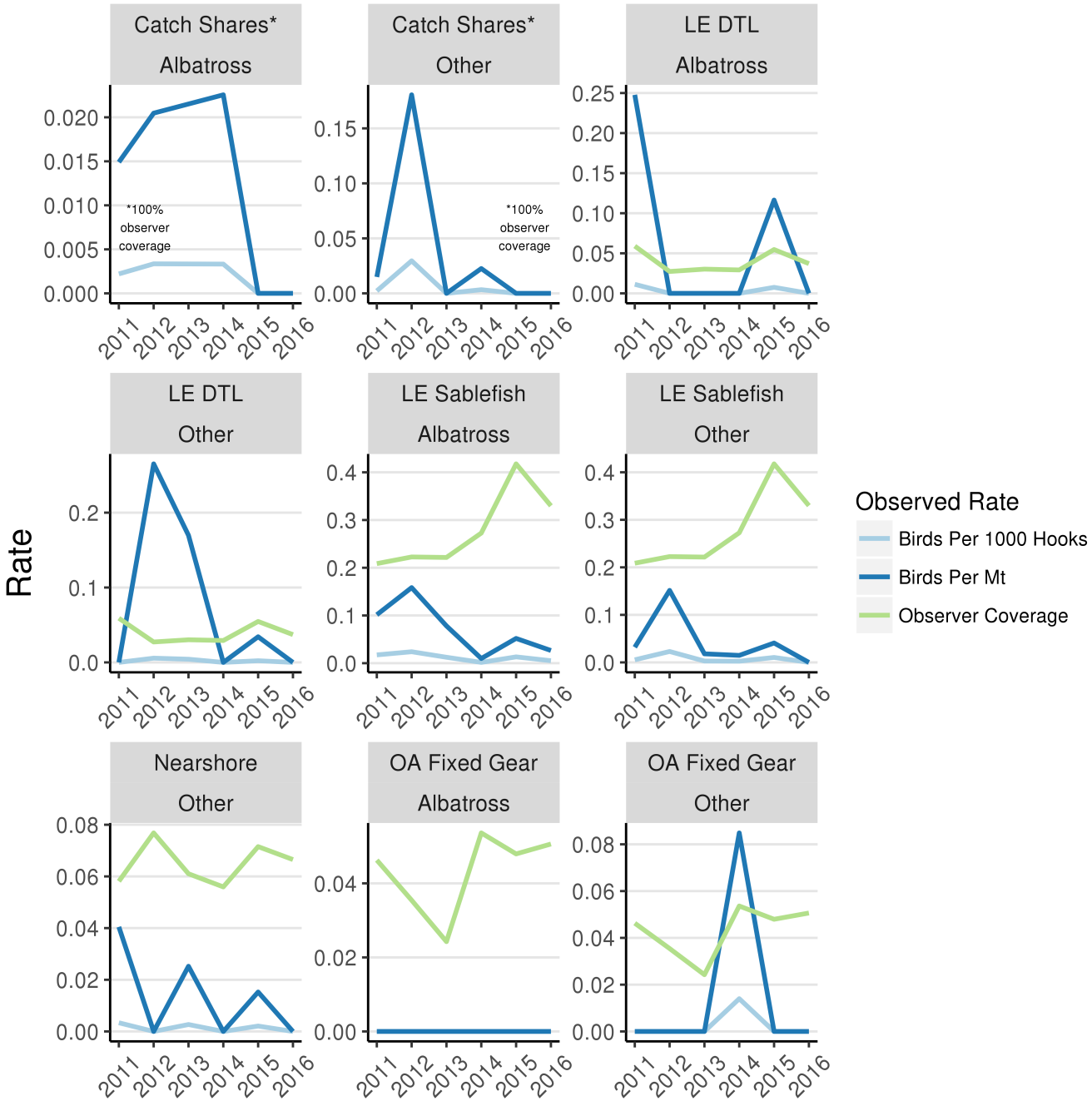


Figure 4: Albatross and other birds observed bycatch rates, as either number of observed birds per 1000 hooks or per metric ton of landed fish, from hook-and-line sectors observed by the NWFSC Groundfish Observer Program. Birds per 1000 hooks is the international standard for reporting seabird bycatch. Caution is necessary in interpreting observed birds per 1000 hooks in this figure because this is the observed hook rate. Fleet-wide estimates of the number of birds killed were obtained using number of birds per metric ton of landed fish because this is the only measure of effort readily available for the entire fleet. LE = Limited Entry, OA = Open Access, DTL = Daily Trip Limits.

Limited Entry Sablefish

The Limited Entry Sablefish Endorsed Fishery longline vessels target sablefish and deliver their catch to shore-based processors managed by a tiered-quota system. The fishing season is only open between April and October.

Black-footed albatross were the main species caught in the Limited Entry Sablefish fishery. Mean annual bycatch of in this fishery over the 15 year period was 74 BFAL (LCL = 58.11, UCL = 92.90; Tables 5 & Table 19). A single ESA-endangered short-tailed albatross was taken in the Limited Entry Sablefish Endorsed fishery in 2011 (Table 5); the only such take of this species observed in any US West Coast groundfish fishery. During the 2012 LE Sablefish season, a single dead Laysan albatross was observed in a random species composition sample which expanded up to 1.88 Laysan in the set (Table 5), giving an estimate of 2.51 Laysan killed (LCL = 0.4, UCL = 8.0) in 2012 by this fishery (Table 5).

Non-albatross species comprise a small amount of LE Sablefish bird bycatch mostly dominated by western and unidentified gulls, and more recently, northern fulmars and shearwaters (Tables 5 & 19). A total of 16 albatross and non-albatross species or taxa have been observed as bycatch in the LE Sablefish fishery over the 14-year period (Tables 5 & 19).

Table 5: Estimated seabird mortality in U.S. West Coast Limited Entry Sablefish fishery 2010-2016 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 19. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	Limited Entry Sablefish Hook-and-Line Gears													
	2010		**2011**		**2012**		**2013**		**2014**		**2015**		**2016**	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	95.16	77-116.3	82.21	65.4-102	90.17	72.5-110.8	50.97	37.9-67	37.18	26.2-51.2	55.44	41.8-72.1	53.54	40.2-69.9
Laysan Albatross	0.58	0-4.8	0.58	0-4.8	2.51	0.4-8	0.37	0-4.4	0.34	0-4.4	0.33	0-4.3	0.41	0-4.5
Short-tailed Albatross	0.32	0-4.3	1.32	0.1-6.1	0.29	0-4.3	0.21	0-4.1	0.19	0-4.1	0.18	0-4	0.23	0-4.1
Pink-footed Shearwater	0.85	0-5.3	0.82	0-5.3	3.74	1-9.9	0.54	0-4.7	0.49	0-4.7	0.48	0-4.6	0.61	0-4.9
Sooty Shearwater	0.78	0-5.2	1.76	0.2-6.8	0.70	0-5	2.49	0.4-8	0.45	0-4.6	0.44	0-4.6	0.56	0-4.8
Shearwater Unid	2.29	0.3-7.7	2.20	0.3-7.5	2.01	0.2-7.2	1.41	0.1-6.3	1.31	0.1-6.1	10.31	5-18.8	1.65	0.1-6.7
Northern Fulmar	2.46	0.4-8	2.33	0.4-7.7	9.15	4.2-17.3	1.52	0.1-6.5	1.39	0.1-6.2	2.39	0.4-7.8	1.76	0.2-6.8
Alcid Unid	0.55	0-4.8	2.54	0.4-8.1	0.50	0-4.7	0.35	0-4.4	0.33	0-4.3	0.31	0-4.3	0.40	0-4.5
Cormorant Unid	0.34	0-4.4	0.34	0-4.4	0.30	0-4.3	0.22	0-4.1	0.20	0-4.1	0.19	0-4.1	0.24	0-4.2
California Gull	0.31	0-4.3	0.31	0-4.3	1.29	0.1-6.1	0.20	0-4.1	0.18	0-4.1	0.18	0-4.1	0.23	0-4.1
Glaucous-winged Gull	3.04	0.6-8.8	1.01	0-5.6	2.92	0.6-8.6	0.64	0-4.9	0.59	0-4.8	0.59	0-4.8	0.74	0-5.1
Ring-billed Gull	0.33	0-4.3	0.33	0-4.3	1.30	0.1-6.1	0.22	0-4.1	0.20	0-4.1	0.18	0-4.1	0.24	0-4.2
Western Gull	5.27	1.8-12.1	8.07	3.5-15.9	14.59	8.1-24.2	4.23	1.2-10.6	3.98	1.1-10.2	6.00	2.2-13.1	3.78	1-9.9
Gull Unid	2.55	0.4-8.1	2.43	0.4-7.9	7.23	3-14.7	1.56	0.1-6.5	2.44	0.4-7.9	3.46	0.8-9.4	1.82	0.2-6.9
Red-necked Phalarope	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	1.00	0-5.6
Bird Unid	1.30	0.1-6.1	3.25	0.7-9.1	1.14	0-5.8	0.80	0-5.2	1.74	0.2-6.8	1.73	0.2-6.8	0.93	0-5.4
Arctic Herring Gull	2.01	0.2-7.2	1.95	0.2-7.1	9.77	4.6-18.1	1.25	0.1-6	1.16	0-5.8	1.15	0-5.8	1.45	0.1-6.3

Table 6: Estimated seabird mortality in U.S. West Coast Limited Entry Daily Trip Limits fishery 2010-2016 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 20. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	Limited Entry Daily Trip Limits Hook-and-Line Gears													
	2010		**2011**		**2012**		**2013**		**2014**		**2015**		**2016**	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	43.12	31.2-58.1	66.99	51.9-85.1	34.93	24.3-48.6	36.81	25.9-50.8	33.95	23.5-47.5	35.72	25-49.5	32.61	22.4-45.9
Pink-footed Shearwater	3.50	0.8-9.5	4.28	1.2-10.6	3.03	0.6-8.8	3.07	0.6-8.9	2.85	0.6-8.5	3.67	0.9-9.8	2.72	0.5-8.3
Sooty Shearwater	9.35	4.3-17.5	11.67	6-20.5	7.79	3.3-15.5	11.05	5.5-19.7	7.50	3.1-15.1	7.10	2.9-14.6	7.22	3-14.7
Shearwater Unid	53.92	40.5-70.4	67.76	52.6-85.9	43.86	31.9-58.9	45.96	33.6-61.3	42.59	30.8-57.4	41.05	29.5-55.7	40.94	29.4-55.6
Double-crested Cormorant	3.82	1-10	4.73	1.5-11.3	4.29	1.2-10.7	3.40	0.8-9.4	3.20	0.7-9.1	2.88	0.6-8.6	3.01	0.6-8.8
Cormorant Unid	3.87	1-10.1	4.74	1.5-11.3	3.31	0.8-9.2	3.45	0.8-9.4	3.17	0.7-9	2.97	0.6-8.7	3.04	0.6-8.8
Western Gull	6.22	2.3-13.4	7.71	3.3-15.4	5.20	1.7-11.9	5.44	1.9-12.3	5.05	1.7-11.7	4.72	1.5-11.3	4.80	1.5-11.4
Gull Unid	11.48	5.8-20.3	14.29	7.9-23.9	10.54	5.2-19.1	9.92	4.7-18.3	9.19	4.2-17.3	8.73	3.9-16.7	8.80	4-16.8
Brown Pelican	8.70	3.9-16.7	10.85	5.4-19.5	9.19	4.2-17.3	7.62	3.2-15.3	7.07	2.9-14.5	6.69	2.6-14	6.75	2.7-14.1

Limited Entry Daily Trip Limits (LE DTL)

Limited Entry DTL longline vessels target groundfish, primarily sablefish and thornyheads. These vessels have attained their annual sablefish quota limit and fish outside the normal LE sablefish season. Catch is delivered to shore-based processors or sold alive.

Unidentified shearwaters tops the list of species that are caught in this fishery followed by black-footed albatross, unidentified gulls, sooty shearwaters, brown pelicans, western gulls, unidentified cormorants, double-crested cormorants, and pink-footed shearwaters Tables 6 & 20.

Open Access Fixed Gears

OA fixed gear vessels use a variety of fixed gear with hooks, including longlines, fishing poles, stick gear, etc. These vessels target non-nearshore groundfish and deliver their catch to shore-based processors.

Only two bird species have been observed caught in the OA fixed gear fishery: black-footed albatross and unidentified gulls (Tables 7 & 21).

Table 7: Estimated seabird mortality in U.S. West Coast Open Access Fixed Gear fishery 2010-2016 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 21. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	Open Access Fixed Gear Hook-and-Line Gears													
	2010		**2011**		**2012**		**2013**		**2014**		**2015**		**2016**	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	14.65	8.1-24.3	7.12	2.9-14.6	5.46	1.9-12.3	3.51	0.8-9.5	3.65	0.9-9.7	5.97	2.2-13	5.09	1.7-11.8
Gull Unid	5.23	1.8-12	2.98	0.6-8.7	2.39	0.4-7.8	1.65	0.1-6.7	2.58	0.4-8.1	2.50	0.4-8	2.13	0.3-7.4

Catch Shares Hook-and-Line

Hook-and-line longline vessels that hold individual fishing quotas (IFQs) primarily target groundfish species, mainly sablefish, and deliver to shore-based processors.

Black-footed albatross, northern fulmars, mew gulls, western gulls, and unidentified gulls were observed as bycatch in this fishery (Table 8). This fishery has 100% observer coverage; therefore, the observed bycatch is a complete census of these vessels.

Table 8: Estimated seabird mortality in U.S. West Coast Catch Shares fishery 2011-2016 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Confidence Limits are not given because Catch Shares fisheries are 100% observed and therefore represent a complete census of seabird mortality.

	Catch Shares Hook-and-Line Gears					
	2011	**2012**	**2013**	**2014**	**2015**	**2016**
Species	Number	Number	Number	Number	Number	Number
Black-footed Albatross	5.00	4.94	0.00	2.38	0.00	0.00
Northern Fulmar	0.00	0.00	0.00	2.38	0.00	0.00
Mew Gull	1.00	0.00	0.00	0.00	0.00	0.00
Western Gull	3.00	41.55	0.00	0.00	0.00	0.00
Gull Unid	1.00	2.00	0.00	0.00	0.00	0.00

Nearshore

Nearshore fixed gear vessels using a variety of hook-and-line gear, including longline, fishing poles, stick gear, etc. targeting nearshore rockfish and other nearshore species managed by state permits in Oregon and California. A subset of vessels also use pot gear to mainly target California sheephead (*Semicossyphus pulcher*). Data from Nearshore pot vessels are combined with data from other pot fisheries and presented in the section on pot gear (below). Catch is delivered to shore-based processors or sold live. Washington does not allow nearshore commercial fixed gear fishing.

Historically, the WCGOP has split the fishery by state but combined hook-and-line with pot gears within states (Jannot et al. 2011, Somers et al. 2017). However, our work here shows that seabird mortality risk from hook-and-line is much greater than from pot gears (Tables 4 & 16). Therefore, we estimate seabird mortality separately for hook-and-line and pot gear types within this fishery.

Overall bycatch in the state-managed nearshore fisheries is low. In the Oregon nearshore fishery has only ever caught common murres, unidentified cormorants, and unidentified birds (Tables 9 & 22). In California nearshore fishery, common murres, Brandt's cormorant, double-crested cormorants, unidentified cormorants, western gulls, and common loons have all been observed as bycatch (Tables 9 & 22)

Table 9: Estimated seabird mortality in U.S. West Coast Nearshore fishery 2010-2016 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 22. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

		Nearshore Hook-and-Line Gears													
		2010		2011		2012		2013		2014		2015		2016	
State	Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
OR	Common Murre	1.15	0-5.8	2.29	0.3-7.7	1.26	0.1-6	1.38	0.1-6.2	1.36	0.1-6.2	1.40	0.1-6.3	1.11	0-5.8
OR	Bird Unid	1.17	0-5.9	1.29	0.1-6.1	1.26	0.1-6	1.41	0.1-6.3	1.34	0.1-6.2	1.39	0.1-6.2	1.11	0-5.8
CA	Common Murre	3.22	0.7-9.1	3.05	0.6-8.8	2.65	0.5-8.2	3.97	1.1-10.2	3.33	0.8-9.3	5.54	1.9-12.4	3.51	0.8-9.5
CA	Brandts Cormorant	2.07	0.3-7.3	1.98	0.2-7.2	1.69	0.2-6.7	1.94	0.2-7.1	2.13	0.3-7.4	3.89	1-10.1	2.26	0.3-7.6
CA	Western Gull	3.27	0.7-9.2	4.02	1.1-10.3	2.66	0.5-8.3	3.04	0.6-8.8	3.38	0.8-9.3	4.62	1.4-11.1	3.54	0.9-9.6
CA	Brown Pelican	4.22	1.2-10.6	2.94	0.6-8.7	2.59	0.4-8.1	3.96	1.1-10.2	3.29	0.7-9.2	4.49	1.3-10.9	3.42	0.8-9.4
CA	Common Loon	2.01	0.2-7.2	2.90	0.6-8.6	1.61	0.1-6.6	1.83	0.2-7	2.06	0.3-7.3	2.74	0.5-8.4	2.13	0.3-7.4

Seabird Bycatch in Trawl Fisheries

Early estimates indicated that potentially up to 45% of the global seabird bycatch occurs in trawl fisheries (Baker et al., 2007). The causes of seabird mortality in trawl fisheries can be broadly categorized into fatalities caused by birds colliding with net transponder cable, warp cables or paravanes; and mortalities caused by birds being trapped in the net, usually diving birds interacting with pelagic trawlers (Sullivan et al., 2006). Seabirds colliding with trawl transponder or warp cables often go unwitnessed. Birds colliding with cables are not typically captured by the gear which can result in unreported cryptic mortality not accounted for in fisheries management (Bartle, 1991; Melvin et al., 2011; Tamini et al., 2015). Seabirds in the air or on the water that strike a cable are rarely observed or recorded. Seabird cable strikes have been documented on mid-water trawl nets fishing for hake in the U.S. West Coast (WA, OR) at-sea hake catcher-processor fleet (J. Jannot, unpublished data) as well as similar trawl fisheries around the globe (Williams & Capdeville 1996, Melvin et al. 2011, Parker et al. 2013, Tamini et al. 2015).

Because at least some portion of seabird bycatch in trawl fisheries is likely to go unreported, our estimates of seabird bycatch in trawl fisheries are biased to the low end. We are currently studying cryptic seabird bycatch due to cable-strikes and will report our findings in the near future. Until then, estimates of seabird bycatch in trawl fisheries reported here should be considered an underestimate of the true numbers.

Northern fulmars and sooty shearwaters are the most frequently observed species in trawl bycatch, followed by common murres, gulls, and cormorants (Tables 10 & 23). A

smaller number of individuals, from 18 other species or taxa, were observed in these trawl fisheries over the 15-year period (Tables 10 & 23). In contrast to hook-and-line fisheries, trawl fisheries kill fewer albatross, only 0-3 black-footed annually, and only one Laysan albatross recorded in 2013 (Figure 5, Table 23). However, preliminary data from the at-sea hake fishery indicates that black-footed albatross frequently strike the transponder cable used in this fishery (J. Jannot, unpublished data). Therefore, mortalities of albatross reported here are likely an underestimate because these species might be more susceptible to cryptic mortality from cable-strikes.

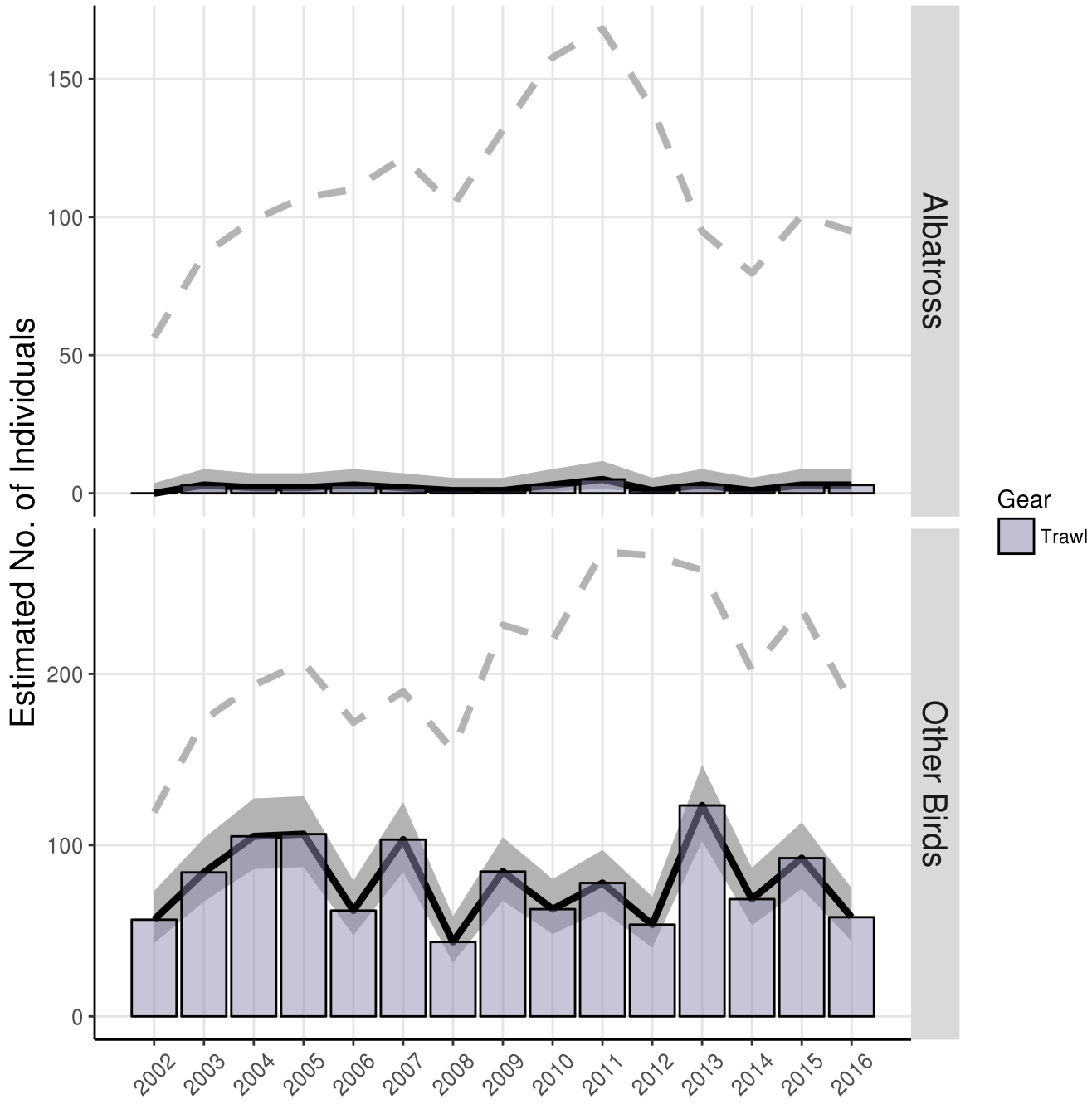


Figure 5: Total estimated seabird mortality from vessels using bottom, midwater, or shrimp trawl gear observed by the NWFSC Groundfish Observer Program. Dashed grey lines represent total bird mortality from all gear types and are the same as those shown in Figure 3. Solid black lines represent mortality from trawl gears. Values are reported in Table 10.

Table 10: Estimated seabird mortality in U.S. West Coast fishery 2010-2016 for vessels fishing with trawl gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 23. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	All Sectors, Trawl Gears													
	2010		2011		2012		2013		2014		2015		2016	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	3.00	0.6-8.8	5.00	1.6-11.7	1.00	0-5.6	2.00	0.2-7.2	1.00	0-5.6	3.00	0.6-8.8	4.00	1.1-10.2
Laysan Albatross	0.00	0	0.00	0	0.00	0	1.00	0-5.6	0.00	0	0.00	0	0.00	0
Storm-Petrel Unid	0.68	0-5	0.00	0	0.00	0	1.04	0-5.6	0.00	0	0.00	0	0.00	0
Pink-footed Shearwater	0.73	0-5.1	2.35	0.4-7.8	1.16	0-5.8	1.67	0.1-6.7	1.50	0.1-6.4	1.48	0.1-6.4	0.48	0-4.6
Sooty Shearwater	17.42	10.2-27.7	21.21	13.2-32.4	35.53	24.8-49.3	42.69	30.9-57.6	43.02	31.1-57.9	51.48	38.4-67.6	21.24	13.2-32.4
Shearwater Unid	1.52	0.1-6.4	2.26	0.3-7.6	2.31	0.3-7.7	5.32	1.8-12.1	4.56	1.4-11	2.64	0.5-8.2	3.66	0.9-9.7
Northern Fulmar	17.78	10.5-28.2	27.00	17.8-39.3	5.03	1.6-11.7	52.00	38.8-68.2	2.00	0.2-7.2	12.00	6.2-21	9.01	4.1-17.1
Tubenoses Unid	0.00	0-3.7	4.00	1.1-10.2	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7
Common Murre	8.72	3.9-16.7	4.92	1.6-11.6	3.16	0.7-9	3.84	1-10	3.66	0.9-9.7	8.56	3.8-16.5	5.61	2-12.5
Murre Unid	0.00	0	0.00	0	1.07	0-5.7	0.00	0	0.00	0	0.00	0	0.00	0
Auklet/Murrelet Unid	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7
Brandts Cormorant	2.26	0.3-7.6	1.31	0.1-6.1	1.12	0-5.8	1.35	0.1-6.2	2.22	0.3-7.6	2.15	0.3-7.5	1.18	0-5.9
Cormorant Unid	5.09	1.7-11.8	2.39	0.4-7.8	1.95	0.2-7.2	2.38	0.4-7.8	2.21	0.3-7.6	2.13	0.3-7.4	3.18	0.7-9
California Gull	0.00	0	0.00	0	0.00	0	0.00	0	1.02	0-5.6	0.00	0	0.00	0
Western Gull	1.39	0.1-6.2	0.79	0-5.2	0.72	0-5.1	0.83	0-5.3	0.73	0-5.1	0.69	0-5	1.71	0.2-6.8
Gull Unid	0.91	0-5.4	8.82	4-16.8	0.82	0-5.3	2.25	0.3-7.6	3.88	1-10.1	7.63	3.2-15.3	5.17	1.7-11.9
Green-winged Teal	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
White-winged Scoter	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Bird Unid	1.34	0.1-6.2	0.77	0-5.2	0.68	0-5	1.81	0.2-6.9	1.69	0.2-6.7	1.66	0.1-6.7	0.67	0-5
Arctic Herring Gull	0.00	0	0.00	0	0.00	0	4.00	1.1-10.2	0.00	0	0.00	0	0.00	0
Cassin's Auklet	1.00	0-5.6	0.00	0-3.7	0.00	0-3.7	2.00	0.2-7.2	2.00	0.2-7.2	0.00	0-3.7	1.00	0-5.6
Leach's Storm-Petrel	3.76	1-9.9	0.00	0-3.7	0.00	0-3.7	2.00	0.2-7.2	0.00	0-3.7	2.00	0.2-7.2	5.00	1.6-11.7

At-sea Hake Fisheries

The At-sea hake fishery is comprised of three separate sectors. At-sea catcher-processors use midwater trawl nets to catch and process Pacific hake at sea. Catcher vessels use midwater trawl nets to catch P. hake and deliver unsorted catch to mothership processors at-sea. The catch is sorted and processed aboard the mothership. At-sea tribal vessels use midwater trawl nets to catch and process Pacific hake at sea by Native American tribes. The tribes must operate within defined boundaries in waters off northwest Washington. Seabird bycatch from at-sea tribal fisheries are *not included* in this report.

Black-footed albatross were the only species observed taken on at-sea catcher processor vessels with between one and five BFALs recorded during 2010-2016 (Table 11). The most frequently caught non-albatross species on these vessels were northern fulmars, followed by gulls (Tables 11 & 24). Very rarely, one to a few individuals of nine other taxa were observed taken annually on at-sea catcher processor vessels (Tables 11 & 24).

Table 11: Estimated seabird mortality in U.S. West Coast at-sea hake catcher processor vessels fishing with midwater trawl gear for 2010-2016 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 24. Confidence Limits are not given because At-sea fisheries are 100% observed and therefore represent a complete census of seabird mortality.

	At-sea Hake Midwater Trawl Gear Catcher Processors						
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Species	Number	Number	Number	Number	Number	Number	Number
Black-footed Albatross	3.00	5.00	1.00	2.00	1.00	1.00	2.00
Sooty Shearwater	0.00	0.00	0.00	1.00	0.00	0.00	0.00
Shearwater Unid	0.00	0.00	0.00	3.00	0.00	0.00	2.00
Northern Fulmar	17.00	27.00	2.00	52.00	2.00	12.00	9.01
Tubenoses Unid	0.00	4.00	0.00	0.00	0.00	0.00	0.00
Common Murre	2.00	0.00	0.00	0.00	0.00	0.00	0.00
Auklet/Murrelet Unid	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Gull Unid	0.00	8.00	0.00	1.00	0.00	4.00	4.00
Bird Unid	0.00	0.00	0.00	1.00	1.00	0.00	0.00
Arctic Herring Gull	0.00	0.00	0.00	4.00	0.00	0.00	0.00
Cassin's Auklet	0.00	0.00	0.00	2.00	0.00	0.00	0.00
Leach's Storm-Petrel	0.00	0.00	0.00	2.00	0.00	2.00	2.00

Albatross have not been observed taken on hake catcher vessels delivering to motherships at-sea (Tables 12 & 25). Seabird bycatch on these vessels is rarely observed, with only one to a few northern fulmars, common murres, Cassin's auklets, and unidentified birds observed taken on catcher vessels delivering to motherships at-sea in some, but not all, years (Tables 12 & 25).

Table 12: Estimated seabird mortality in U.S. West Coast At-sea hake catcher vessels fishing with midwater trawl gear and delivering to motherships for 2010-2016. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 25. Confidence Limits are not given because At-sea fisheries are 100% observed and therefore represent a complete census of seabird mortality.

	At-sea Hake Midwater Trawl Gear Catcher Vessels Delivering to Mothership						
	2010	2011	2012	2013	2014	2015	2016
Species	Number	Number	Number	Number	Number	Number	Number
Northern Fulmar	0.00	0.00	2.00	0.00	0.00	0.00	0.00
Common Murre	0.00	0.00	0.00	0.00	0.00	2.00	0.00
Bird Unid	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cassin's Auklet	0.00	0.00	0.00	0.00	2.00	0.00	1.00

Limited Entry and Catch Shares Trawl Fisheries

Limited Entry and Catch Shares bottom trawl vessels use nets to catch a variety of non-hake groundfish species. Catch is delivered to shore-based processors. From 2002-2010, the LE bottom trawl vessels were managed under trip-limits and annual catch limits and observer coverage rate varied from 10 to 25% of landings. Since 2011, the Catch Shares program requires bottom trawl vessels to possess individual fishing quota (IFQ) for all IFQ species landed and discarded at sea. The Catch Shares program also requires 100% observer coverage on all trips, unless vessels are participating in the Exempted Fishing Permit program that allows vessels to carry electronic monitoring (EM) equipment in lieu of an observer.

Some Catch Shares vessels use midwater trawl nets to target mid-water non-hake species, typically rockfish. Vessels must possess IFQ for all landed and discarded IFQ species. Landings of Pacific hake from these vessels are less than 50% (by weight) of total trip landings. Catch is delivered to shore-based processors.

Observers did not observe lethal interactions between seabirds and IFQ shoreside hake vessels, midwater rockfish vessels, or vessels carrying EM in lieu of an observer. Because the Limited Entry Trawl program was converted to Catch Shares in 2011, any seabird bycatch observed on vessels fishing in the Limited Entry California halibut fishery (see below) since 2011 were included with the Catch Shares trawl estimates shown here.

Both black-footed and Laysan albatross mortalities have been observed on Limited Entry and Catch Shares bottom trawl vessels: one black-footed was killed in 2004 under the Limited Entry program. Two black-footed albatross were killed in 2015 and one in 2016 under the Catch Shares program. One Laysan albatross was killed in 2013 under Catch Shares management (Tables 13 & 26). The most frequently caught non-albatross species

on these vessels were Leach's and unidentified storm-petrels, followed by, in decreasing numbers, by northern fulmars, unidentified murres, Cassin's auklet, and gulls (Tables 13 & 26).

Table 13: Estimated seabird mortality in U.S. West Coast Limited Entry and Catch Shares fishery 2010-2016 for vessels fishing with trawl gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 26. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit, LE = Limited Entry

	LE Trawl		Catch Shares Trawl											
	2010		2011		2012		2013		2014		2015		2016	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	2.00	0	1.00	0
Laysan Albatross	0.00	0	0.00	0	0.00	0	1.00	0	0.00	0	0.00	0	0.00	0
Storm-Petrel Unid	0.68	0-5	0.00	0	0.00	0	1.04	0	0.00	0	0.00	0	0.00	0
Sooty Shearwater	0.00	0	0.00	0	0.00	0	2.05	0	0.00	0	0.00	0	0.00	0
Northern Fulmar	0.78	0-5.2	0.00	0	1.03	0	0.00	0	0.00	0	0.00	0	0.00	0
Murre Unid	0.00	0	0.00	0	1.07	0	0.00	0	0.00	0	0.00	0	0.00	0
California Gull	0.00	0	0.00	0	0.00	0	0.00	0	1.02	0	0.00	0	0.00	0
Gull Unid	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Green-winged Teal	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
White-winged Scoter	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Cassin's Auklet	1.00	0-5.6	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Leach's Storm-Petrel	3.76	1-9.9	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	3.00	0

California Halibut Fisheries

Limited Entry (LE) California halibut trawl vessels use bottom trawl nets to target California halibut. Fishers must possess a state California halibut permit and an LE federal trawl groundfish permit. The LE Trawl program was converted to Catch Shares in 2011, and thus LE California halibut bycatch estimates since 2011 are included with Catch Shares trawl estimates (Table 13). California halibut trawl participants that do not hold an LE federal groundfish trawl permit can still operate under open access privileges if they possess a state California halibut permit. In both cases, catch is delivered to shore-based processors. The 2010 LE California halibut estimates are included with the 2010 Open Access (OA) values to maintain confidentiality.

Albatross have not been observed as bycatch in California halibut fisheries (Tables 14, 27, & 28). Common murres were by far the most frequently caught species in both the LE and OA California halibut fisheries, followed by unidentified and Brant's cormorants (Tables 14, 27, & 28).

Open Access WA, OR and CA Pink Shrimp Fisheries

Each of the three US West Coast states operates and manages pink shrimp trawl fisheries in their state waters. Pink shrimp vessels use shrimp trawl nets to target pink shrimp on

vessels carrying a state pink shrimp permit. Catch is delivered to shore-based processors.

Albatross have not been recorded as bycatch in US West Coast pink shrimp fisheries (Tables 15 & 15). Shearwaters are the single most common group observed in these state-managed fisheries, with pink-footed shearwaters recorded in the California pink shrimp fishery, and sooty shearwaters the main species recorded in Washington and Oregon pink shrimp fisheries (Table 15).

Table 14: Estimated seabird mortality in U.S. West Coast Open Access (OA) California halibut vessels fishing with trawl gears for 2010-2016. The 2010 OA California halibut estimates include the 2010 Limited Entry California halibut values to maintain confidentiality. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002-2009 can be found in Table 28. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit, LE = Limited Entry

	LE & OA		OA California halibut Trawl											
	2010		2011		2012		2013		2014		2015		2016	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Common Murre	6.72	2.7-12.7	4.92	2.7-8.2	3.16	1.1-6	3.84	1.3-7.3	3.66	1.6-6.8	6.56	4.5-9.7	5.61	3.5-8.5
Brandts Cormorant	2.26	0.3-5.6	1.31	0.2-3.2	1.12	0.1-2.9	1.35	0.2-3.4	2.22	1.2-4.1	2.15	1.2-3.9	1.18	0.2-2.9
Cormorant Unid	5.09	2.1-9.7	2.39	0.7-5.3	1.95	0.4-4.4	2.38	0.5-5.3	2.21	0.6-4.8	2.13	0.6-4.7	3.18	1.7-5.8
Western Gull	1.39	0.1-4.6	0.79	0-2.6	0.72	0-2.3	0.83	0-2.7	0.73	0-2.4	0.69	0-2.2	1.71	1-3.4
Bird Unid	1.34	0.1-4.3	0.77	0-2.5	0.68	0-2.2	0.81	0.1-2.6	0.69	0-2.3	1.66	1-3.1	0.67	0-2.1

Table 15: Estimated seabird mortality in U.S. West Coast Open Access (OA) pink shrimp vessels fishing with shrimp trawl gears for 2010-2016. WCGOP began observing OR and CA pink shrimp fisheries in 2004 and WA pink shrimp in 2010. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2004-2009 can be found in Table 29. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

		OA Pink Shrimp Trawl													
		2010		2011		2012		2013		2014		2015		2016	
State	Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
WA	Sooty Shearwater	8.46	4.1-14	7.76	3.9-12.7	21.81	18-26.4	11.91	6.1-19.6	27.83	14.4-44.7	35.76	18.6-57.1	11.40	6-18.3
WA	Gull Unid	0.91	0-2.9	0.82	0-2.8	0.82	0-2.8	1.25	0.1-4	3.88	1.1-10.3	3.63	0.2-13	1.17	0.1-4.1
OR	Sooty Shearwater	8.97	4.5-14.4	13.45	6.9-21.7	13.73	6.8-21.8	27.73	21.3-36.1	15.19	7.9-24.3	15.72	8.1-25.7	9.83	4.9-15.8
OR	Shearwater Unid	1.52	0.2-4.1	2.26	0.3-6.2	2.31	0.3-6.2	2.32	0.2-6.5	4.56	2.3-8.9	2.64	0.3-7.1	1.66	0.2-4.5
CA	Pink-footed Shearwater	0.73	0-2.3	2.35	1.1-5.2	1.16	0-3.6	1.67	0.1-5.3	1.50	0.1-4.7	1.48	0.1-4.7	0.48	0-1.6

Seabird Bycatch in Pot Gear Fisheries

Very few birds have been observed in US West Coast groundfish pot gear. The vessels using pot gear to catch groundfish fish in the same sectors described above for hook-and-line vessels. Due to confidentiality, we do not report seabird bycatch by sector. To date, seabird mortalities have been observed on vessels fishing with pot gear in Catch Shares, Limited Entry Sablefish, and OR and CA Nearshore fisheries.

Table 16: Estimated seabird mortality in U.S. West Coast pot fisheries for 2010-2016. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2004-2009 can be found in Table 30. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	All Sectors, Pot Gears													
	2010		2011		2012		2013		2014		2015		2016	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	0.00	0	0.00	0	0.00	0	0.00	0	1.00	0-5.6	0.00	0	0.00	0
Storm-Petrel Unid	0.00	0	0.00	0	0.00	0	1.00	0-5.6	0.00	0	0.00	0	0.00	0
Northern Fulmar	0.00	0	1.00	0-5.6	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Brandts Cormorant	4.43	1.3-10.9	4.75	1.5-11.3	4.57	1.4-11.1	4.47	1.3-10.9	8.14	3.5-15.9	5.18	1.7-11.9	4.36	1.3-10.8
Double-crested Cormorant	2.16	0.3-7.5	2.11	0.3-7.4	3.00	0.6-8.8	1.98	0.2-7.2	2.25	0.3-7.6	2.19	0.3-7.5	1.89	0.2-7.1
Cormorant Unid	5.28	1.8-12.1	5.71	2-12.7	6.57	2.5-13.8	5.49	1.9-12.4	6.15	2.3-13.3	6.28	2.4-13.4	6.30	2.4-13.5

Seabird Bycatch Mitigation and Avoidance

In response to the 2012 U.S. Fish and Wildlife Service Biological Opinion regarding short-tailed albatross interactions with U.S. West Coast groundfish fisheries, the PFMC and NOAA implemented a regulation requiring the use of streamer lines on non-tribal longline vessels in December 2015 (NOAA, 2015). This rule requires:

- Commercial, non-tribal, longline vessels 16.76 m (55 feet) and larger to deploy one or two streamer lines during fishing, depending on gear configuration
- Streamer lines must meet technical specifications and be available for inspection
- Rough weather exemption is permitted for Gale Warning or more severe warnings issued by the National Weather Service.

As a result of these regulations, the NMFS West Coast Regional Office has asked the WCGOP to collect data that may be used to characterize and evaluate the effectiveness of seabird avoidance gear or measures used by longline vessels. Prior to these regulations, some vessels voluntarily used a number of seabird avoidance and mitigation measures and the WCGOP haphazardly collected data regarding these voluntary measures. Here we present data from all vessels regardless of size and from all years for which the WCGOP has collected data.

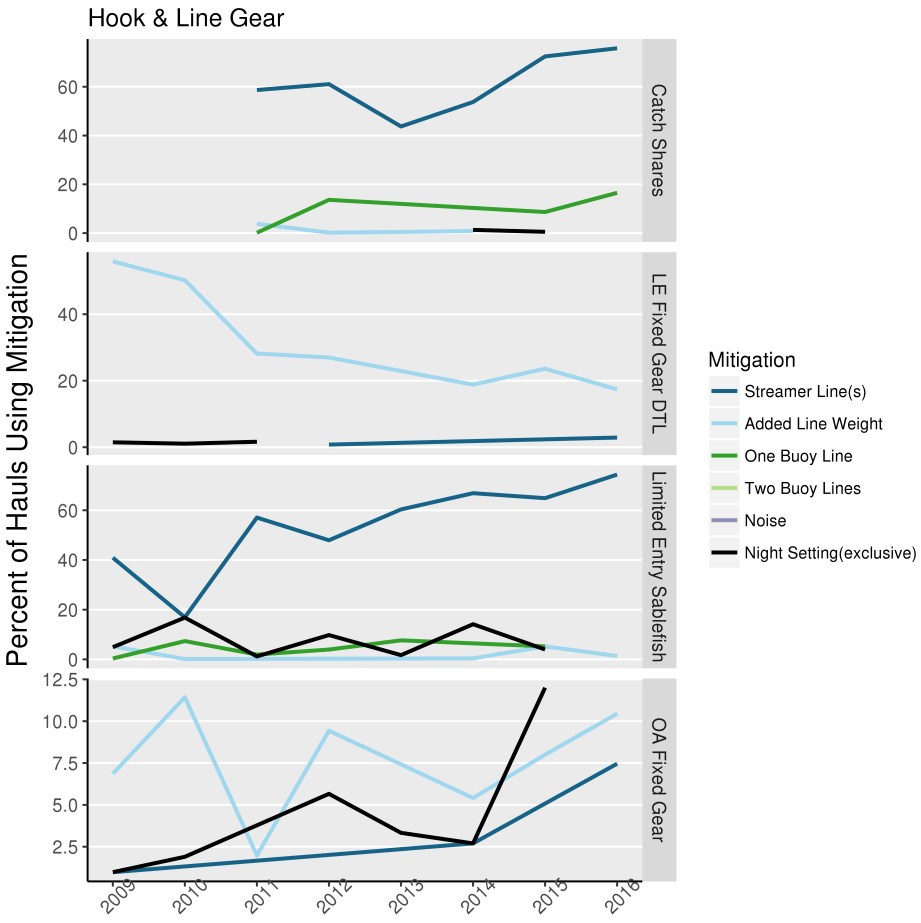


Figure 6: Percentage of observed hauls by seabird mitigation type by year for the 2009-2016 period. More than one type could be used on a single haul. Data on seabird mitigation type was not collected prior to 2009. Only vessels using hook-and-line gears are shown. Vessels over 55 feet in length using hook-and-line gear were required to use streamer lines starting in 2015.

Seabird Non-Lethal Interactions

In addition to lethal interactions, both A-SHOP and WCGOP collect information regarding seabird interactions that are not lethal nor are likely to cause injury. Interactions are defined here as any bird that comes into contact with the vessel, gear, catch, or vessel discharge (e.g., offal, discards, vessel trash, etc.). This definition excludes sightings of seabirds that do not interact with the vessel in any manner. Seabird sightings are documented for any endangered or threatened seabird but only haphazardly collected for other species. See Table 2 for the number of recorded sightings for each species for all years combined.

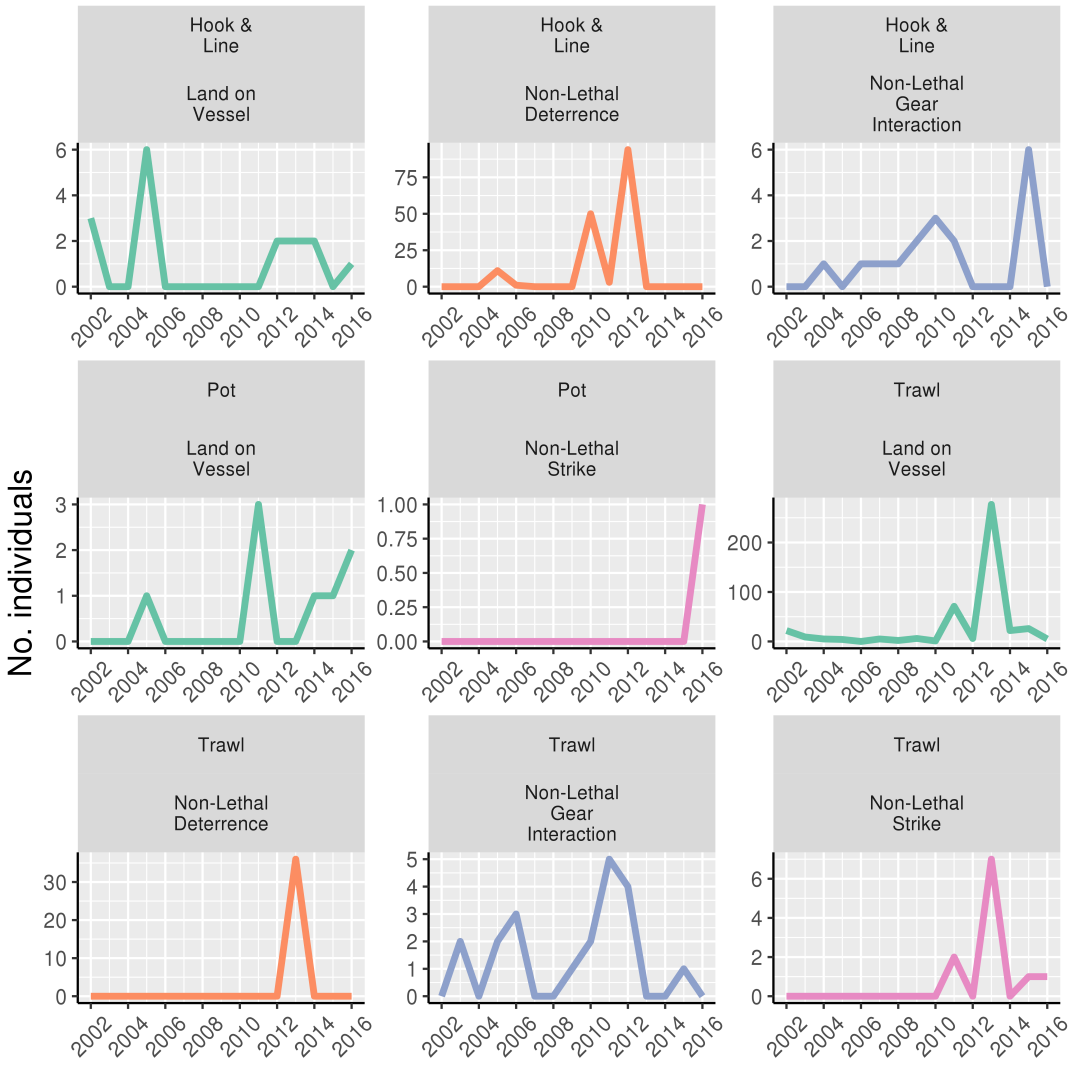


Figure 7: Observed number of non-lethal, non-feeding, seabird interactions by year, gear type, and non-lethal interaction type. Feeding interactions are shown in Figure 8.

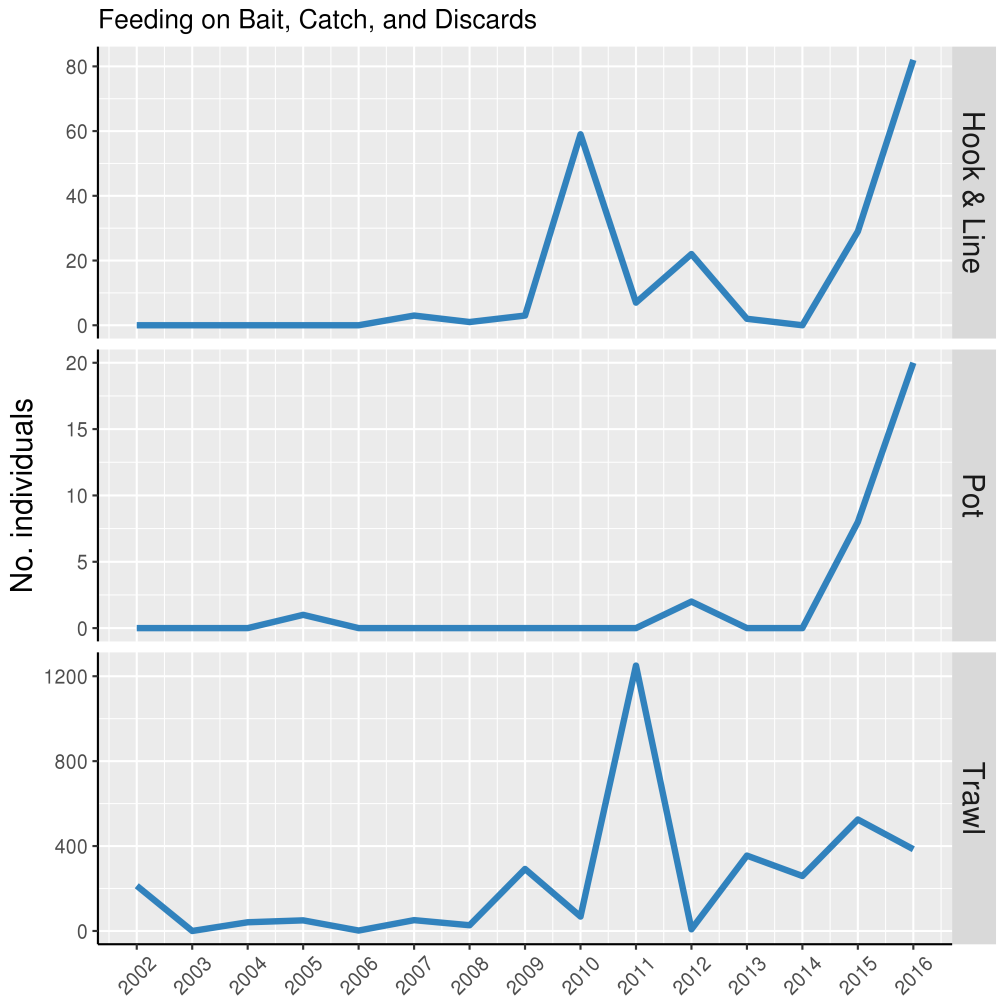


Figure 8: : Observed number of seabirds feeding on bait, catch, and discards by year and gear type.

Methods

Data Sources

Data sources for this analysis include on-board observer data (from the WCGOP and A-SHOP), landing receipt data (referred to as fish tickets, obtained from PacFIN) and data generated from vessels carrying electronic monitoring (a.k.a. EM) equipment. Currently only vessels in the IFQ sector fishing on an exempted fishing permit (EFP) carry EM equipment (Table 69. Pacific States Marine Fisheries Commission houses and delivers EM data to the NWFSC Observer Program. To date, EM video reviewers have not observed any seabird interactions on vessels using EM. Handling rules for vessels under the

current EM EFP require vessel personnel to clearly display any protected species bycatch, including seabirds, to the EM camera system for identification and documentation. WCGOP also places observers on a randomly selected subset of EM vessels for protected species sampling; observer coverage on EM vessels is provided in Appendix , Tables 69 & 69. A list of fisheries, coverage priorities and data collection methods employed by WCGOP in each observed fishery can be found in the WCGOP manuals (NWFSC, 2017b). A-SHOP program information, documentation and data collection methods can be found in the A-SHOP observer manual (NWFSC, 2017a). Both WCGOP and A-SHOP observer coverage, effort, and observed takes are reported by fishery sector and year in Appendix .

WCGOP observers mainly sample the discarded portion of the catch of each haul. Trip-level fish landing receipts (aka fish tickets) are used to adjust observer estimates of retained catch, to ensure estimates of the retained catch are accurate, as described on the WCGOP Data Processing webpage and was conducted prior to the analyses presented in this report. Estimates of observer coverage and observed catch can be found in Appendix .

For data processing purposes, species and species groups were defined based on management. A complete listing of groundfish species is defined in the Pacific Coast Groundfish Fishery Management Plan (PFMC 2016).

Fish ticket landing receipts are completed by fish-buyers in each port for each delivery of fish by a vessel. Fish tickets are trip-aggregate sales receipts for market categories that may represent single or multiple species. Fish tickets are issued to fish-buyers by a state agency and must be returned to the agency for processing. Fish ticket and species-composition data are submitted by state agencies to the PacFIN regional database. Annual fish ticket landings data were retrieved from the PacFIN database (April 2016) and subsequently divided into various sectors of the groundfish fishery as indicated in Figure 63 and in further detail online.

For all PacFIN, WCGOP, and A-SHOP data, we maintain confidentiality of persons and businesses, as required by the Magnuson-Stevens Fishery Conservation and Management Act (often referred as Magnuson-Stevens Acts or MSA), which is most recently reauthorized in 2007. NOAA Fisheries guidance recommends, and NWFSC Fisheries Observation Science Program follows, the "rule of three," which states that, "Information from at least three participants in the fishery must be aggregated/summarized at a temporal and spatial level to protect not only the identity of a person or a business, but also any business information."

Bycatch Estimation

For some of these fisheries, there is 100% observer coverage or electronic monitoring (EM) on every haul and trip. In these cases, we assume a complete census of seabirds on every haul. Seabirds mortality is one of the highest priorities of observers and crew are required to hold all seabirds up to the camera on EM vessels. However, a portion of the catch can be unobserved, e.g., when hauls are subsampled or if an observer is ill. In these cases we do simple extrapolations to estimate unobserved seabird mortality (see below).

For fisheries where there is less than 100% observer monitoring, we present estimates seabird bycatch in two ways:

1. using a deterministic method by employing ratio estimators and
2. using a model based approach employing Bayesian methods.

Ratio estimators are presented to provide a comparison with past reports from these fisheries (Jannot et al., 2011) as well as assess how historical estimates might differ after adopting the Bayesian method. We provide ratio estimator estimates of seabird mortality for the period 2002-2015, but Bayesian estimates of seabird mortality for the period 2002-2016.

Sectors with less than 100% Observer Coverage

Fisheries observers monitor and record catch data on commercial fishing vessels by following protocols in the WCGOP manual (NWFSC 2017). Observer sampling focuses on discarded catch and supplements existing fish ticket landing receipt data to inform weights of retained catch. Observers generally sample 100% of tows or sets made during a trip. On trawlers, the total weight of discarded catch is estimated, and the discarded catch is then sampled for species composition. The species composition sample could represent either a census or a subsample of all discarded catch. On fixed gear vessels (hook-and-line and pot gears), observers sample total catch (similar to at-sea hake observer sampling methodology) and sample anywhere from 30 to 100% of the catch from each set.

Seabirds are often encountered while the observer is conducting species composition sampling, and thus might not be fully accounted for in the sampled portion of the catch alone. Prior to computing bycatch rates, the number of seabirds in the sample must be expanded to the tow/set level, as is explained on the WCGOP Data Processing webpage.

Ratio Estimators NWFSC Observer Program uses a deterministic approach to estimate discard mortality of fish for all WCGOP observed sectors of the groundfish fishery (Jannot et al., 2017; Somers et al., 2017a). Historically, ratio estimators (Cochran, 1977)

have been used to extrapolate seabird bycatch in U.S. West Coast Groundfish fisheries from observed bycatch rates using effort metrics for the fishery (e.g., the ratio of observed bycatch to total retained catch; Jannot et al. 2011).

Historically, we applied a single stratification scheme for all seabird species based on findings from aerial and boat surveys synthesized by Tyler et al. (1993). Latitudinal strata were defined in accordance with the gradient in upwelling intensity north and south of Cape Blanco, OR (42°50′ N. latitude) (Bakun et al. 1974, Barth et al. 2000). Three seasonal strata were also defined to coincide with the seasonal trends in upwelling and seabird abudance:

1. winter = January through April
2. summer = May through August
3. fall = September through December

For comparisons with historical estimates, we maintain this stratification when applying the ratio estimators. However, we do not apply any stratification when using the Bayesian method to estimate seabird bycatch (see below). Post-stratification did not follow the sampling design with potential but unknown consequences (Cochran 1977). The ratio estimation method is a design-based method and thus stemmed from the survey design. In contrast, the Bayesian method is a model based method intended to model the underlying process (in this case Poisson) that results in seabird bycatch. In this sense, the Bayesian method can incorporate covariates (i.e, appropriate spatial, temporal, and other factors) into the modeling process. Preliminary testing and analysis (not presented) suggests that covariates might only moderately improve our estimates. However, results are preliminary and this is an area for future research and improvements.

To compare prior estimates of seabird bycatch calculated with ratio estimators (Jannot et al., 2011) to those calculated with a Bayesian model, we computed bycatch ratios by sector, year, area (north or south of Cape Blanco, OR) and season (winter, summer, fall). Bycatch ratios were defined as the number of takes divided by the catch weight recorded in observer data. Bycatch ratios were then expanded to the fleet-wide level based on the total catch or landings from each sector. The only available proxy of total fishing effort in the non-hake fishery sectors is landed catch. Logbooks are only available in the bottom trawl fleet and only record retained (landed) catch, not total catch. Bycatch rates are therefore computed as the number of observed takes divided by the observed weight of retained catch in metric tons from fish tickets. Thus, the denominator used in bycatch ratios differed considerably by fishery sector because of differences in target species and fishing behavior. Because of differences in data availability and management structure among sectors of the groundfish fishery, expansions were applied with minor differences between fishery sectors. In general, estimates were made within each stratum and summed to obtain coast-wide estimates of total seabird mortality.

Bayes Estimation Ratio estimators have been widely used in discard estimation (Stratoudakis et al., 1999; Borges et al., 2005; Walmsley et al., 2007). This method relies heavily on the assumption that bycatch is proportional to some metric or proxy of fishing effort, such as fishery landings (Rochet and Trenkel, 2005). Rochet and Trenkel (2005) note that this assumption is often not supported by data and that in some cases, bycatch might vary nonlinearly or even be unrelated to the ratio estimator denominator. Seabirds are encountered so rarely by the groundfish fishery that it is difficult to assess whether the number of bycatch events is indeed linked to levels of fishing effort. Furthermore, bycatch estimates produced using ratio estimators have been shown to be biased, particularly when observer coverage is low (Carretta and Moore 2014, Martin et al. 2015).

To overcome the limitations of ratio estimators for estimating seabird bycatch, we applied a Bayesian modeling approach. We used simple Bayesian models while estimating variances of total bycatch. These methods have been used with other rare bycatch species, including cetaceans, delphinids, pinnipeds, sea turtles, and sharks (Martin et al. 2015). To do this, we modeled bycatch rate as constant and inferred annual expected mortality, given a specified level of effort. Fleet-wide bycatch of each seabird species was estimated for each sector and gear type using observer coverage data (Appendix).

The general modeling approach was to use a simple Poisson process model, where the total number of bycatch events were assumed to follow a Poisson distribution,

$$n_{take,y} \sim (\lambda_y = \theta \cdot E_y) \tag{1}$$

where:

$n_{take,y}$ = number of observed bycatch events (or take events) in year *y*
λ_y = mean expected bycatch
θ = estimated bycatch rate
E_y = effort in year *y*

The estimated bycatch rate θ is assumed constant through time, but the quantity $\theta \cdot E_y$ includes uncertainty, as θ is estimated. Thus, a time series of the mean bycatch can be generated for a given species, with a given metric of effort. All uncertainty in the time series originates from fluctuating levels of effort through time (percent observer coverage only affects the expansion). We used a Bayesian model (Martin et al. 2015) to generate mean and 95% CIs of the parameter θ, as well as for $\theta \cdot E_y$. In future versions of this report, we will explore the assumption that θ is constant through time.

Because observer coverage is less than 100% in some fleets, and variable through time, we need to expand the estimated bycatch, $\theta \cdot E_y$, to the fleet-wide level. One approach for expansion would be to divide $\theta \cdot E_y$ by the percent observer coverage; however, this

ignores uncertainty in the expansion. We accounted for uncertainty in the expansion by treating the observer coverage and estimated bycatch ($\theta \cdot E_y$) as known ('p', 'x', respectively) and sampling from the distribution of total bycatch (N) in proportion to the Binomial density function. This process was repeated for each Markov Chain Monte Carlo (MCMC) draw, to propagate uncertainty in the estimates through the uncertainty in the expansion.

To examine the effects of different fishing effort metrics on our bycatch estimates (Rochet and Trenkel, 2005), we estimated bycatch using the Bayes approach described above with three different metrics of effort: sector landings, gear units, and hours gear spent in the water. We compare the results of these different effort metrics to each other and to the estimated bycatch using a ratio estimator, by sector, gear type and bird species (Appendix). Our results indicate that in the majority of cases, the annual bycatch estimate does not vary substantially among effort metrics using the Bayesian approach. However, there are significant differences in annual bycatch estimates between the Bayesian approach and the ratio estimator method, as was expected (Carretta and Moore 2014, Martin et al. 2015). We chose to use landings as our effort metric because the total landings of each fleet are the only available measure of fleet-wide effort in sectors with less than 100% observer coverage.

We did not post-stratify the data, as has been done in previous reports (Jannot et al. 2011) and as discussed above. Dropping the post-stratification could account for the differences between the Bayesian estimates and the ratio estimator estimates. We tested for this effect by comparing Bayesian estimates generated with the strata described above to those generated without strata. The largest difference between annual estimates calculated by the two methods was less than 1%. Thus, we do not feel that removal of the stratification accounts for the large differences between Bayesian and ratio estimates. Here we report the Bayesian estimates generated without post-stratification. As mentioned above, incorporating covariates into our estimates is in the preliminary stages and will be incorporated into future reports.

One limitation of this method is that the time-series must be complete (i.e., no gaps). The Open Access California halibut fishery was observed from 2003-2005, but not in 2006. To create a complete series (2003-present) we used the average across 2004-2008 to fill-in the missing 2006 data. This method was employed just to create a complete series and not attempt to estimate 2006 bycatch levels. Therefore, we do not report the bycatch estimtes from 2006.

Sectors with 100% Observer Coverage

The At-sea hake fishery, which is observed by the A-SHOP and the Catch Shares, or IFQ, fishery which is observed by the WCGOP both require 100% observer coverage.

Currently in the Catch Shares fishery, vessels that participate in the electronic monitoring programcan forgo 100% observer coverage provided that:

- they hold an Exempted Fishing Permit for the EM program;
- electronic monitoring equipment is installed, used and working properly on every trip;
- they take observers for scientific data collection on trips when selected to do so by the NWFSC Observer Program.

At-sea Hake Fishery Bycatch Estimation A-SHOP observers monitor for seabirds in two distinct ways. First, if a seabird was caught and is present in the observer's species composition sample, the appropriate information (including weight, length, etc.) is documented. Secondly, observers monitor the dumping of catch from the net into the sorting tank for about 50-70% of the hauls. This is done to detect the presence of marine mammals; however, observers would also collect any seabirds at this time if any were observed, e.g., caught in the warps, cables, or wings of the net. Observers also record information on all interactions seen between fishing operations and seabirds, and as time allows, document sightings. It should be recognized that some incidental seabird interactions resulting in mortality could occur when this fishery's trawl gear is being set or due to collision with the trawl door warp wires or trawl net data cables while the vessel is fishing. These interactions would be unobserved, as observers do not monitor the setting or fishing of the gear.

Bycatch data for seabirds is primarily recorded during species composition sampling. Seabirds are small enough to make it below deck where the observer samples the catch and are recorded only if they happen to be included in the observer's random species composition sample of a particular tow. Any bycatch of seabirds recorded in a species composition sample must be expanded to the haul level. Often, this results in the observation of one seabird expanding to two seabirds, depending on the observed sample size for that haul. However, since every vessel is observed and almost 100% of the fleet's tows are sampled, the bycatch expansion to the entire at-sea sector is quite small.

To estimate total seabird bycatch in the at-sea hake fishery, all of the sampled tows were used in our analysis. Once the bycatch estimate of seabirds was expanded within each sampled tow, the estimate was then expanded to the entire fleet. This method for calculating seabird bycatch is the same as the method used to calculate fish bycatch in the at-sea hake sector.

For each seabird species, the total number of takes during each tow was calculated using the following formula:

$$Y_t = y_t \times \frac{W_t}{w_t} \tag{2}$$

where:

Y_t = total number of takes in tow *t*
y_t = number of observed takes in the species composition of tow *t*
W_t = weight of the total catch in tow *t*
w_t = weight of the sampled catch in tow *t*

The total number of takes of each seabird species in the at-sea hake fleet was then calculated using the following formula:

$$B = \sum_t Y_t \times \left(\frac{C_{total}}{c_{obs}} \right) \tag{3}$$

where:

B = total estimated bycatch for the species
C_{total} = total catch from all tows in the at-sea hake sector
c_{obs} = catch from the observed tows in the at-sea hake sector
w_t = weight of the sampled catch in tow *t*

Seabird bycatch data do not contain the necessary replicates for calculating within tow variation. The only source of uncertainty that could have been evaluated for fleet-wide seabird bycatch estimates was that associated with the variance between tows. Since nearly 100% of tows were sampled, this variation was quite small and not useful for uncertainty.

In addition to seabird data compiled during species composition sampling, observers also record opportunistic seabird mortalities whenever possible. These non-random observations are excluded from bycatch expansion. All randomly and opportunisticlly sampled seabird data from A-SHOP fisheries are presented in Tables 52 & 53. The proportion of randomly to opportunistically sampled mortalities are provided in Figure 62.

Shore-based IFQ Sectors Fleet-wide seabird bycatch estimates for the shore-based IFQ sectors were derived from WCGOP observer data and fish ticket landings data (Fig. 63) . Fish tickets associated with the IFQ fishery were defined by analysts through an extensive quality control and review process of all available data sources, including those utilized for in-season management.

IFQ bottom trawl vessels can hold a California halibut bottom trawl permit and participate in the state-permitted California halibut fishery. Limited entry California halibut tows can

occur on the same trip as tows targeting IFQ groundfish and were identified at the tow-level based on the use of bottom trawl gear and the following criteria:

1. the target was California halibut and more than 150 lbs. of California halibut was landed or
2. the target was nearshore mix, sand sole, or other flatfish, and the tow took place in less than 30 fathoms and south of 40°10′ N. latitude.

All IFQ bottom trawl tows that met at least one of the above requirements were analyzed using methods for IFQ discard estimation to reflect the sampling protocol performed by observers on the boat. Tow targets are typically determined by the vessel captain. In 2015, however, no limited entry California halibut tows occurred.

Since 2011, all (100%) IFQ trips are required to carry an observer or EM equipment. Therefore, observed counts of seabird bycatch in these sectors represent a near complete census. However, on rare occasions, sets or portions thereof, are unsampled. We used ratio estimators to apportion any unsampled bycatch to specific species, based on observed numbers of individuals in the sampled catch. Note that in most cases, this adds only a small amount (less than a whole bird) to our estimates of seabird bycatch. In the spirit of transparency, we provide the methods below for expanding this very small amount.

Infrequently, entire hauls, including species that would have normally been retained, are discarded at-sea either because of errors (e.g., net rips before landed) or operational considerations (e.g., deliberate release of catch from net before landing because of safety or other concerns). In these instances, the observer records a visual estimate of unsorted catch weight, including both discarded and retained species. Very infrequently, haul data fail quality control measures. In all of these cases, bycatch was estimated based on retained weight from fish tickets. To obtain the estimated number of discarded indivuduals of a species (*B*) when the entire haul or set was unsampled, the unsampled weight was multiplied by the ratio of the bycatch number of individuals of the species divided by either the (a) weight of all species (discarded + would-have-been-retained) discarded at-sea or (b) retained weight of all species in all sampled hauls, depending on if haul was unsampled because of complete discard at sea (a) or failed data (b):

$$\hat{B} = \sum_{p} x_p \times \frac{\sum_f b_f}{\sum_f x_f} \tag{4}$$

where:

$\hat{B}$ = estimated number of unsampled individuals of a given species
p = unsampled haul
x = weight of all species discarded at-sea or retained weight from fish tickets
f = sampled haul

b = sampled number of individuals of a given species

We used discard weight as the denominator in the ratio because we only have an estimated weight of unsampled hauls, counts of individuals are not available for unsampled hauls.

For partially unsampled hauls, observers are instructed to sample such that species in the sample are not also included in the unsampled portion of the catch to avoid double counting. To obtain the estimated number of bycatch individuals (B) included in partially unsampled hauls, the unsampled discard weight (visually estimated) was multiplied by the ratio of the sampled number of individuals of the species divided by the sampled weight of all species .

The estimated number of unsampled individuals of a particular species were then added to the sampled number of individuals of that species to obtain the total bycatch estimate.

Statistical Software The statistical software `R` (R Core Team, 2017) was used to produce the analyses, tables, figures in this report. Specifically, we relied heavily on the R packages:

- `dplyr` (Wickham et al. 2017) for data wrangling,
- `bycatch` (Ward, 2017) for modeling and simulation,
- `ggplot2` (Wickham, 2009) for plotting figures, and
- `knitr` (Xie, 2018) for tables and dynamic reporting.

Acknowledgements

The authors gratefully acknowledge the hard work and dedication of observers from the Northwest Fisheries Science Center Fisheries Observation Science Program (NWFSC FOS), Ryan Shama (NWFSC FOS) and Tim Peretti (NWFSC FOS) for answering questions regarding WCGOP sampling strategies and seabird data, and all the NWFSC Observer Program staff for their hard work and dedication. This report benefited from the comments and suggestions from our colleagues Amanda Gladics (Oregon State University Sea Grant), Eric Ward (NWFSC), and Michelle McClure (NWFSC). We thank Eric Ward (NWFSC) for developing the R code package 'bycatch' used for the Bayesian models and MCMC simulations and Rebecca Hoch (NWFSC) for designing the cover and citation pages. We thank our partners at Pacific States Marine Fisheries Commission who provide us with data from the IFQ Electronic Monitoring EFP and landings data from PacFIN.

References

Ainley, D., L. Spear, C. Tynan, J. Barth, S. Pierce, R. Glenn Ford, and T. Cowles. 2005. Physical and biological variables affecting seabird distributions during the upwelling season of the northern California Current. Deep Sea Research Part II: Topical Studies in Oceanography 52:123-143.

Anderson, O. R. J., et al. 2011. Global seabird bycatch in longline fisheries. Endangered Species Research 14(2):91-106.

Arkin, H. and R. Colton. 1970. Statistical Methods. Barnes and Noble Inc. New York, NY.

Bakun, A., D. McLain, and F. Mayo. 1974. The mean annual cycle of coastal upwelling off western North America as observed from surface measurements. Fishery Bulletin 72:843-844.

Bartle, J. A. 1991. Incidental capture of seabirds in the New Zealand subantarctic squid trawl fishery, 1990. Bird Conservation International 1:351-359.

Barth, J., S. Pierce, and R. Smith. 2000. A separating coastal upwelling jet at Cape Blanco, Oregon and its connection to the California Current System. Deep Sea Research Part II: Topical Studies in Oceanography 47:783-810.

Borges, L., A. R. Zuur, E. Rogan, and R. Officer. 2005. Choosing the best sampling unit and auxiliary variable for discards estimations. Fisheries Research 75:29-39.

Briggs, K. and E. Chu. 1986. Sooty shearwaters off California: distribution, abundance and habitat use. Condor 88:355-364.

Cochran, W. G. 1977. Sampling Techniques. John Wiley & Sons, New York.

Croxall, J. P., et al. 2012. Seabird conservation status, threats and priority actions: a global assessment. Bird Conservation International 22(1):1-34.

Favero, M., et al. 2011. Seabird mortality associated with ice trawlers in the Patagonian shelf: effect of discards on the occurrence of interactions with fishing gear. Animal Conservation 14(2):131-139.

Ford, R., D. Ainley, J. Casey, C. Keiper, L. Spear, and L. Ballance. 2004. The biogeographic patterns of seabirds in the central portion of the California Current. Marine Ornithology 32:77-96.

González-Zevallos, D., et al. 2007. Seabird mortality at trawler warp cables and a proposed mitigation measure: A case of study in Golfo San Jorge, Patagonia, Argentina. Biological

Conservation 136(1):108-116.

Good, T. P., E. Ward, J. Jannot, R. Shama, N. Riley, and J. McVeigh. 2017. Observed and Estimated Bycatch of Short-tailed Albatross in U.S. West Coast Groundfish Fisheries 2014-2015. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112.

Hyrenbach, K. and R. Dotson. 2003. Assessing the susceptibility of female black-footed albatross (Phoebastria nigripes) to longline fisheries during their post-breeding dispersal: an integrated approach. Biological Conservation 112:391-404.

Hyrenbach, K., P. Fernandez, and D. J. Anderson. 2002. Oceanographic habitats of two sympatiric North Pacific albatross. Marine Ecology Progress Series 233:283-301.

Jannot, J. E., V. Tuttle, K. Somers, Y.-W. Lee, J. McVeigh. 2016. Marine Mammal, Seabird, and Sea Turtle Summary of Observed Interactions, 2002-2014. West Coast Groundfish Observer Program. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112.

Jannot, J., Heery, E., Bellman, M.A., and J. Majewski. 2011. Estimated bycatch of marine mammals, seabirds, and sea turtles in the US west coast commercial groundfish fishery, 2002-2009. West Coast Groundfish Observer Program. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112.

Lascelles, B., et al. 2016. Chapter 38. Seabirds. in Innis, L., et al. eds. The First Global Integrated Marine Assessment World Ocean Assessment I. United Nations General Assembly.

Maree, B. A., et al. 2014. Significant reductions in mortality of threatened seabirds in a South African trawl fishery. Animal Conservation 17(6):520-529.

Naughton, M.B., Pitkin, D.J., Lowe, R.W., So, K.J., and Strong, C.S. 2007. Catalog of Oregon seabird colonies. USFWS Biol. Tech. Publ. BTP-R1009-2007.

Northwest Fisheries Science Center (NWFSC). 2017. At-Sea Hake Observer Program, 2017 Sampling Manual. Fishery Resource Analysis and Monitoring, At-Sea Hake Observer Program. NWFSC, 2725 Montlake Blvd. East, Seattle, Washington 98112.

Northwest Fisheries Science Center (NWFSC). 2017 Training Manual. West Coast Groundfish Observer Program. NWFSC, 2725 Montlake Blvd East, Seattle, WA 98112.

PFMC. 2016. Pacific Groundfish Fishery Management Plan. Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 100, Portland, OR.

R Core Team. 2017. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria.

Rochet, M. J. and V. M. Trenkel. 2005. Factors for the variability of discards: assumptions and field evidence. Canadian Journal of Fisheries and Aquatic Sciences 62:224-235.

Stratoudakis, Y., R. Fryer, R. Cook, and G. Pierce. 1999. Fish discarded from Scottish demersal vessels: estimators of total discards and annual estimates for targeted gadoids. ICES Journal of Marine Science: Journal du Conseil 56:592.

Somers, K. A., J. E. Jannot, V. Tuttle, N. B. Riley, J.T. McVeigh. 2018. Estimated Discard and Catch of Groundfish Species in the 2017 US West Coast Fisheries. West Coast Groundfish Observer Program. National Marine Fisheries Service, NWFSC, 2725 Montlake Blvd E., Seattle, WA 98112.

Tamini, L. L., et al. 2015. Estimating mortality of black-browed albatross (Thalassarche melanophris, Temminck, 1828) and other seabirds in the Argentinean factory trawl fleet and the use of bird-scaring lines as a mitigation measure. Polar Biology 38(11):1867-1879.

Tyler, W., K. Briggs, D. Lewis, and R. Ford. 1993. Seabird distribution and abundance in relation to oceanographic processes in the California Current System. Pages 48-60 in K. Vermeer, K. T. Briggs, K. H. Morgan, and D. Siegel-Causey, editors. The status, ecology, and conservation of marine birds in the North Pacific. Canadian Wildlife Service Special Publication, Ottawa.

Walmsley, S., R. Leslie, and W. Sauer. 2007. Bycatch and discarding in the South African demersal trawl fishery. Fisheries Research 86:15-30.

Ward, E. J. 2017. bycatch: Using Bayesian generalized linear models for estimating bycatch rates and generating fleet-level expansions. R package version 1.0.

Watkins, B. P., et al. 2008. Interactions between seabirds and deep-water hake trawl gear: an assessment of impacts in South African waters. Animal Conservation 11(4):247-254.

Weimerskirch, H., et al. 2000. Factors affecting the number and mortality of seabirds attending trawlers and long-liners in the Kerguelen area. Polar Biology 23(4):236-249.

Wickham, H., R. Francois, L. Henry and K. Muller. 2017. dplyr: A Grammar of Data Manipulation. R package version 0.7.4.

Wickham, H. 2009. ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York.

Xie, Yihui. 2018. knitr: A General-Purpose Package for Dynamic Report Generation in R. R package version 1.20.

Historical Bycatch Estimates

Table 17: Estimated seabird mortality in U.S. West Coast groundfish fishery 2002-2009. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	All Sectors, All Gears															
	2002		2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	55.80	42.1-72.5	85.79	68.6-106	97.95	79.5-119.4	106.37	87.1-128.6	108.98	89.5-131.5	120.88	100.3-144.4	103.36	84.4-125.3	130.11	108.7-154.5
Laysan Albatross	0.38	0-4.4	0.51	0-4.7	0.71	0-5.1	0.49	0-4.7	0.66	0-5	0.48	0-4.6	0.46	0-4.6	0.93	0-5.5
Short-tailed Albatross	0.21	0-4.1	0.29	0-4.3	0.40	0-4.5	0.26	0-4.2	0.36	0-4.4	0.26	0-4.2	0.25	0-4.2	0.55	0-4.8
Storm-Petrel Unid	0.66	0-5	0.69	0-5	1.54	0.1-6.5	0.57	0-4.8	0.54	0-4.8	0.66	0-5	0.71	0-5.1	0.73	0-5.1
Pink-footed Shearwater	2.98	0.6-8.7	1.85	0.2-7	2.74	0.5-8.4	3.52	0.9-9.5	2.60	0.5-8.2	2.16	0.3-7.5	2.96	0.6-8.7	4.58	1.4-11.1
Sooty Shearwater	4.98	1.6-11.6	3.53	0.9-9.6	7.26	3-14.8	12.00	6.2-21	9.44	4.4-17.7	10.02	4.8-18.4	13.22	7.1-22.5	14.77	8.2-24.5
Shearwater Unid	21.42	13.3-32.6	18.27	10.9-28.8	24.64	15.9-36.5	23.41	14.9-35	38.50	27.3-52.7	22.26	14-33.6	30.14	20.4-43	43.20	31.3-58.2
Northern Fulmar	3.30	0.7-9.2	2.87	0.6-8.6	24.55	15.8-36.4	4.71	1.5-11.3	3.39	0.8-9.4	66.75	51.7-84.8	6.74	2.7-14.1	37.36	26.4-51.4
Tubenoses Unid	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	2.00	0.2-7.2	0.00	0-3.7
Common Murre	37.79	26.7-51.9	72.80	57-91.6	54.78	41.2-71.3	67.19	52.1-85.3	45.59	33.3-60.9	12.16	6.3-21.2	18.31	10.9-28.8	27.46	18.2-39.8
Murre Unid	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Auklet/Murrelet Unid	0.00	0-3.7	0.00	0-3.7	3.00	0.6-8.8	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7
Alcid Unid	0.36	0-4.4	0.47	0-4.6	0.69	0-5	0.46	0-4.6	0.63	0-4.9	0.46	0-4.6	0.44	0-4.6	0.88	0-5.4
Brandts Cormorant	1.43	0.1-6.3	12.23	6.4-21.3	10.62	5.2-19.2	10.50	5.1-19	9.52	4.5-17.8	7.70	3.3-15.4	10.65	5.2-19.2	10.87	5.4-19.5
Double-crested Cormorant	2.68	0.5-8.3	4.45	1.3-10.9	3.67	0.9-9.8	4.52	1.4-11	3.48	0.8-9.5	3.19	0.7-9.1	5.26	1.8-12	5.33	1.8-12.1
Cormorant Unid	8.07	3.5-15.9	17.67	10.4-28	17.03	9.9-27.3	17.96	10.6-28.4	13.53	7.3-22.9	10.50	5.1-19	12.65	6.7-21.8	16.24	9.3-26.3
California Gull	0.21	0-4.1	0.28	0-4.3	0.42	0-4.5	0.27	0-4.2	0.36	0-4.4	0.27	0-4.2	0.25	0-4.2	0.55	0-4.8
Glaucous-winged Gull	0.66	0-5	0.89	0-5.4	1.26	0.1-6	0.88	0-5.4	1.18	0-5.9	0.86	0-5.3	0.83	0-5.3	1.56	0.1-6.5
Mew Gull	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Ring-billed Gull	0.22	0-4.1	0.30	0-4.3	0.43	0-4.5	0.28	0-4.2	0.39	0-4.5	0.27	0-4.2	0.26	0-4.2	0.59	0-4.8
Western Gull	10.76	5.3-19.4	11.22	5.6-20	12.73	6.7-21.9	12.39	6.5-21.5	12.52	6.6-21.6	11.13	5.6-19.8	13.50	7.3-22.9	19.38	11.7-30.1
Gull Unid	6.75	2.7-14.1	9.51	4.5-17.8	9.44	4.4-17.7	13.96	7.6-23.4	12.71	6.7-21.9	22.93	14.5-34.4	13.41	7.2-22.7	16.55	9.6-26.7
Brown Pelican	4.37	1.3-10.8	6.11	2.3-13.2	6.09	2.3-13.2	8.94	4.1-17	6.48	2.5-13.7	6.96	2.8-14.4	8.68	3.9-16.7	10.42	5.1-18.9
Common Loon	0.00	0	2.15	0.3-7.5	2.26	0.3-7.6	2.36	0.4-7.8	2.34	0.4-7.8	2.46	0.4-7.9	2.77	0.5-8.4	2.45	0.4-7.9
Green-winged Teal	0.00	0	0.00	0	0.00	0	10.00	4.8-18.4	0.00	0	0.00	0	0.00	0	0.00	0
White-winged Scoter	0.00	0	0.00	0	0.00	0	3.00	0.6-8.8	0.00	0	0.00	0	0.00	0	0.00	0
Red-necked Phalarope	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Bird Unid	0.82	0-5.3	2.47	0.4-8	3.85	1-10	5.01	1.6-11.7	3.17	0.7-9	2.76	0.5-8.4	6.95	2.8-14.4	6.57	2.5-13.8
Arctic Herring Gull	1.28	0.1-6	1.72	0.2-6.8	2.42	0.4-7.9	1.70	0.2-6.7	2.28	0.3-7.7	1.66	0.1-6.7	1.61	0.1-6.6	2.94	0.6-8.7
Cassin's Auklet	0.00	0-3.7	0.00	0-3.7	1.00	0-5.6	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	2.00	0.2-7.2
Leach's Storm-Petrel	10.53	5.2-19.1	3.67	0.9-9.8	2.98	0.6-8.7	3.11	0.7-8.9	2.99	0.6-8.7	4.54	1.4-11	3.97	1.1-10.2	4.11	1.1-10.4

Hook-and-Line gears, all sectors

Table 18: Estimated seabird mortality in U.S. West Coast groundfish fishery 2002-2009 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	All Sectors, Hook-and-Line Gears															
	2002		2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	55.80	42.1-72.5	82.79	65.9-102.7	95.95	77.7-117.2	104.37	85.3-126.4	105.98	86.8-128.2	118.88	98.5-142.3	102.36	83.5-124.2	129.11	107.8-153.4
Laysan Albatross	0.38	0-4.4	0.51	0-4.7	0.71	0-5.1	0.49	0-4.7	0.66	0-5	0.48	0-4.6	0.46	0-4.6	0.93	0-5.5
Short-tailed Albatross	0.21	0-4.1	0.29	0-4.3	0.40	0-4.5	0.26	0-4.2	0.36	0-4.4	0.26	0-4.2	0.25	0-4.2	0.55	0-4.8
Pink-footed Shearwater	2.98	0.6-8.7	1.85	0.2-7	2.25	0.3-7.6	2.80	0.5-8.5	2.16	0.3-7.5	1.93	0.2-7.1	2.56	0.4-8.1	4.03	1.1-10.3
Sooty Shearwater	4.98	1.6-11.6	3.53	0.9-9.6	3.55	0.9-9.6	5.06	1.7-11.7	3.81	1-10	3.90	1-10.1	5.31	1.8-12.1	8.13	3.5-15.9
Shearwater Unid	21.42	13.3-32.6	18.27	10.9-28.8	15.94	9.1-25.9	22.47	14.2-33.9	37.48	26.5-51.6	20.16	12.3-31.1	28.74	19.2-41.3	42.00	30.3-56.8
Northern Fulmar	1.56	0.1-6.5	2.10	0.3-7.4	2.94	0.6-8.7	2.07	0.3-7.3	2.78	0.5-8.4	4.02	1.1-10.3	1.93	0.2-7.1	3.53	0.9-9.6
Common Murre	0.00	0	3.41	0.8-9.4	5.25	1.8-12	5.14	1.7-11.9	4.77	1.5-11.3	5.22	1.7-12	5.71	2-12.7	5.47	1.9-12.3
Alcid Unid	0.36	0-4.4	0.47	0-4.6	0.69	0-5	0.46	0-4.6	0.63	0-4.9	0.46	0-4.6	0.44	0-4.6	0.88	0-5.4
Brandts Cormorant	0.00	0	2.30	0.3-7.7	2.40	0.4-7.9	2.49	0.4-8	2.47	0.4-8	2.61	0.5-8.2	2.93	0.6-8.7	2.58	0.4-8.1
Double-crested Cormorant	2.68	0.5-8.3	1.22	0.1-5.9	1.26	0.1-6	2.24	0.3-7.6	1.31	0.1-6.1	1.38	0.1-6.2	2.03	0.3-7.3	2.92	0.6-8.6
Cormorant Unid	3.79	1-9.9	2.51	0.4-8	1.65	0.1-6.7	2.54	0.4-8.1	1.73	0.2-6.8	1.62	0.1-6.6	2.30	0.3-7.7	3.59	0.9-9.6
California Gull	0.21	0-4.1	0.28	0-4.3	0.42	0-4.5	0.27	0-4.2	0.36	0-4.4	0.27	0-4.2	0.25	0-4.2	0.55	0-4.8
Glaucous-winged Gull	0.66	0-5	0.89	0-5.4	1.26	0.1-6	0.88	0-5.4	1.18	0-5.9	0.86	0-5.3	0.83	0-5.3	1.56	0.1-6.5
Mew Gull	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Ring-billed Gull	0.22	0-4.1	0.30	0-4.3	0.43	0-4.5	0.28	0-4.2	0.39	0-4.5	0.27	0-4.2	0.26	0-4.2	0.59	0-4.8
Western Gull	10.76	5.3-19.4	10.85	5.4-19.5	11.88	6.1-20.8	11.68	6-20.5	11.83	6.1-20.7	10.61	5.2-19.2	12.79	6.8-22	17.32	10.1-27.6
Gull Unid	6.75	2.7-14.1	9.51	4.5-17.8	9.44	4.4-17.7	12.96	6.9-22.2	12.71	6.7-21.9	7.93	3.4-15.7	13.41	7.2-22.7	16.55	9.6-26.7
Brown Pelican	4.37	1.3-10.8	6.11	2.3-13.2	6.09	2.3-13.2	8.94	4.1-17	6.48	2.5-13.7	6.96	2.8-14.4	8.68	3.9-16.7	10.42	5.1-18.9
Common Loon	0.00	0	2.15	0.3-7.5	2.26	0.3-7.6	2.36	0.4-7.8	2.34	0.4-7.8	2.46	0.4-7.9	2.77	0.5-8.4	2.45	0.4-7.9
Red-necked Phalarope	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Bird Unid	0.82	0-5.3	2.11	0.3-7.4	3.04	0.6-8.8	2.34	0.4-7.8	2.49	0.4-8	2.25	0.3-7.6	2.26	0.3-7.6	4.51	1.4-11
Arctic Herring Gull	1.28	0.1-6	1.72	0.2-6.8	2.42	0.4-7.9	1.70	0.2-6.7	2.28	0.3-7.7	1.66	0.1-6.7	1.61	0.1-6.6	2.94	0.6-8.7

Limited Entry Sablefish

Table 19: Estimated seabird mortality in U.S. West Coast Limited Entry Sablefish fishery 2002-2009 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	Limited Entry Sablefish Hook-and-Line Gears															
	2002		2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	39.73	28.3-54.2	60.66	46.4-78	77.31	61-96.6	76.61	60.4-95.8	84.16	67.1-104.2	98.70	80.2-120.2	75.01	59-94	87.63	70.2-108
Laysan Albatross	0.38	0-4.4	0.51	0-4.7	0.71	0-5.1	0.49	0-4.7	0.66	0-5	0.48	0-4.6	0.46	0-4.6	0.93	0-5.5
Short-tailed Albatross	0.21	0-4.1	0.29	0-4.3	0.40	0-4.5	0.26	0-4.2	0.36	0-4.4	0.26	0-4.2	0.25	0-4.2	0.55	0-4.8
Pink-footed Shearwater	0.54	0-4.8	0.73	0-5.1	1.03	0-5.6	0.71	0-5.1	0.95	0-5.5	0.70	0-5	0.67	0-5	1.28	0.1-6.1
Sooty Shearwater	0.50	0-4.7	0.67	0-5	0.97	0-5.5	0.66	0-5	0.89	0-5.4	0.65	0-4.9	0.62	0-4.9	1.19	0.1-5.9
Shearwater Unid	1.45	0.1-6.3	1.97	0.2-7.2	2.74	0.5-8.4	1.94	0.2-7.1	2.59	0.5-8.2	1.87	0.2-7	1.81	0.2-6.9	3.33	0.8-9.3
Northern Fulmar	1.56	0.1-6.5	2.10	0.3-7.4	2.94	0.6-8.7	2.07	0.3-7.3	2.78	0.5-8.4	4.02	1.1-10.3	1.93	0.2-7.1	3.53	0.9-9.6
Alcid Unid	0.36	0-4.4	0.47	0-4.6	0.69	0-5	0.46	0-4.6	0.63	0-4.9	0.46	0-4.6	0.44	0-4.6	0.88	0-5.4
Cormorant Unid	1.22	0.1-6	0.30	0-4.3	0.42	0-4.5	0.28	0-4.2	0.39	0-4.5	0.28	0-4.3	0.27	0-4.2	0.58	0-4.8
California Gull	0.21	0-4.1	0.28	0-4.3	0.42	0-4.5	0.27	0-4.2	0.36	0-4.4	0.27	0-4.2	0.25	0-4.2	0.55	0-4.8
Glaucous-winged Gull	0.66	0-5	0.89	0-5.4	1.26	0.1-6	0.88	0-5.4	1.18	0-5.9	0.86	0-5.3	0.83	0-5.3	1.56	0.1-6.5
Ring-billed Gull	0.22	0-4.1	0.30	0-4.3	0.43	0-4.5	0.28	0-4.2	0.39	0-4.5	0.27	0-4.2	0.26	0-4.2	0.59	0-4.8
Western Gull	7.30	3-14.8	4.49	1.3-11	6.25	2.4-13.4	4.45	1.3-10.9	5.97	2.2-13	4.30	1.2-10.7	4.15	1.2-10.5	7.58	3.2-15.2
Gull Unid	1.59	0.1-6.6	2.17	0.3-7.5	3.02	0.6-8.8	3.14	0.7-9	4.89	1.6-11.5	2.07	0.3-7.3	2.00	0.2-7.2	3.70	0.9-9.8
Red-necked Phalarope	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Bird Unid	0.82	0-5.3	2.11	0.3-7.4	1.54	0.1-6.5	1.09	0-5.7	1.46	0.1-6.4	1.05	0-5.7	1.01	0-5.6	1.94	0.2-7.1
Arctic Herring Gull	1.28	0.1-6	1.72	0.2-6.8	2.42	0.4-7.9	1.70	0.2-6.7	2.28	0.3-7.7	1.66	0.1-6.7	1.61	0.1-6.6	2.94	0.6-8.7

Limited Entry Daily Trip Limits

Table 20: Estimated seabird mortality in U.S. West Coast Limited Entry Daily Trip Limits fishery 2002-2009 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	Limited Entry Daily Trip Limits Hook-and-Line Gears															
	2002		2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	16.08	9.2-26.1	12.95	6.9-22.2	10.63	5.2-19.2	16.73	9.7-26.9	12.68	6.7-21.8	14.67	8.2-24.3	20.57	12.7-31.6	30.84	20.9-43.8
Pink-footed Shearwater	2.44	0.4-7.9	1.12	0-5.8	1.22	0.1-6	2.09	0.3-7.4	1.21	0.1-5.9	1.24	0.1-6	1.89	0.2-7	2.75	0.5-8.4
Sooty Shearwater	4.47	1.3-10.9	2.86	0.6-8.6	2.58	0.4-8.1	4.39	1.3-10.8	2.92	0.6-8.6	3.25	0.7-9.1	4.69	1.5-11.2	6.93	2.8-14.3
Shearwater Unid	19.98	12.2-30.9	16.30	9.4-26.4	13.20	7.1-22.5	20.53	12.6-31.5	34.89	24.3-48.5	18.29	10.9-28.8	26.93	17.7-39.2	38.67	27.5-52.9
Double-crested Cormorant	2.68	0.5-8.3	1.22	0.1-5.9	1.26	0.1-6	2.24	0.3-7.6	1.31	0.1-6.1	1.38	0.1-6.2	2.03	0.3-7.3	2.92	0.6-8.6
Cormorant Unid	2.56	0.4-8.1	2.21	0.3-7.6	1.24	0.1-6	2.26	0.3-7.6	1.34	0.1-6.2	1.34	0.1-6.2	2.03	0.3-7.3	3.01	0.6-8.8
Western Gull	3.46	0.8-9.5	2.93	0.6-8.7	1.84	0.2-7	3.29	0.7-9.2	2.04	0.3-7.3	2.18	0.3-7.5	3.21	0.7-9.1	5.73	2-12.7
Gull Unid	5.16	1.7-11.9	3.50	0.8-9.5	3.06	0.6-8.9	5.06	1.7-11.8	3.56	0.9-9.6	3.93	1.1-10.1	8.55	3.8-16.5	8.43	3.7-16.3
Brown Pelican	4.37	1.3-10.8	2.69	0.5-8.3	2.41	0.4-7.9	5.13	1.7-11.9	2.74	0.5-8.4	2.98	0.6-8.7	4.37	1.3-10.8	6.56	2.5-13.8

Open Access Fixed Gear

Table 21: Estimated seabird mortality in U.S. West Coast Open Access Fixed Gear fishery 2003-2009 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	Open Access Fixed Gear Hook-and-Line Gears													
	2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	9.19	4.2-17.3	8.01	3.5-15.8	11.03	5.5-19.7	9.15	4.2-17.3	5.50	1.9-12.4	6.78	2.7-14.1	10.64	5.2-19.2
Gull Unid	3.84	1-10	3.36	0.8-9.3	4.75	1.5-11.3	4.26	1.2-10.6	1.93	0.2-7.1	2.86	0.6-8.6	4.42	1.3-10.8

Oregon and California Nearshore

Table 22: Estimated seabird mortality in U.S. West Coast Nearshore fishery 2003-2009 for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

		Nearshore Hook-and-Line Gears													
		2003		2004		2005		2006		2007		2008		2009	
State	Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
OR	Common Murre	0.00	0	1.52	0.1-6.4	1.27	0.1-6	1.02	0-5.6	1.20	0.1-5.9	1.26	0.1-6	1.55	0.1-6.5
OR	Bird Unid	0.00	0	1.50	0.1-6.4	1.25	0.1-6	1.03	0-5.6	1.20	0.1-5.9	1.25	0.1-6	2.57	0.4-8.1
CA	Common Murre	3.41	0.8-9.4	3.74	1-9.9	3.87	1-10.1	3.75	1-9.9	4.02	1.1-10.3	4.45	1.3-10.9	3.92	1.1-10.1
CA	Brandts Cormorant	2.30	0.3-7.7	2.40	0.4-7.9	2.49	0.4-8	2.47	0.4-8	2.61	0.5-8.2	2.93	0.6-8.7	2.58	0.4-8.1
CA	Western Gull	3.42	0.8-9.4	3.79	1-9.9	3.93	1.1-10.1	3.82	1-10	4.13	1.2-10.4	5.43	1.9-12.3	4.02	1.1-10.3
CA	Brown Pelican	3.42	0.8-9.4	3.69	0.9-9.8	3.81	1-10	4.75	1.5-11.3	3.98	1.1-10.2	4.31	1.3-10.7	3.85	1-10
CA	Common Loon	2.15	0.3-7.5	2.26	0.3-7.6	2.36	0.4-7.8	2.34	0.4-7.8	2.46	0.4-7.9	2.77	0.5-8.4	2.45	0.4-7.9

Trawl gears, all sectors

Table 23: Estimated seabird mortality in U.S. West Coast fishery 2002-2009 for vessels fishing with trawl gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	All Sectors, Trawl Gears															
	2002		2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	0.00	0-3.7	3.00	0.6-8.8	2.00	0.2-7.2	2.00	0.2-7.2	3.00	0.6-8.8	2.00	0.2-7.2	1.00	0-5.6	1.00	0-5.6
Laysan Albatross	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Storm-Petrel Unid	0.66	0-5	0.69	0-5	1.54	0.1-6.5	0.57	0-4.8	0.54	0-4.8	0.66	0-5	0.71	0-5.1	0.73	0-5.1
Pink-footed Shearwater	0.00	0	0.00	0	0.49	0-4.7	0.73	0-5.1	0.44	0-4.6	0.23	0-4.2	0.40	0-4.5	0.55	0-4.8
Sooty Shearwater	0.00	0-3.7	0.00	0-3.7	3.71	0.9-9.8	6.95	2.8-14.4	5.63	2-12.6	6.12	2.3-13.2	7.90	3.4-15.6	6.65	2.6-13.9
Shearwater Unid	0.00	0-3.7	0.00	0-3.7	8.70	3.9-16.7	0.94	0-5.5	1.02	0-5.6	2.10	0.3-7.4	1.40	0.1-6.2	1.20	0.1-5.9
Northern Fulmar	1.74	0.2-6.8	0.77	0-5.2	21.60	13.5-32.8	2.64	0.5-8.2	0.61	0-4.9	62.73	48.2-80.3	4.81	1.5-11.4	33.84	23.4-47.3
Tubenoses Unid	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	2.00	0.2-7.2	0.00	0-3.7
Common Murre	37.79	26.7-51.9	69.39	54-87.8	49.53	36.7-65.4	62.05	47.6-79.5	40.82	29.3-55.4	6.94	2.8-14.3	12.60	6.6-21.7	21.99	13.8-33.3
Murre Unid	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Auklet/Murrelet Unid	0.00	0-3.7	0.00	0-3.7	3.00	0.6-8.8	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7
Brandts Cormorant	1.43	0.1-6.3	2.53	0.4-8.1	2.49	0.4-8	2.90	0.6-8.6	2.28	0.3-7.7	0.97	0-5.5	1.39	0.1-6.2	3.47	0.8-9.5
Cormorant Unid	4.28	1.2-10.6	6.30	2.4-13.5	8.42	3.7-16.3	9.16	4.2-17.3	6.06	2.2-13.1	2.90	0.6-8.6	2.89	0.6-8.6	5.89	2.1-12.9
California Gull	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Western Gull	0.00	0	0.37	0-4.4	0.86	0-5.3	0.71	0-5.1	0.69	0-5	0.52	0-4.7	0.71	0-5.1	2.07	0.3-7.3
Gull Unid	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	1.00	0-5.6	0.00	0-3.7	15.00	8.4-24.7	0.00	0-3.7	0.00	0-3.7
Green-winged Teal	0.00	0	0.00	0	0.00	0	10.00	4.8-18.4	0.00	0	0.00	0	0.00	0	0.00	0
White-winged Scoter	0.00	0	0.00	0	0.00	0	3.00	0.6-8.8	0.00	0	0.00	0	0.00	0	0.00	0
Bird Unid	0.00	0-3.7	0.37	0-4.4	0.81	0-5.2	2.67	0.5-8.3	0.68	0-5	0.51	0-4.7	4.68	1.4-11.2	2.06	0.3-7.3
Arctic Herring Gull	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Cassin's Auklet	0.00	0-3.7	0.00	0-3.7	1.00	0-5.6	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	0.00	0-3.7	2.00	0.2-7.2
Leach's Storm-Petrel	10.53	5.2-19.1	3.67	0.9-9.8	2.98	0.6-8.7	3.11	0.7-8.9	2.99	0.6-8.7	4.54	1.4-11	3.97	1.1-10.2	4.11	1.1-10.4

At-sea Hake Catcher Processors

Table 24: Estimated seabird mortality in U.S. West Coast At-sea hake catcher processor vessels fishing with midwater trawl gear for 2002-2009. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Confidence Limits are not given because At-sea fisheries are 100% observed and therefore represent a complete census of seabird mortality.

	At-sea Hake Midwater Trawl Gear Catcher Processors							
	2002	2003	2004	2005	2006	2007	2008	2009
Species	Number	Number	Number	Number	Number	Number	Number	Number
Black-footed Albatross	0.00	3.00	1.00	2.00	3.00	2.00	1.00	1.00
Sooty Shearwater	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00
Shearwater Unid	0.00	0.00	8.00	0.00	0.00	1.00	0.00	0.00
Northern Fulmar	0.00	0.00	21.00	0.00	0.00	62.00	4.00	32.00
Tubenoses Unid	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
Common Murre	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00
Auklet/Murrelet Unid	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00
Gull Unid	0.00	0.00	0.00	0.00	0.00	15.00	0.00	0.00
Bird Unid	0.00	0.00	0.00	0.00	0.00	0.00	2.00	0.00
Arctic Herring Gull	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Cassin's Auklet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	2.00
Leach's Storm-Petrel	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

At-sea Hake Catcher Vessels

Table 25: Estimated seabird mortality in U.S. West Coast At-sea hake catcher vessels fishing with midwater trawl gear and delivering to motherships for 2002-2009. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Confidence Limits are not given because At-sea fisheries are 100% observed and therefore represent a complete census of seabird mortality.

	At-sea Hake Midwater Trawl Gear Catcher Vessels Delivering to Mothership							
	2002	2003	2004	2005	2006	2007	2008	2009
Species	Number	Number	Number	Number	Number	Number	Number	Number
Northern Fulmar	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00
Common Murre	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00
Bird Unid	0.00	0.00	0.00	2.00	0.00	0.00	2.00	0.00
Cassin's Auklet	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Limited Entry Trawl

Table 26: Estimated seabird mortality in U.S. West Coast Limited Entry (LE) fishery 2002-2009 for vessels fishing with trawl gears. LE Trawl fishery became Catch Shares Trawl in 2011. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	Limited Entry Trawl															
	2002		2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	0.00	0	0.00	0	1.00	0-5.6	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Laysan Albatross	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Storm-Petrel Unid	0.66	0-5	0.69	0-5	1.54	0.1-6.5	0.57	0-4.8	0.54	0-4.8	0.66	0-5	0.71	0-5.1	0.73	0-5.1
Sooty Shearwater	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Northern Fulmar	1.74	0.2-6.8	0.77	0-5.2	0.60	0-4.9	0.64	0-4.9	0.61	0-4.9	0.73	0-5.1	0.81	0-5.2	1.84	0.2-7
Murre Unid	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
California Gull	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Gull Unid	0.00	0	0.00	0	0.00	0	1.00	0-5.6	0.00	0	0.00	0	0.00	0	0.00	0
Green-winged Teal	0.00	0	0.00	0	0.00	0	10.00	4.8-18.4	0.00	0	0.00	0	0.00	0	0.00	0
White-winged Scoter	0.00	0	0.00	0	0.00	0	3.00	0.6-8.8	0.00	0	0.00	0	0.00	0	0.00	0
Cassin's Auklet	0.00	0	0.00	0	1.00	0-5.6	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Leach's Storm-Petrel	10.53	5.2-19.1	3.67	0.9-9.8	2.98	0.6-8.7	3.11	0.7-8.9	2.99	0.6-8.7	4.54	1.4-11	3.97	1.1-10.2	4.11	1.1-10.4

California Halibut

Table 27: Estimated seabird mortality in U.S. West Coast Limited Entry (LE) California halibut vessels fishing with trawl gears for 2002-2009. The 2010 LE California halibut estimates are included in the 2010 Open Access California halibut values to maintain confidentiality (Table 14). Since 2011, LE CA Halibut values are included with Catch Shares Trawl values (Table 13) Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	LE California halibut Trawl															
	2002		2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Common Murre	37.79	25.3-51.9	66.89	57.9-77.4	42.63	30.9-55.8	56.73	40-76	37.65	26.7-50.4	4.72	3.2-6.5	9.58	6.7-13	15.99	10.8-22.3
Brandts Cormorant	1.43	0.1-4.6	1.96	1.1-4.2	1.15	0.1-3.7	1.76	0.1-5.8	1.20	0.1-4.1	0.16	0-0.5	0.31	0-1.1	0.63	0-2
Cormorant Unid	4.28	1-10.1	5.35	2.9-9.4	6.02	3.2-10.8	6.10	1.7-13.3	4.09	1.1-8.9	0.52	0.1-1.2	1.05	0.3-2.3	1.81	0.5-4

Table 28: Estimated seabird mortality in U.S. West Coast Open Access (OA) California halibut vessels fishing with trawl gears for 2002-2009. This fishery was not observed in 2006. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	OA California halibut Trawl													
	2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Common Murre	2.49	1.5-4	3.90	1.4-7.4	3.32	1.4-6.1	–	–	2.22	0.7-4.5	3.02	1-6	6.00	1.2-14
Brandts Cormorant	0.57	0-1.5	1.34	0.2-3.5	1.13	0.1-3	–	–	0.81	0.1-2.1	1.08	0.1-2.8	2.84	0.2-8.5
Cormorant Unid	0.95	0.2-2.2	2.40	0.7-5.3	3.06	1.6-5.6	–	–	2.38	1.3-4.1	1.85	0.4-4.2	4.07	0.6-10.2
Western Gull	0.37	0-1.2	0.86	0-2.8	0.71	0-2.4	–	–	0.52	0-1.7	0.71	0-2.4	2.07	0.1-6.9
Bird Unid	0.37	0-1.3	0.81	0-2.7	0.67	0-2.1	–	–	0.51	0-1.7	0.68	0-2.1	2.06	0.1-6.5

WA, OR, CA Pink Shrimp

Table 29: Estimated seabird mortality in U.S. West Coast Open Access (OA) pink shrimp vessels fishing with shrimp trawl gears for 2004-2009. WCGOP began observing OR and CA pink shrimp fisheries in 2004 and WA pink shrimp in 2010. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Asteriks (*) are confidential data and (–) are years when this fishery was unobserved. LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

		OA Pink Shrimp Trawl											
		2004		2005		2006		2007		2008		2009	
State	Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
OR	Sooty Shearwater	3.71	1.7-6	4.95	2.3-8.3	–	–	6.12	2.9-10.1	7.90	3.9-12.8	6.65	3.2-11
OR	Shearwater Unid	0.70	0.1-2	0.94	0.1-2.9	–	–	1.10	0.1-2.9	1.40	0.2-3.7	1.20	0.2-3.2
CA	*	*	*	*	*	–	–	*	*	*	*	*	*

Pot gears, all sectors

Table 30: Estimated seabird mortality in U.S. West Coast pot fisheries for for 2002-2009. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). LCL = lower 95% confidence limit, UCL = upper 95% confidence limit

	All Sectors, Pot Gears													
	2003		2004		2005		2006		2007		2008		2009	
Species	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL	Estimate	LCL-UCL
Black-footed Albatross	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Storm-Petrel Unid	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Northern Fulmar	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Brandts Cormorant	7.41	3.1-15	5.73	2-12.7	5.11	1.7-11.8	4.77	1.5-11.3	4.12	1.2-10.4	6.33	2.4-13.5	4.83	1.5-11.4
Double-crested Cormorant	3.23	0.7-9.1	2.40	0.4-7.9	2.28	0.3-7.7	2.16	0.3-7.5	1.81	0.2-6.9	3.23	0.7-9.1	2.41	0.4-7.9
Cormorant Unid	8.86	4-16.9	6.95	2.8-14.4	6.25	2.4-13.4	5.73	2-12.7	5.97	2.2-13	7.46	3.1-15	6.76	2.7-14.1

Observer Coverage, Observed Takes, Non-Lethal Interactions, and Sightings

Limited Entry Sablefish

Table 31: U.S. West Coast Limited Entry Sablefish vessels using hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Limited Entry Sablefish Hook-and-Line								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	No.Units	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2011	Alcid Unid	23	98	673	1405444	240.74	1153.50	0.21	2.00	0.00
2012	Arctic Herring Gull	17	88	532	1580075	239.32	1075.02	0.22	7.60	0.00
2003	Bird Unid	15	48	351	733602	222.85	1034.90	0.22	1.00	0.00
2011	Bird Unid	23	98	673	1405444	240.74	1153.50	0.21	1.67	0.00
2014	Bird Unid	17	85	495	1200615	203.23	745.23	0.27	1.00	0.00
2015	Bird Unid	26	97	632	1536820	391.96	938.45	0.42	1.00	0.00
2002	Black-footed Albatross	25	68	391	779624	190.79	788.54	0.24	1.00	0.00
2003	Black-footed Albatross	15	48	351	733602	222.85	1034.90	0.22	8.00	0.00
2004	Black-footed Albatross	17	45	326	492009	180.02	1309.36	0.14	4.50	0.00
2005	Black-footed Albatross	26	101	678	1456102	481.45	1293.13	0.37	23.50	0.00
2006	Black-footed Albatross	19	68	470	939951	295.93	1377.29	0.21	13.58	0.00
2007	Black-footed Albatross	22	75	517	1034046	298.49	1080.66	0.28	48.40	0.00
2008	Black-footed Albatross	18	77	540	1244141	338.15	1094.65	0.31	25.90	0.00
2010	Black-footed Albatross	21	143	762	1761173	345.77	1304.18	0.27	33.19	0.00
2011	Black-footed Albatross	23	98	673	1405444	240.74	1153.50	0.21	23.44	0.00
2012	Black-footed Albatross	17	88	532	1580075	239.32	1075.02	0.22	36.02	0.00
2013	Black-footed Albatross	18	58	353	1047526	166.42	751.11	0.22	13.00	0.00
2014	Black-footed Albatross	17	85	495	1200615	203.23	745.23	0.27	2.00	0.00
2015	Black-footed Albatross	26	97	632	1536820	391.96	938.45	0.42	20.34	0.00
2016	Black-footed Albatross	21	94	671	1743233	338.09	1025.26	0.33	9.00	0.00
2012	California Gull	17	88	532	1580075	239.32	1075.02	0.22	1.00	0.00
2002	Cormorant Unid	25	68	391	779624	190.79	788.54	0.24	1.00	0.00
2010	Glaucous-winged Gull	21	143	762	1761173	345.77	1304.18	0.27	1.94	0.00
2012	Glaucous-winged Gull	17	88	532	1580075	239.32	1075.02	0.22	2.00	0.00
2005	Gull Unid	26	101	678	1456102	481.45	1293.13	0.37	0.00	1.00
2006	Gull Unid	19	68	470	939951	295.93	1377.29	0.21	2.00	0.00
2012	Gull Unid	17	88	532	1580075	239.32	1075.02	0.22	5.00	0.00
2014	Gull Unid	17	85	495	1200615	203.23	745.23	0.27	1.00	0.00
2015	Gull Unid	26	97	632	1536820	391.96	938.45	0.42	2.00	0.00
2012	Laysan Albatross	17	88	532	1580075	239.32	1075.02	0.22	1.88	0.00
2009	No Birds Observed	8	45	287	648980	97.81	1447.59	0.07	0.00	0.00
2007	Northern Fulmar	22	75	517	1034046	298.49	1080.66	0.28	2.00	0.00
2012	Northern Fulmar	17	88	532	1580075	239.32	1075.02	0.22	6.99	0.00
2015	Northern Fulmar	26	97	632	1536820	391.96	938.45	0.42	1.00	0.00
2012	Pink-footed Shearwater	17	88	532	1580075	239.32	1075.02	0.22	3.13	0.00
2016	Red-necked Phalarope	21	94	671	1743233	338.09	1025.26	0.33	0.00	1.00
2012	Ring-billed Gull	17	88	532	1580075	239.32	1075.02	0.22	1.00	0.00
2015	Shearwater Unid	26	97	632	1536820	391.96	938.45	0.42	9.00	0.00
2011	Short-tailed Albatross	23	98	673	1405444	240.74	1153.50	0.21	1.00	0.00
2011	Sooty Shearwater	23	98	673	1405444	240.74	1153.50	0.21	1.00	0.00
2013	Sooty Shearwater	18	58	353	1047526	166.42	751.11	0.22	2.00	0.00
2002	Western Gull	25	68	391	779624	190.79	788.54	0.24	4.00	0.00
2011	Western Gull	23	98	673	1405444	240.74	1153.50	0.21	3.00	0.00
2012	Western Gull	17	88	532	1580075	239.32	1075.02	0.22	9.53	0.00

Table 31: U.S. West Coast Limited Entry Sablefish vessels using hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled. *(continued)*

		Limited Entry Sablefish Hook-and-Line								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	No.Units	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2013	Western Gull	18	58	353	1047526	166.42	751.11	0.22	1.00	0.00
2014	Western Gull	17	85	495	1200615	203.23	745.23	0.27	1.00	0.00
2015	Western Gull	26	97	632	1536820	391.96	938.45	0.42	3.00	0.00

Table 32: U.S. West Coast Limited Entry Sablefish vessels using pot gear, fishery observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Limited Entry Sablefish Pot Gear								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	No.Units	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2002	No Birds Observed	6	23	247	5438	82.47	352.20	0.23	0.00	0.00
2003	No Birds Observed	6	35	362	9017	148.31	604.24	0.25	0.00	0.00
2004	No Birds Observed	3	13	139	5378	82.68	619.60	0.13	0.00	0.00
2005	No Birds Observed	7	39	492	13822	281.18	615.00	0.46	0.00	0.00
2006	No Birds Observed	7	39	289	10708	200.47	581.80	0.34	0.00	0.00
2007	No Birds Observed	4	30	154	5816	89.97	428.37	0.21	0.00	0.00
2008	No Birds Observed	6	24	329	13638	244.87	432.98	0.57	0.00	0.00
2009	No Birds Observed	3	27	67	3883	66.48	489.07	0.14	0.00	0.00
2010	No Birds Observed	7	43	314	11294	140.39	503.54	0.28	0.00	0.00
2011	No Birds Observed	3	22	227	9029	137.42	371.93	0.37	0.00	0.00
2012	No Birds Observed	5	19	351	14218	101.10	285.98	0.35	0.00	0.00
2013	No Birds Observed	3	14	47	1934	40.52	283.13	0.14	0.00	0.00
2014	Black-footed Albatross	4	16	195	7574	104.01	338.09	0.31	0.00	1.00
2015	No Birds Observed	9	35	299	11329	218.78	358.21	0.61	0.00	0.00
2016	No Birds Observed	7	55	596	21219	254.27	359.00	0.71	0.00	0.00

Table 33: U.S. West Coast Limited Entry Sablefish fishery non-lethal seabird interactions, all gear types 2002-2016.

			Limited Entry Sablefish	
			Observed	
Year	Gear	Species	Interaction	Number
2002	Hook-and-Line	Black-footed Albatross	Boarded Vessel	1
2010	Hook-and-Line	Black-footed Albatross	Deterrence Used	50
2012	Hook-and-Line	Black-footed Albatross	Deterrence Used	93
2010	Hook-and-Line	Black-footed Albatross	Entangled In Gear - Trailing Gear	1
2016	Hook-and-Line	Black-footed Albatross	Feeding on Bait - Attached to Hook	28
2015	Hook-and-Line	Black-footed Albatross	Feeding On Bait - Attached To Hook	2
2016	Hook-and-Line	Black-footed Albatross	Feeding on Bait - Floating Free	50
2007	Hook-and-Line	Black-footed Albatross	Feeding On Catch	3
2008	Hook-and-Line	Black-footed Albatross	Feeding On Catch	1
2010	Hook-and-Line	Black-footed Albatross	Feeding On Catch	52
2012	Hook-and-Line	Black-footed Albatross	Feeding On Catch	1
2016	Hook-and-Line	Black-footed Albatross	Feeding on Discarded Catch	1
2015	Hook-and-Line	Black-footed Albatross	Feeding On Discarded Catch	25
2005	Hook-and-Line	Cassins Auklet	Boarded Vessel	5
2013	Hook-and-Line	Cassins Auklet	Boarded Vessel	1
2005	Hook-and-Line	Gull Unid	Deterrence Used	11
2015	Hook-and-Line	Laysan Albatross	Feeding On Bait - Floating Free	2
2010	Hook-and-Line	Laysan Albatross	Feeding On Catch	1
2012	Hook-and-Line	Laysan Albatross	Feeding On Catch	1
2016	Hook-and-Line	Laysan Albatross	Feeding on Discarded Catch	1
2012	Hook-and-Line	Northern Fulmar	Boarded Vessel	2
2013	Hook-and-Line	Northern Fulmar	Boarded Vessel	1
2014	Hook-and-Line	Northern Fulmar	Boarded Vessel	2
2016	Hook-and-Line	Red-necked Phalarope	Boarded Vessel	1
2005	Hook-and-Line	Semipalmated Plover	Boarded Vessel	1
2015	Hook-and-Line	Shearwater Unid	Killed By Gear	4
2010	Hook-and-Line	Short-tailed Albatross	Feeding On Bait - Floating Free	1
2011	Hook-and-Line	Short-tailed Albatross	Feeding On Discarded Catch	2
2016	Hook-and-Line	Short-tailed Albatross	Feeding on Offal	1
2002	Hook-and-Line	Storm-Petrel Unid	Boarded Vessel	2
2011	Hook-and-Line	Western Gull	Deterrence Used	3
2012	Hook-and-Line	Western Gull	Deterrence Used	1
2005	Pot	Brown Booby	Boarded Vessel	1
2011	Pot	Heermanns Gull	Boarded Vessel	3
2005	Pot	Laysan Albatross	Feeding On Bait - Floating Free	1
2014	Pot	Northern Fulmar	Boarded Vessel	1

Table 34: U.S. West Coast Limited Entry Sablefish seabird sightings, all gear types 2002-2016. Sightings are haphazardly collected, often only for ESA listed species.

Limited Entry Sablefish			
Year	Gear	Species	Sightings
2003	Hook-and-Line	Bird Unid	1
2013	Hook-and-Line	Bird Unid	1
2002	Hook-and-Line	Black-footed Albatross	375
2003	Hook-and-Line	Black-footed Albatross	405
2004	Hook-and-Line	Black-footed Albatross	3
2005	Hook-and-Line	Black-footed Albatross	180
2006	Hook-and-Line	Black-footed Albatross	50
2007	Hook-and-Line	Black-footed Albatross	3
2008	Hook-and-Line	Black-footed Albatross	301
2009	Hook-and-Line	Black-footed Albatross	5
2010	Hook-and-Line	Black-footed Albatross	2
2012	Hook-and-Line	Black-footed Albatross	1
2013	Hook-and-Line	Black-footed Albatross	80
2014	Hook-and-Line	Black-footed Albatross	20
2015	Hook-and-Line	Black-footed Albatross	2
2005	Hook-and-Line	Brown Pelican	4
2003	Hook-and-Line	Fork-tailed Storm-Petrel	4
2002	Hook-and-Line	Guillemot Unid	38
2002	Hook-and-Line	Gull Unid	36
2003	Hook-and-Line	Laysan Albatross	2
2005	Hook-and-Line	Laysan Albatross	1
2011	Hook-and-Line	Laysan Albatross	1
2014	Hook-and-Line	Laysan Albatross	1
2002	Hook-and-Line	Northern Fulmar	8
2003	Hook-and-Line	Northern Fulmar	11
2003	Hook-and-Line	Pink-footed Shearwater	6
2003	Hook-and-Line	Shearwater Unid	4
2002	Hook-and-Line	Short-tailed Albatross	1
2003	Hook-and-Line	Short-tailed Albatross	1
2005	Hook-and-Line	Short-tailed Albatross	3
2006	Hook-and-Line	Short-tailed Albatross	3

Table 34: U.S. West Coast Limited Entry Sablefish seabird sightings, all gear types 2002-2016. Sightings are haphazardly collected, often only for ESA listed species. *(continued)*

Limited Entry Sablefish			
Year	Gear	Species	Sightings
2007	Hook-and-Line	Short-tailed Albatross	2
2008	Hook-and-Line	Short-tailed Albatross	1
2009	Hook-and-Line	Short-tailed Albatross	1
2010	Hook-and-Line	Short-tailed Albatross	4
2011	Hook-and-Line	Short-tailed Albatross	1
2012	Hook-and-Line	Short-tailed Albatross	1
2016	Hook-and-Line	Short-tailed Albatross	1
2014	Hook-and-Line	Storm-Petrel Unid	1
2003	Hook-and-Line	Tufted Puffin	2
2002	Pot	Bird Unid	1
2002	Pot	Black-footed Albatross	191
2003	Pot	Black-footed Albatross	139
2005	Pot	Black-footed Albatross	61
2009	Pot	Black-footed Albatross	60
2003	Pot	Common Murre	4
2009	Pot	Glaucous-winged Gull	4
2003	Pot	Gull Unid	74
2009	Pot	Heermanns Gull	1
2002	Pot	Laysan Albatross	2
2003	Pot	Laysan Albatross	2
2005	Pot	Laysan Albatross	2
2009	Pot	Laysan Albatross	3
2011	Pot	Laysan Albatross	1
2011	Pot	Leachs Storm-Petrel	30
2009	Pot	Northern Fulmar	6
2002	Pot	Pigeon Guillemot	99
2009	Pot	Pink-footed Shearwater	3
2002	Pot	Shearwater Unid	99
2008	Pot	Short-tailed Albatross	1
2010	Pot	Short-tailed Albatross	2
2011	Pot	Short-tailed Albatross	2

Table 34: U.S. West Coast Limited Entry Sablefish seabird sightings, all gear types 2002-2016. Sightings are haphazardly collected, often only for ESA listed species. *(continued)*

Limited Entry Sablefish			
Year	Gear	Species	Sightings
2009	Pot	Sooty Shearwater	3
2009	Pot	Western Gull	40

Limited Entry Daily Trip Limits (DTL)

Table 35: U.S. West Coast Limited Entry Daily Trip Limits (DTL) vessels using hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Limited Entry DTL Hook-and-Line Gear								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	No.Units	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2002	No Birds Observed	4	11	22	46000	1.66	231.89	0.01	0.00	0.00
2003	Cormorant Unid	17	130	219	537817	14.32	213.49	0.07	1.00	0.00
2003	Western Gull	17	130	219	537817	14.32	213.49	0.07	1.00	0.00
2004	No Birds Observed	14	62	130	318048	3.74	161.08	0.02	0.00	0.00
2005	Brown Pelican	11	35	60	198150	2.43	245.34	0.01	1.00	0.00
2006	Shearwater Unid	21	121	201	533830	6.96	200.53	0.03	19.00	0.00
2007	No Birds Observed	36	158	304	724389	16.50	241.63	0.07	0.00	0.00
2008	Gull Unid	32	122	221	631689	9.32	323.53	0.03	3.00	0.00
2008	Shearwater Unid	32	122	221	631689	9.32	323.53	0.03	1.00	0.00
2009	Western Gull	34	138	273	669091	11.97	484.03	0.02	1.00	0.00
2010	No Birds Observed	38	226	472	1103073	33.84	699.87	0.05	0.00	0.00
2011	Black-footed Albatross	38	201	426	1154241	52.47	889.35	0.06	13.00	0.00
2012	Brown Pelican	26	128	252	706437	15.09	552.93	0.03	2.00	0.00
2012	Double-crested Cormorant	26	128	252	706437	15.09	552.93	0.03	1.00	0.00
2012	Gull Unid	26	128	252	706437	15.09	552.93	0.03	1.00	0.00
2013	Sooty Shearwater	22	124	248	705827	17.67	584.94	0.03	3.00	0.00
2014	No Birds Observed	18	77	154	493845	15.71	537.51	0.03	0.00	0.00
2015	Black-footed Albatross	21	65	144	453472	29.21	534.29	0.05	3.40	0.00
2015	Pink-footed Shearwater	21	65	144	453472	29.21	534.29	0.05	1.00	0.00
2016	No Birds Observed	16	41	70	247067	19.38	522.32	0.04	0.00	0.00

Table 36: U.S. West Coast Limited Entry Daily Trip Limits (DTL) fishery non-lethal seabird interactions, all gear types 2002-2016.

			Limited Entry Daily Trip Limits (DTL)	
			Observed	
Year	Gear	Species	Interaction	Number
2009	Hook-and-Line	Black-footed Albatross	Feeding On Catch	1
2012	Hook-and-Line	Black-footed Albatross	Feeding On Catch	20
2010	Hook-and-Line	Brown Pelican	Feeding On Catch	5
2013	Hook-and-Line	Double-crested Cormorant	Feeding On Catch	2
2009	Hook-and-Line	Laysan Albatross	Feeding On Bait - Floating Free	2

Table 37: U.S. West Coast Limited Entry Daily Trip Limit (DTL) seabird sightings, all gear types 2002-2016. Sightings are haphazardly collected, often only for ESA listed species.

Limited Entry Daily Trip Limits (DTL)			
Year	Gear	Species	Sightings
2009	Hook-and-Line	Black-footed Albatross	17
2011	Hook-and-Line	Black-footed Albatross	7
2013	Hook-and-Line	Black-footed Albatross	19
2015	Hook-and-Line	Black-footed Albatross	32
2008	Hook-and-Line	Brown Pelican	2
2009	Hook-and-Line	Brown Pelican	2
2008	Hook-and-Line	Laysan Albatross	1
2011	Hook-and-Line	Pink-footed Shearwater	1
2011	Hook-and-Line	Sooty Shearwater	100
2015	Hook-and-Line	Sooty Shearwater	1

Open Access Fixed Gear

Table 38: U.S. West Coast Open Access (OA) Fixed Gear vessels using hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		OA Fixed Gear Hook-and-Line Gear								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	No.Units	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2003	No Birds Observed	13	41	49	86518	16.59	548.42	0.03	0.00	0.00
2004	No Birds Observed	14	42	52	85895	16.25	477.88	0.03	0.00	0.00
2005	No Birds Observed	10	34	37	58384	9.79	632.60	0.02	0.00	0.00
2006	No Birds Observed	7	10	11	29296	4.50	491.44	0.01	0.00	0.00
2007	Black-footed Albatross	25	51	67	55215	10.52	267.33	0.04	1.00	0.00
2008	No Birds Observed	33	58	68	73885	16.31	409.91	0.04	0.00	0.00
2009	No Birds Observed	34	69	104	119849	22.28	650.13	0.03	0.00	0.00
2010	Black-footed Albatross	37	70	105	160570	23.08	758.15	0.03	1.86	0.00
2011	No Birds Observed	40	69	101	162419	20.19	436.25	0.05	0.00	0.00
2012	No Birds Observed	24	34	53	82597	11.48	324.04	0.04	0.00	0.00
2013	No Birds Observed	14	23	30	51870	4.71	194.04	0.02	0.00	0.00
2014	Gull Unid	21	28	39	71459	11.78	219.77	0.05	1.00	0.00
2015	No Birds Observed	20	38	54	124895	17.47	364.28	0.05	0.00	0.00
2016	No Birds Observed	31	57	78	111092	15.66	309.34	0.05	0.00	0.00

Table 39: U.S. West Coast Open Access (OA) Fixed Gear vessels using pot gear, fishery observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		OA Fixed Gear Pot Gear								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	No.Units	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2003	No Birds Observed	7	16	50	345	2.94	186.59	0.02	0.00	0.00
2004	No Birds Observed	17	96	185	1950	16.99	186.03	0.09	0.00	0.00
2005	No Birds Observed	14	43	50	835	10.67	379.37	0.03	0.00	0.00
2006	No Birds Observed	15	38	39	666	7.90	443.29	0.02	0.00	0.00
2007	No Birds Observed	21	46	75	624	8.75	257.89	0.03	0.00	0.00
2008	No Birds Observed	20	55	75	833	10.43	240.87	0.04	0.00	0.00
2009	No Birds Observed	18	30	45	540	8.53	372.63	0.02	0.00	0.00
2010	No Birds Observed	26	40	71	646	10.66	318.29	0.03	0.00	0.00
2011	No Birds Observed	29	61	85	831	18.94	255.80	0.07	0.00	0.00
2012	No Birds Observed	19	35	70	610	9.13	127.21	0.07	0.00	0.00
2013	No Birds Observed	17	25	48	590	6.30	72.18	0.09	0.00	0.00
2014	No Birds Observed	21	41	63	686	11.67	147.81	0.08	0.00	0.00
2015	No Birds Observed	17	49	64	604	14.61	234.25	0.06	0.00	0.00
2016	No Birds Observed	28	56	74	717	15.41	206.47	0.07	0.00	0.00

Table 40: U.S. West Coast Open Access (OA) Fixed Gear fishery non-lethal seabird interactions, all gear types 2002-2016.

			Open Access (OA) Fixed Gear	
			Observed	
Year	Gear	Species	Interaction	Number
2016	Hook-and-Line	Black-footed Albatross	Feeding on Bait - Floating Free	1
2011	Hook-and-Line	Black-footed Albatross	Feeding On Catch	3
2016	Pot	Black-footed Albatross	Feeding on Discarded Catch	13
2016	Pot	Laysan Albatross	Feeding on Discarded Catch	2

Table 41: U.S. West Coast Open Access (OA) Fixed Gear fishery seabird sightings, all gear types 2002-2016. Sightings are haphazardly collected, often only for ESA listed species.

Open Access (OA) Fixed Gear			
Year	Gear	Species	Sightings
2003	Hook-and-Line	Black-footed Albatross	2
2009	Hook-and-Line	Black-footed Albatross	113
2012	Hook-and-Line	Black-footed Albatross	60
2013	Hook-and-Line	Black-footed Albatross	40
2014	Hook-and-Line	Black-footed Albatross	1
2011	Hook-and-Line	Black-legged Kittiwake	1
2012	Hook-and-Line	Fork-tailed Storm-Petrel	2
2012	Hook-and-Line	Heermanns Gull	4
2011	Hook-and-Line	Laysan Albatross	1
2012	Hook-and-Line	Laysan Albatross	1
2012	Hook-and-Line	Northern Fulmar	1
2012	Hook-and-Line	Pink-footed Shearwater	1
2009	Hook-and-Line	Rhinoceros Auklet	1
2012	Hook-and-Line	Western Gull	12
2003	Pot	Black-footed Albatross	10
2009	Pot	Black-footed Albatross	6
2010	Pot	Black-footed Albatross	42
2016	Pot	Black-footed Albatross	15
2011	Pot	California Gull	2
2011	Pot	Glaucous-winged Gull	2
2012	Pot	Herring Gull	1
2009	Pot	Laysan Albatross	10
2016	Pot	Laysan Albatross	2
2011	Pot	Northern Fulmar	5
2011	Pot	Rhinoceros Auklet	1
2010	Pot	Short-tailed Albatross	1
2016	Pot	Sooty Shearwater	1
2016	Pot	Tufted Puffin	2
2011	Pot	Western Gull	80

Catch Shares Fixed Gear Fisheries

Catch Shares Hook-and-Line Gears

Table 42: U.S. West Coast Catch Shares vessels fishing with hook-and-line gear not participating in the Electronic Monitoring Exempt Fishing Permit, fishery observer coverage, fishing effort, and observed bird takes 2011-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Catch Shares Hook-and-Line Gears											
					Sets			Catch					
Year	Species	Vessels	Trips	Units	Sampled	Unsampled	Proportion	Sampled	Unsampled	Proportion	Observed.No.	Estimated.No.	Opportunistic
2011	Black-footed Albatross	11	94	2265264	630	1	1.00	335.56	0.00	1.00	5.00	5.00	0
2011	Gull Unid	11	94	2265264	630	1	1.00	335.56	0.00	1.00	1.00	1.00	0
2011	Mew Gull	11	94	2265264	630	1	1.00	335.56	0.00	1.00	1.00	1.00	0
2011	Western Gull	11	94	2265264	630	1	1.00	335.56	0.00	1.00	3.00	3.00	0
2012	Black-footed Albatross	8	32	1472865	506	0	1.00	241.30	0.00	1.00	4.94	4.94	0
2012	Gull Unid	8	32	1472865	506	0	1.00	241.30	0.00	1.00	2.00	2.00	0
2012	Western Gull	8	32	1472865	506	0	1.00	241.30	0.00	1.00	41.55	41.55	0
2013	No Birds Observed	8	29	587238	215	0	1.00	79.48	0.00	1.00	0.00	0.00	0
2014	Black-footed Albatross	8	31	601654	227	32	0.88	88.68	9.84	0.90	2.00	2.38	0
2014	Northern Fulmar	8	31	601654	227	32	0.88	88.68	9.84	0.90	2.00	2.38	0
2015	No Birds Observed	5	16	592919	185	0	1.00	137.84	0.00	1.00	0.00	0.00	0
2016	No Birds Observed	5	30	1110926	351	0	1.00	192.79	0.00	1.00	0.00	0.00	0

Table 43: U.S. West Coast Catch Shares vessels fishing with hook-and-line gear not participating in the Electronic Monitoring Exempt Fishing Permit, non-lethal seabird interactions, all gear types, 2011-2016.

			Catch Shares Hook-and-Line	
			Observed	
Year	Gear	Species	Interaction	Number
2011	Hook-and-Line	Short-tailed Albatross	Feeding On Discarded Catch	1

Table 44: U.S. West Coast Catch Shares vessels fishing with hook-and-line gear not participating in the Electronic Monitoring Exempt Fishing Permit, seabird sightings, all gear types 2011-2016. Sightings are haphazardly collected, often only for ESA listed species.

Catch Shares Hook-and-Line			
Year	Gear	Species	Sightings
2012	Hook-and-Line	Short-tailed Albatross	3

Catch Shares Pot Gears

Table 45: U.S. West Coast Catch Shares vessels fishing with pot gear not participating in the Electronic Monitoring Exempt Fishing Permit, fishery observer coverage, fishing effort, and observed bird takes 2011-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Catch Shares Pot Gears											
					Sets			Catch					
Year	Species	Vessels	Trips	Units	Sampled	Unsampled	Proportion	Sampled	Unsampled	Proportion	Observed.No.	Estimated.No.	Opportunistic
2011	Northern Fulmar	17	233	41307	1536	18	0.99	813.82	3.41	1.00	1.00	1.00	0
2012	No Birds Observed	19	278	52248	1709	0	1.00	740.69	0.00	1.00	0.00	0.00	0
2013	Storm-Petrel Unid	10	100	30097	1086	0	1.00	470.84	0.00	1.00	1.00	1.00	0
2014	No Birds Observed	14	118	31876	1288	0	1.00	681.15	0.00	1.00	0.00	0.00	0
2015	No Birds Observed	8	62	18808	584	0	1.00	405.29	0.00	1.00	0.00	0.00	0
2016	No Birds Observed	8	61	15785	584	0	1.00	387.05	0.00	1.00	0.00	0.00	0

Table 46: U.S. West Coast Catch Shares vessels fishing with pot gear not participating in the Electronic Monitoring Exempt Fishing Permit, non-lethal seabird interactions, all gear types, 2011-2016.

			Catch Shares Pot	
			Observed	
Year	Gear	Species	Interaction	Number
2016	Pot	Black-footed Albatross	Vessel Strike	1
2015	Pot	Laysan Albatross	Boarded Vessel	1
2015	Pot	Laysan Albatross	Feeding On Bait	5
2015	Pot	Laysan Albatross	Feeding On Discarded Catch	3
2016	Pot	Short-tailed Albatross	Feeding on Bait - Floating Free	5
2012	Pot	Short-tailed Albatross	Feeding On Catch	2

Table 47: U.S. West Coast Catch Shares vessels fishing with pot gear not participating in the Electronic Monitoring Exempt Fishing Permit, seabird sightings, all gear types 2011-2016. Sightings are haphazardly collected, often only for ESA listed species.

		Catch Shares Pot	
Year	Gear	Species	Sightings
2016	Pot	Bird Unid	100
2012	Pot	Brown Booby	1
2011	Pot	Short-tailed Albatross	2
2012	Pot	Short-tailed Albatross	2

Oregon and California State Nearshore Fisheries

Nearshore Hook-and-Line Gears

Table 48: Oregon and California Nearshore Fisheries vessels fishing with hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

			Nearshore Hook-and-Line Gears								
			Observed						Observed		
State	Year	Species	Vessels	Trips	Sets	Units	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
Oregon											
OR	2004	No Birds Observed	31	109	184	25112	9.72	204.50	0.05	0.00	0
OR	2005	No Birds Observed	48	138	170	44235	11.85	176.19	0.07	0.00	0
OR	2006	No Birds Observed	55	238	365	69772	18.72	160.49	0.12	0.00	0
OR	2007	No Birds Observed	36	164	230	54286	15.30	176.47	0.09	0.00	0
OR	2008	No Birds Observed	43	149	183	47677	14.51	184.64	0.08	0.00	0
OR	2009	Bird Unid	45	151	197	59983	13.39	220.45	0.06	1.00	0
OR	2010	No Birds Observed	56	162	209	60178	13.41	169.11	0.08	0.00	0
OR	2011	Common Murre	57	205	244	80497	15.88	191.49	0.08	1.00	0
OR	2012	No Birds Observed	60	235	290	109675	20.70	193.82	0.11	0.00	0
OR	2013	No Birds Observed	65	209	259	74698	15.58	203.76	0.08	0.00	0
OR	2014	No Birds Observed	57	174	194	60396	16.50	200.20	0.08	0.00	0
OR	2015	No Birds Observed	57	189	235	65441	18.31	210.88	0.09	0.00	0
OR	2016	No Birds Observed	53	214	263	79133	21.73	176.26	0.12	0.00	0
California											
CA	2003	No Birds Observed	30	98	177	52829	5.71	190.67	0.03	0.00	0
CA	2004	No Birds Observed	57	220	334	115083	17.70	235.09	0.08	0.00	0
CA	2005	No Birds Observed	43	151	192	79707	11.45	232.91	0.05	0.00	0
CA	2006	No Birds Observed	39	100	148	51072	7.97	217.33	0.04	0.00	0
CA	2007	No Birds Observed	40	133	214	76767	10.82	238.51	0.05	0.00	0
CA	2008	Western Gull	24	70	79	62042	6.33	247.43	0.03	1.00	0
CA	2009	No Birds Observed	28	89	121	72765	6.70	222.57	0.03	0.00	0
CA	2010	Brown Pelican	22	87	108	131934	6.56	184.20	0.04	1.00	0
CA	2011	Common Loon	32	145	214	146393	8.47	178.51	0.05	1.00	0
CA	2011	Western Gull	32	145	214	146393	8.47	178.51	0.05	1.00	0
CA	2012	No Birds Observed	31	138	211	155080	9.88	158.75	0.06	0.00	0
CA	2013	Brown Pelican	34	131	173	119332	9.63	178.41	0.05	1.00	0
CA	2013	Common Murre	34	131	173	119332	9.63	178.41	0.05	1.00	0
CA	2014	No Birds Observed	32	119	151	111841	8.88	196.69	0.05	0.00	0
CA	2015	Brandts Cormorant	33	176	230	165065	18.89	282.23	0.07	1.00	0
CA	2015	Common Murre	33	176	230	165065	18.89	282.23	0.07	1.00	0
CA	2016	No Birds Observed	23	87	99	75487	9.68	205.70	0.05	0.00	0

Table 49: Oregon and California Nearshore Fisheries vessels fishing with hook-and-line gear, non-lethal seabird interactions 2002-2016. There were no non-lethal seabird interactions observed on Nearshore vessels fishing with pot gear.

				Nearshore Hook-and-Line	
				Observed	
State	Year	Gear	Species	Interaction	Number
Oregon					
OR	2008	Hook-and-Line	Common Murre	Entangled In Gear - Not Trailing Gear	1
OR	2009	Hook-and-Line	Common Murre	Entangled In Gear - Not Trailing Gear	1
OR	2011	Hook-and-Line	Common Murre	Entangled In Gear - Not Trailing Gear	2
OR	2006	Hook-and-Line	Murre Unid	Entangled In Gear - Not Trailing Gear	1
OR	2015	Hook-and-Line	Tufted Puffin	Entangled In Gear - Not Trailing Gear	1
California					
CA	2006	Hook-and-Line	Brown Pelican	Deterrence Used	1
CA	2011	Hook-and-Line	Common Loon	Feeding On Catch	1
CA	2004	Hook-and-Line	Common Murre	Entangled In Gear - Not Trailing Gear	1
CA	2015	Hook-and-Line	Common Murre	Entangled In Gear - Not Trailing Gear	1
CA	2009	Hook-and-Line	Murre Unid	Entangled In Gear - Not Trailing Gear	1
CA	2007	Hook-and-Line	Northern Fulmar	Entangled In Gear - Not Trailing Gear	1
CA	2010	Hook-and-Line	Western Gull	Entangled In Gear - Not Trailing Gear	2

Nearshore Pot Gears

Table 50: Oregon and California Nearshore Fisheries vessels fishing with pot gear, fishery observer coverage, fishing effort, and observed bird takes 2003-2016. States are combined to maintain confidentiality. Observed bird takes are either randomly sampled (observed takes) or opportunistically sampled. Asteriks (*) indicated confidential data.

			OR & CA Nearshore Pot Gears								
			Observed						Observed		
State	Year	Species	Vessels	Trips	Sets	Units	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
OR & CA	2003	No Birds Observed	5	14	31	2121	2.40	68.60	0.04	0.00	0
OR & CA	2004	No Birds Observed	24	64	126	4500	6.12	58.86	0.10	0.00	0
OR & CA	2005	No Birds Observed	7	21	27	801	1.58	47.24	0.03	0.00	0
OR & CA	2006	No Birds Observed	5	16	33	667	1.31	43.06	0.03	0.00	0
OR & CA	2007	Cormorant Unid	4	26	31	878	1.95	38.72	0.05	1.00	0
OR & CA	2008	No Birds Observed	4	8	12	306	0.48	49.75	0.01	0.00	0
OR & CA	2009	*	*	*	*	*	*	*	*	*	*
OR & CA	2010	No Birds Observed	6	9	13	403	0.56	36.45	0.02	0.00	0
OR & CA	2011	No Birds Observed	6	14	24	807	1.49	42.99	0.03	0.00	0
OR & CA	2012	Cormorant Unid	8	16	28	1058	2.04	43.22	0.05	1.00	0
OR & CA	2012	Double-crested Cormorant	8	16	28	1058	2.04	43.22	0.05	1.00	0
OR & CA	2013	No Birds Observed	7	16	25	1125	2.54	43.12	0.06	0.00	0
OR & CA	2014	Brandts Cormorant	11	22	33	1586	2.71	49.01	0.06	3.00	0
OR & CA	2015	No Birds Observed	12	39	49	5296	4.08	51.38	0.08	0.00	0
OR & CA	2016	Cormorant Unid	17	37	61	3890	4.05	44.17	0.09	1.07	0

Table 51: Oregon and California Nearshore Fisheries vessels fishing with hook-and-line or pot gear (combined), seabird sightings 2002-2016. Sightings are haphazardly collected, often only for ESA listed species. Hook-and-line and pot gears are combined.

Nearshore Fixed Gears			
Year	Gear	Species	Sightings
2013	Fixed Gears	Ancient Murrelet	1
2003	Fixed Gears	Brown Pelican	4
2008	Fixed Gears	Brown Pelican	7
2012	Fixed Gears	Brown Pelican	2
2003	Fixed Gears	Common Murre	60
2003	Fixed Gears	Cormorant Unid	2
2007	Fixed Gears	Cormorant Unid	1
2011	Fixed Gears	Glaucous-winged Gull	1
2003	Fixed Gears	Gull Unid	28
2010	Fixed Gears	Heermanns Gull	2
2011	Fixed Gears	Heermanns Gull	6
2012	Fixed Gears	Marbled Murrelet	154
2014	Fixed Gears	Northern Fulmar	2
2011	Fixed Gears	Pelagic Cormorant	7
2015	Fixed Gears	Tufted Puffin	1

At-sea Hake Fishery

Table 52: U.S. West Coast At-sea Hake catcher processor vessels observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		At-sea Catcher Processors Midwater Trawl									
				Tows			Catch				
Year	Species	Vessels	Tow.Hrs.	Sampled	Unsampled	Proportion	Sampled	Unsampled	Proportion	Estimated.No.	Opportunistic
2002	No Birds Observed	5	1061.35	556	1	1.00	36529.70	89.52	1.00	0.00	0
2003	Black-footed Albatross	6	911.03	766	1	1.00	41408.12	25.05	1.00	3.00	0
2004	Auklet/Murrelet Unid	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	3.00	0
2004	Black-footed Albatross	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	0.00	1
2004	Common Murre	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	3.00	0
2004	Northern Fulmar	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	21.00	0
2004	Shearwater Unid	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	8.00	0
2005	Black-footed Albatross	6	2238.80	1332	2	1.00	79310.60	22.18	1.00	2.00	0
2005	Sooty Shearwater	6	2238.80	1332	2	1.00	79310.60	22.18	1.00	2.00	0
2006	Black-footed Albatross	9	2980.68	1488	2	1.00	79917.44	28.41	1.00	2.00	1
2007	Black-footed Albatross	9	4403.67	1566	4	1.00	74214.50	89.06	1.00	0.00	2
2007	Gull Unid	9	4403.67	1566	4	1.00	74214.50	89.06	1.00	0.00	15
2007	Northern Fulmar	9	4403.67	1566	4	1.00	74214.50	89.06	1.00	51.00	11
2007	Shearwater Unid	9	4403.67	1566	4	1.00	74214.50	89.06	1.00	0.00	1
2008	Bird Unid	8	5557.86	1864	18	0.99	109939.76	1086.35	0.99	2.00	0
2008	Black-footed Albatross	8	5557.86	1864	18	0.99	109939.76	1086.35	0.99	1.00	0
2008	Northern Fulmar	8	5557.86	1864	18	0.99	109939.76	1086.35	0.99	2.00	2
2008	Tubenoses Unid	8	5557.86	1864	18	0.99	109939.76	1086.35	0.99	2.00	0
2009	Black-footed Albatross	5	1932.42	863	0	1.00	38495.22	0.00	1.00	0.00	1
2009	Cassin's Auklet	5	1932.42	863	0	1.00	38495.22	0.00	1.00	2.00	0
2009	Northern Fulmar	5	1932.42	863	0	1.00	38495.22	0.00	1.00	32.00	0
2010	Black-footed Albatross	6	2653.10	1063	1	1.00	54750.79	29.24	1.00	1.00	2
2010	Common Murre	6	2653.10	1063	1	1.00	54750.79	29.24	1.00	2.00	0
2010	Northern Fulmar	6	2653.10	1063	1	1.00	54750.79	29.24	1.00	17.00	0
2011	Black-footed Albatross	9	4761.93	1530	4	1.00	72600.76	157.61	1.00	0.00	5
2011	Gull Unid	9	4761.93	1530	4	1.00	72600.76	157.61	1.00	0.00	8
2011	Northern Fulmar	9	4761.93	1530	4	1.00	72600.76	157.61	1.00	24.00	3
2011	Tubenoses Unid	9	4761.93	1530	4	1.00	72600.76	157.61	1.00	0.00	4
2012	Black-footed Albatross	9	3545.57	1100	2	1.00	55534.53	133.70	1.00	0.00	1
2012	Northern Fulmar	9	3545.57	1100	2	1.00	55534.53	133.70	1.00	2.00	0
2013	Arctic Herring Gull	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0.00	4
2013	Bird Unid	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0.00	1
2013	Black-footed Albatross	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0.00	2
2013	Cassin's Auklet	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	2.00	0
2013	Gull Unid	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0.00	1
2013	Leach's Storm-Petrel	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	2.00	0
2013	Northern Fulmar	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	4.00	48
2013	Shearwater Unid	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	2.00	1
2013	Sooty Shearwater	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0.00	1
2014	Bird Unid	9	4731.41	1683	1	1.00	103546.79	89.47	1.00	0.00	1
2014	Black-footed Albatross	9	4731.41	1683	1	1.00	103546.79	89.47	1.00	0.00	1
2014	Northern Fulmar	9	4731.41	1683	1	1.00	103546.79	89.47	1.00	2.00	0
2015	Black-footed Albatross	9	5690.86	1503	4	1.00	69076.94	129.21	1.00	0.00	1
2015	Gull Unid	9	5690.86	1503	4	1.00	69076.94	129.21	1.00	2.00	2
2015	Leach's Storm-Petrel	9	5690.86	1503	4	1.00	69076.94	129.21	1.00	2.00	0
2015	Northern Fulmar	9	5690.86	1503	4	1.00	69076.94	129.21	1.00	7.00	5
2016	Black-footed Albatross	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	0.00	2
2016	Gull Unid	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	2.00	2
2016	Leach's Storm-Petrel	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	2.00	0
2016	Northern Fulmar	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	9.01	0
2016	Shearwater Unid	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	2.00	0

Table 53: U.S. West Coast At-sea Hake catcher vessels delivering to motherships at-sea observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		At-sea Catcher Vessels Midwater Trawl									
				Tows			Catch				
Year	Species	Vessels	Tow.Hrs.	Sampled	Unsampled	Proportion	Sampled	Unsampled	Proportion	Estimated.No.	Opportunistic
2002	No Birds Observed	11	1624.62	573	1	1.00	26607.64	32.52	1.00	0.00	0
2003	No Birds Observed	12	500.95	522	14	0.97	25368.28	671.74	0.97	0.00	0
2004	No Birds Observed	10	796.83	569	2	1.00	24109.61	52.99	1.00	0.00	0
2005	Bird Unid	18	1882.70	1038	1	1.00	49314.84	20.00	1.00	2.00	0
2005	Common Murre	18	1882.70	1038	1	1.00	49314.84	20.00	1.00	2.00	0
2005	Northern Fulmar	18	1882.70	1038	1	1.00	49314.84	20.00	1.00	2.00	0
2006	No Birds Observed	20	2325.70	1243	40	0.97	53873.81	1729.10	0.97	0.00	0
2007	No Birds Observed	20	3133.57	1135	11	0.99	47582.68	402.45	0.99	0.00	0
2008	Bird Unid	19	3866.22	1346	3	1.00	58083.57	175.07	1.00	2.00	0
2009	No Birds Observed	19	1686.32	597	3	0.99	24249.04	47.54	1.00	0.00	0
2010	No Birds Observed	22	2804.51	908	0	1.00	35935.42	0.00	1.00	0.00	0
2011	No Birds Observed	18	2975.70	1246	2	1.00	50329.67	1.02	1.00	0.00	0
2012	Northern Fulmar	16	3161.84	931	18	0.98	37988.72	654.52	0.98	2.00	0
2013	No Birds Observed	18	3075.74	1249	7	0.99	52746.24	141.04	1.00	0.00	0
2014	Cassin's Auklet	19	3547.11	1288	18	0.99	62178.77	155.11	1.00	2.00	0
2015	Common Murre	14	2134.68	625	6	0.99	27805.00	47.15	1.00	2.00	0
2016	Cassin's Auklet	17	5502.07	1550	7	1.00	65426.74	64.31	1.00	0.00	1

Table 54: U.S. West Coast At-sea Hake fishery, both vessel types, non-lethal seabird interactions, 2002-2016.

		At-sea Hake Midwater Trawl	
		Observed	
Year	Species	Interaction	Number
Catcher Processor			
2013	Bird Unid	Land on Vessel	1
2002	Black-footed Albatross	Foraging, Not Bait	80
2005	Cassins Auklet	Land on Vessel	1
2011	Cassins Auklet	Rig Strike	1
2013	Glaucous-winged Gull	Land on Vessel	4
2010	Gull Unid	Gear Interaction	1
2013	Gull Unid	Land on Vessel	2
2013	Leachs Storm-Petrel	Land on Vessel	1
2013	Leachs Storm-Petrel	Rig Strike	1
2009	Northern Fulmar	Gear Interaction	1
2011	Northern Fulmar	Gear Interaction	3
2015	Northern Fulmar	Gear Interaction	1
2011	Northern Fulmar	Land on Vessel	2
2013	Northern Fulmar	Land on Vessel	1
2013	Northern Fulmar	Third Wire, Paravane or Warp Cable Contact	5
2014	Shearwater Unid	Land on Vessel	1
2013	Short-tailed Shearwater	Land on Vessel	1
2005	Sooty Shearwater	Gear Interaction	1
2006	Sooty Shearwater	Gear Interaction	3
2015	Storm-Petrel Unid	Land on Vessel	1
MS Catcher Vessels			
2013	Black-footed Albatross	Feeding On Catch	75
2012	Cassins Auklet	Land on Vessel	1
2014	Cassins Auklet	Land on Vessel	1
2013	Northern Fulmar	Boarded Vessel	1650
2013	Northern Fulmar	Feeding On Catch	100
2012	Northern Fulmar	Land on Vessel	2
2011	Short-tailed Albatross	Feeding On Catch	1
2013	Western Gull	Boarded Vessel	2600
2013	Western Gull	Feeding On Catch	5000

Table 55: U.S. West Coast At-sea Hake fishery, both vessel types, seabird sightings, 2002-2016. Sightings are haphazardly collected, often only for ESA listed species.

At-sea Hake Midwater Trawl		
Year	Species	Sightings
Catcher Processor		
2002	Black-footed Albatross	1
2003	Black-footed Albatross	1
MS Catcher Vessels		
2013	Black-footed Albatross	50
2014	Gull Unid	1
2011	Laysan Albatross	1
2011	Short-tailed Albatross	1
2012	Short-tailed Albatross	1
2013	Sooty Shearwater	175
2013	Western Gull	20

Limited Entry (2002-2010) and Catch Shares (2011-2016) Trawl Fisheries

Limited Entry Trawl 2002-2010

Table 57: U.S. West Coast Limited Entry fishery using trawl gear non-lethal seabird interactions, 2002-2010. Bottom and midwater trawl gears are combined.

		Limited Entry Trawl*	
		Observed	
Year	Species	Interaction	Number
2002	Bird Unid	Boarded Vessel	3
2004	Bird Unid	Boarded Vessel	1
2008	Bird Unid	Boarded Vessel	1
2002	Black-footed Albatross	Feeding On Catch	130
2004	Black-footed Albatross	Feeding On Catch	40
2005	Black-footed Albatross	Entangled In Gear - Not Trailing Gear	1
2005	Black-footed Albatross	Feeding On Catch	50

Table 57: U.S. West Coast Limited Entry fishery using trawl gear non-lethal seabird interactions, 2002-2010. Bottom and midwater trawl gears are combined. *(continued)*

		Limited Entry Trawl*	
		Observed	
Year	Species	Interaction	Number
2006	Black-footed Albatross	Feeding On Catch	1
2007	Black-footed Albatross	Boarded Vessel	1
2007	Black-footed Albatross	Feeding On Catch	50
2008	Black-footed Albatross	Feeding On Catch	27
2009	Black-footed Albatross	Feeding On Catch	261
2010	Black-footed Albatross	Feeding On Catch	65
2005	Brown Booby	Boarded Vessel	1
2009	Brown Pelican	Feeding On Catch	1
2002	Cassins Auklet	Boarded Vessel	10
2008	Cassins Auklet	Boarded Vessel	1
2009	Cassins Auklet	Boarded Vessel	1
2003	Fork-tailed Storm-Petrel	Boarded Vessel	1
2004	Fork-tailed Storm-Petrel	Boarded Vessel	1
2002	Fox Sparrow	Boarded Vessel	1
2002	Laysan Albatross	Feeding On Discarded Catch	1
2004	Laysan Albatross	Feeding On Catch	1
2005	Laysan Albatross	Boarded Vessel	1
2006	Laysan Albatross	Feeding On Catch	1
2007	Laysan Albatross	Feeding On Catch	1
2009	Laysan Albatross	Feeding On Catch	5
2002	Leachs Storm-Petrel	Boarded Vessel	1
2003	Leachs Storm-Petrel	Boarded Vessel	1
2007	Leachs Storm-Petrel	Boarded Vessel	2
2002	Lesser Goldfinch	Boarded Vessel	1
2002	Marbled Murrelet	Boarded Vessel	1
2002	Northern Fulmar	Boarded Vessel	2
2003	Northern Fulmar	Boarded Vessel	2
2007	Northern Fulmar	Boarded Vessel	1
2009	Northern Fulmar	Boarded Vessel	1
2002	Orange-crowned Warbler	Boarded Vessel	3

Table 57: U.S. West Coast Limited Entry fishery using trawl gear non-lethal seabird interactions, 2002-2010. Bottom and midwater trawl gears are combined. *(continued)*

		Limited Entry Trawl*	
		Observed	
Year	Species	Interaction	Number
2003	Rhinoceros Auklet	Boarded Vessel	1
2009	Rhinoceros Auklet	Boarded Vessel	1
2003	Shearwater Unid	Boarded Vessel	1
2007	Shearwater Unid	Boarded Vessel	1
2002	Short-tailed Albatross	Feeding On Catch	2
2009	Short-tailed Albatross	Feeding On Catch	2
2010	Short-tailed Albatross	Feeding On Catch	3
2003	Storm-Petrel Unid	Boarded Vessel	1
2003	Storm-Petrel Unid	Entangled In Gear - Not Trailing Gear	1
2004	Storm-Petrel Unid	Boarded Vessel	1
2009	Storm-Petrel Unid	Boarded Vessel	1
2009	Western Gull	Boarded Vessel	2
2009	Western Gull	Feeding On Discarded Catch	23

* Includes both bottom and midwater trawl gear in some years

Table 58: U.S. West Coast Limited Entry fishery using bottom trawl gear seabird sightings, 2002-2010. Sightings are haphazardly collected, often only for ESA listed species. Bottom and midwater trawl gears are combined.

		Limited Entry Trawl*
Year	Species	Sightings
2002	Albatross Unid	2
2004	Alcid Unid	1
2004	American White Pelican	1
2004	Bird Unid	1
2002	Black-footed Albatross	400
2003	Black-footed Albatross	919
2004	Black-footed Albatross	95

Table 58: U.S. West Coast Limited Entry fishery using bottom trawl gear seabird sightings, 2002-2010. Sightings are haphazardly collected, often only for ESA listed species. Bottom and midwater trawl gears are combined. *(continued)*

Limited Entry Trawl*		
Year	Species	Sightings
2005	Black-footed Albatross	82
2007	Black-footed Albatross	1
2009	Black-footed Albatross	38
2007	Brown Booby	1
2002	Brown Pelican	1
2003	Brown Pelican	2
2008	Brown Pelican	4
2009	Brown Pelican	21
2009	California Gull	30
2010	Cassins Auklet	1
2002	Common Murre	2
2003	Common Murre	8
2004	Common Murre	12
2002	Guillemot Unid	2
2002	Gull Unid	99
2003	Gull Unid	2596
2004	Gull Unid	21
2003	Heermanns Gull	12
2002	Laysan Albatross	1
2003	Laysan Albatross	2
2004	Laysan Albatross	19
2005	Laysan Albatross	2
2006	Laysan Albatross	3
2007	Laysan Albatross	3
2008	Laysan Albatross	2
2009	Laysan Albatross	7
2010	Laysan Albatross	3
2002	Northern Fulmar	12
2003	Northern Fulmar	105
2004	Northern Fulmar	31

Table 58: U.S. West Coast Limited Entry fishery using bottom trawl gear seabird sightings, 2002-2010. Sightings are haphazardly collected, often only for ESA listed species. Bottom and midwater trawl gears are combined. *(continued)*

Limited Entry Trawl*		
Year	Species	Sightings
2002	Pacific Loon	1
2003	Pink-footed Shearwater	1
2010	Pink-footed Shearwater	3
2002	Shearwater Unid	1
2004	Shearwater Unid	2
2002	Short-tailed Albatross	12
2003	Short-tailed Albatross	4
2004	Short-tailed Albatross	4
2005	Short-tailed Albatross	3
2006	Short-tailed Albatross	1
2007	Short-tailed Albatross	1
2009	Short-tailed Albatross	17
2010	Short-tailed Albatross	5
2010	Sooty Shearwater	2
2002	Western Gull	5

* Includes both bottom and midwater trawl gear in some years

Table 56: U.S. West Coast Limited Entry fishery using trawl gear, observer coverage, fishing effort, and observed bird takes 2002-2010. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled. Bottom and midwater trawl gears are combined.

		Limited Entry Trawl*								
		Observed						**Observed**		
Year	Species	Vessels	Trips	Sets	Tow Hrs.	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2002	Leach's Storm-Petrel	133	578	3206	13573.88	2681.36	19708.41	0.14	6.51	0
2002	Northern Fulmar	133	578	3206	13573.88	2681.36	19708.41	0.14	1.00	0
2003	No Birds Observed	125	465	2315	11578.80	2590.42	20109.28	0.13	0.00	0
2004	Black-footed Albatross	103	616	3483	13900.86	4310.96	18652.17	0.23	0.00	1
2004	Cassin's Auklet	103	616	3483	13900.86	4310.96	18652.17	0.23	0.00	1
2004	Common Murre	103	616	3483	13900.86	4310.96	18652.17	0.23	1.00	0
2004	Storm-Petrel Unid	103	616	3483	13900.86	4310.96	18652.17	0.23	1.00	0
2005	Green-winged Teal	105	524	3504	12715.41	4249.34	19286.20	0.22	0.00	10
2005	Gull Unid	105	524	3504	12715.41	4249.34	19286.20	0.22	0.00	1
2005	White-winged Scoter	105	524	3504	12715.41	4249.34	19286.20	0.22	0.00	3
2006	No Birds Observed	87	477	3027	11577.61	3443.35	17794.94	0.19	0.00	0
2007	Leach's Storm-Petrel	88	374	2550	11457.89	3448.56	20516.26	0.17	0.00	1
2008	No Birds Observed	100	438	3224	15129.47	4918.53	24203.21	0.20	0.00	0
2009	Northern Fulmar	101	590	4455	19786.54	6074.60	26063.94	0.23	0.00	1
2010	Cassin's Auklet	83	348	2640	13151.99	4076.35	22320.42	0.18	0.00	1

* Includes both bottom and midwater trawl gear in some years

Catch Shares Trawl (2011-2016)

Table 59: U.S. West Coast Catch Shares vessels using bottom or midwater trawl gear, observer coverage, fishing effort, and observed bird takes 2011-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Catch Shares Trawl											
					Tows			Catch					
Year	Species	Vessels	Trips	Tow.Hrs.	Sampled	Unsampled	Proportion	Sampled	Unsampled	Proportion	Observed.No.	Estimated.No.	Opportunistic
Catch Shares													
2011*	Arctic Herring Gull	72	1134	40198.07	9195	58	0.99	17253.18	96.64	0.99	1.00	1.07	0
2011*	Northern Fulmar	72	1134	40198.07	9195	58	0.99	17253.18	96.64	0.99	1.00	1.00	0
2012	Murre Unid	67	1089	38029.43	8968	52	0.99	17178.76	106.43	0.99	1.00	1.07	0
2012	Northern Fulmar	67	1089	38029.43	8968	52	0.99	17178.76	106.43	0.99	1.00	1.03	0
2013	Laysan Albatross	68	1193	42066.17	10017	24	1.00	18615.37	50.89	1.00	1.00	1.00	0
2013	Sooty Shearwater	68	1193	42066.17	10017	24	1.00	18615.37	50.89	1.00	2.00	2.05	0
2013	Storm-Petrel Unid	68	1193	42066.17	10017	24	1.00	18615.37	50.89	1.00	1.00	1.04	0
2014	California Gull	64	1033	34171.20	8333	32	1.00	16094.11	75.70	1.00	1.00	1.02	0
2015	Black-footed Albatross	60	904	28855.21	7480	13	1.00	15666.07	52.41	1.00	2.00	2.00	0
2016	Black-footed Albatross	53	802	25050.62	6623	16	1.00	14968.26	42.70	1.00	0.00	0.00	1
2016	Leach's Storm-Petrel	53	802	25050.62	6623	16	1.00	14968.26	42.70	1.00	0.00	0.00	3
Midwater Rockfish													
2012	No Birds Observed	5	10	72.96	36	0	1.00	197.64	0.00	1.00	0.00	0.00	0
2013	No Birds Observed	8	26	137.96	79	0	1.00	404.75	0.00	1.00	0.00	0.00	0
2014	No Birds Observed	9	34	268.46	133	0	1.00	873.69	0.00	1.00	0.00	0.00	0
2015	No Birds Observed	7	43	246.47	147	0	1.00	968.50	0.00	1.00	0.00	0.00	0
2016	No Birds Observed	4	16	100.63	49	0	1.00	375.35	0.00	1.00	0.00	0.00	0
Midwater Hake													
2011	No Birds Observed	27	929	3974.59	1717	0	1.00	90777.27	0.00	1.00	0.00	0.00	0
2012	No Birds Observed	24	744	5960.79	1601	0	1.00	65396.38	0.00	1.00	0.00	0.00	0
2013	No Birds Observed	24	960	4628.08	1734	0	1.00	96867.80	0.00	1.00	0.00	0.00	0
2014	No Birds Observed	25	996	4732.66	1725	1	1.00	97925.22	57.48	1.00	0.00	0.00	0
2015	No Birds Observed	5	129	1193.99	289	0	1.00	11461.43	0.00	1.00	0.00	0.00	0
2016	No Birds Observed	4	100	652.59	207	0	1.00	8969.97	0.00	1.00	0.00	0.00	0

* Includes both bottom and midwater trawl gear

Table 60: U.S. West Coast Catch Shares vessels using bottom or midwater trawl gear non-lethal seabird interactions, 2011-2016.

		Catch Shares Bottom and Midwater Trawl	
		Observed	
Year	Species	Interaction	Number
Catch Shares			
2011*	Black-footed Albatross	Boarded Vessel	40
2011*	Black-footed Albatross	Feeding On Catch	122
2013	Black-footed Albatross	Boarded Vessel	8
2013	Black-footed Albatross	Deterrence Used	36
2013	Black-footed Albatross	Feeding On Catch	176
2014	Black-footed Albatross	Feeding On Catch	253
2014	Black-footed Albatross	Feeding On Discarded Catch	1
2015	Black-footed Albatross	Feeding On Catch	69
2015	Black-footed Albatross	Feeding On Discarded Catch	80
2016	Black-footed Albatross	Boarded Vessel	1
2016	Black-footed Albatross	Feeding on Catch	130
2016	Black-footed Albatross	Feeding on Discarded Catch	150
2014	Brown Booby	Boarded Vessel	1
2016	Brown Booby	Boarded Vessel	1
2012	Brown Pelican	Boarded Vessel	1
2012	Brown Pelican	Feeding On Catch	1
2011*	Cassins Auklet	Boarded Vessel	2
2016	Cassins Auklet	Vessel Strike	1
2015	Gull Unid	Boarded Vessel	20
2015	Gull Unid	Feeding On Catch	265
2015	Gull Unid	Feeding On Discarded Catch	35
2015	Laysan Albatross	Feeding On Discarded Catch	3
2016	Laysan Albatross	Feeding on Catch	5
2016	Laysan Albatross	Feeding on Discarded Catch	7
2011*	Leachs Storm-Petrel	Boarded Vessel	1
2011*	Northern Fulmar	Boarded Vessel	21
2014	Northern Fulmar	Boarded Vessel	10
2016	Northern Fulmar	Boarded Vessel	2
2011*	Short-tailed Albatross	Feeding On Catch	4
2012	Short-tailed Albatross	Feeding On Catch	3
2013	Short-tailed Albatross	Feeding On Catch	3
2014	Short-tailed Albatross	Feeding On Catch	4

Table 60: U.S. West Coast Catch Shares vessels using bottom or midwater trawl gear non-lethal seabird interactions, 2011-2016. *(continued)*

		Catch Shares Bottom and Midwater Trawl	
		Observed	
Year	Species	Interaction	Number
2015	Short-tailed Albatross	Feeding On Catch	2
2015	Short-tailed Albatross	Feeding On Discarded Catch	1
2016	Short-tailed Albatross	Feeding on Catch	2
2011*	Storm-Petrel Unid	Entangled In Gear - Not Trailing Gear	1
2013	Storm-Petrel Unid	Vessel Strike	1
Midwater Rockfish			
2015	Gull Unid	Feeding On Catch	70
Midwater Hake			
2011	Black-footed Albatross	Feeding On Catch	242
2016	Black-footed Albatross	Feeding on Catch	1
2011	Fork-tailed Storm-Petrel	Feeding On Catch	98
2014	Laysan Albatross	Feeding On Catch	1
2011	Northern Fulmar	Boarded Vessel	1
2011	Northern Fulmar	Feeding On Catch	740
2011	Northern Fulmar	Vessel Strike	1
2011	Parasitic Jaeger	Feeding On Catch	1
2011	Pink-footed Shearwater	Feeding On Catch	4
2011	Shearwater Unid	Entangled In Gear - Not Trailing Gear	1
2011	Short-tailed Albatross	Feeding On Catch	1
2012	Short-tailed Albatross	Feeding On Catch	2
2013	Short-tailed Albatross	Feeding On Catch	1
2011	Short-tailed Jaeger	Feeding On Catch	1
2011	Sooty Shearwater	Feeding On Catch	12
2011	South Polar Skua	Feeding On Catch	1
2011	Western Gull	Feeding On Catch	23

* Includes both bottom and midwater trawl gear

Table 61: U.S. West Coast Catch Shares vessels using bottom or midwater trawl gear seabird sightings, 2011-2016. Sightings are haphazardly collected, often only for ESA listed species.

Catch Shares Bottom and Midwater Trawl			
Year	Gear	Species	Sightings
Catch Shares			
2011*	Bottom Trawl	Black-footed Albatross	160
2013	Bottom Trawl	Black-footed Albatross	36
2014	Bottom Trawl	Black-footed Albatross	25
2015	Bottom Trawl	Black-footed Albatross	2
2016	Bottom Trawl	Black-footed Albatross	170
2016	Bottom Trawl	Brown Booby	1
2011*	Bottom Trawl	Heermanns Gull	9
2012	Bottom Trawl	Laysan Albatross	1
2015	Bottom Trawl	Laysan Albatross	2
2016	Bottom Trawl	Laysan Albatross	3
2011*	Bottom Trawl	Northern Fulmar	12
2011*	Bottom Trawl	Short-tailed Albatross	33
2012	Bottom Trawl	Short-tailed Albatross	8
2013	Bottom Trawl	Short-tailed Albatross	13
2014	Bottom Trawl	Short-tailed Albatross	3
2015	Bottom Trawl	Short-tailed Albatross	1
2016	Bottom Trawl	Short-tailed Albatross	3
Midwater Rockfish			
2013	Midwater Trawl	Cassins Auklet	1
Midwater Hake			
2012	Midwater Trawl	Black-footed Albatross	50
2011	Midwater Trawl	Gull Unid	20
2012	Midwater Trawl	Laysan Albatross	1
2011	Midwater Trawl	Pink-footed Shearwater	30
2011	Midwater Trawl	Short-tailed Albatross	2
2012	Midwater Trawl	Short-tailed Albatross	1
2013	Midwater Trawl	Short-tailed Albatross	1

* Includes both bottom and midwater trawl gear

Limited Entry (2002-2009) and Open Access (2003-2016) California Halibut Fishery

Table 62: California Limited Entry (LE) California halibut fishery, observer coverage, fishing effort, and observed bird takes 2002-2009. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled. Confidentiality rules require combining LE and OA California halibut fisheries in 2010. Starting in 2011, the LE CA Halibut fishery has been combined with the Catch Shares bottom trawl vessels.

		LE California Halibut Trawl								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Tow Hrs.	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2002	No Birds Observed	7	19	52	4824.29	3.59	108.27	0.03	0.00	0
2003	Brandts Cormorant	12	73	207	17190.81	19.09	105.54	0.18	1.00	0
2003	Common Murre	12	73	207	17190.81	19.09	105.54	0.18	36.00	0
2003	Cormorant Unid	12	73	207	17190.81	19.09	105.54	0.18	2.00	0
2004	Common Murre	8	46	171	16009.46	31.49	136.40	0.23	5.00	0
2004	Cormorant Unid	8	46	171	16009.46	31.49	136.40	0.23	2.00	0
2005	No Birds Observed	10	74	235	17830.06	30.51	188.88	0.16	0.00	0
2006	No Birds Observed	9	78	224	11458.35	14.29	119.55	0.12	0.00	0
2007	No Birds Observed	5	40	81	6640.27	5.45	18.60	0.29	0.00	0
2008	No Birds Observed	6	40	118	9132.49	9.64	36.39	0.26	0.00	0
2009	No Birds Observed	3	12	29	1106.74	2.90	47.20	0.06	0.00	0

Table 63: California Open Access California halibut fishery, observer coverage, fishing effort, and observed bird takes 2003-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled. The Open Access CA Halibut fishery was not observed in 2006. Confidentiality rules require combining LE and OA California halibut fisheries in 2010.

		OA California Halibut Trawl								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Tow Hrs.	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2003	Common Murre	5	18	110	2018.30	1.98	25.75	0.08	1.00	0
2004	No Birds Observed	4	53	244	5404.53	5.10	70.89	0.07	0.00	0
2005	Cormorant Unid	6	59	362	7752.13	7.43	64.51	0.12	1.00	0
2006	Fishery Not Observed	0	0	0	–	–	–	–	–	–
2007	Cormorant Unid	8	48	227	2694.93	2.75	39.21	0.07	1.00	0
2008	No Birds Observed	7	49	199	2701.22	2.67	51.87	0.05	0.00	0
2009	No Birds Observed	3	9	30	586.41	0.63	82.36	0.01	0.00	0
2010*	Cormorant Unid	8	43	153	5587.85	8.80	123.56	0.07	1.00	0
2011	Common Murre	13	48	204	7187.03	12.45	79.92	0.16	1.00	0
2012	No Birds Observed	7	27	78	1835.13	3.54	55.78	0.06	0.00	0
2013	No Birds Observed	5	29	81	3350.56	4.30	68.86	0.06	0.00	0
2014	Brandts Cormorant	6	51	145	5484.31	18.14	81.44	0.22	1.00	0
2015	Bird Unid	8	100	339	11546.38	30.61	92.05	0.33	1.00	0
2015	Brandts Cormorant	8	100	339	11546.38	30.61	92.05	0.33	1.00	0
2015	Common Murre	8	100	339	11546.38	30.61	92.05	0.33	3.00	0
2016	Common Murre	11	114	500	14131.20	27.33	89.62	0.30	2.00	0
2016	Cormorant Unid	11	114	500	14131.20	27.33	89.62	0.30	1.00	0
2016	Western Gull	11	114	500	14131.20	27.33	89.62	0.30	1.00	0

* LE and OA California Halibut vessels combined

Table 64: California Limited Entry (LE) and Open Access (OA) California (CA) halibut fisheries non-lethal seabird interactions, 2002-2016. Confidentiality rules require combining LE and OA California halibut fisheries in 2010. Starting in 2011, the LE CA Halibut fishery has been combined with the Catch Shares bottom trawl vessels.

		California Halibut Trawl	
		Observed	
Year	Species	Interaction	Number
LE & OA CA Halibut			
2010*	Cormorant Unid	Boarded Vessel	1
2010*	Cormorant Unid	Entangled In Gear - Not Trailing Gear	1
OA CA Halibut			
2015	Brown Pelican	Boarded Vessel	1

* LE and OA California Halibut vessels combined

Table 65: California Limited Entry and Open Access California halibut fisheries seabird sightings, 2002-2016. Sightings are haphazardly collected, often only for ESA listed species. Confidentiality rules require combining LE and OA California halibut fisheries in 2010. Starting in 2011, the LE CA Halibut fishery has been combined with the Catch Shares bottom trawl vessels.

California Halibut Trawl			
Year	Gear	Species	Sightings
LE CA Halibut			
2003	Bottom Trawl	Brown Pelican	40
2003	Bottom Trawl	Common Murre	10
2003	Bottom Trawl	Gull Unid	40
OA CA Halibut			
2012	Bottom Trawl	Pacific Loon	1
2016	Bottom Trawl	California Least Tern	2

Washington, Oregon and California State Pink Shrimp Fisheries

Table 66: Washington, Oregon, and California pink shrimp fisheries, observer coverage, fishing effort, and observed bird takes 2002-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled. Asteriks (*) indicate confidential data; double dashes (–) indicate years when the particular fishery was not observed.

			Pink Shrimp Trawl								
			Observed						Observed		
State	Year	Species	Vessels	Trips	Sets	Tow Hrs.	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
WA	2002	Fishery Not Observed	0	0	0	–	–	–	–	–	–
WA	2003	Fishery Not Observed	0	0	0	–	–	–	–	–	–
WA	2004	*	*	*	*	*	*	*	*	*	*
WA	2005	Fishery Not Observed	0	0	0	–	–	–	–	–	–
WA	2006	Fishery Not Observed	0	0	0	–	–	–	–	–	–
WA	2007	Fishery Not Observed	0	0	0	–	–	–	–	–	–
WA	2008	Fishery Not Observed	0	0	0	–	–	–	–	–	–
WA	2009	Fishery Not Observed	0	0	0	–	–	–	–	–	–
WA	2010	No Birds Observed	7	18	341	6551.33	399.48	4295.6	0.09	0	0
WA	2011	No Birds Observed	11	35	578	12142.38	697.24	4312.14	0.16	0	0
WA	2012	Sooty Shearwater	10	31	522	9751.98	625.95	4239.4	0.15	14	0
WA	2013	No Birds Observed	13	29	386	5731.42	626.82	6157.86	0.1	0	0
WA	2014	Gull Unid	17	44	401	6536.66	980.85	13876.25	0.07	1	0
WA	2015	No Birds Observed	24	100	1458	31290.56	2151.09	18814.34	0.11	0	0
WA	2016	No Birds Observed	17	59	974	21828.61	1107.93	6395.87	0.17	0	0
OR	2002	Fishery Not Observed	0	0	0	–	–	–	–	–	–
OR	2003	Fishery Not Observed	0	0	0	–	–	–	–	–	–
OR	2004	No Birds Observed	18	43	765	24688.11	427.21	5537.01	0.08	0	0
OR	2005	No Birds Observed	22	36	533	12441.05	402.89	7159.42	0.06	0	0
OR	2006	Fishery Not Observed	0	0	0	–	–	–	–	–	–
OR	2007	No Birds Observed	28	61	929	19047.5	649.98	9128.6	0.07	0	0
OR	2008	No Birds Observed	30	49	785	17144.57	672.49	11575.86	0.06	0	0
OR	2009	No Birds Observed	34	52	672	10586.31	751.2	10048.69	0.07	0	0
OR	2010	No Birds Observed	39	94	1233	19055.05	1706.84	14290.37	0.12	0	0
OR	2011	No Birds Observed	41	132	1892	36261.35	2985.96	21915.06	0.14	0	0
OR	2012	No Birds Observed	52	154	2122	28754.77	3014.22	22291.59	0.14	0	0
OR	2013	Sooty Shearwater	46	107	1403	20142.96	2313.24	21604.27	0.11	13.54	0
OR	2014	Shearwater Unid	38	106	1463	25802.88	2291.35	23573.3	0.1	2	0
OR	2015	No Birds Observed	42	131	1990	31465.94	2282.09	24273.62	0.09	0	0
OR	2016	No Birds Observed	54	157	2467	46138.74	2309.36	16115.58	0.14	0	0
CA	2002	Fishery Not Observed	0	0	0	–	–	–	–	–	–
CA	2003	Fishery Not Observed	0	0	0	–	–	–	–	–	–
CA	2004	*	*	*	*	*	*	*	*	*	*
CA	2005	*	*	*	*	*	*	*	*	*	*
CA	2006	Fishery Not Observed	0	0	0	–	–	–	–	–	–
CA	2007	*	*	*	*	*	*	*	*	*	*
CA	2008	*	*	*	*	*	*	*	*	*	*
CA	2009	*	*	*	*	*	*	*	*	*	*
CA	2010	No Birds Observed	8	14	134	1193.87	265.53	1770.87	0.15	0	0
CA	2011	Pink-footed Shearwater	8	19	203	1720.44	420.59	3332.92	0.13	1	0
CA	2012	No Birds Observed	7	15	175	1178.01	347.6	2790.62	0.12	0	0
CA	2013	No Birds Observed	10	17	188	1357.95	359.77	3915.31	0.09	0	0
CA	2014	No Birds Observed	11	26	337	3666.42	597.53	3844.99	0.16	0	0
CA	2015	No Birds Observed	9	23	335	4976.99	334.66	3452.95	0.1	0	0
CA	2016	No Birds Observed	11	28	406	8103.87	313.38	1337.21	0.23	0	0

Table 67: Washington, Oregon, and California pink shrimp fisheries non-lethal seabird interactions, 2002-2016. Double dashes (–) indicate years when the particular fishery was not observed.

			Pink Shrimp Trawl	
			Observed	
State	Year	Species	Interaction	Number
WA	2014	Cassins Auklet	Boarded Vessel	1
WA	2015	Fork-tailed Storm-Petrel	Boarded Vessel	1
WA	2015	Pink-footed Shearwater	Vessel Strike	1
WA	2012	Sooty Shearwater	Entangled In Gear - Not Trailing Gear	4
WA	2014	Sooty Shearwater	Boarded Vessel	1
OR	2014	California Gull	Boarded Vessel	1
OR	2011	Cassins Auklet	Boarded Vessel	3
OR	2013	Cassins Auklet	Boarded Vessel	2
OR	2014	Cassins Auklet	Boarded Vessel	6
OR	2012	Laysan Albatross	Feeding On Catch	2
OR	2013	Leachs Storm-Petrel	Boarded Vessel	1
OR	2004	Northern Fulmar	Boarded Vessel	1
OR	2011	Northern Fulmar	Boarded Vessel	1
OR	2015	Snowy Plover	Boarded Vessel	1
OR	2012	Sooty Shearwater	Boarded Vessel	2
OR	2013	Sooty Shearwater	Boarded Vessel	3
OR	2013	Storm-Petrel Unid	Boarded Vessel	3
OR	2005	Wilsons Warbler	Boarded Vessel	1

Table 68: Washington, Oregon, and California pink shrimp fisheries seabird sightings, 2002-2016. Sightings are haphazardly collected, often only for ESA listed species. Double dashes (–) indicate years when the particular fishery was not observed.

Pink Shrimp Trawl			
Year	Gear	Species	Sightings
2007	Shrimp Trawl	Bird Unid	1
2011	Shrimp Trawl	Black-footed Albatross	32
2015	Shrimp Trawl	Black-footed Albatross	10
2016	Shrimp Trawl	Black-footed Albatross	1
2014	Shrimp Trawl	Cassins Auklet	1
2004	Shrimp Trawl	Laysan Albatross	2
2005	Shrimp Trawl	Pink-footed Shearwater	3
2004	Shrimp Trawl	Short-tailed Albatross	1
2010	Shrimp Trawl	Short-tailed Albatross	1
2005	Shrimp Trawl	Sooty Shearwater	175
2013	Shrimp Trawl	Sooty Shearwater	1
2004	Shrimp Trawl	Tufted Puffin	4
2009	Shrimp Trawl	Tufted Puffin	1
2015	Shrimp Trawl	Tufted Puffin	1
2016	Shrimp Trawl	Tufted Puffin	2

Exempted Fishing Permits

Electronic Monitoring

Table 69: U.S. West Coast Catch Shares vessels fishing with bottom and midwater trawl gear and participating in the Electronic Monitoring (EM) Exempt Fishing Permit, fishery observer coverage, fishing effort, and observed bird takes 2015-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		EM Catch Shares Bottom and Midwater Trawl								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Tow Hrs.	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2015	No Birds Observed	4	9	57	317.38	134.78	404.46	0.33	0	0
2016	No Birds Observed	8	30	186	922.57	503.53	1732.01	0.29	0	0

Table 70: U.S. West Coast Catch Shares vessels fishing with pot gear and participating in the Electronic Monitoring Exempt Fishing Permit, fishery observer coverage, fishing effort, and observed bird takes 2015-2016. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		EM Catch Shares Pot								
		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Units	Retained (mt)	Landed (mt)	Cov. Rate	Takes	Opportunistic
2015	No Birds Observed	7	18	184	4272	102.37	339.38	0.30	0	0
2016	No Birds Observed	6	19	249	6275	151.96	470.47	0.32	0	0

Table 71: U.S. West Coast Catch Shares vessels participating in the Electronic Monitoring Exempt Fishing Permit, non-lethal seabird interactions, 2015-2016.

Electronic Monitoring Catch Shares				
			Observed	
Year	Gear	Species	Interaction	Number
2015	Trawl	Northern Fulmar	Boarded Vessel	1
2015	Trawl	Storm-Petrel Unid	Boarded Vessel	1
2016	Trawl	Black-footed Albatross	Feeding on Catch	90
2016	Trawl	Laysan Albatross	Boarded Vessel	1
2016	Pot	Leachs Storm-Petrel	Boarded Vessel	2

* Trawl includes both bottom and midwater trawl gear

Table 72: U.S. West Coast Catch Shares vessels participating in the Electronic Monitoring Exempt Fishing Permit, seabird sightings, all gear types, 2015-2016. Sightings are haphazardly collected, often only for ESA listed species.

Electronic Monitoring Catch Shares			
Year	Gear	Species	Sightings
2015	Pot	Black-footed Albatross	2

Non-EM Exempted Fishing Permit

Table 73: Observed, seabird interactions and sightings from Exempted Permit Fisheries (EFP), not participating in the Electronic Monitoring EFP (non-EM), 2002-2016. These fisheries have had observers collecting data on every trip (100% observer coverage).

Non-EM EFP Fisheries				
Year	Gear	Species	Interaction	Number
2009	Hook-and-Line	Black-footed Albatross	Sighting	1
2010	Hook-and-Line	Black-footed Albatross	Entangled In Gear - Not Trailing Gear	1
2010	Hook-and-Line	Laysan Albatross	Sighting	1
2003	Bottom Trawl	Northern Fulmar	Boarded Vessel	2
2013	Hook-and-Line	Shearwater Unid	Sighting	40
2002	Bottom Trawl	Short-tailed Albatross	Sighting	12
2013	Hook-and-Line	Sooty Shearwater	Sighting	400
2003	Bottom Trawl	Tufted Puffin	Sighting	2

Other Fishery Observations

Table 74: Observed, seabird interactions and sightings from fisheries no longer observed by the NWFSC or where the fishery was unknown, 2002-2016.

Other Fishery Observations				
Year	Sector	Species	Interaction	Number
2003	Prawn Fisheries	Brown Pelican	Sighting	9
2004	Prawn Fisheries	Brown Pelican	Boarded Vessel	1
2003	Prawn Fisheries	Cormorant Unid	Entangled In Gear - Not Trailing Gear	1
2016	Unknown Fisheries	Black-footed Albatross	Boarded Vessel	1

Bayesian and Ratio Estimator Comparisons

Figure 9: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified alcids (Family Alcidae) for hook-and-line vessels in the Limited Entry Sablefish fishery.

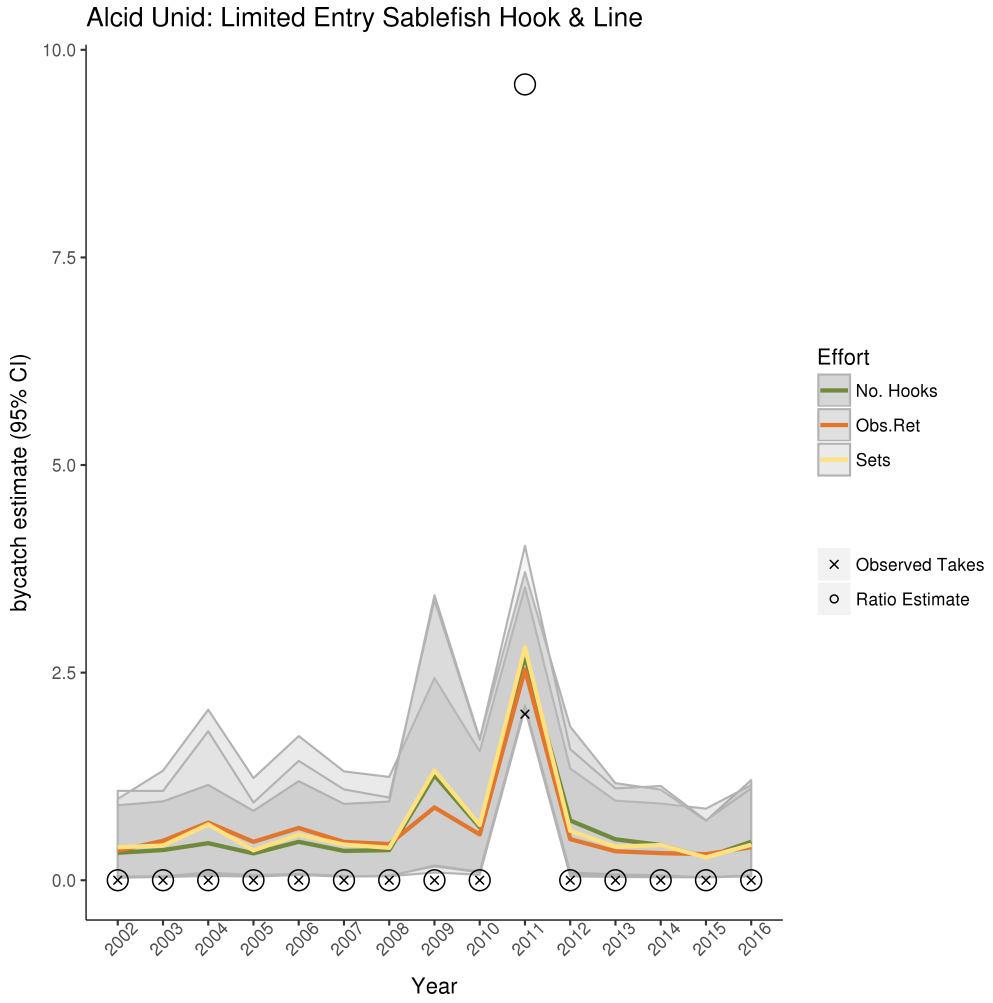


Figure 10: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified birds (Class Aves) for hook and line vessels in the Limited Entry Sablefish fishery.

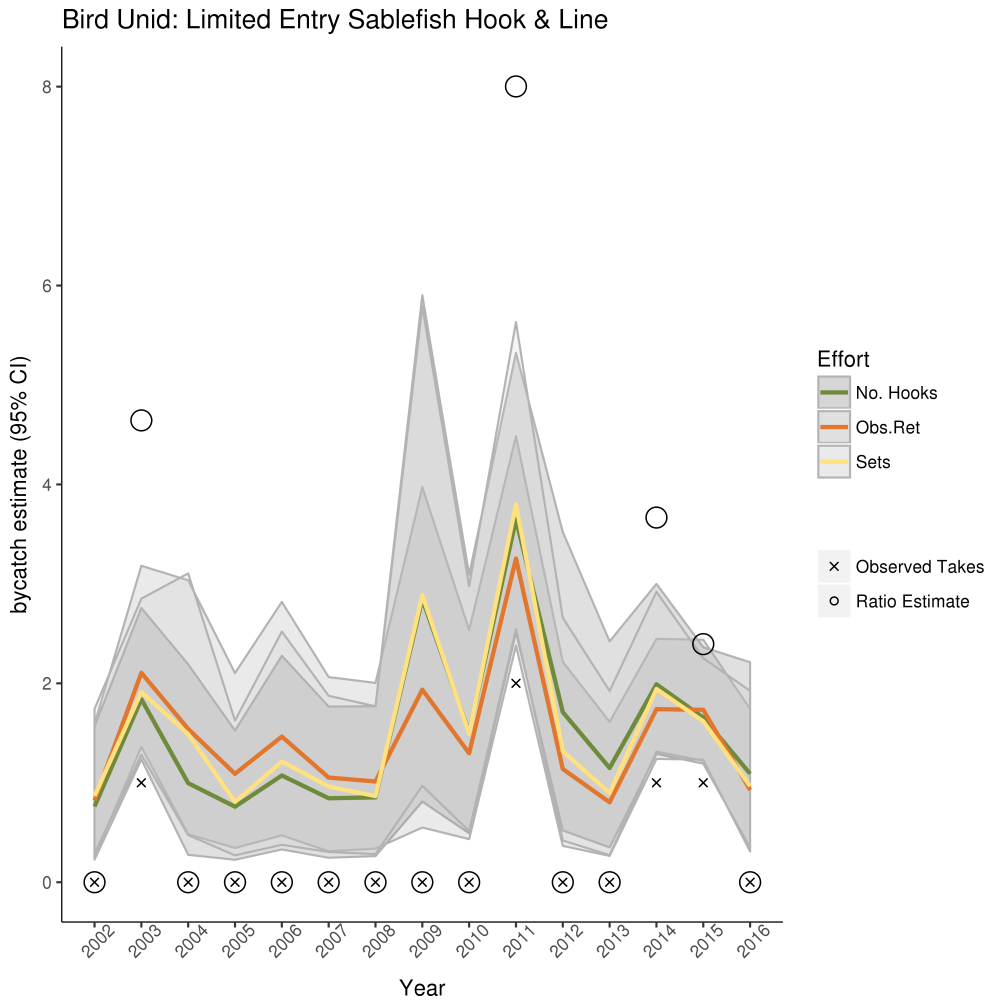


Figure 11: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for Black-footed Albatross (*Phoebastria nigripes*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

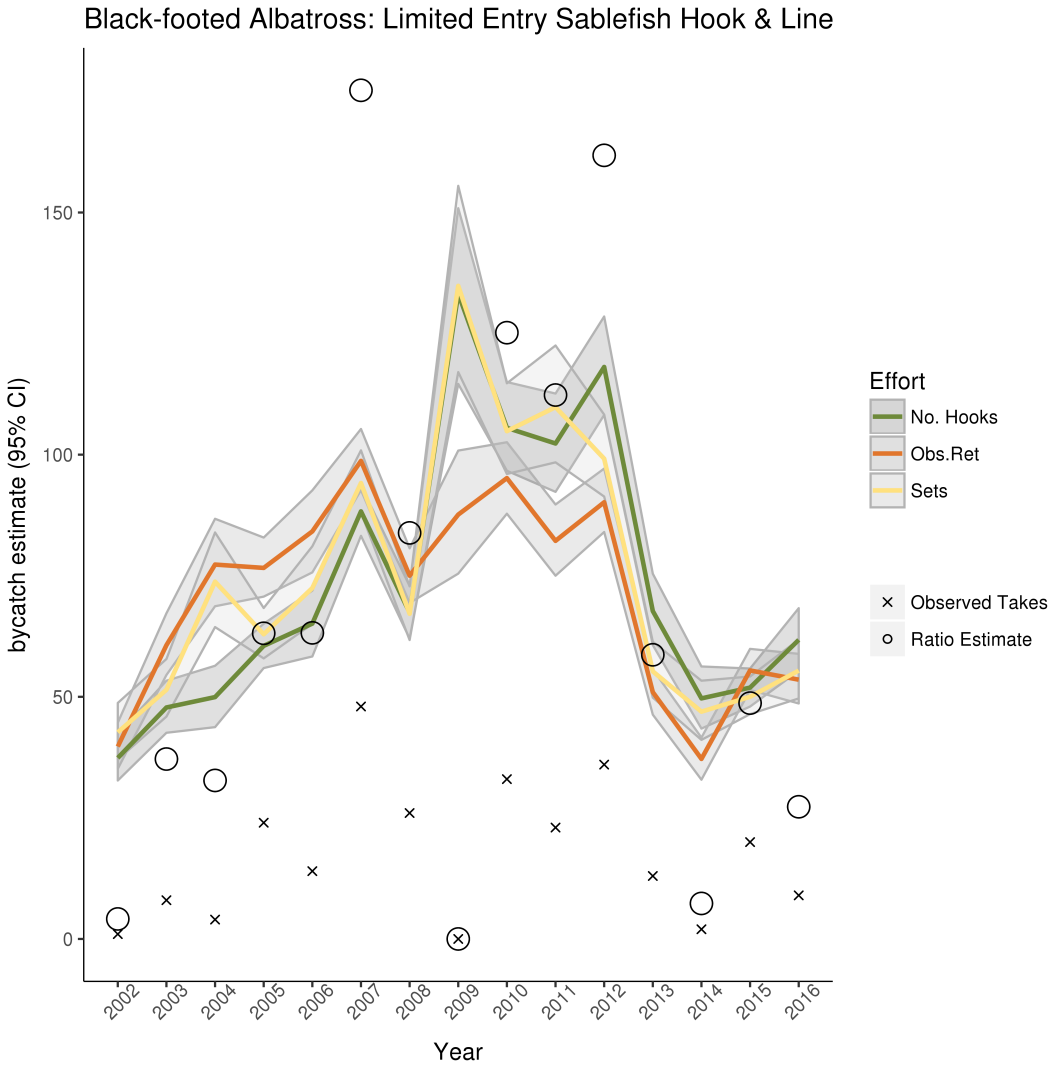


Figure 12: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for California gull (*Larus californicus*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

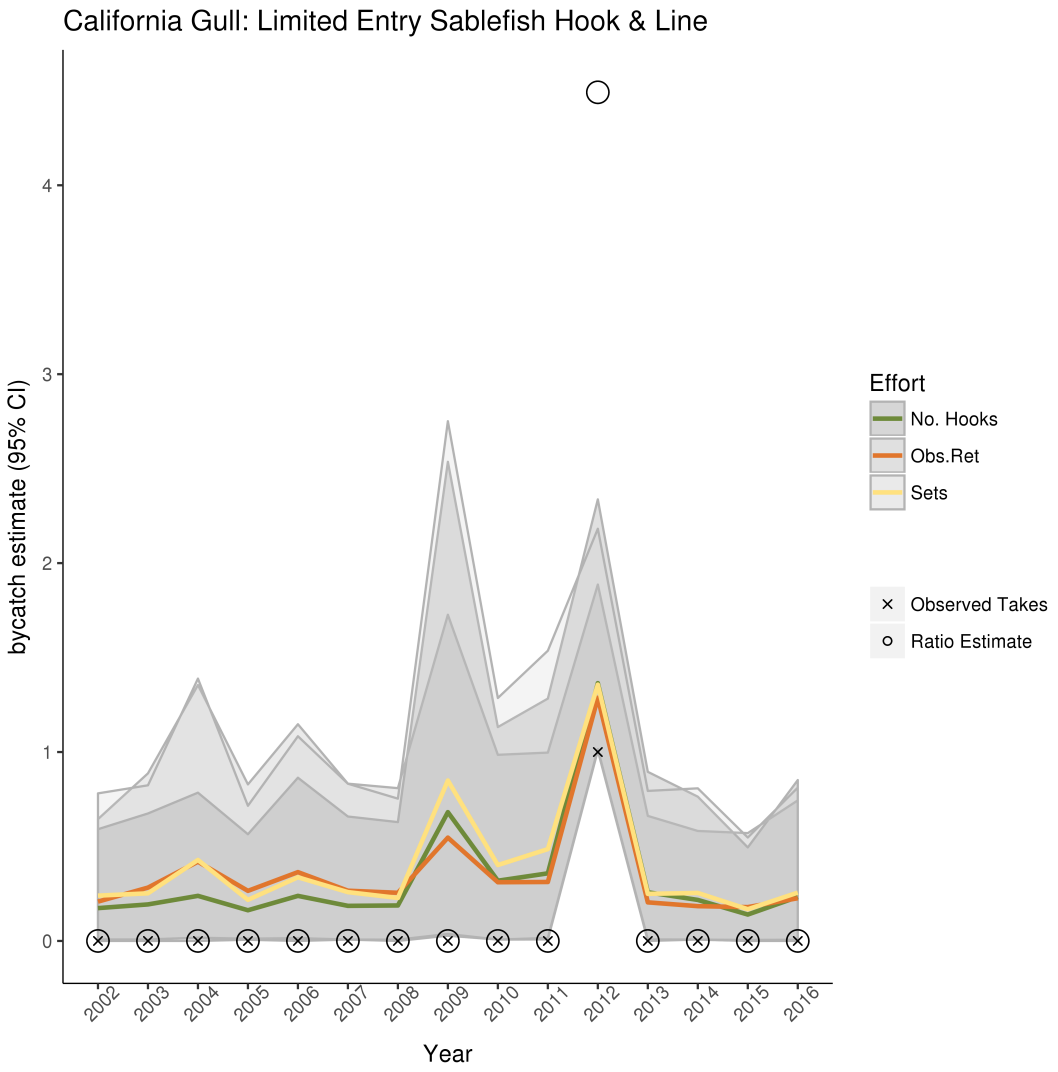


Figure 13: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified cormorants (Phalacrocorax spp.) for hook-and-line vessels in the Limited Entry Sablefish fishery.

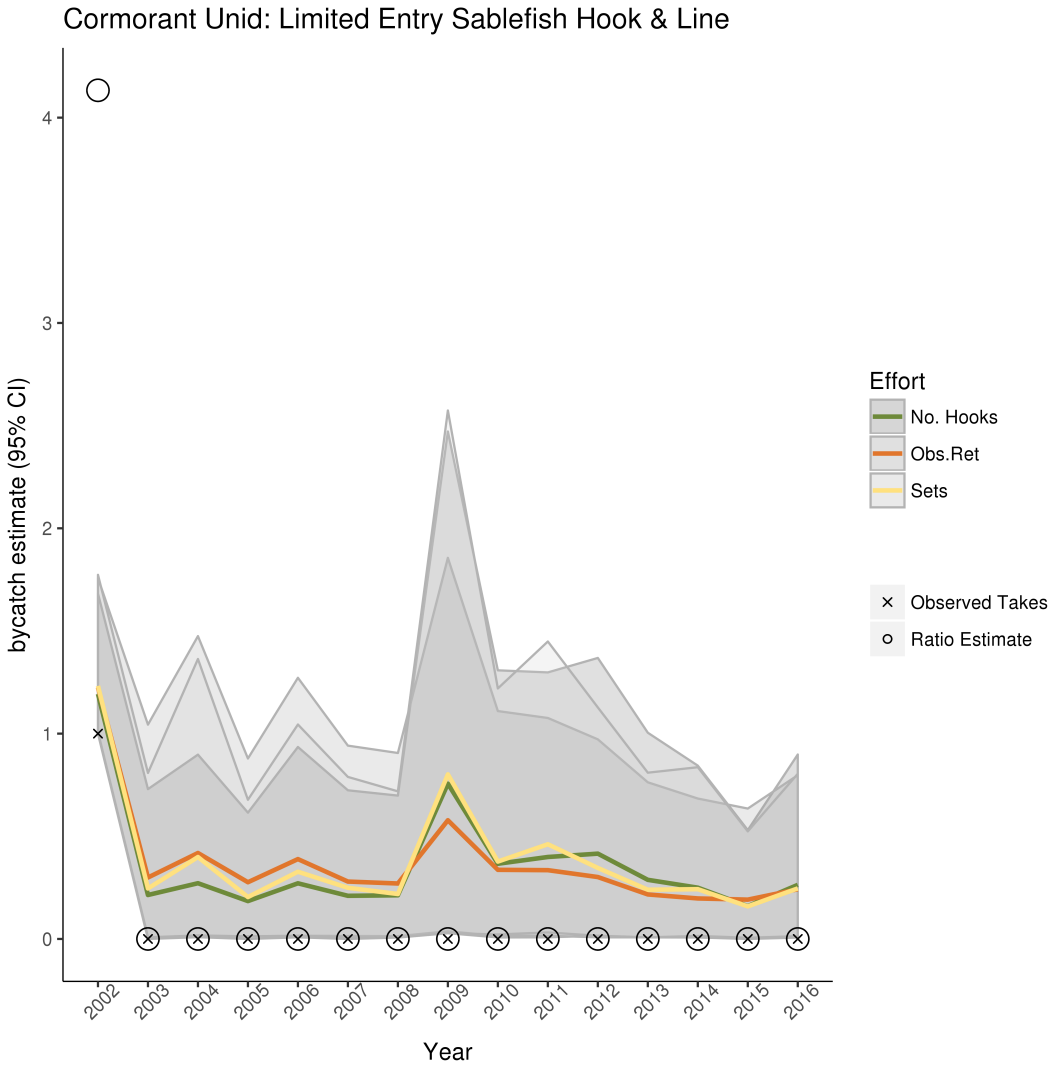


Figure 14: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for glaucous-winged gulls (*Larus glaucescens*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

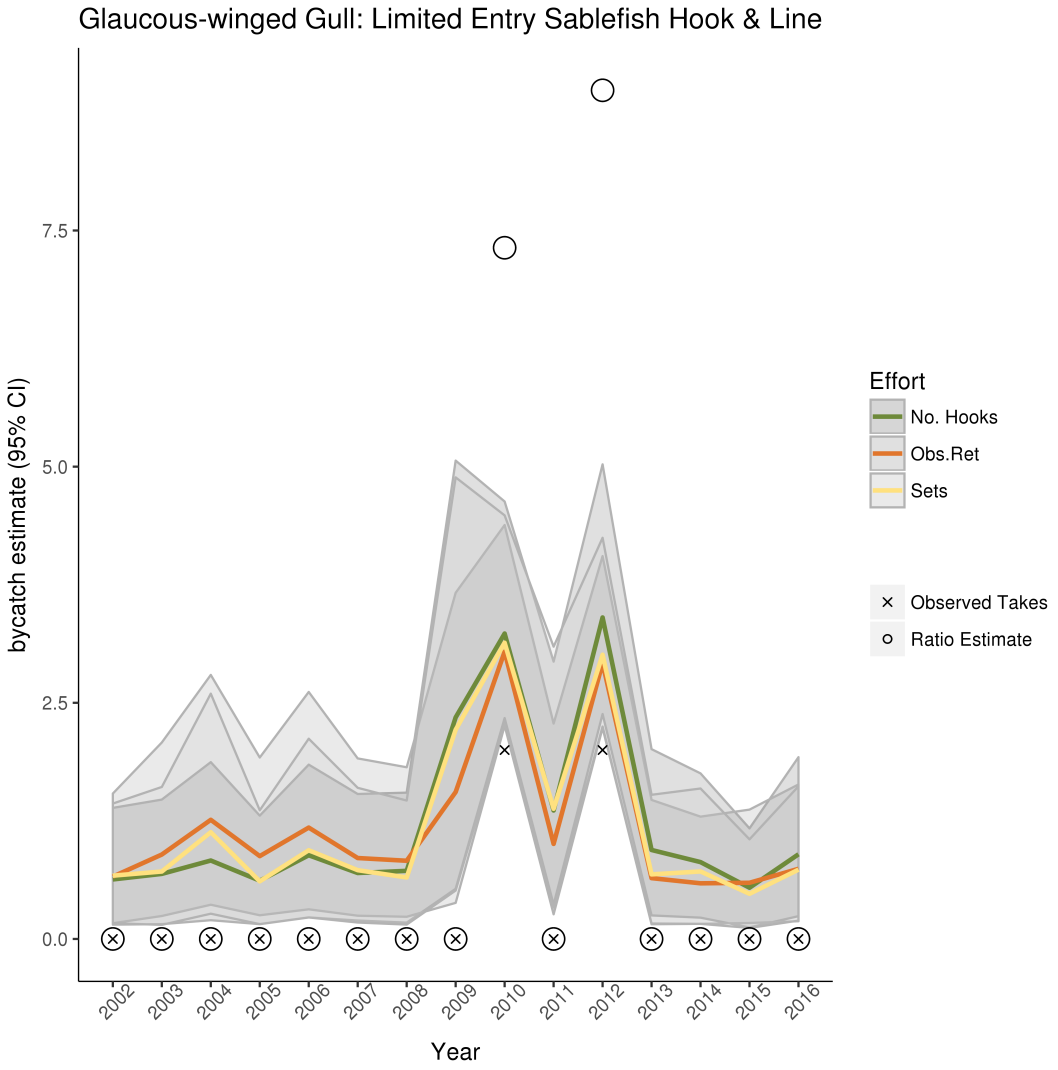


Figure 15: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified gulls (Family Laridae) for hook-and-line vessels in the Limited Entry Sablefish fishery.

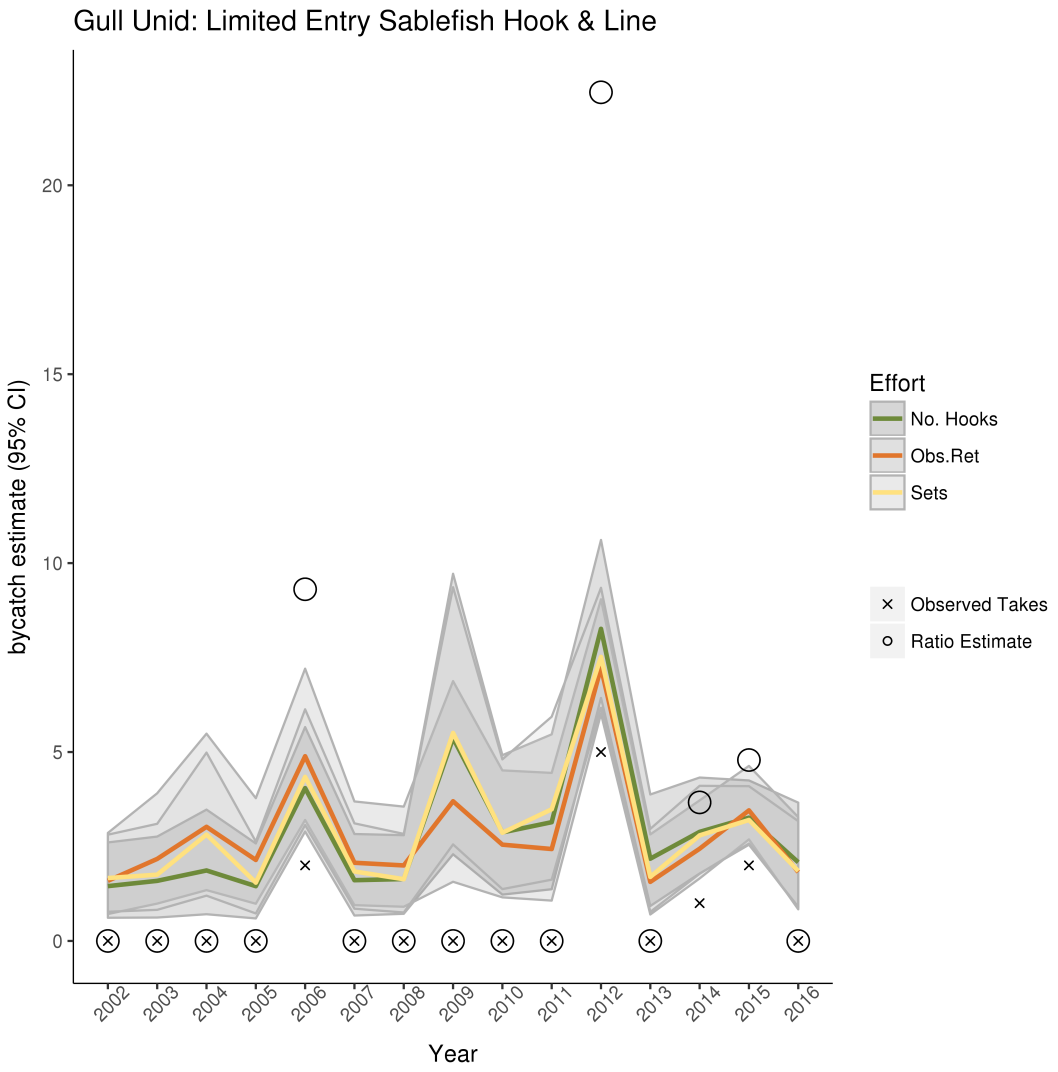


Figure 16: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for herring gulls (*Larus argentatus smithsonianus*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

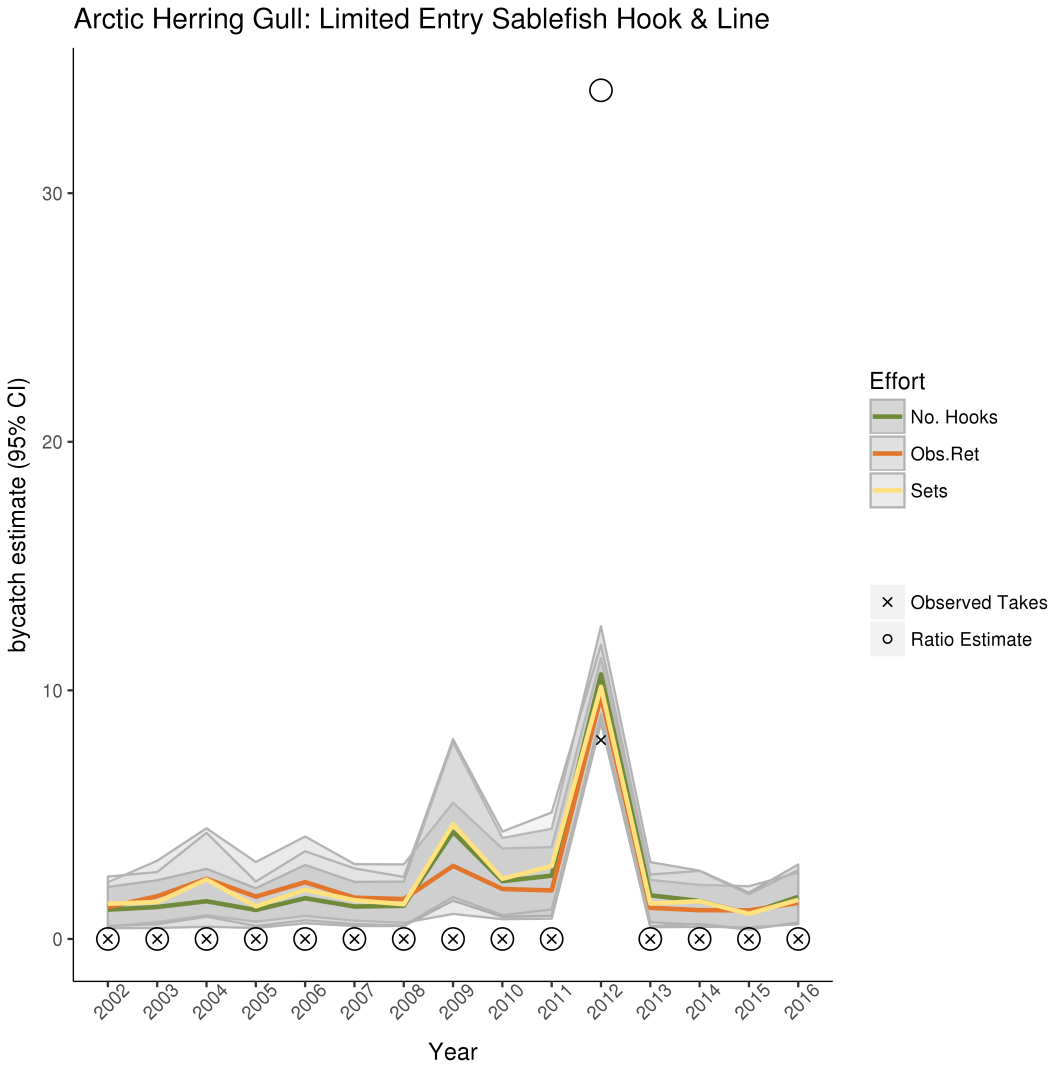


Figure 17: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for Laysan albatross (*Phoebastria immutabilis*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

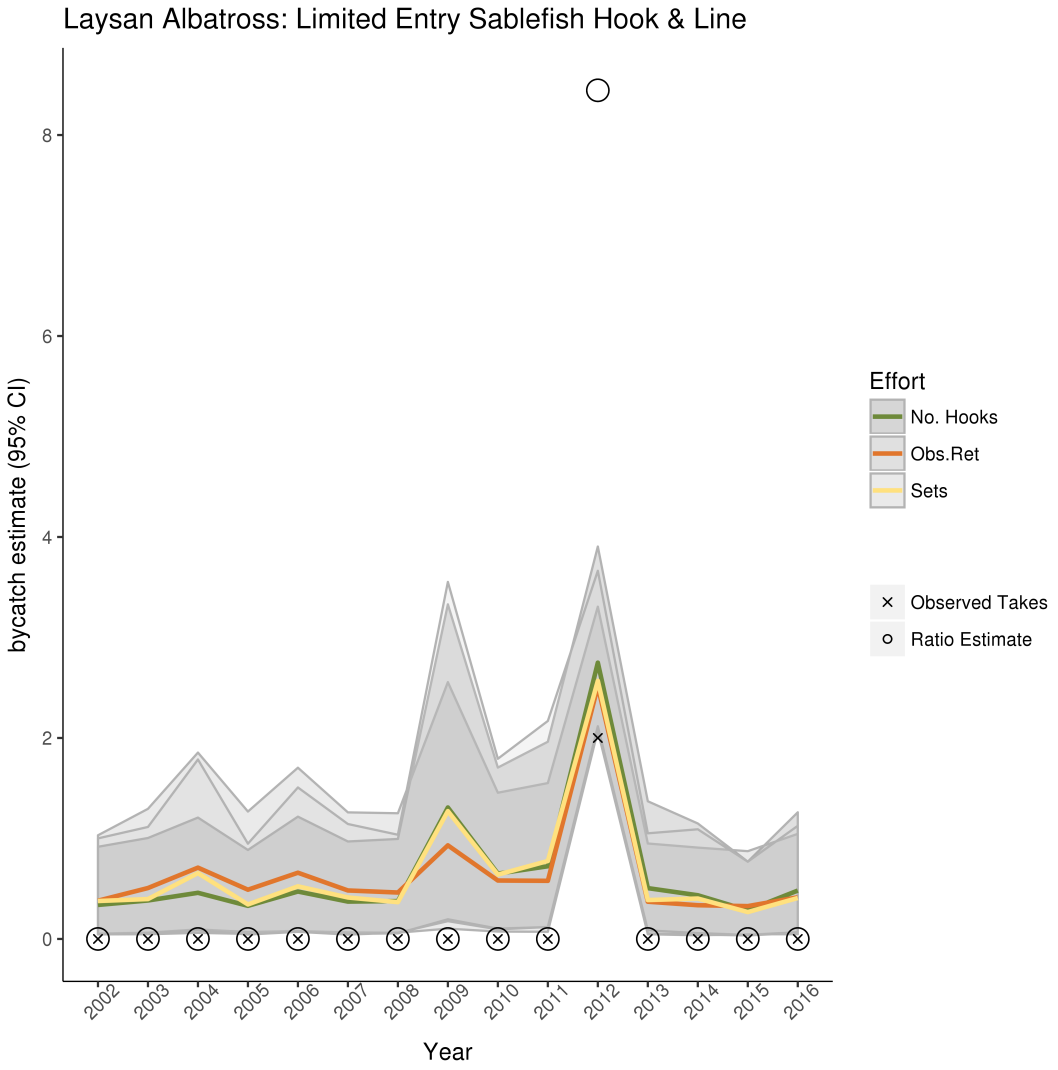


Figure 18: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for northern fulmar (*Fulmarus glacialis*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

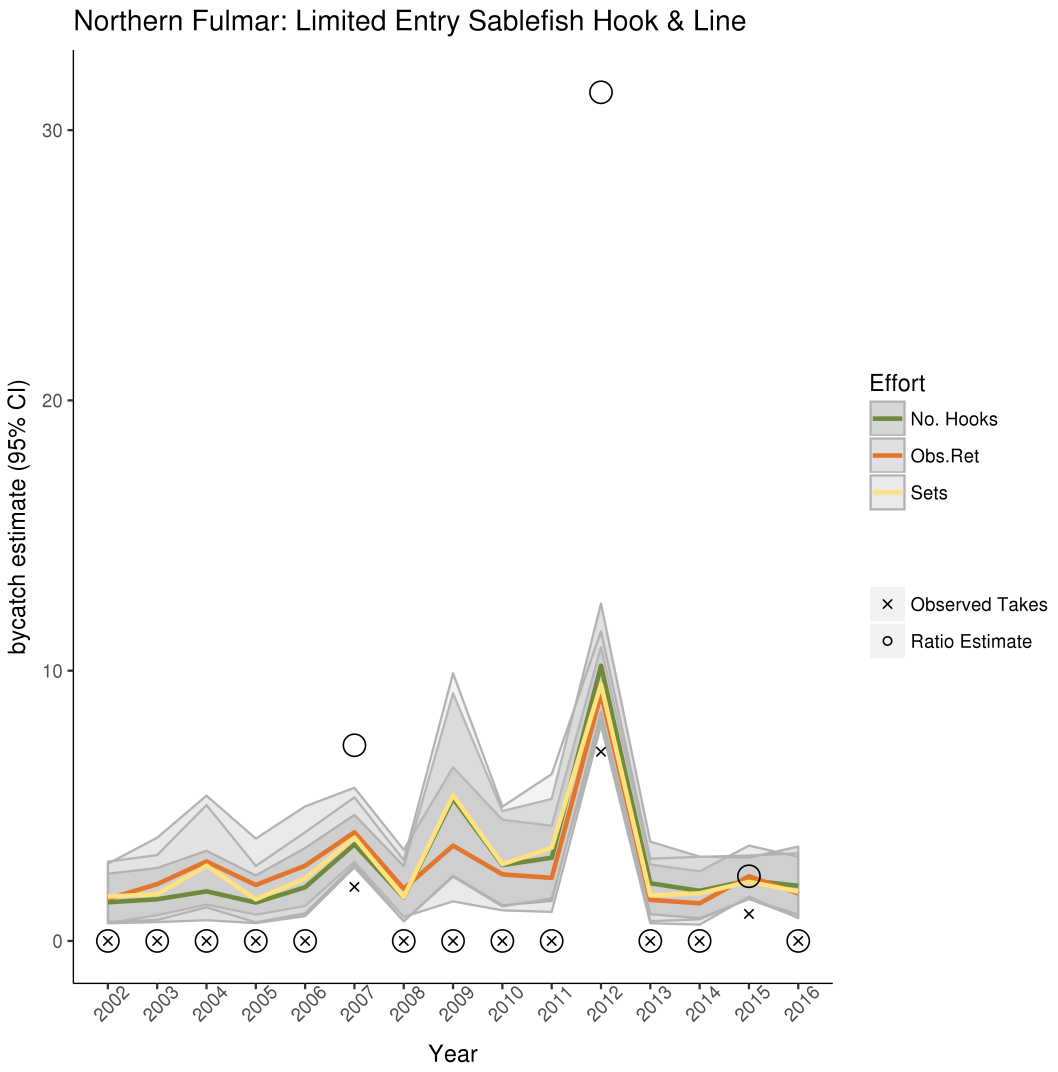


Figure 19: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for pink-footed shearwater (*Ardenna creatopus*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

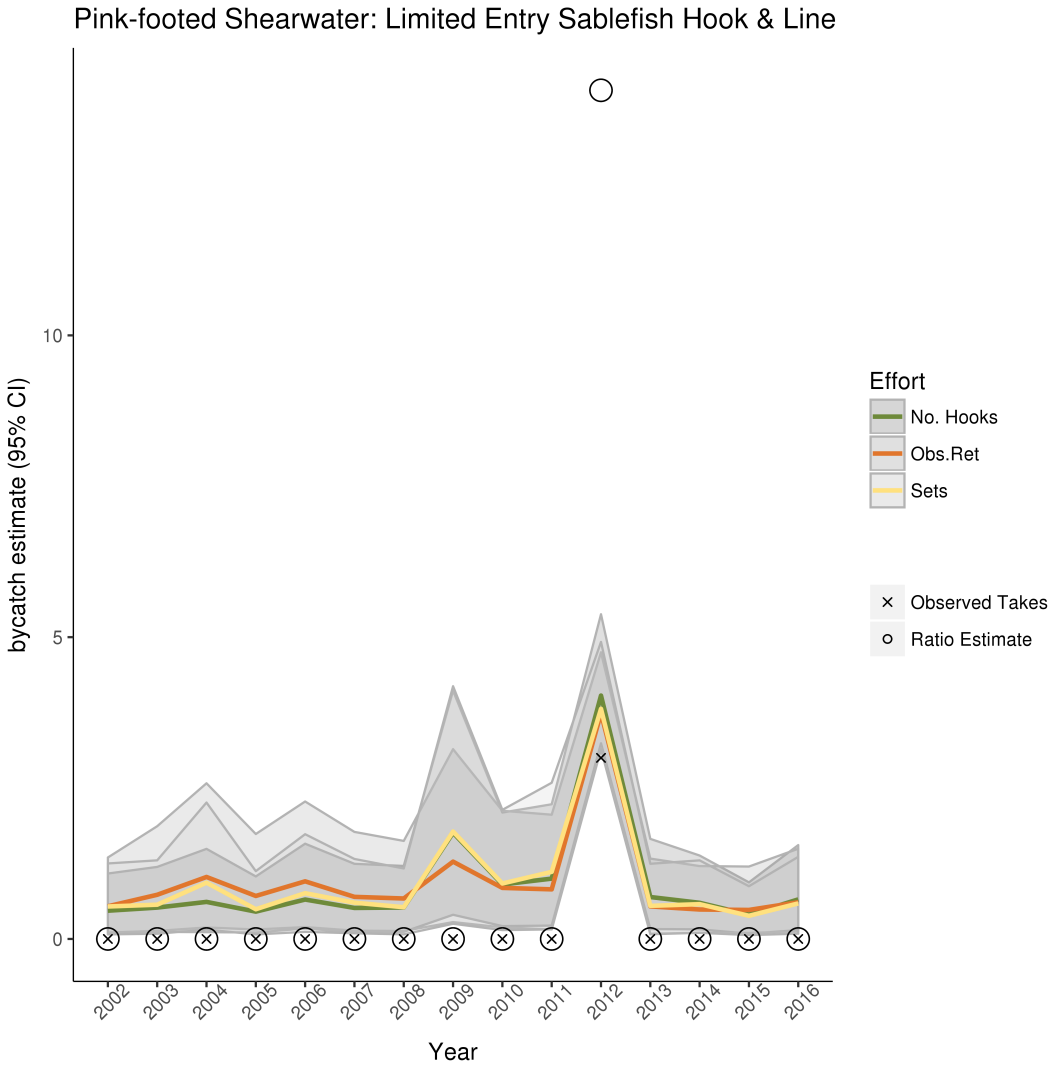


Figure 20: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for ring-billed gull (*Larus delawarensis*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

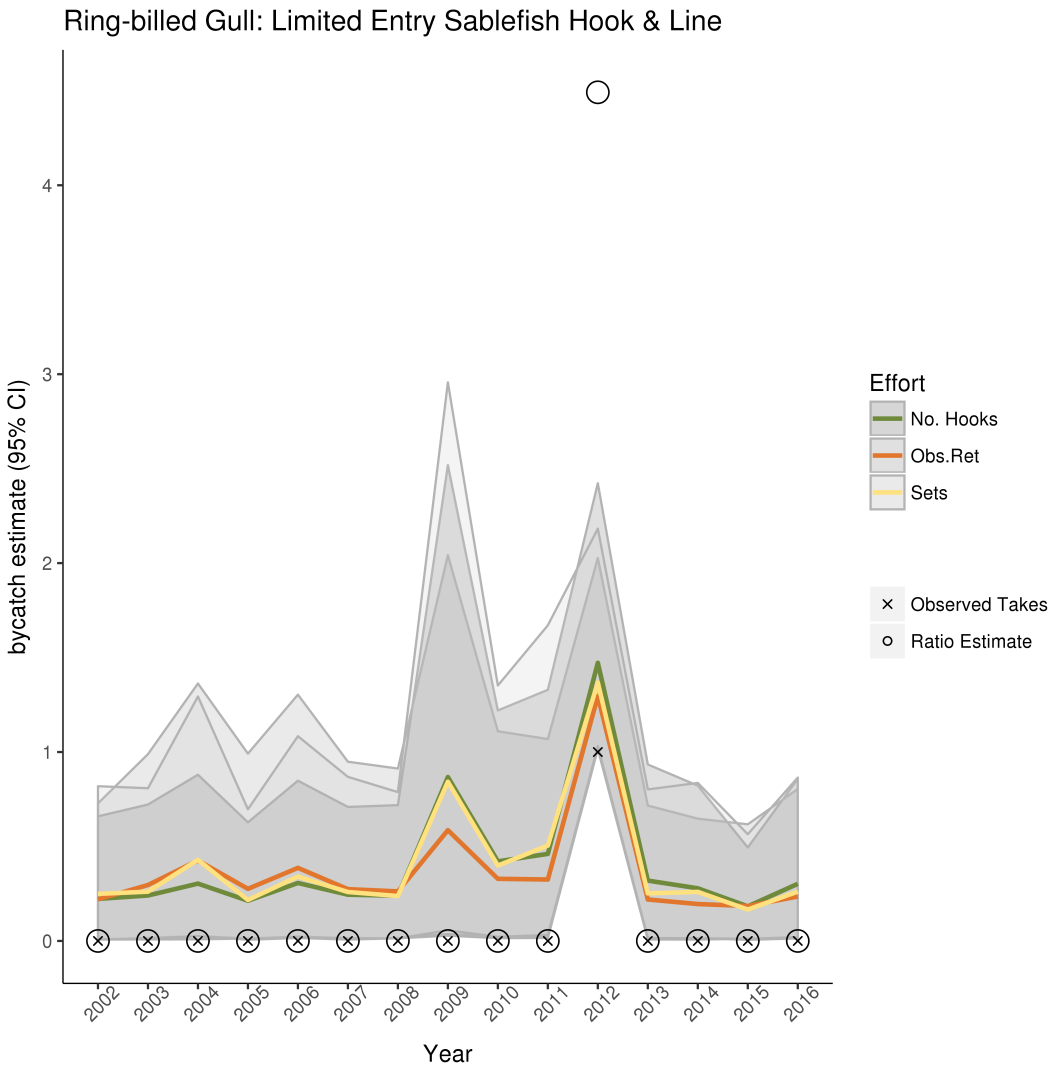


Figure 21: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified shearwaters (Family Procellariidae) for hook-and-line vessels in the Limited Entry Sablefish fishery.

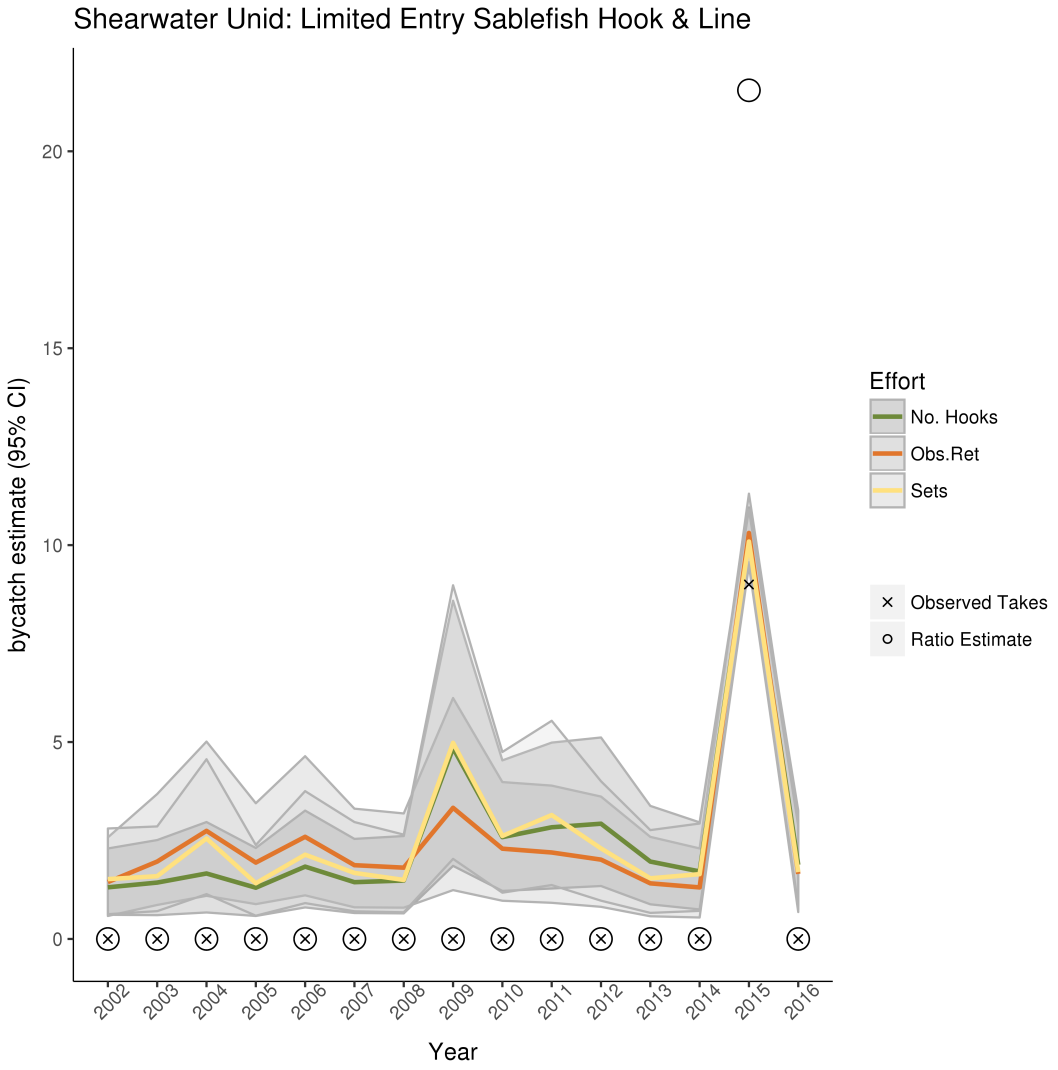


Figure 22: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for short-tailed albatross (*Phoebastria albatrus*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

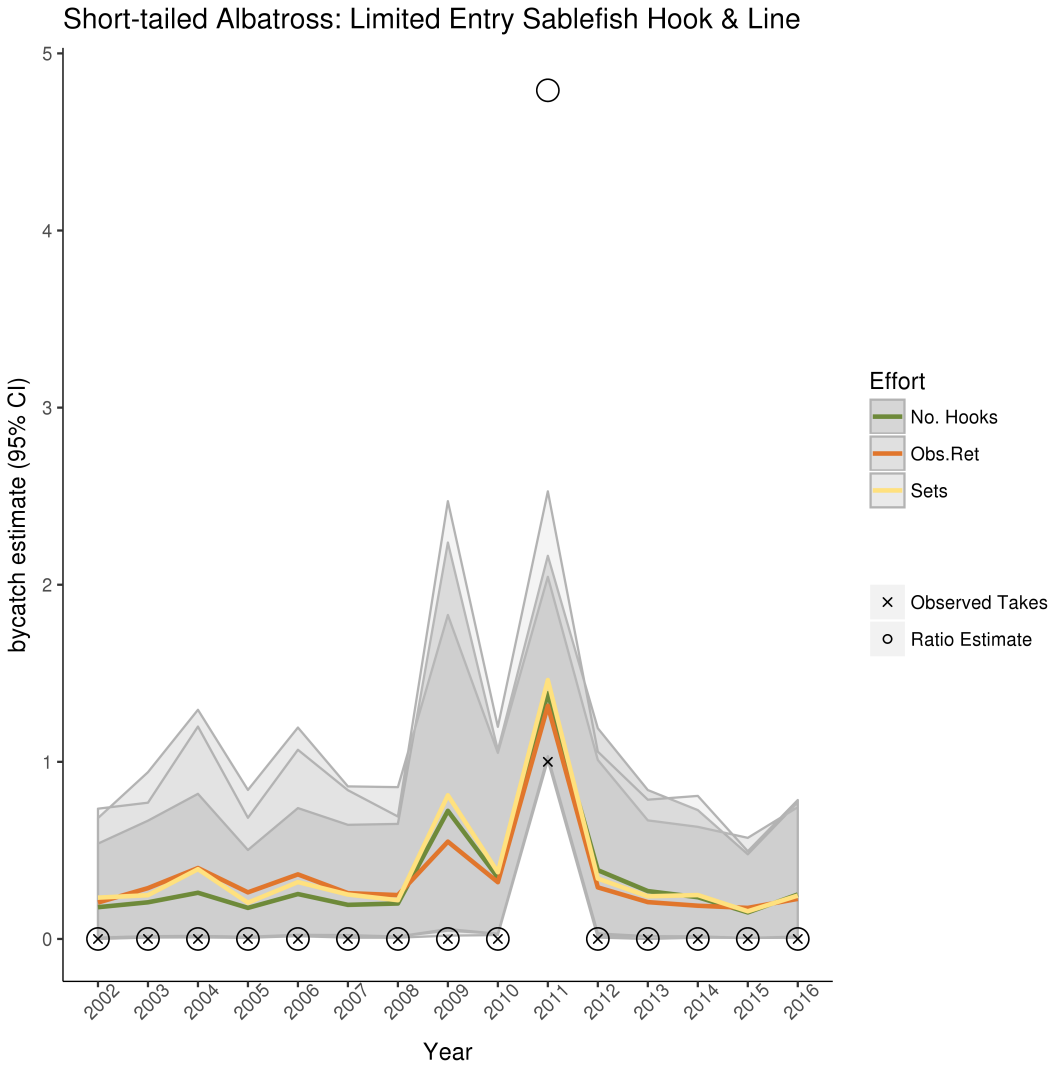


Figure 23: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for sooty shearwaters (*Ardenna grisea*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

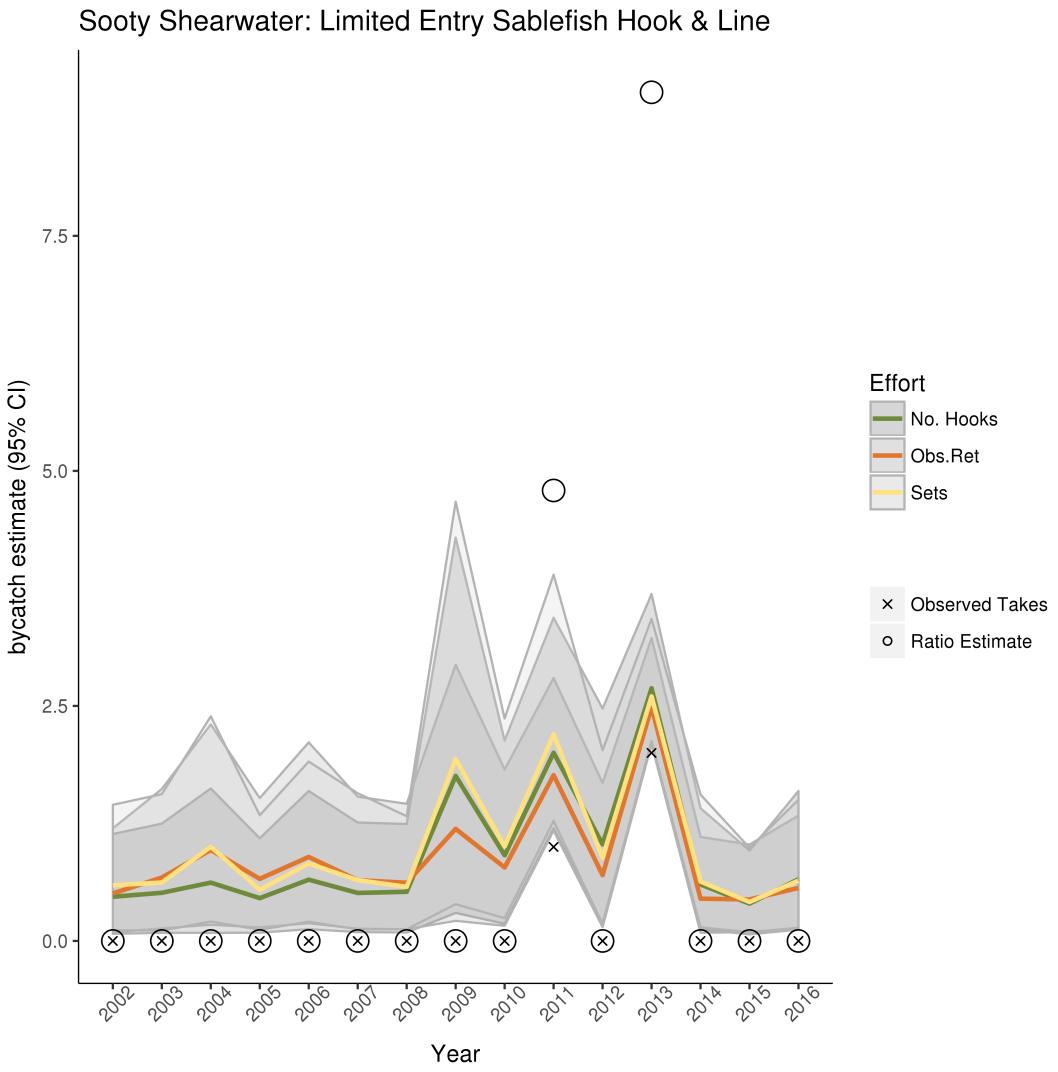


Figure 24: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for western gulls (*Larus occidentalis*) for hook-and-line vessels in the Limited Entry Sablefish fishery.

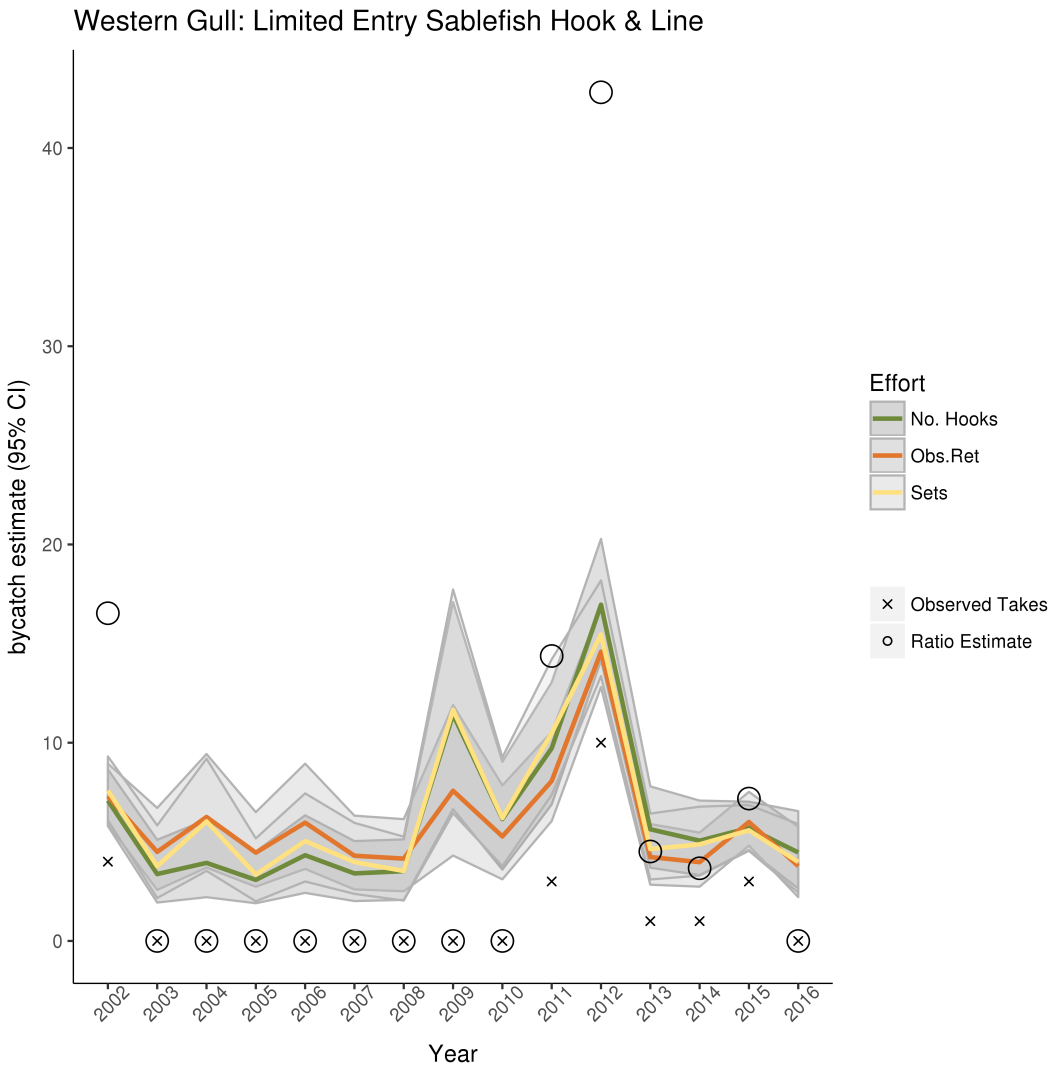


Figure 25: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for black-footed albatross (*Phoebastria nigripes*) for hook-and-line vessels in the Limited Entry Fixed Gear Daily Trip Limits (DTL) fishery.

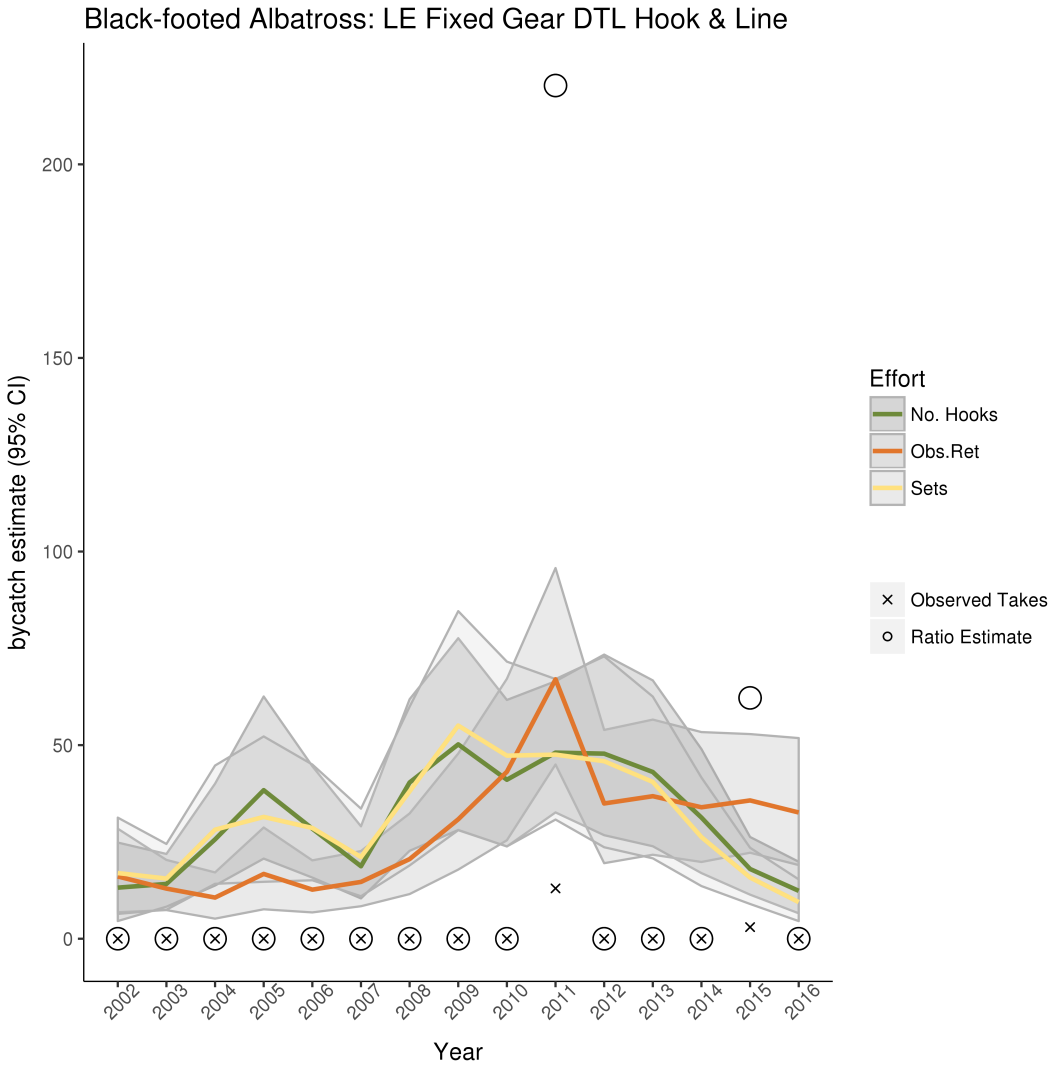


Figure 26: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for brown pelicans (*Pelecanus occidentalis*) for hook-and-line vessels in the Limited Entry Fixed Gear Daily Trip Limits (DTL) fishery.

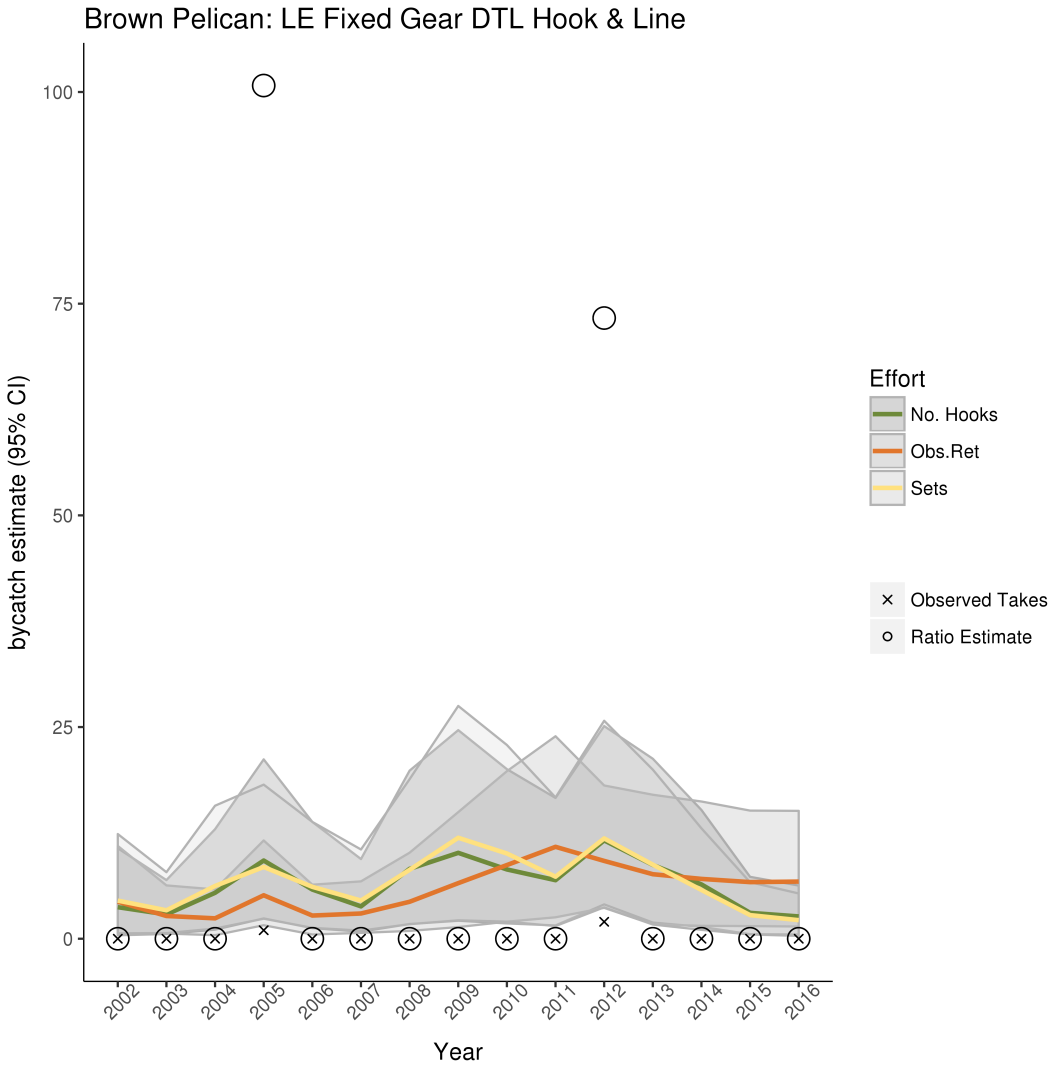


Figure 27: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified cormorants (*Phalacrocorax* spp.) for hook-and-line vessels in the Limited Entry Fixed Gear Daily Trip Limits (DTL) fishery.

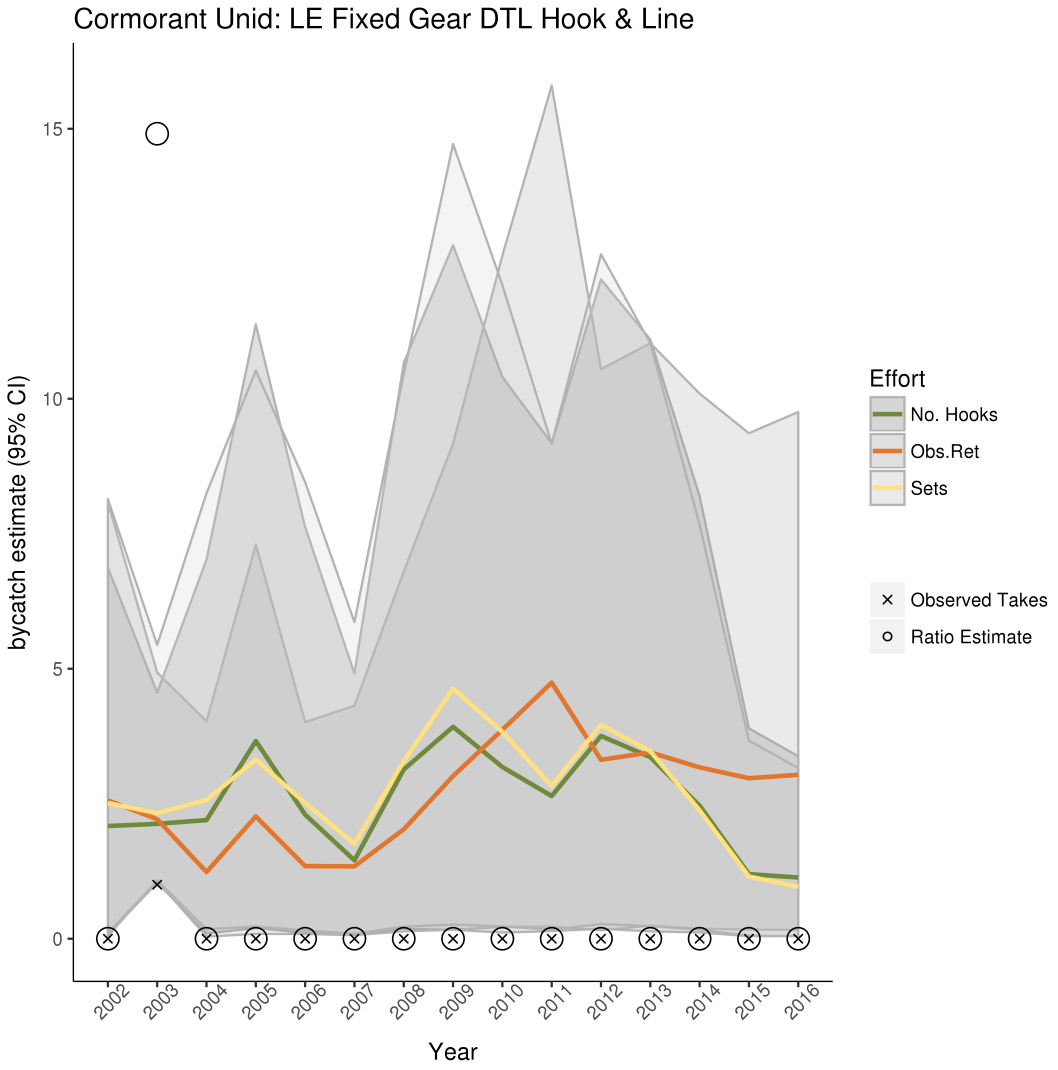


Figure 28: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for double-crested cormorants (*Phalacrocorax auritus*) for hook-and-line vessels in the Limited Entry Fixed Gear Daily Trip Limits (DTL) fishery.

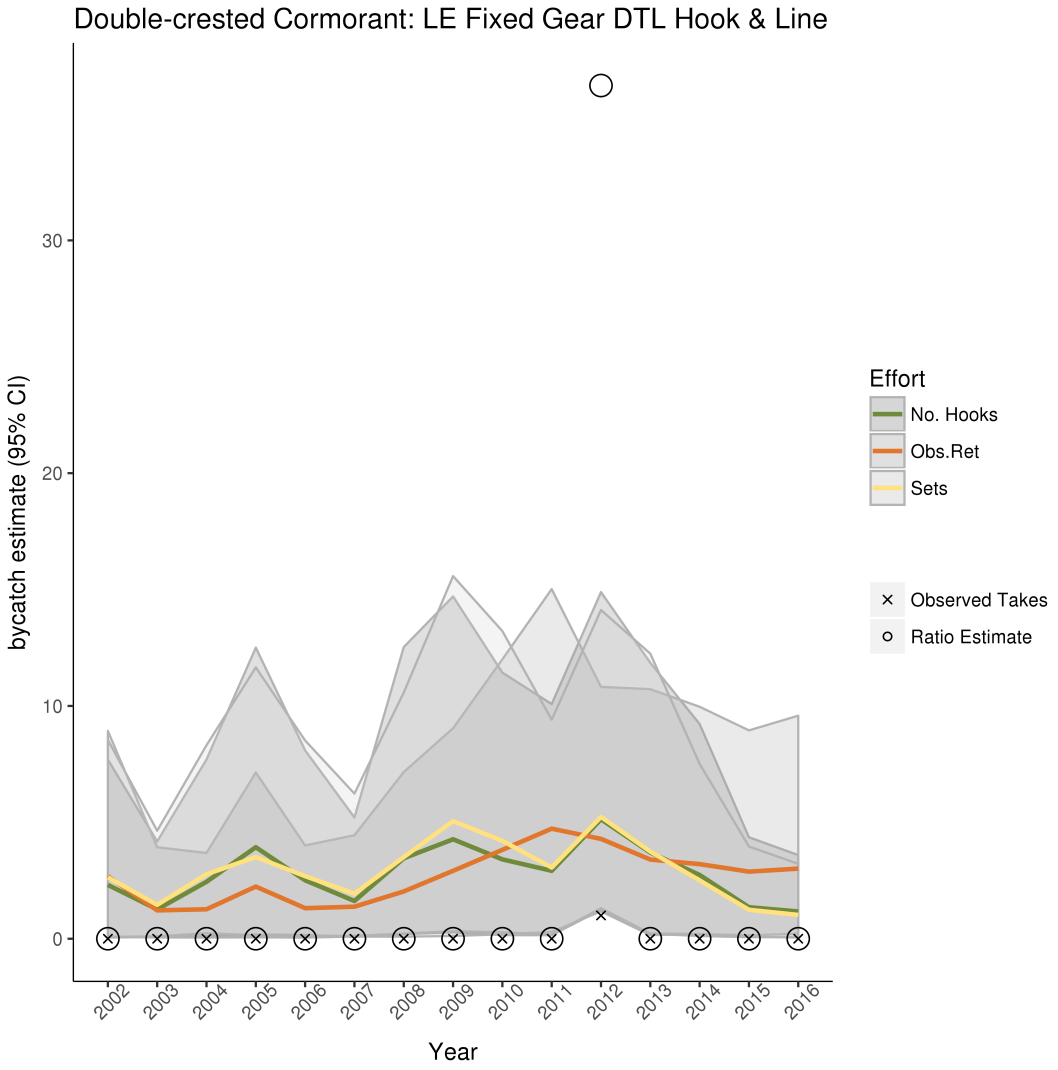


Figure 29: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified gulls (Family Laridae) for hook-and-line vessels in the Limited Entry Fixed Gear Daily Trip Limits (DTL) fishery.

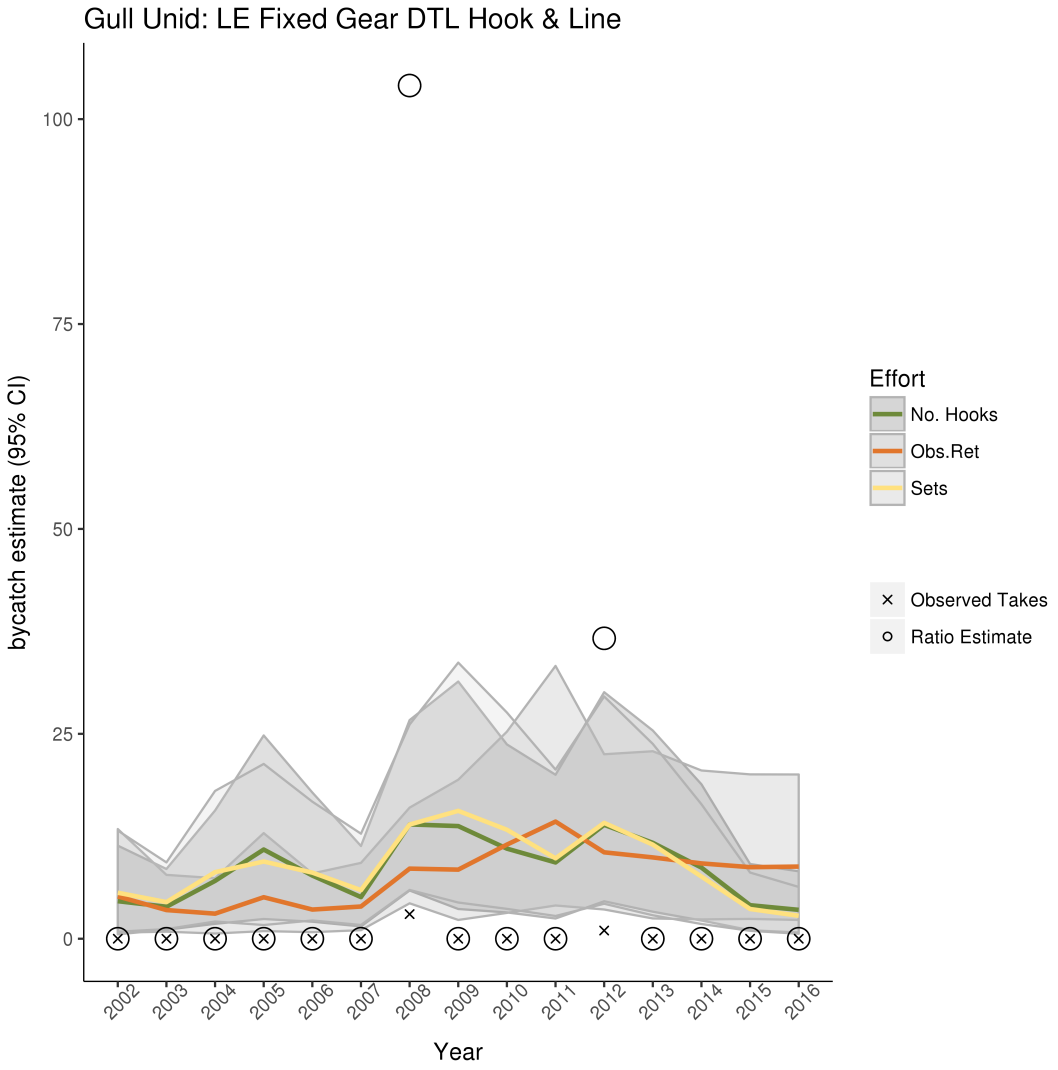


Figure 30: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for pink-footed shearwaters (*Ardenna creatopus*) for hook-and-line vessels in the Limited Entry Fixed Gear Daily Trip Limits (DTL) fishery.

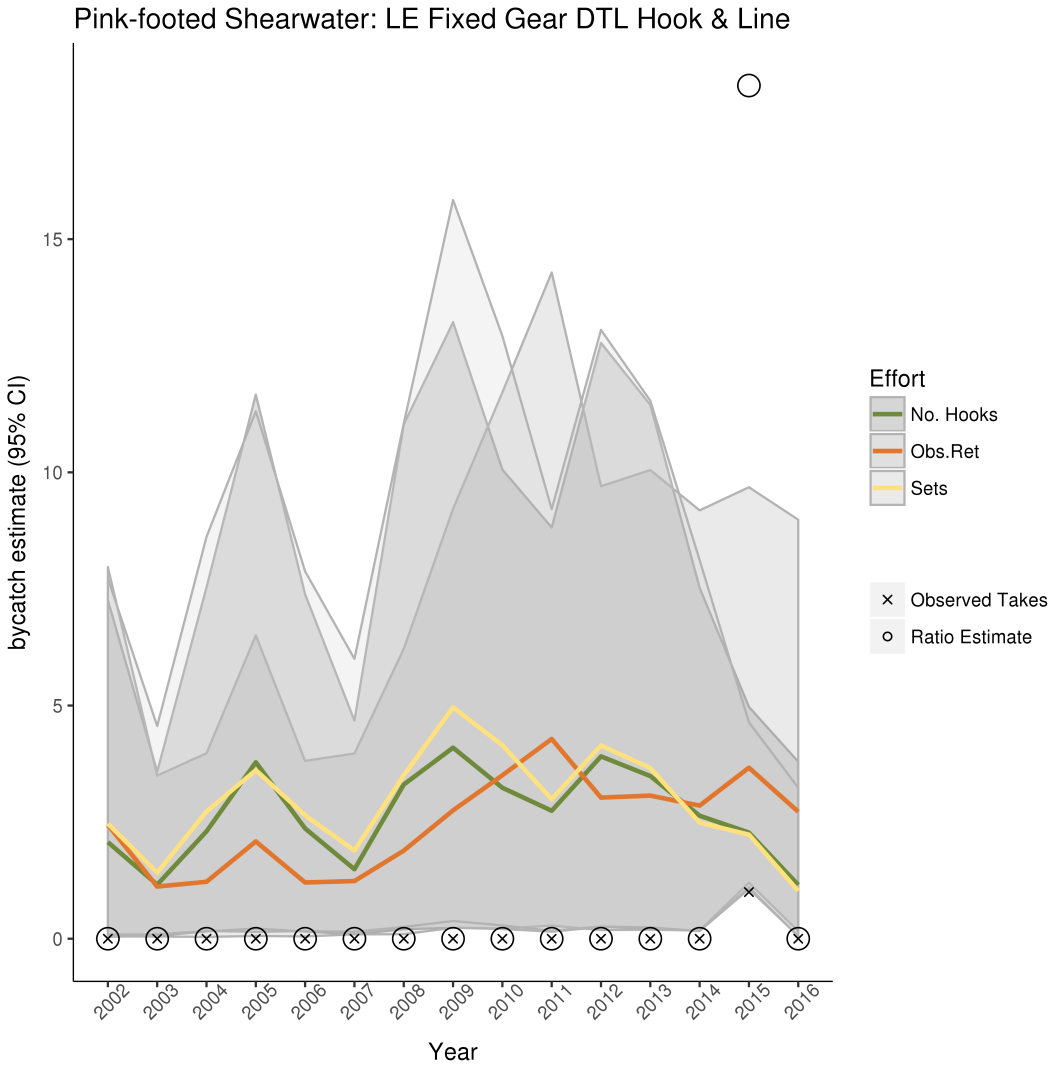


Figure 31: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified shearwaters (Family Procellariidae) for hook-and-line vessels in the Limited Entry Fixed Gear Daily Trip Limits (DTL) fishery.

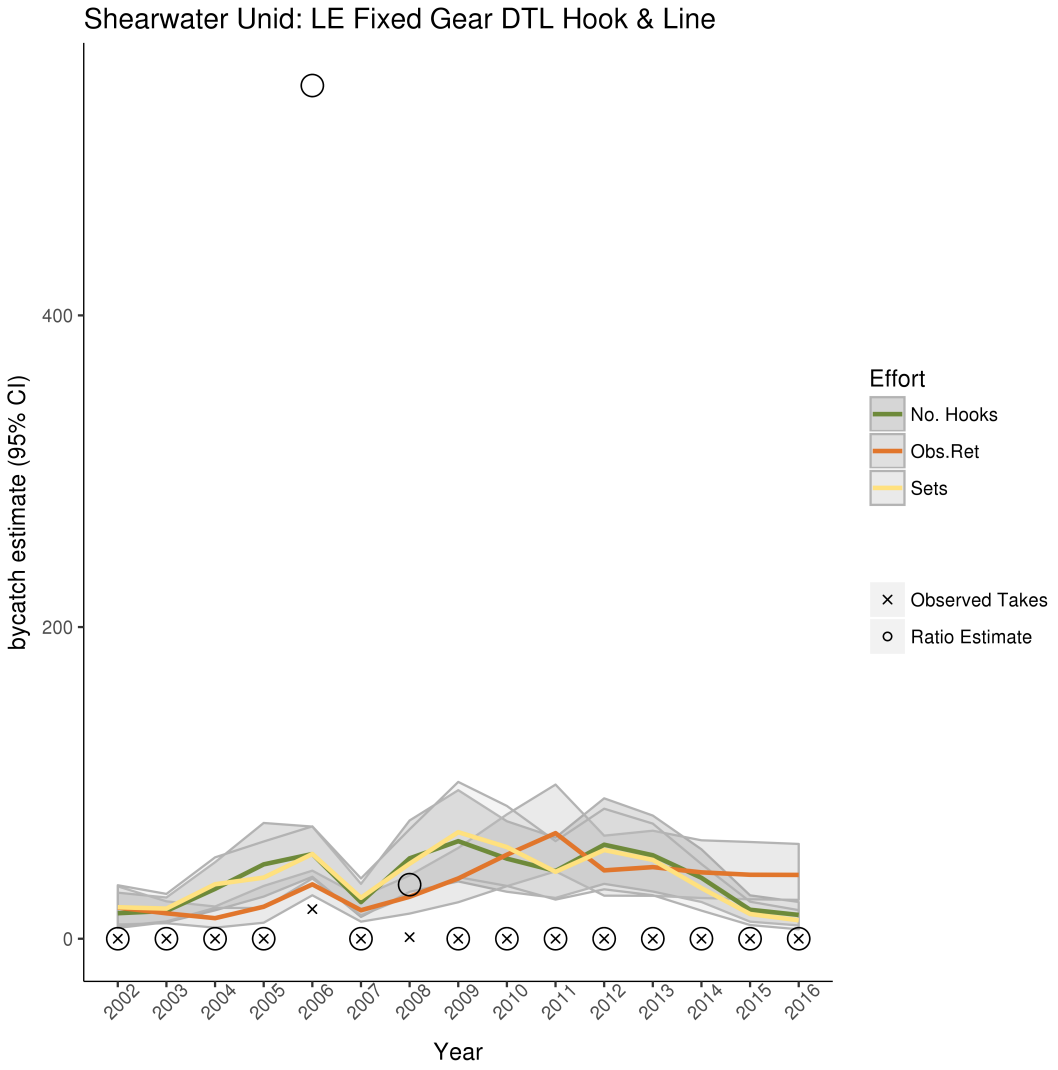


Figure 32: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for sooty shearwaters (*Ardenna grisea*) for hook-and-line vessels in the Limited Entry Fixed Gear Daily Trip Limits (DTL) fishery.

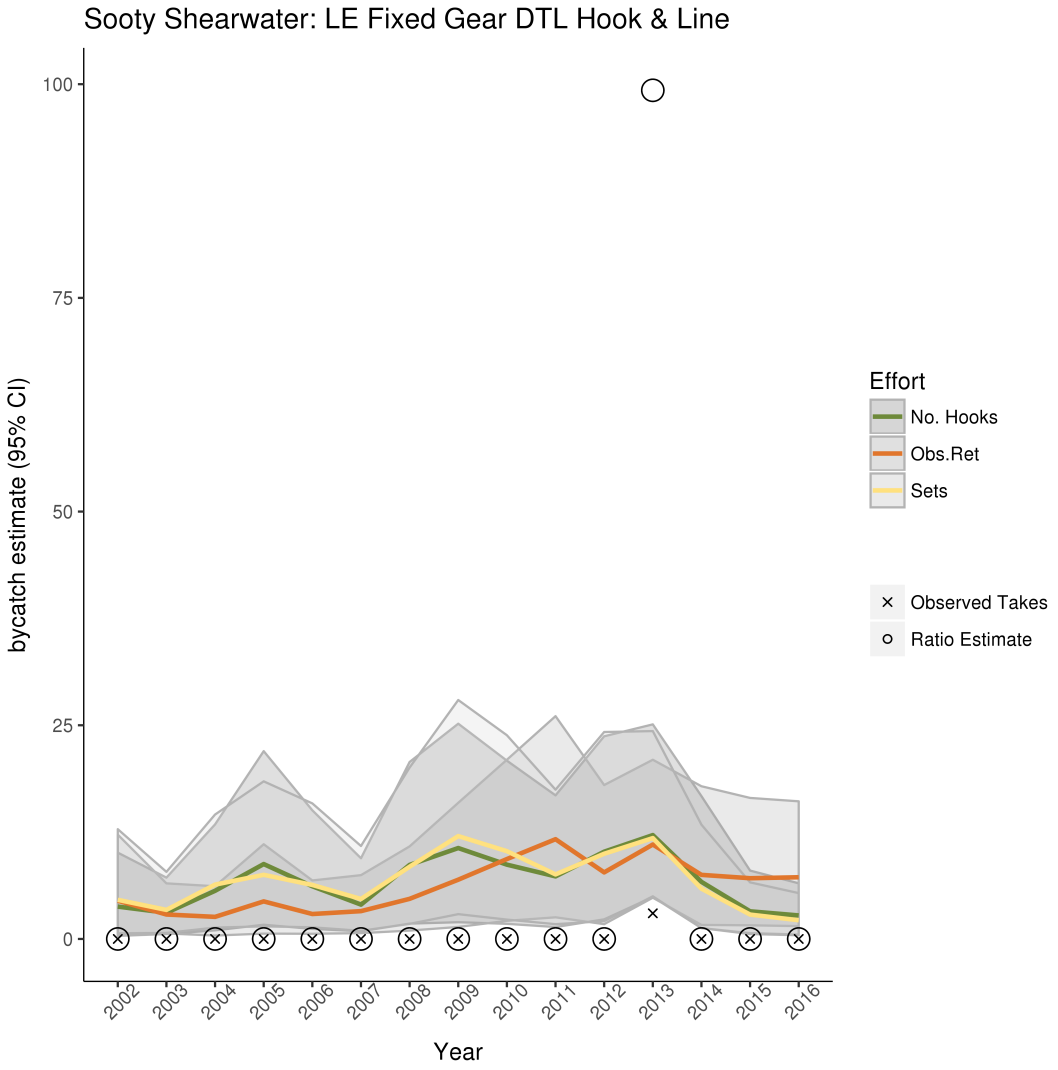


Figure 33: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for western gulls (*Ardenna grisea*) for hook-and-line vessels in the Limited Entry Fixed Gear Daily Trip Limits (DTL) fishery.

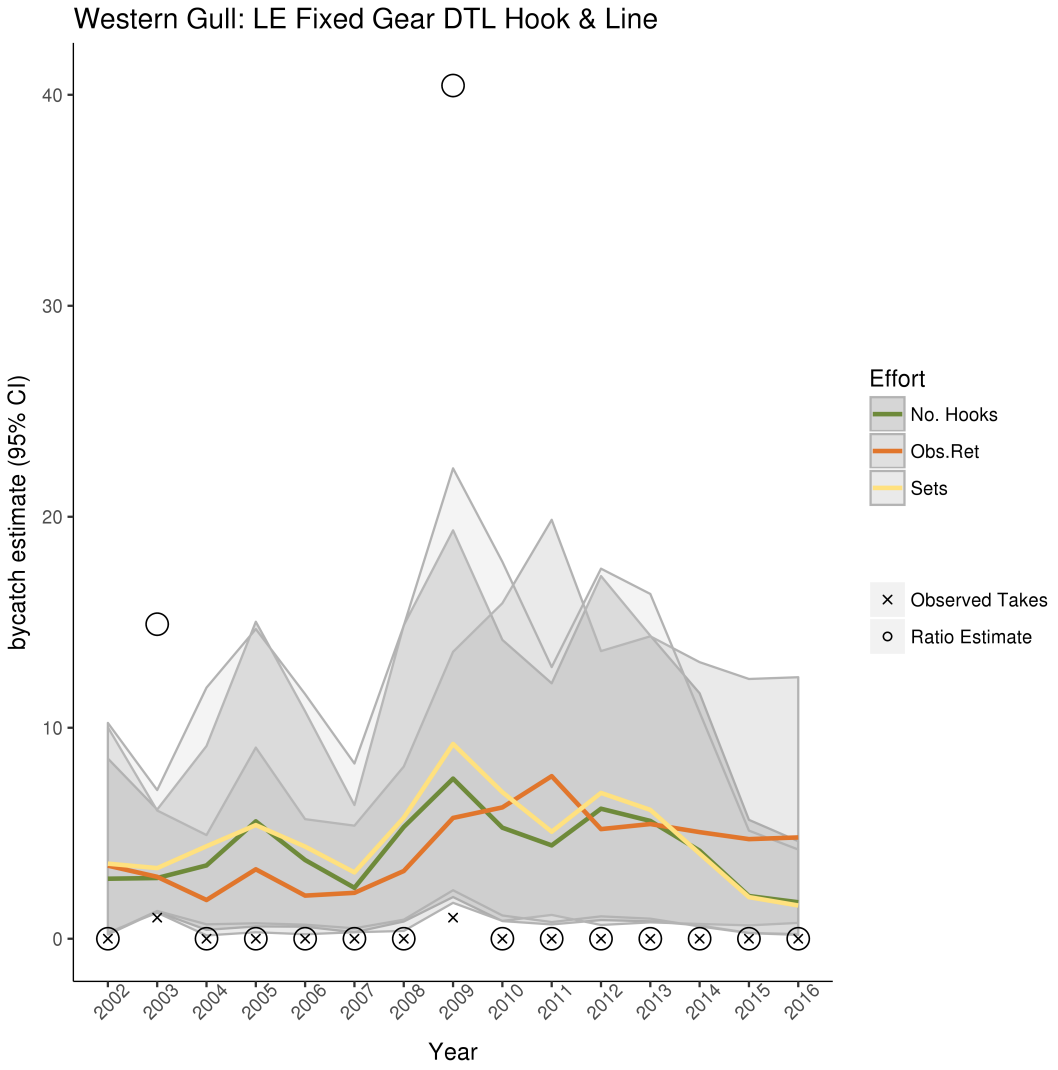


Figure 34: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for black-footed albatross (*Phoebastria nigripes*) for hook-and-line vessels in the Open Access Fixed Gear fishery.

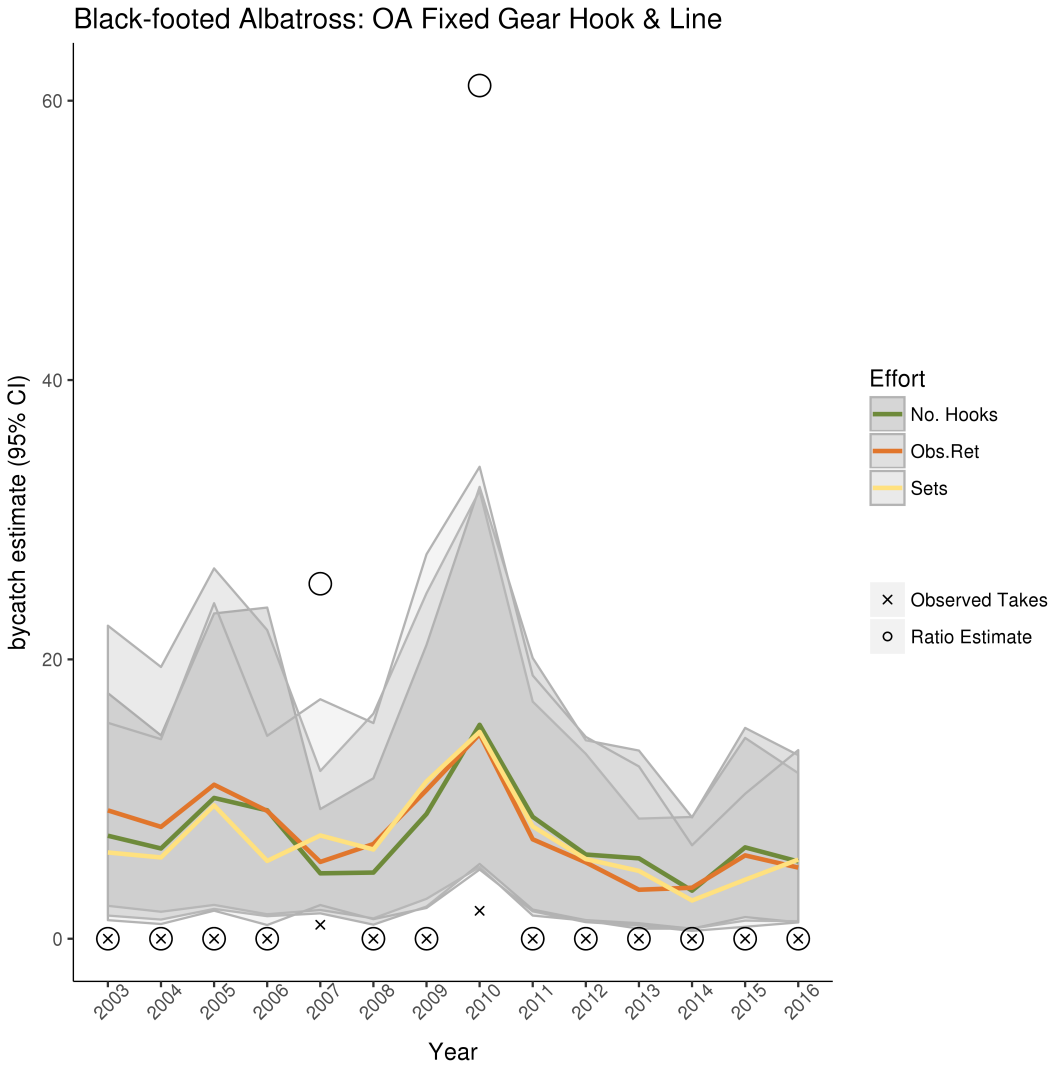


Figure 35: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified gulls (Family Laridae) for hook-and-line vessels in the Open Access Fixed Gear fishery.

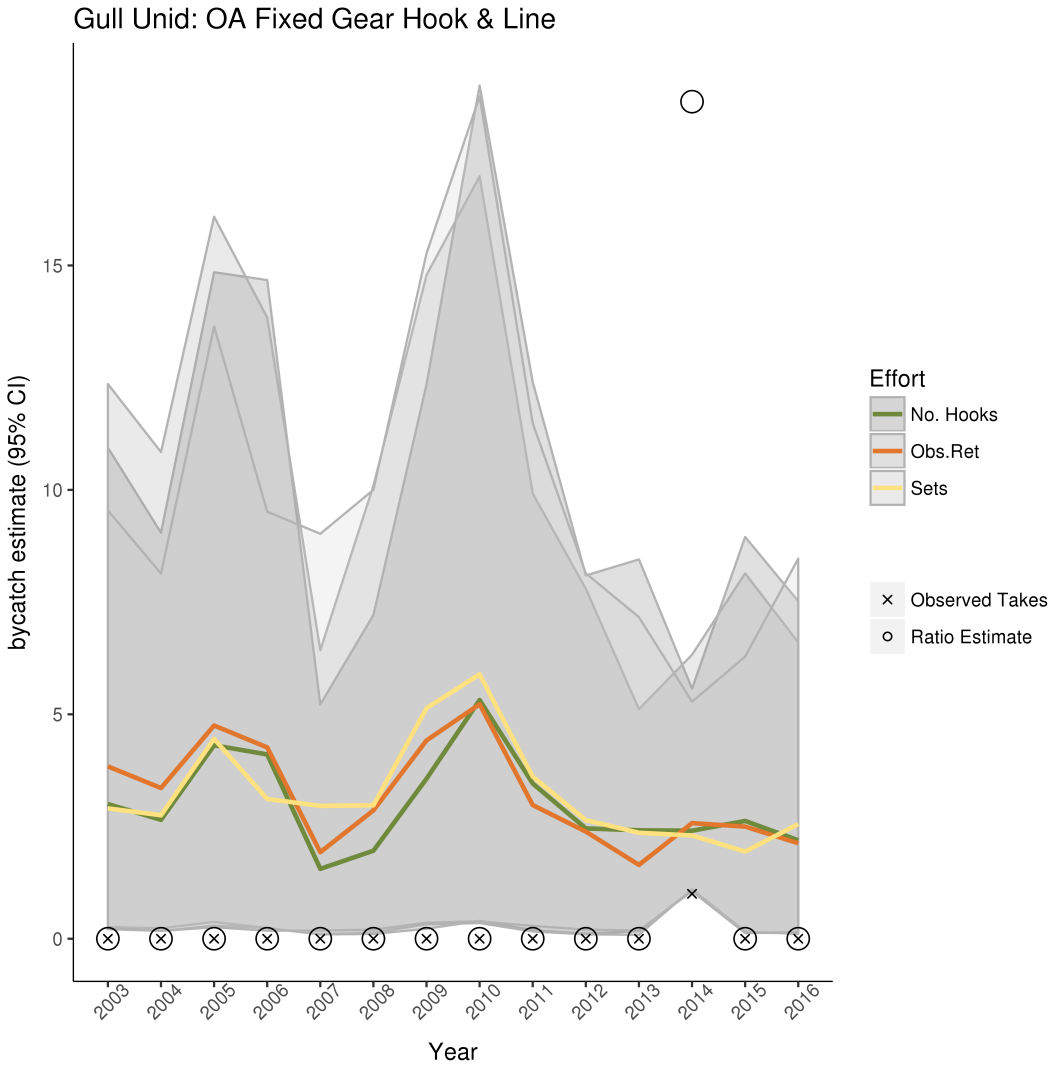


Figure 36: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified birds (Class Aves) for hook-and-line vessels in the Oregon Nearshore fishery.

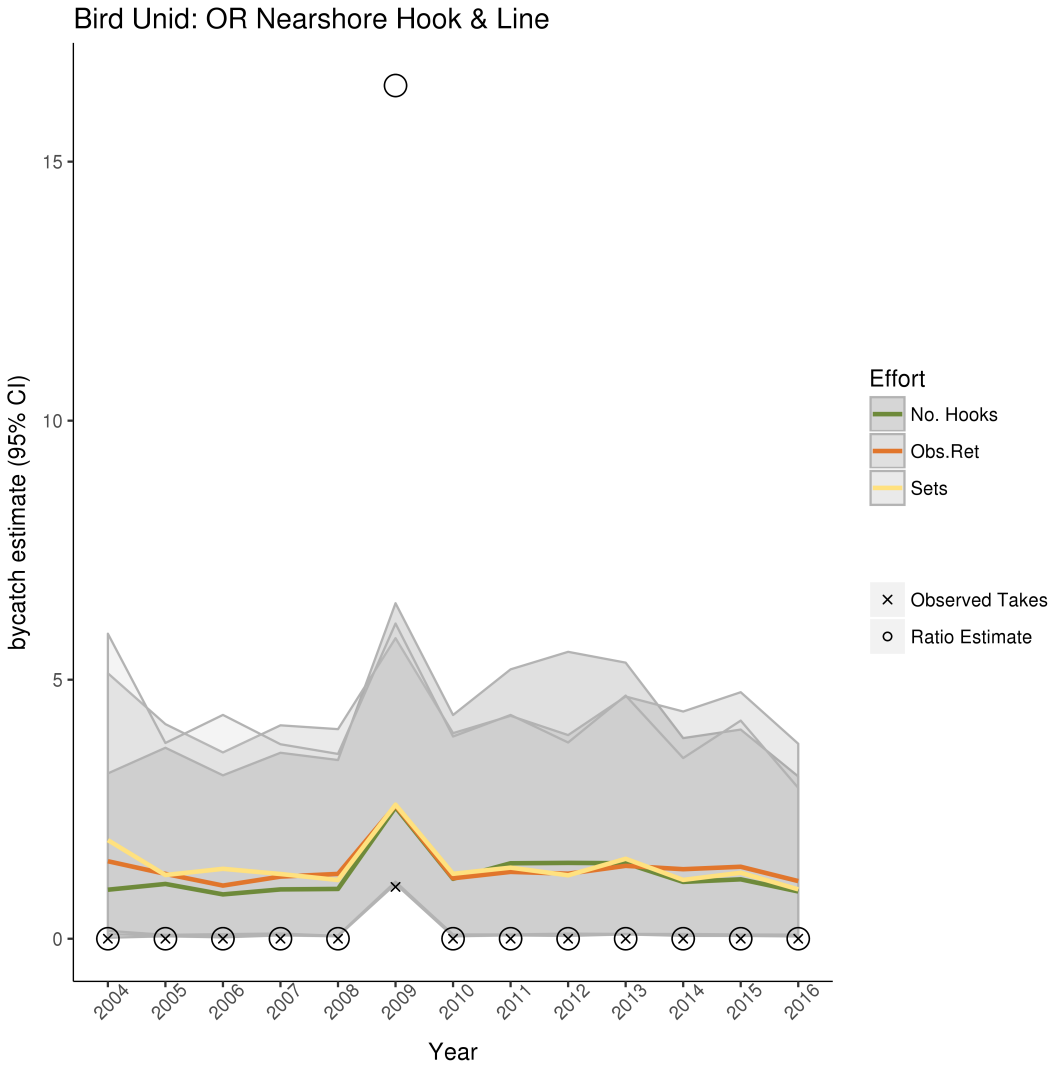


Figure 37: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for common murres (*Uria aalge*) for hook-and-line vessels in the Oregon Nearshore fishery.

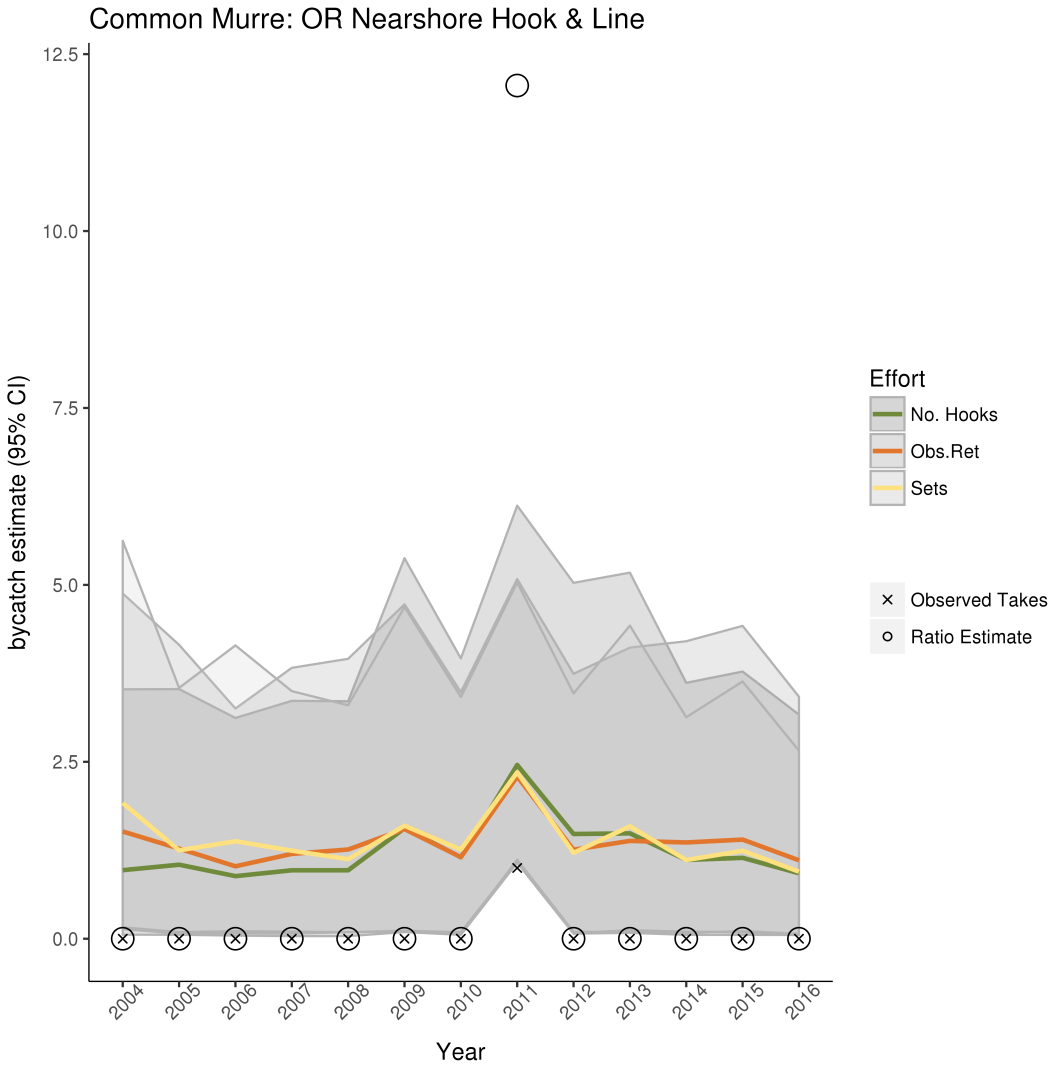


Figure 38: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for Brandt's cormorants (*Phalacrocorax penicillatus*) for hook-and-line vessels in the California Nearshore fishery.

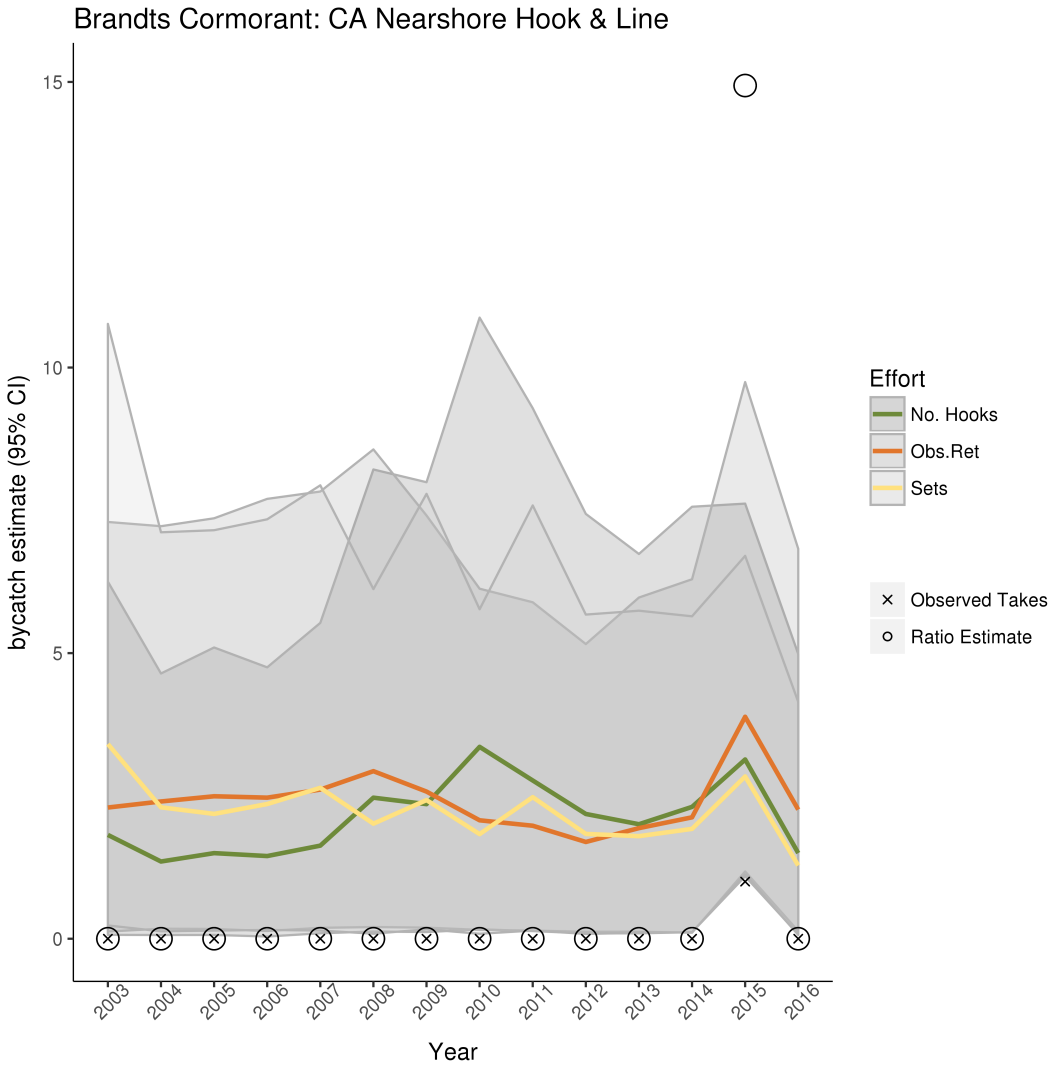


Figure 39: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for brown pelicans (*Pelecanus occidentalis*) for hook-and-line vessels in the California Nearshore fishery.

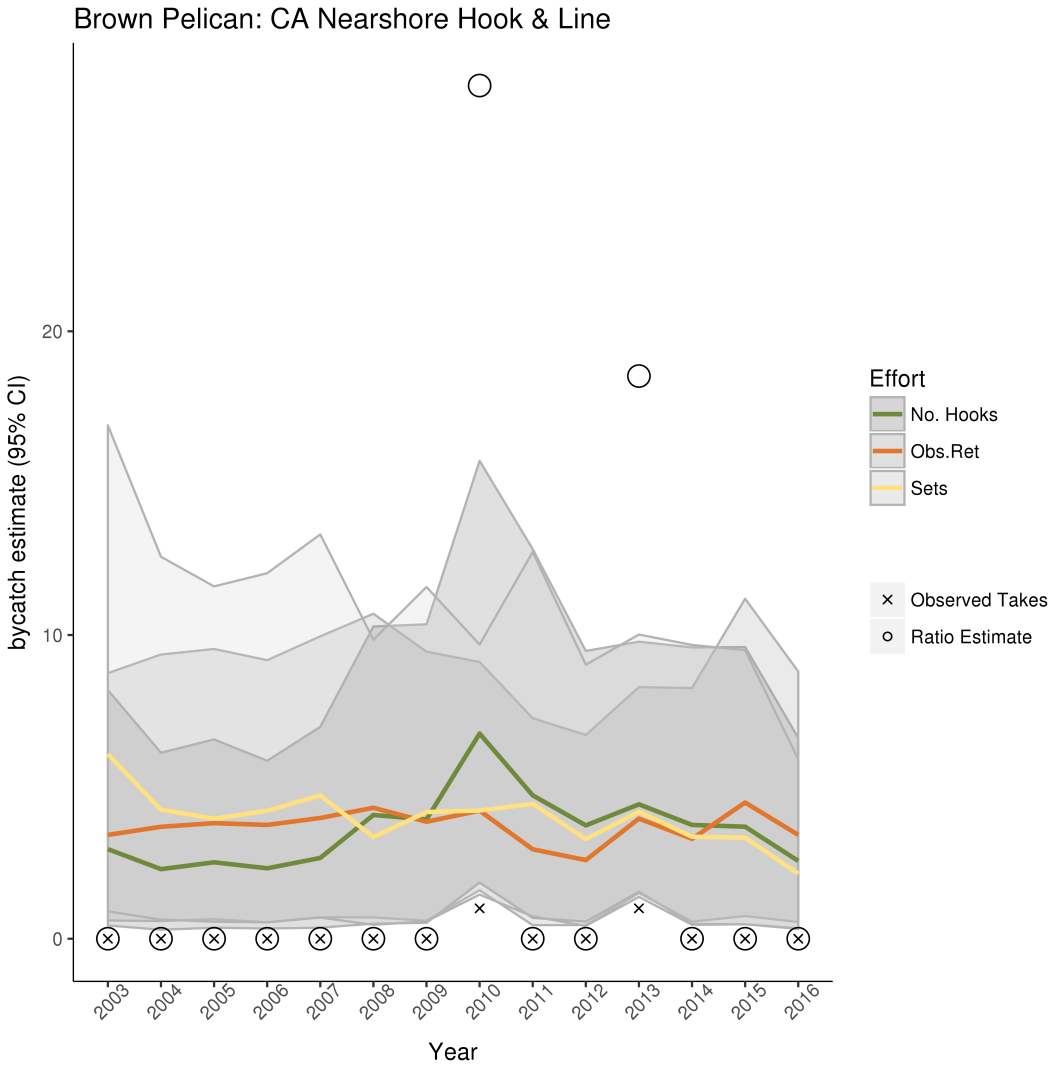


Figure 40: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for common loons (*Gavia immer*) for hook-and-line vessels in the California Nearshore fishery.

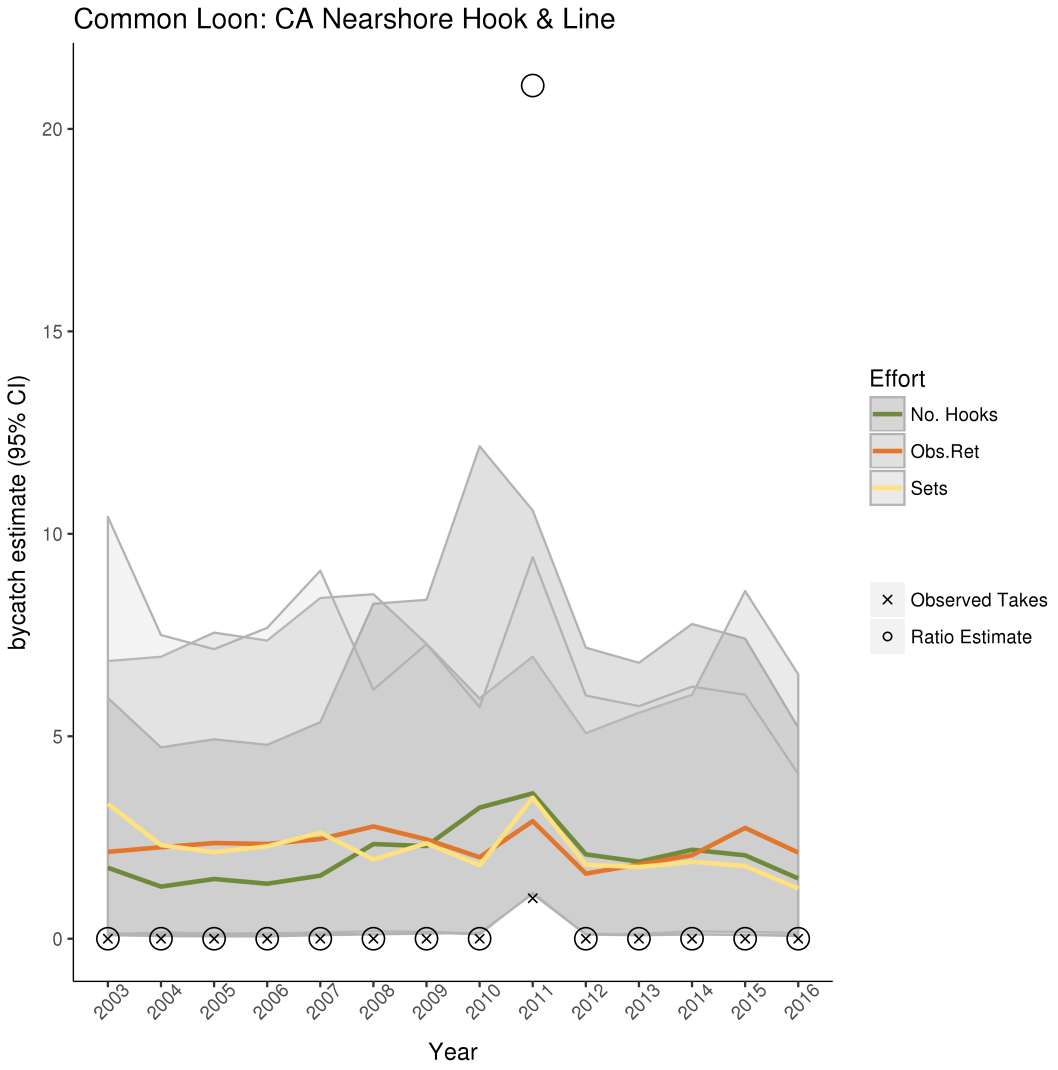


Figure 41: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for common murres (*Uria aalge*) for hook-and-line vessels in the California Nearshore fishery.

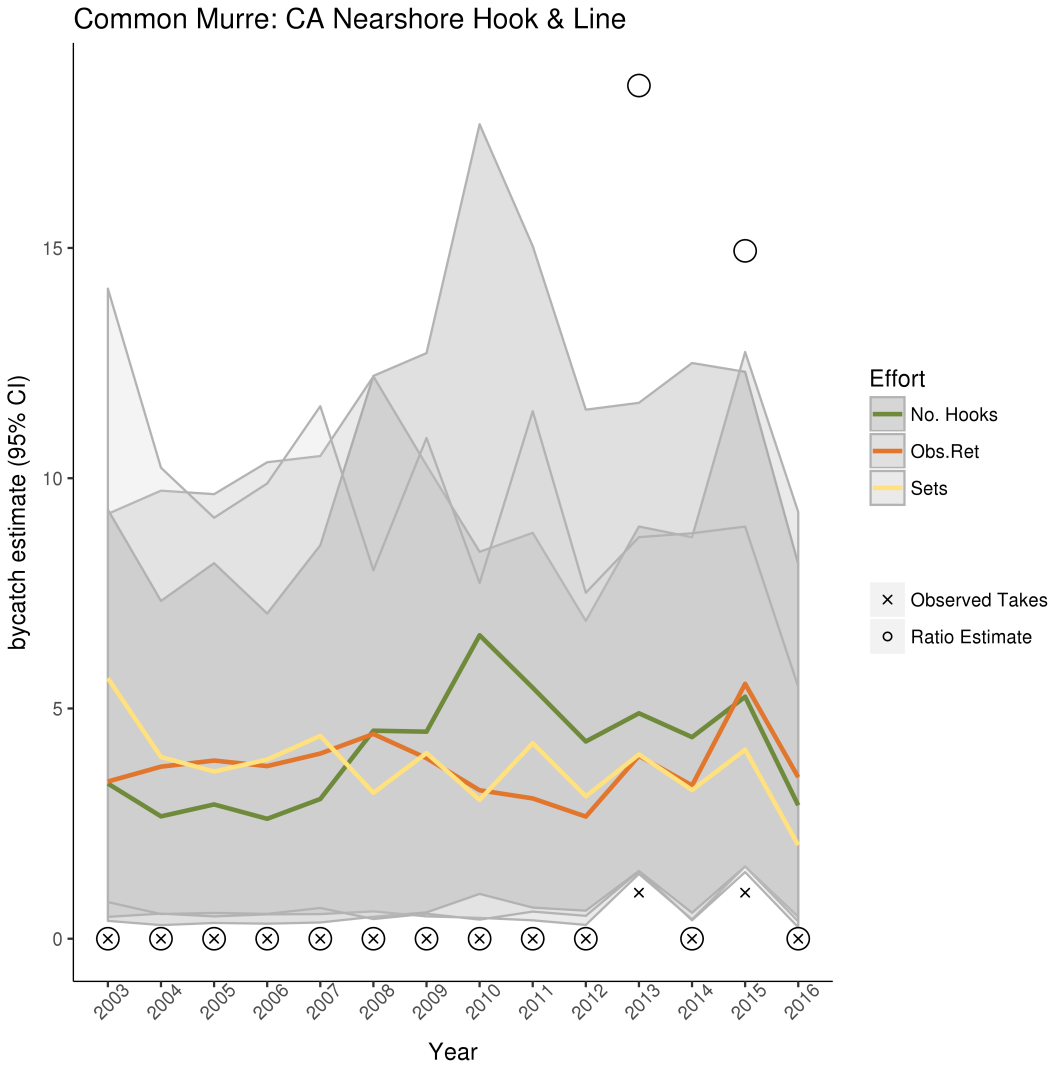


Figure 42: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for western gulls (*Larus occidentalis*) for hook-and-line vessels in the California Nearshore fishery.

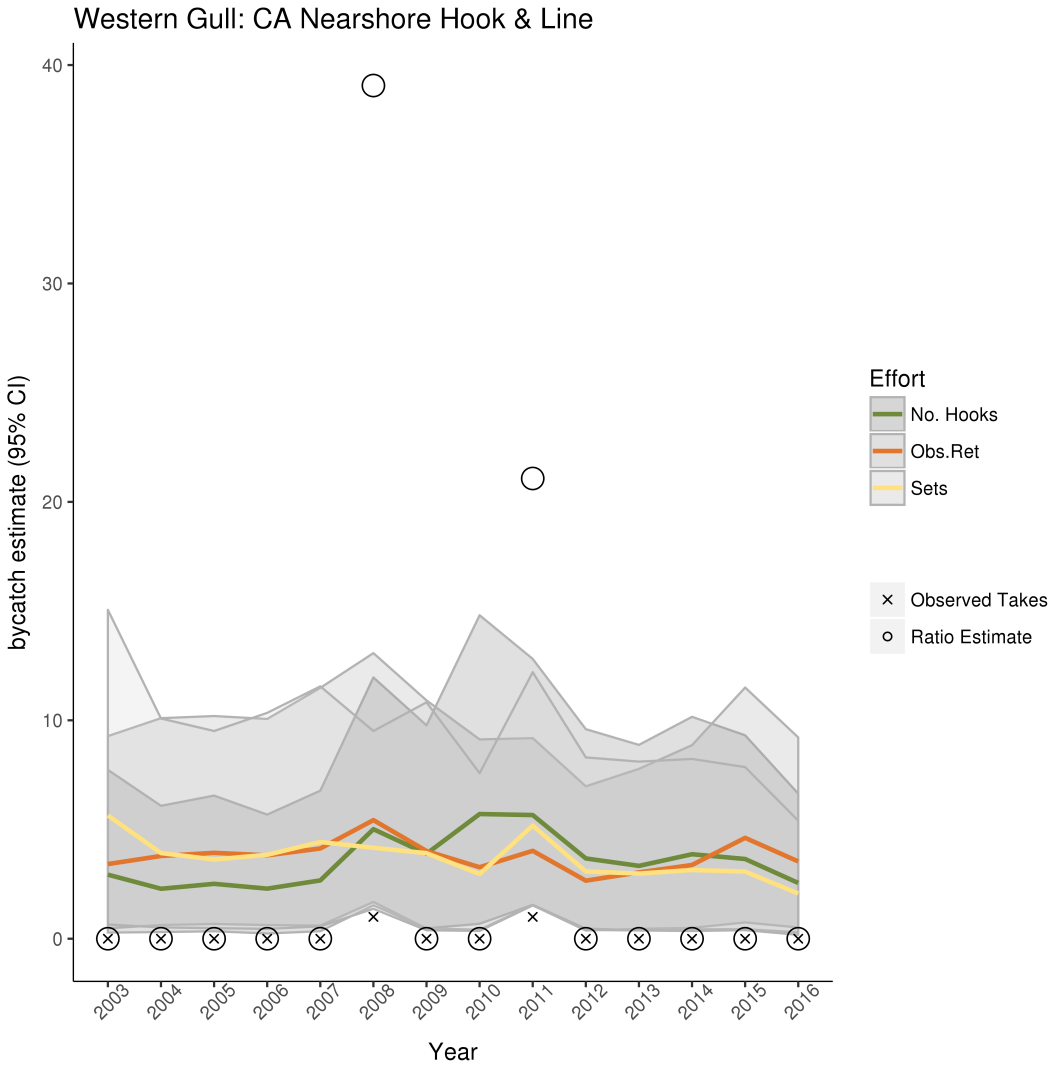


Figure 43: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for Brandt's cormorants (*Phalacrocorax penicillatus*) for pot gear vessels in the Oregon and California Nearshore fisheries combined. Data for 2009 were removed to ensure confidentiality. In 2011, no pot vessels were observed in the nearshore fishery.

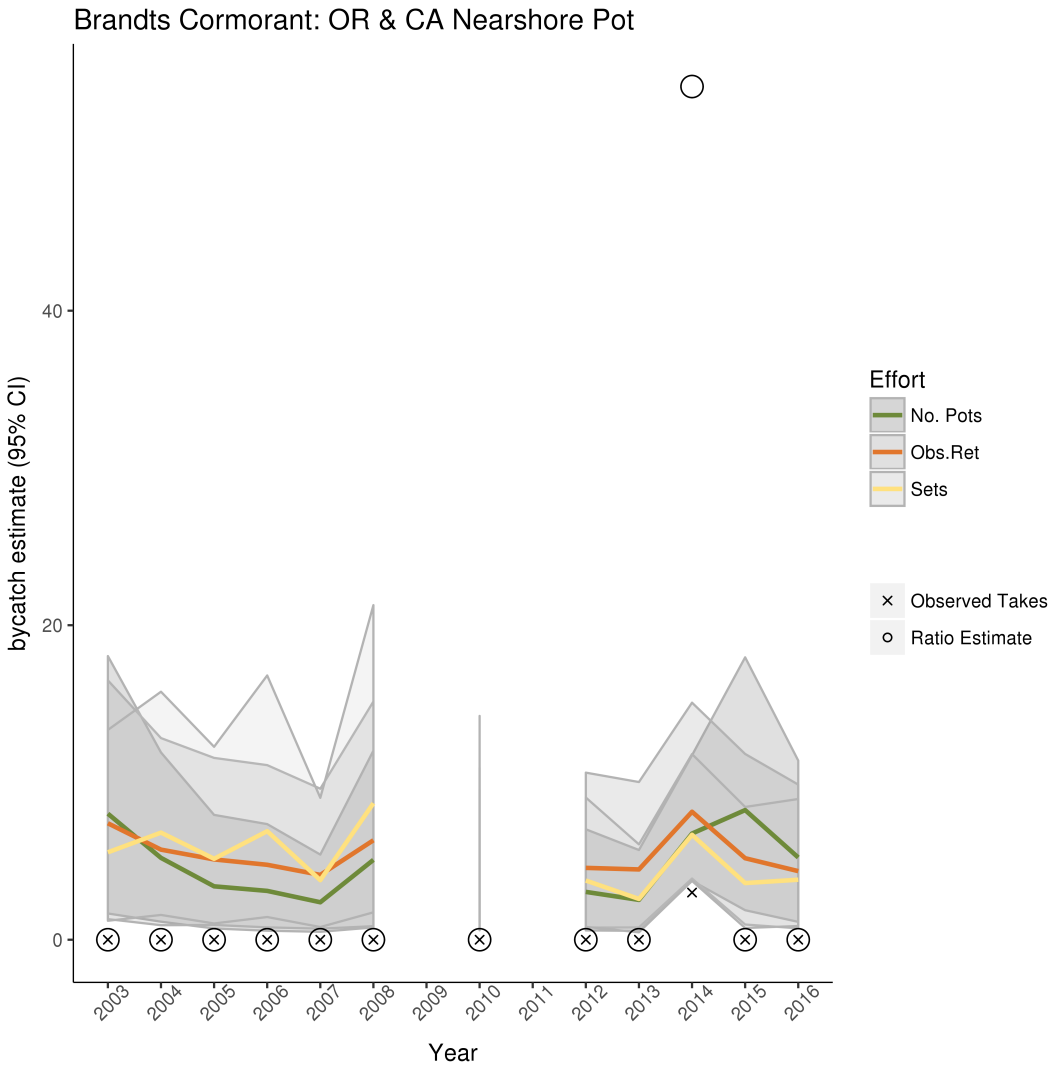


Figure 44: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified cormorants (*Phalacrocorax* spp.) for pot gear vessels in the Oregon and California Nearshore fisheries combined. Data for 2009 were removed to ensure confidentiality. In 2011, no pot vessels were observed in the nearshore fishery.

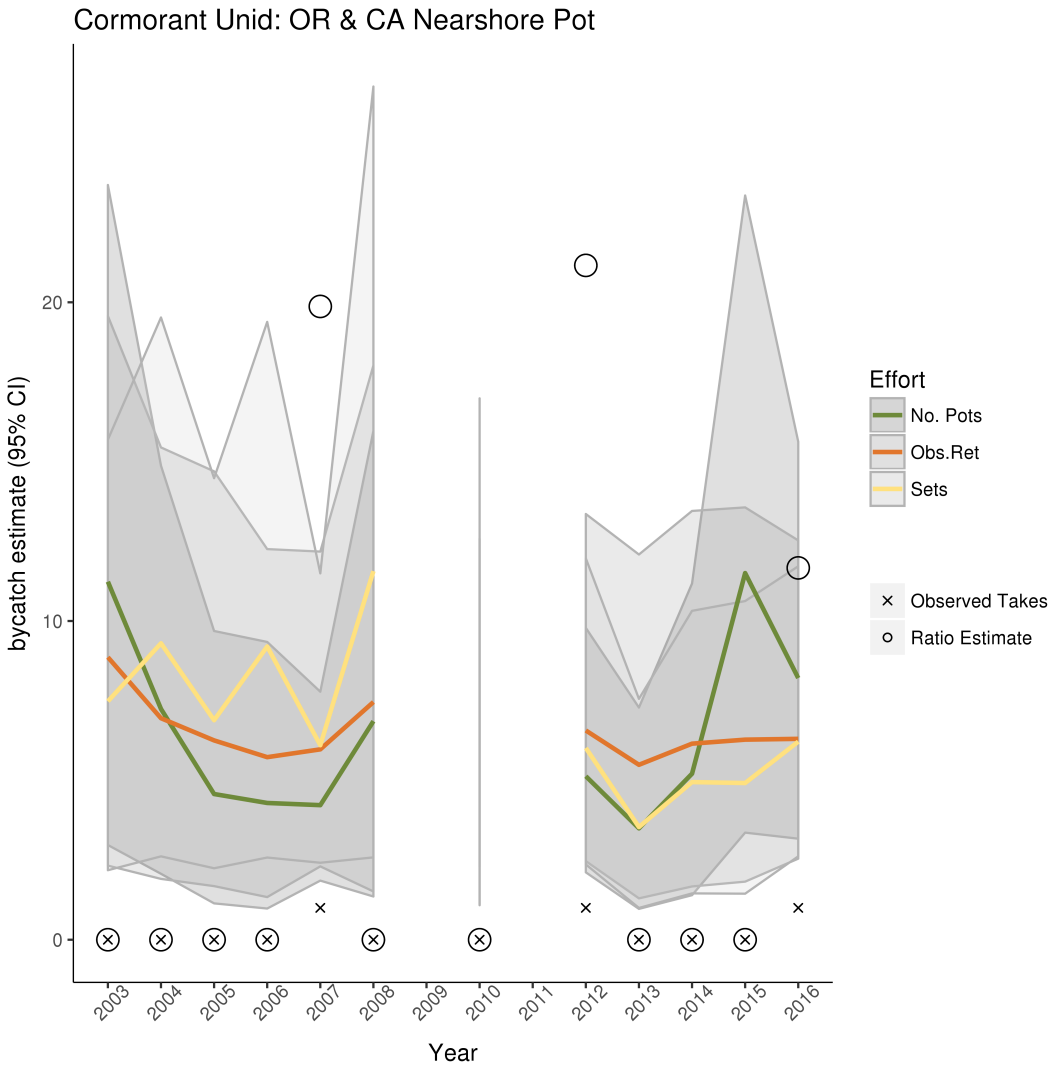


Figure 45: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for double-crested cormorants (*Phalacrocorax auritus*) for pot gear vessels in the Oregon and California Nearshore fisheries combined. Data for 2009 were removed to ensure confidentiality. In 2011, no pot vessels were observed in the nearshore fishery.

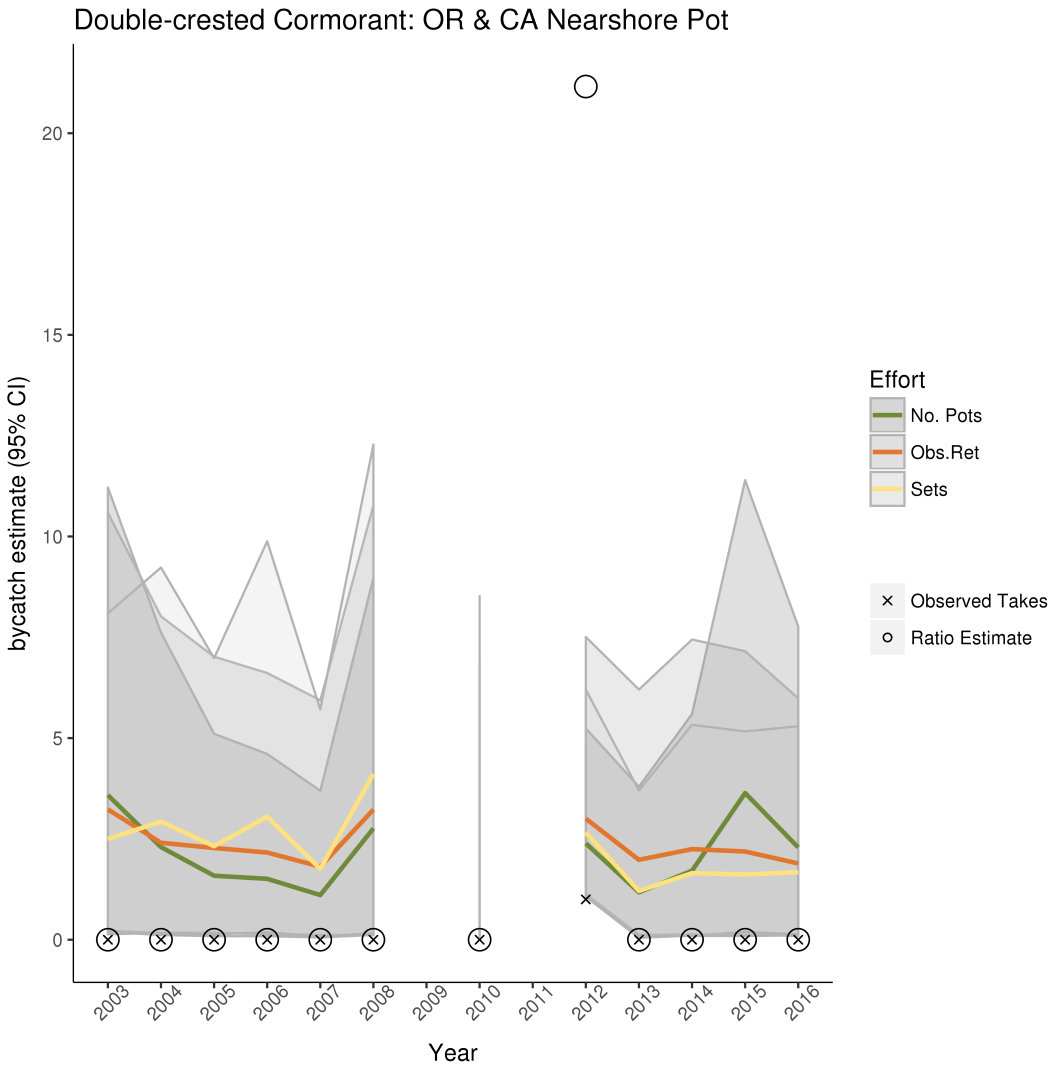


Figure 46: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for Leach's storm petrels (*Oceanodroma leucorhoa*) for bottom trawl vessels in the Limited Entry fishery from 2002-2010.

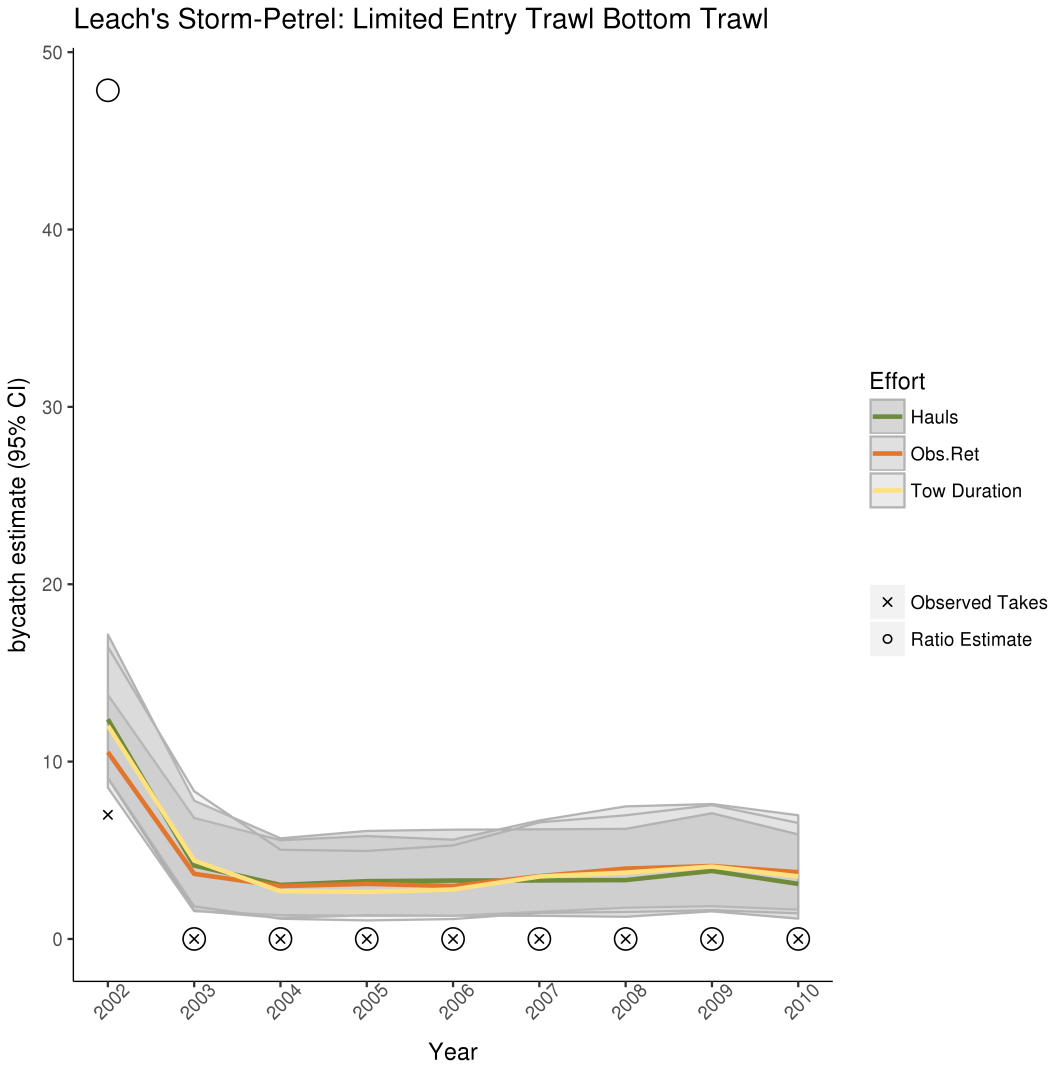


Figure 47: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for northern fulmars (*Fulmarus glacialis*) for bottom trawl vessels in the Limited Entry fishery from 2002-2010.

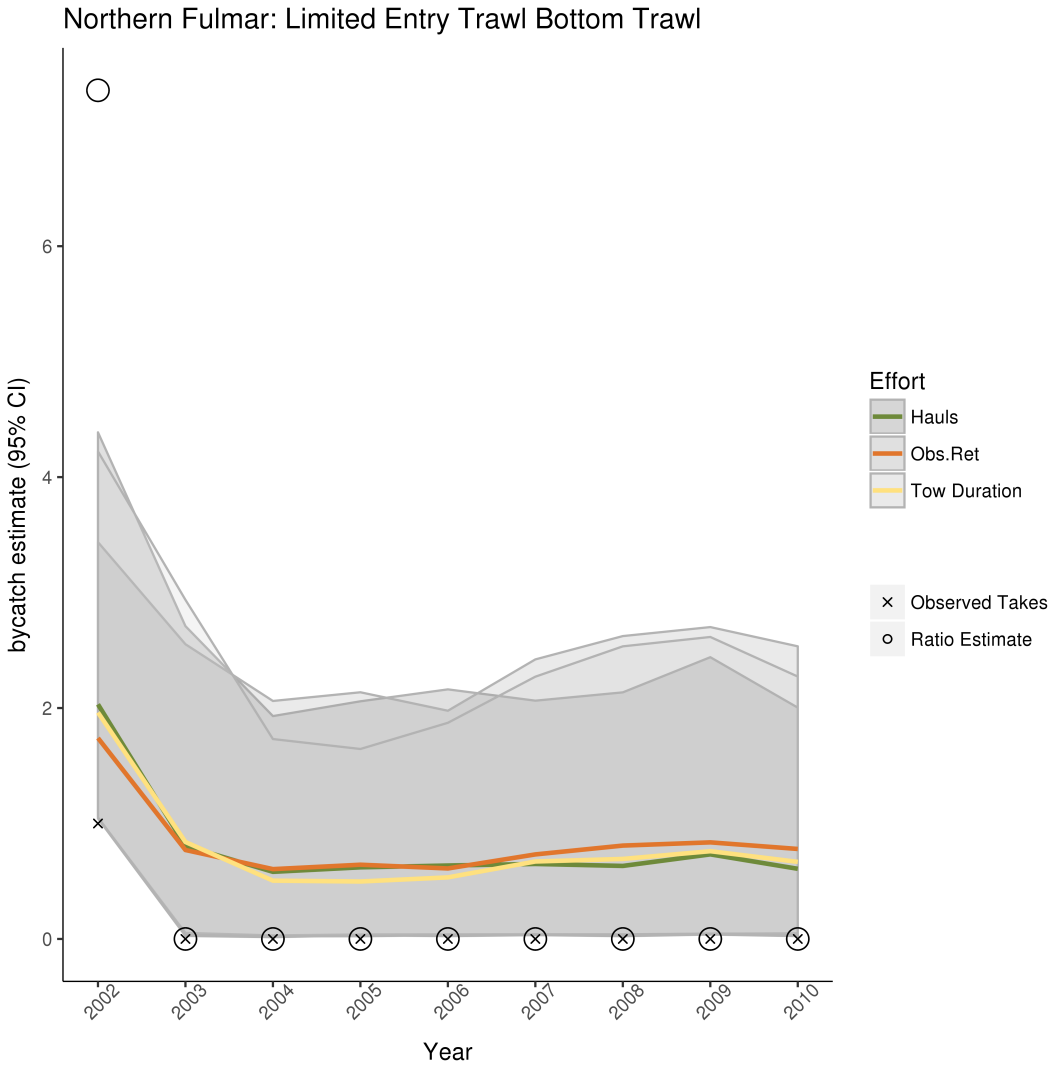


Figure 48: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified storm petrels (Family Procellariiformes, Subfamily Hydrobatinae) for bottom trawl vessels in the Limited Entry fishery from 2002-2010.

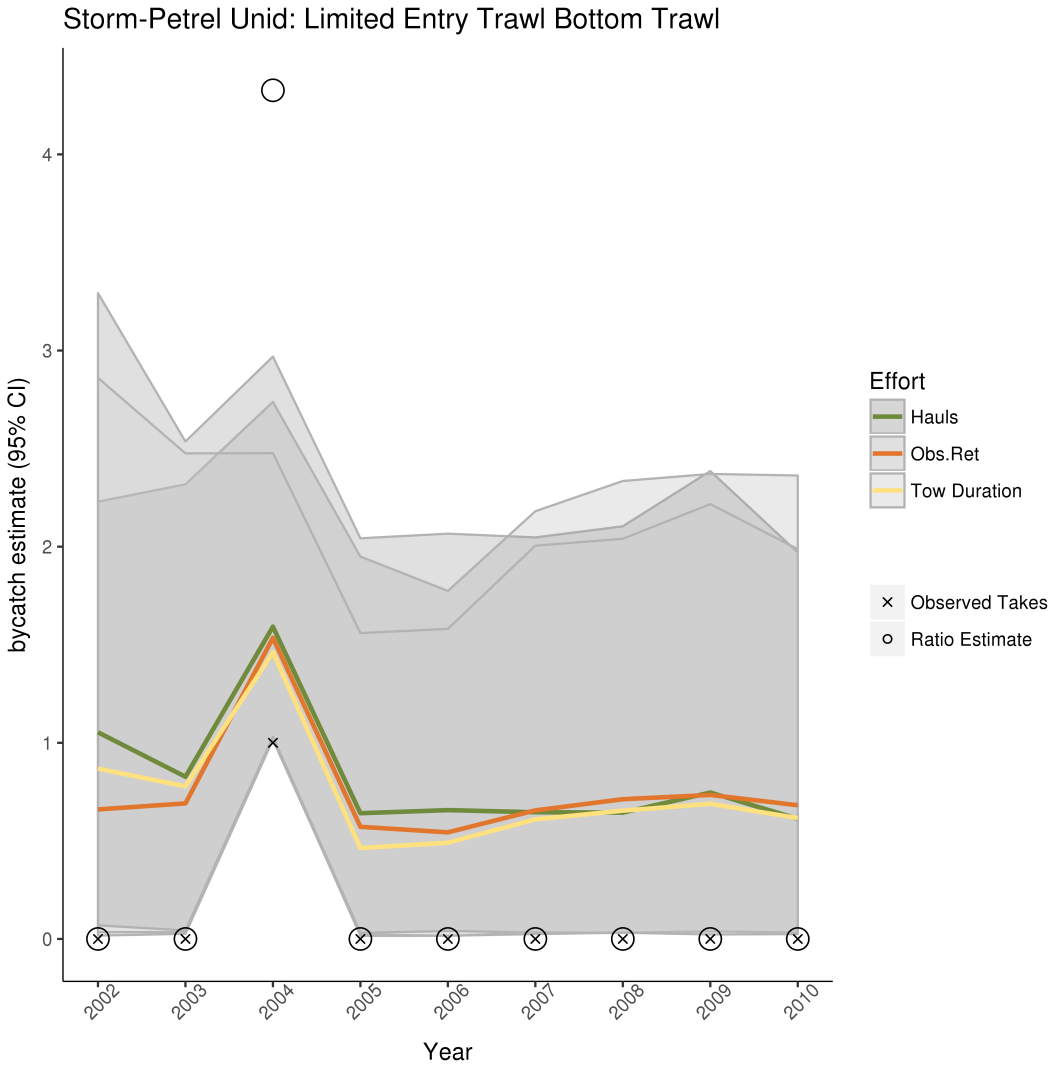


Figure 49: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for Brandt's cormorants (*Phalacrocorax penicillatus*) for bottom trawl vessels in the Limited Entry California halibut fishery from 2002-2009. LE California halibut 2010 seabird bycatch is included in the 2010 Open Access California halibut fishery to maintain confidentiality. From 2011 forward, all LE California halibut seabird bycatch is reported under Catch Shares bottom trawl vessels.

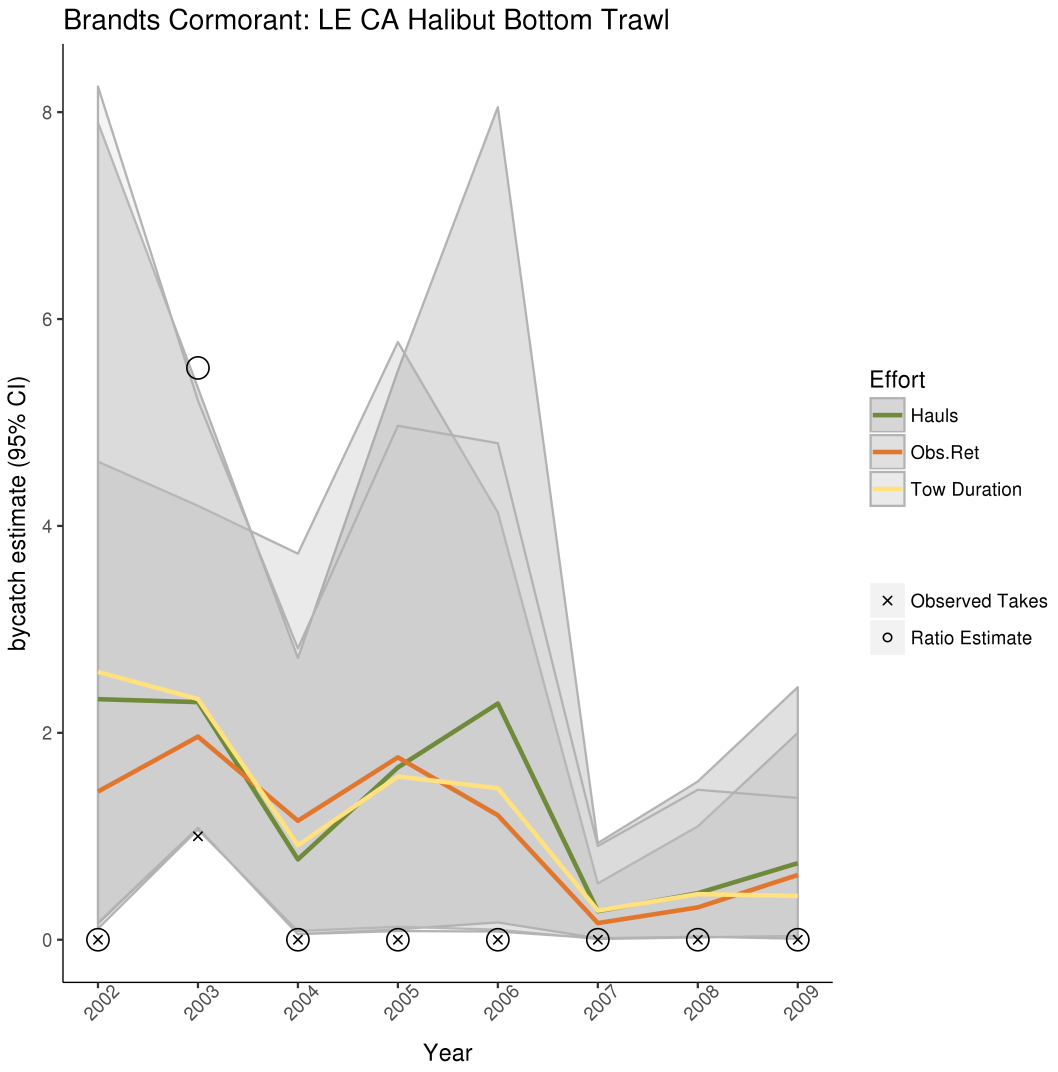


Figure 50: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for common murres (*Uria aalge*) for bottom trawl vessels in the Limited Entry California halibut fishery from 2002-2009. LE California halibut 2010 seabird bycatch is included in the 2010 Open Access California halibut fishery to maintain confidentiality. From 2011 forward, all LE California halibut seabird bycatch is reported under Catch Shares bottom trawl vessels.

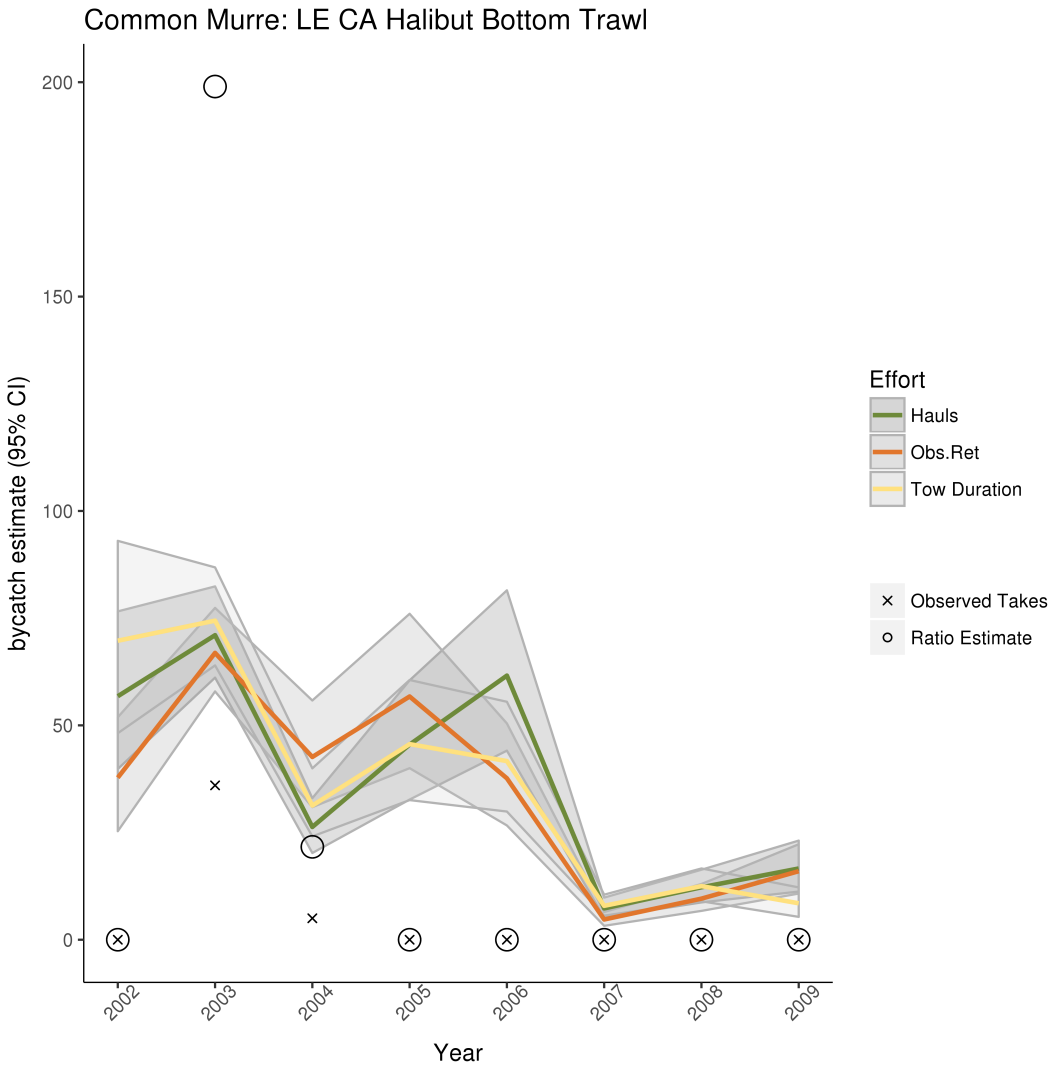


Figure 51: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified cormorants (*Phalacrocorax* spp.) for bottom trawl vessels in the Limited Entry California halibut fishery from 2002-2009. LE California halibut 2010 seabird bycatch is included in the 2010 Open Access California halibut fishery to maintain confidentiality. From 2011 forward, all LE California halibut seabird bycatch is reported under Catch Shares bottom trawl vessels.

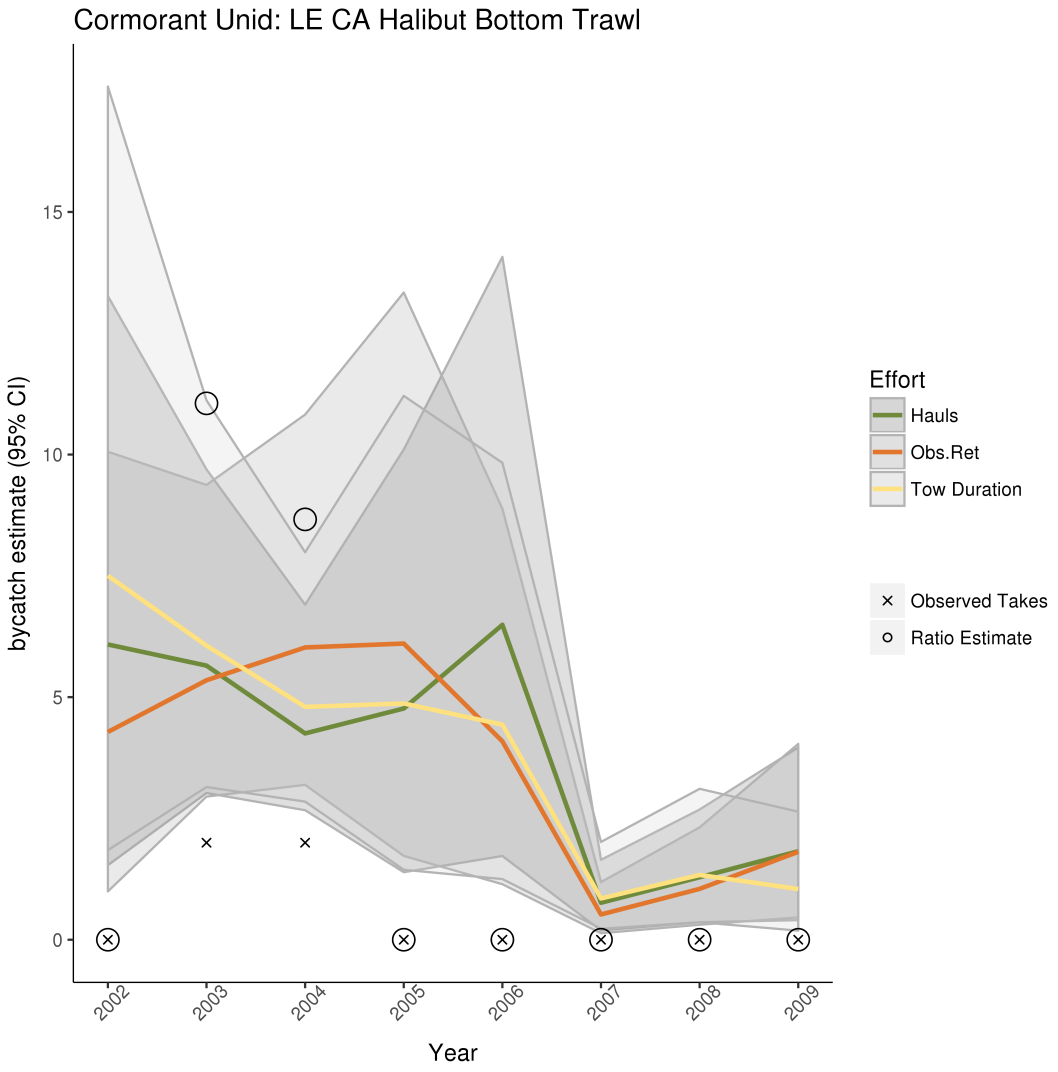


Figure 52: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified birds (Class Aves) for bottom trawl vessels in the Open Access (OA) California halibut fishery from 2003-2016. LE California halibut 2010 seabird bycatch is included in the 2010 Open Access California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006 and thus no values are presented for 2006.

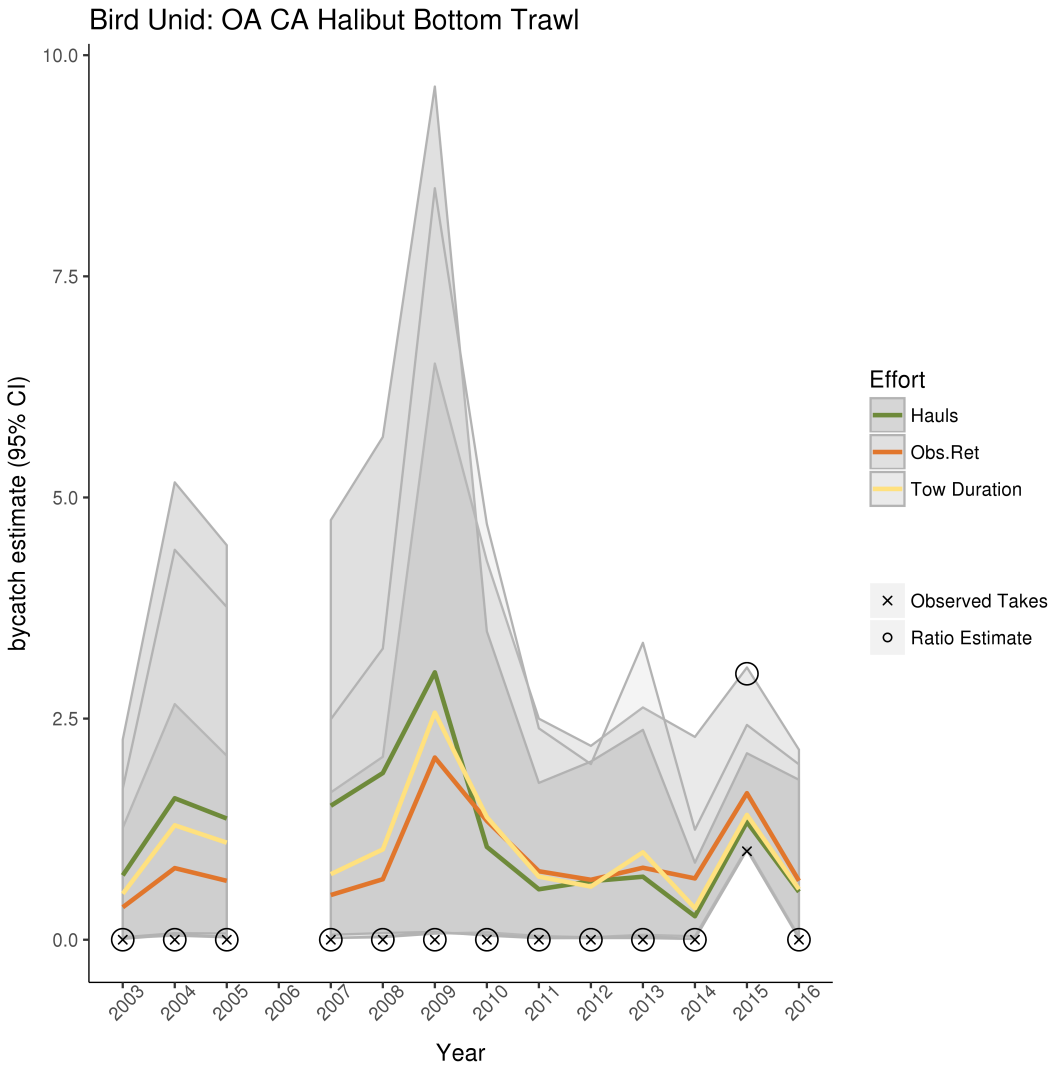


Figure 53: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for Brandt's cormorants (*Phalacrocorax penicillatus*) for bottom trawl vessels in the Open Access (OA) California halibut fishery from 2003-2016. LE California halibut 2010 seabird bycatch is included in the 2010 Open Access California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006 and thus no values are presented for 2006.

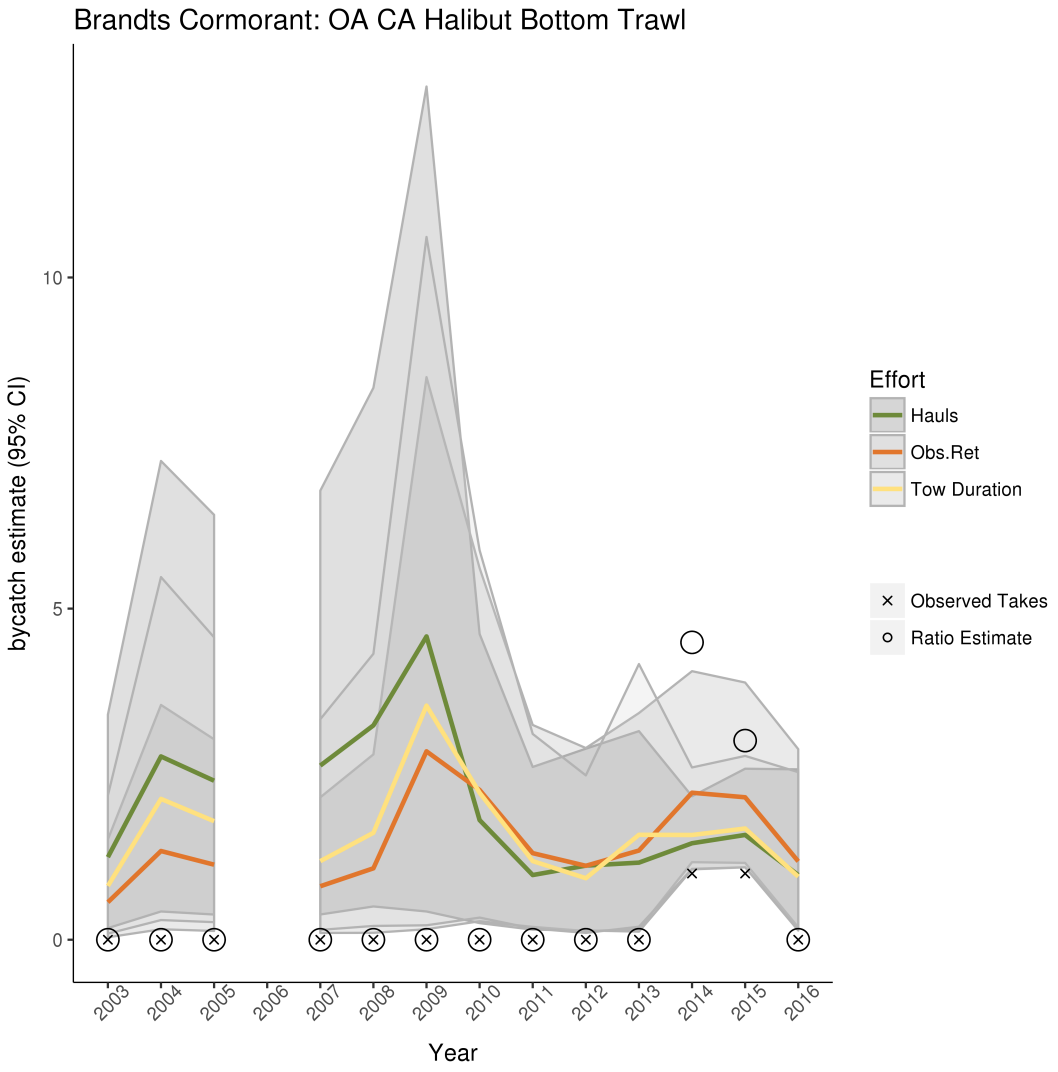


Figure 54: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for common murres (*Uria aalge*) for bottom trawl vessels in the Open Access (OA) California halibut fishery from 2003-2016. LE California halibut 2010 seabird bycatch is included in the 2010 Open Access California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006 and thus no values are presented for 2006.

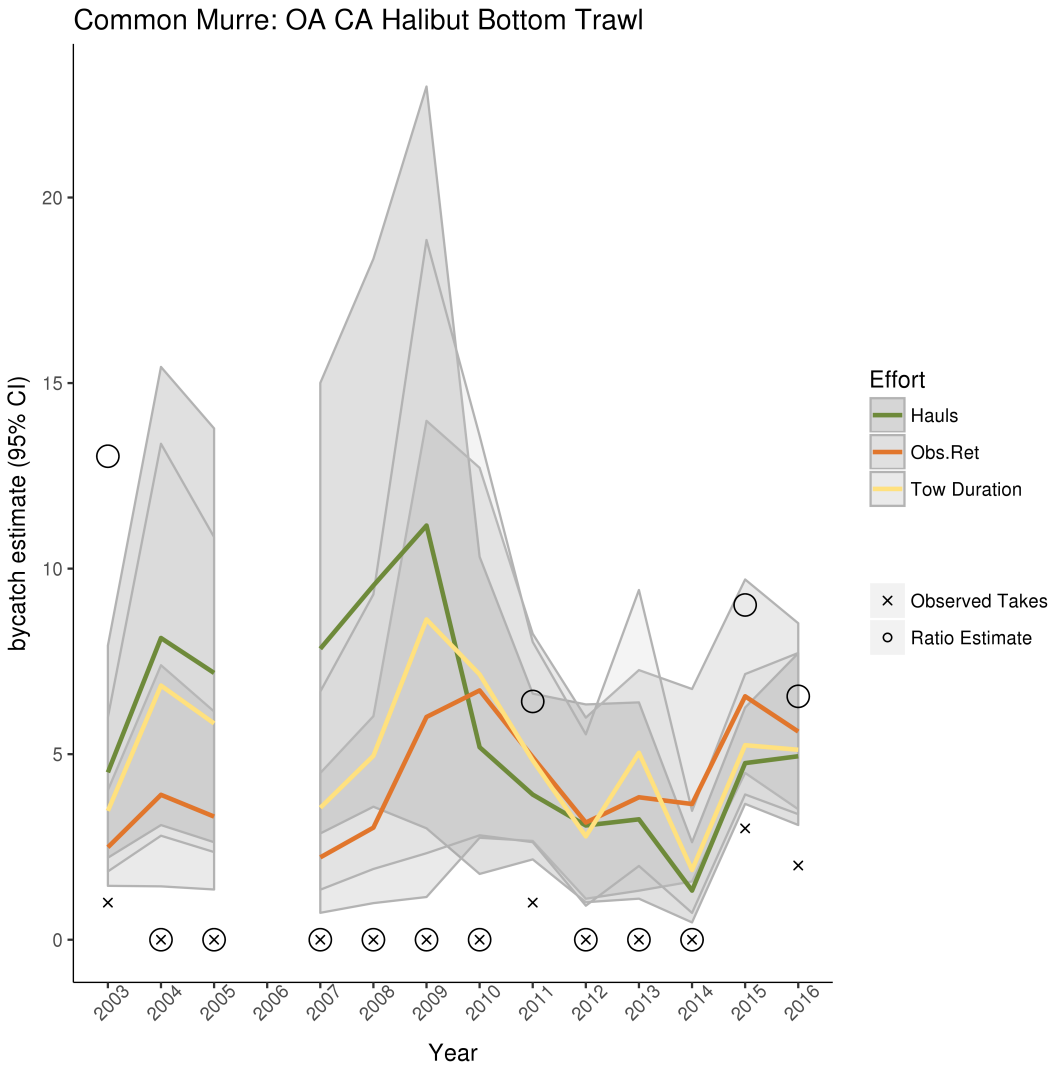


Figure 55: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified cormorants (*Phalacrocorax* spp.) for bottom trawl vessels in the Open Access (OA) California halibut fishery from 2003-2016. LE California halibut 2010 seabird bycatch is included in the 2010 Open Access California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006 and thus no values are presented for 2006.

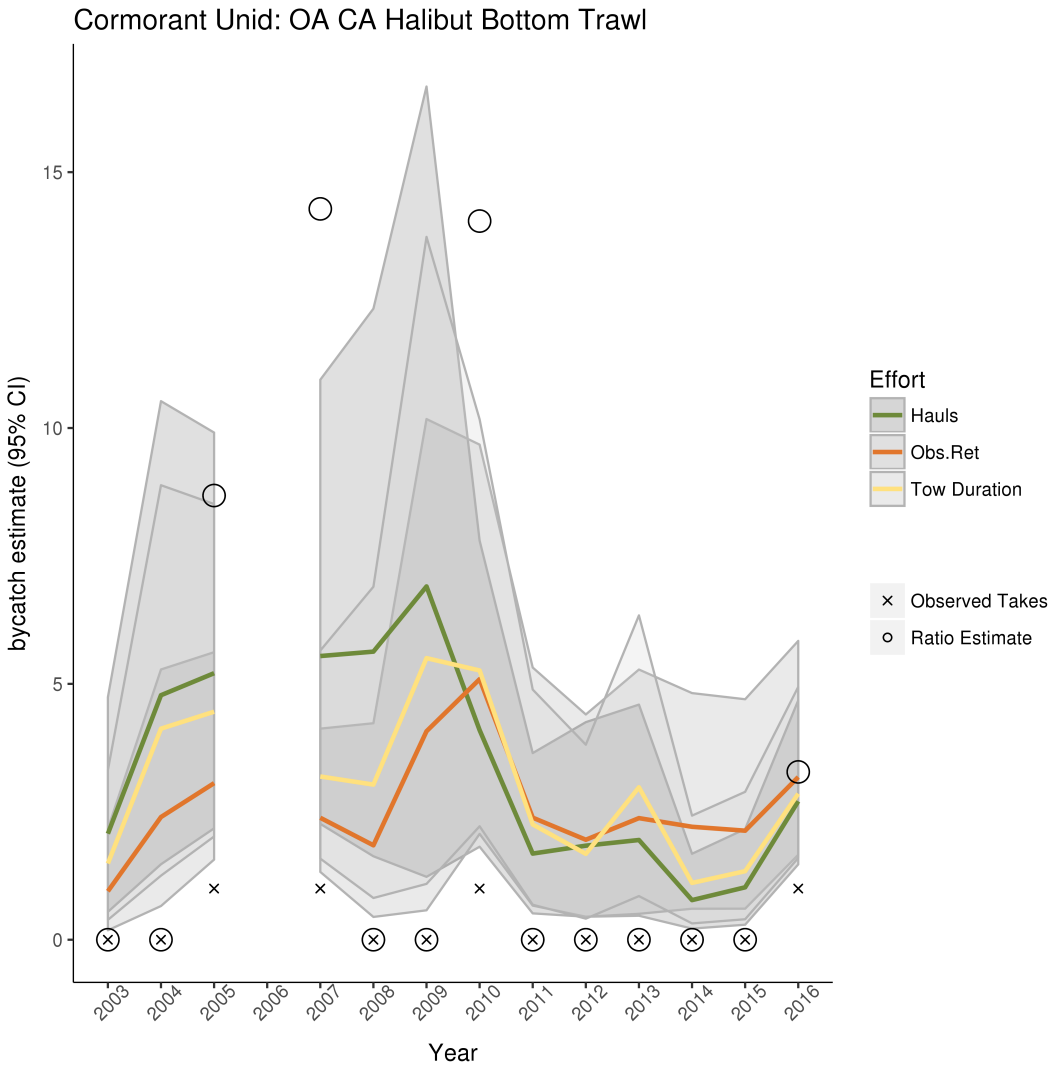


Figure 56: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for western gulls (*Larus occidentalis*) for bottom trawl vessels in the Open Access (OA) California halibut fishery from 2003-2016. LE California halibut 2010 seabird bycatch is included in the 2010 Open Access California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006 and thus no values are presented for 2006.

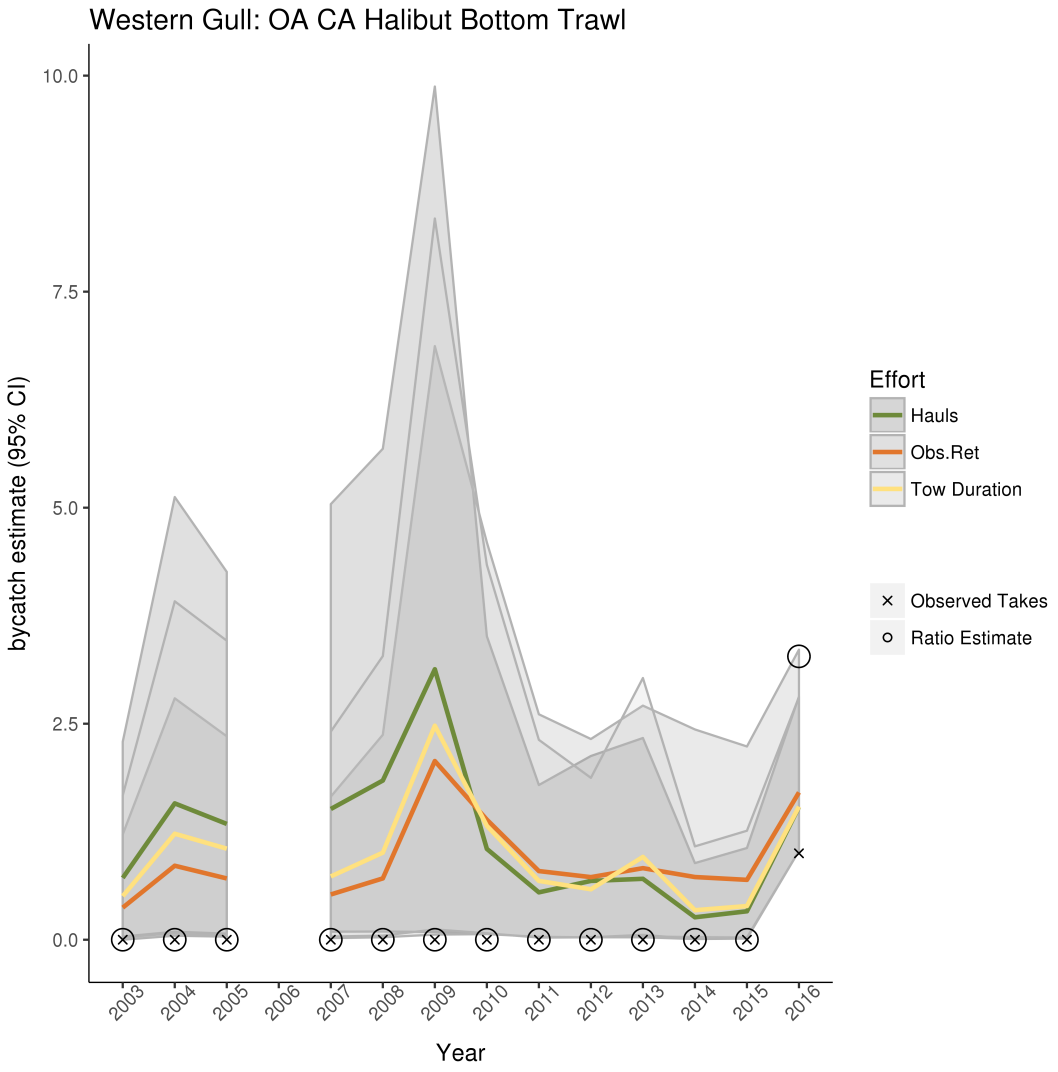


Figure 57: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified gulls (Family Laridae) for shrimp trawl vessels in the Washington state pink shrimp fishery 2010-2016.

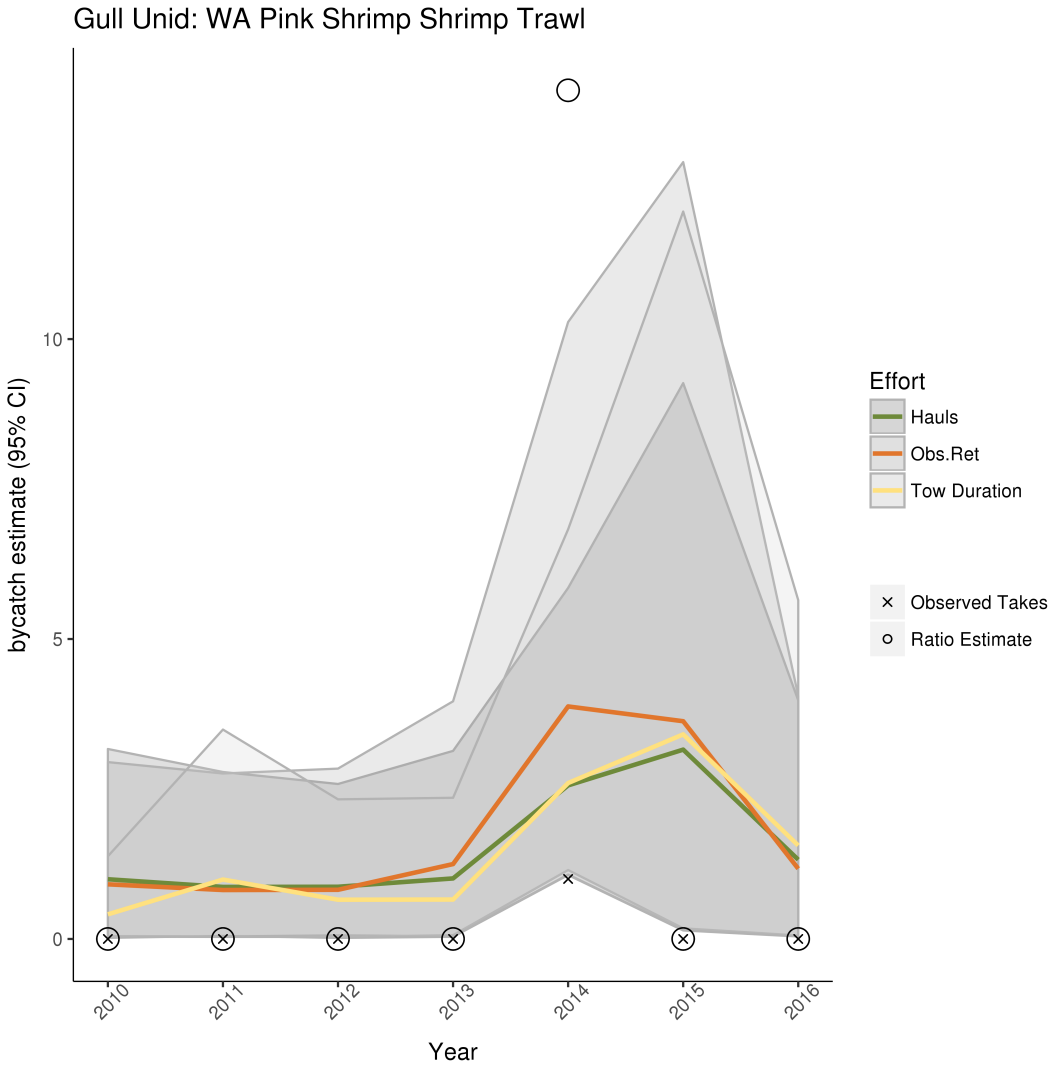


Figure 58: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for sooty shearwaters (*Ardenna grisea*) for shrimp trawl vessels in the Washington state pink shrimp fishery 2010-2016.

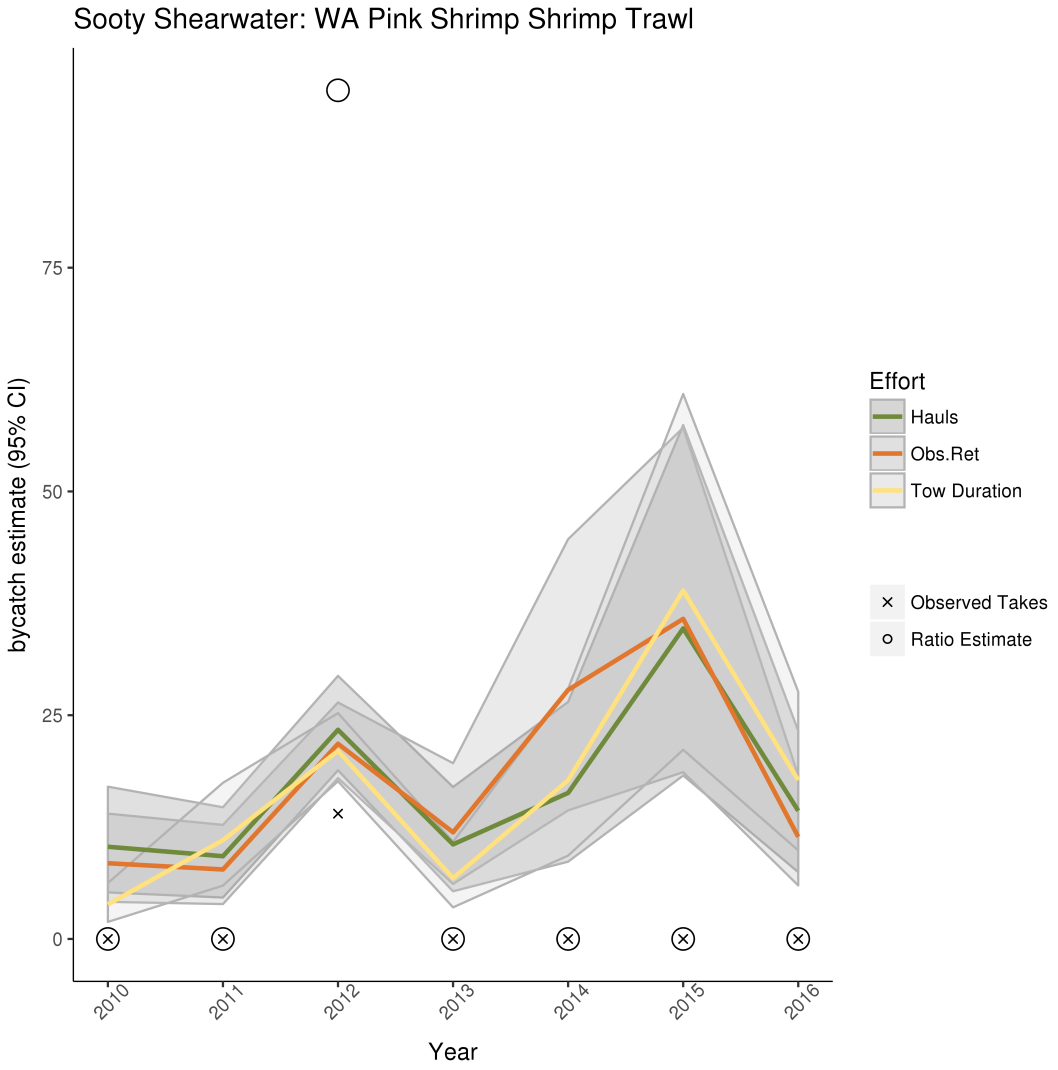


Figure 59: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for unidentified shearwaters (Family Procellariidae) for shrimp trawl vessels in the Oregon state pink shrimp fishery 2004-2016. The Oregon pink shrimp fishery was not observed in 2006 and therefore no estimates are shown for 2006.

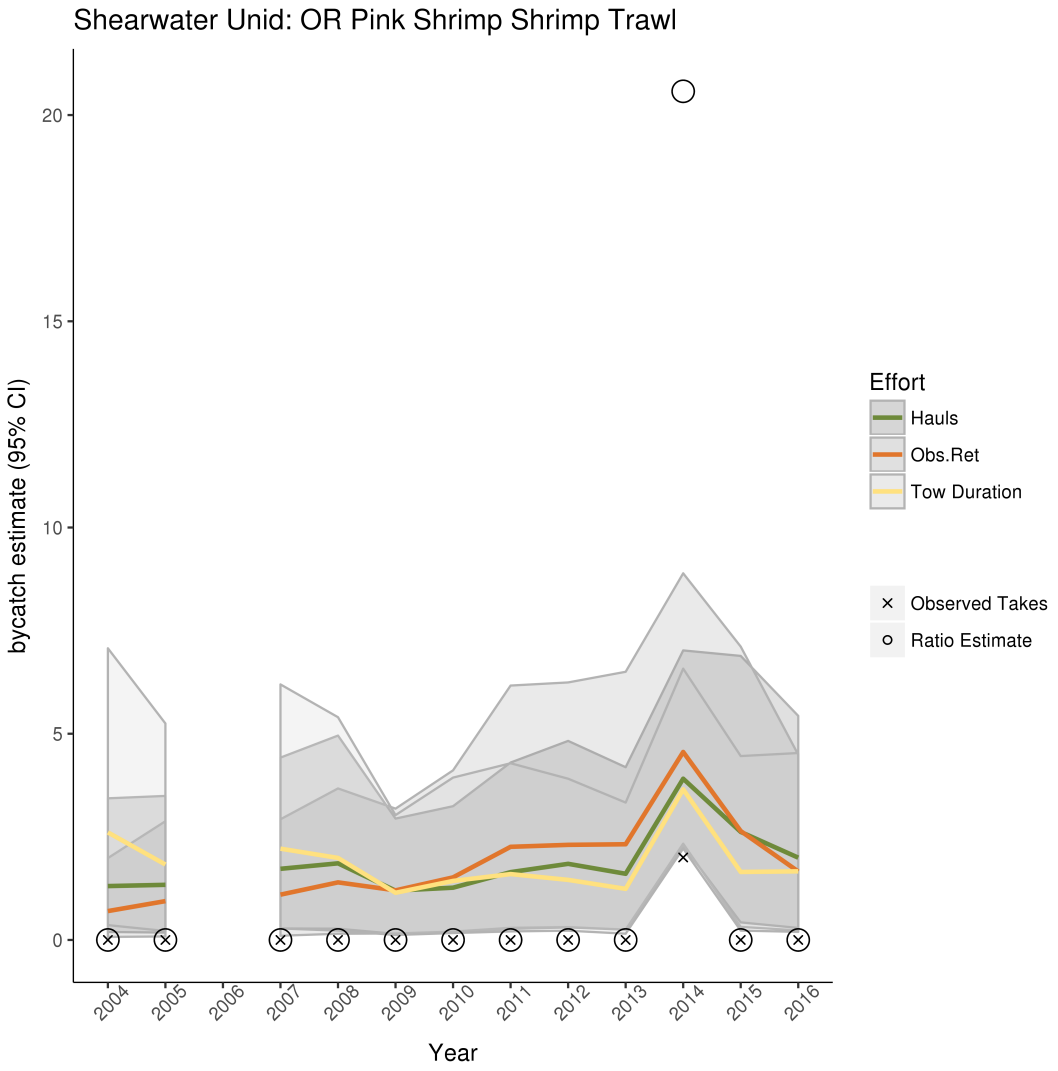


Figure 60: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for sooty shearwaters (*Ardenna grisea*) for shrimp trawl vessels in the Oregon state pink shrimp fishery 2004-2016. The Oregon pink shrimp fishery was not observed in 2006 and therefore no estimates are shown for 2006.

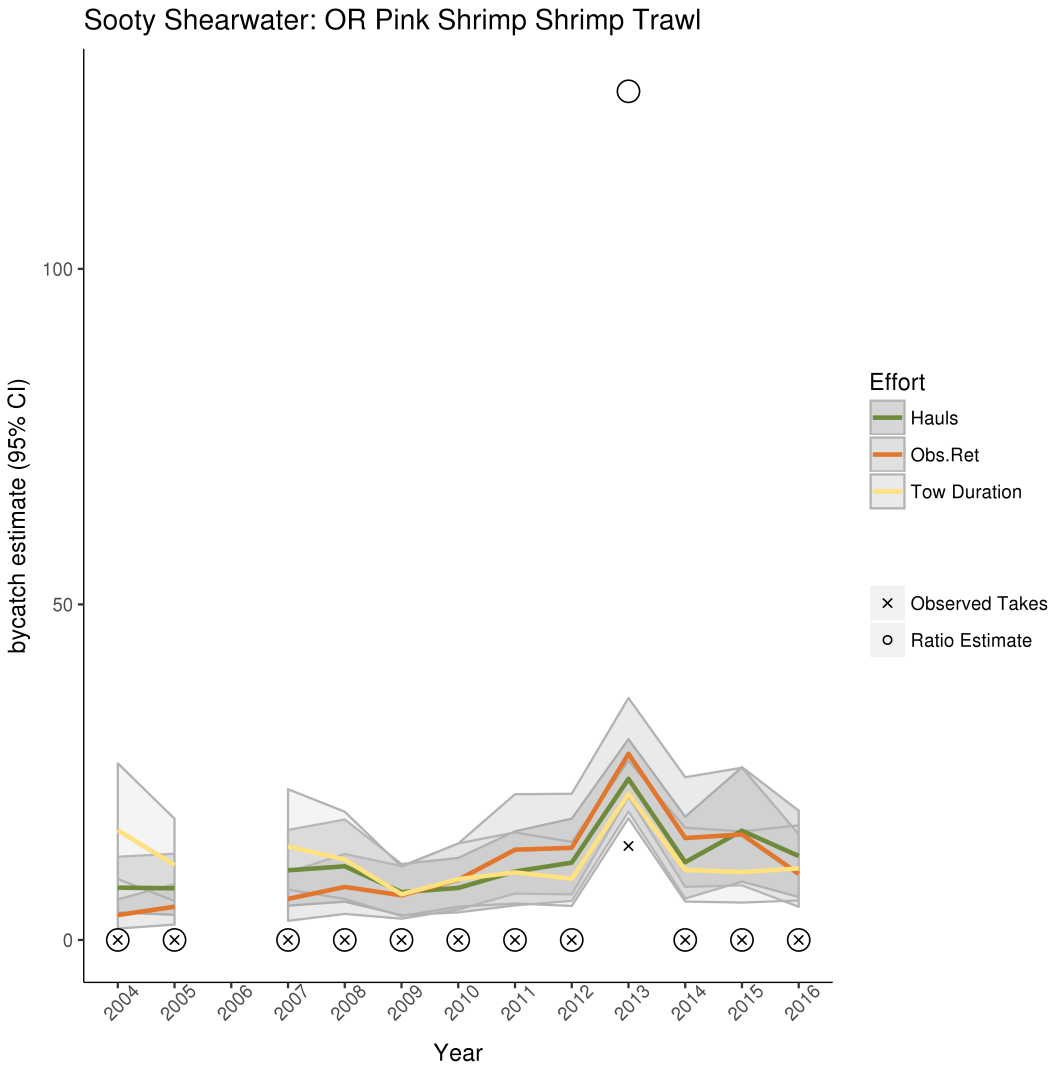
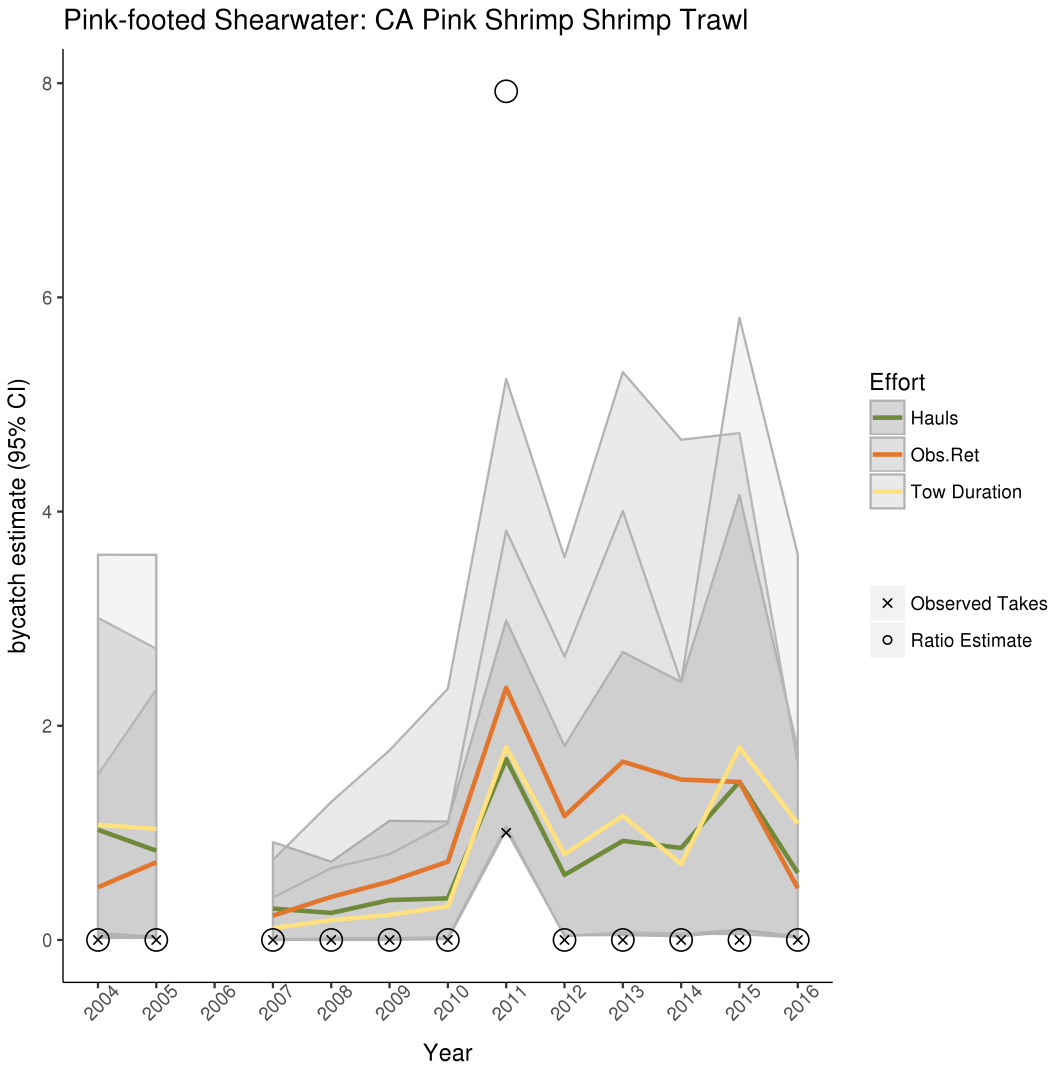
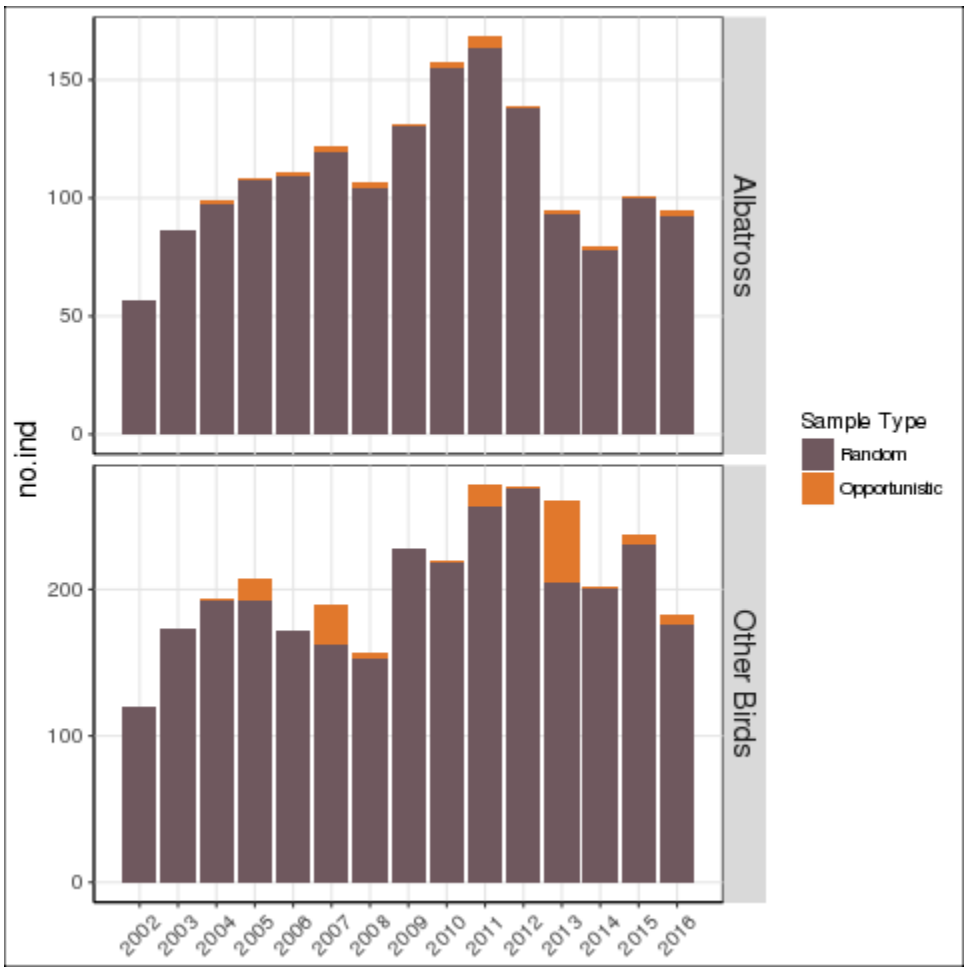


Figure 61: Observed takes, Bayesian mean bycatch estimate with $\pm$ 95% confidence interval (shaded polygons), and ratio bycatch estimate for pink-footed shearwaters (*Ardenna grisea*) for shrimp trawl vessels in the California state pink shrimp fishery 2004-2016. The California pink shrimp fishery was not observed in 2006 and therefore no estimates are shown for 2006.



Opportunistic and Random Samples

Figure 62: Randomly sampled and opportunistic samples as a fraction of total samples by year.



Fishery Sector Descriptions

Table 75: A description of permits, gears used, target groups, vessel length range, fishing depth range, and management of fishery sectors and sub-sectors in U.S. west coast groundfish fisheries. For brevity, management descriptors are generalized for the given time period and are not meant to be complete or comprehensive.

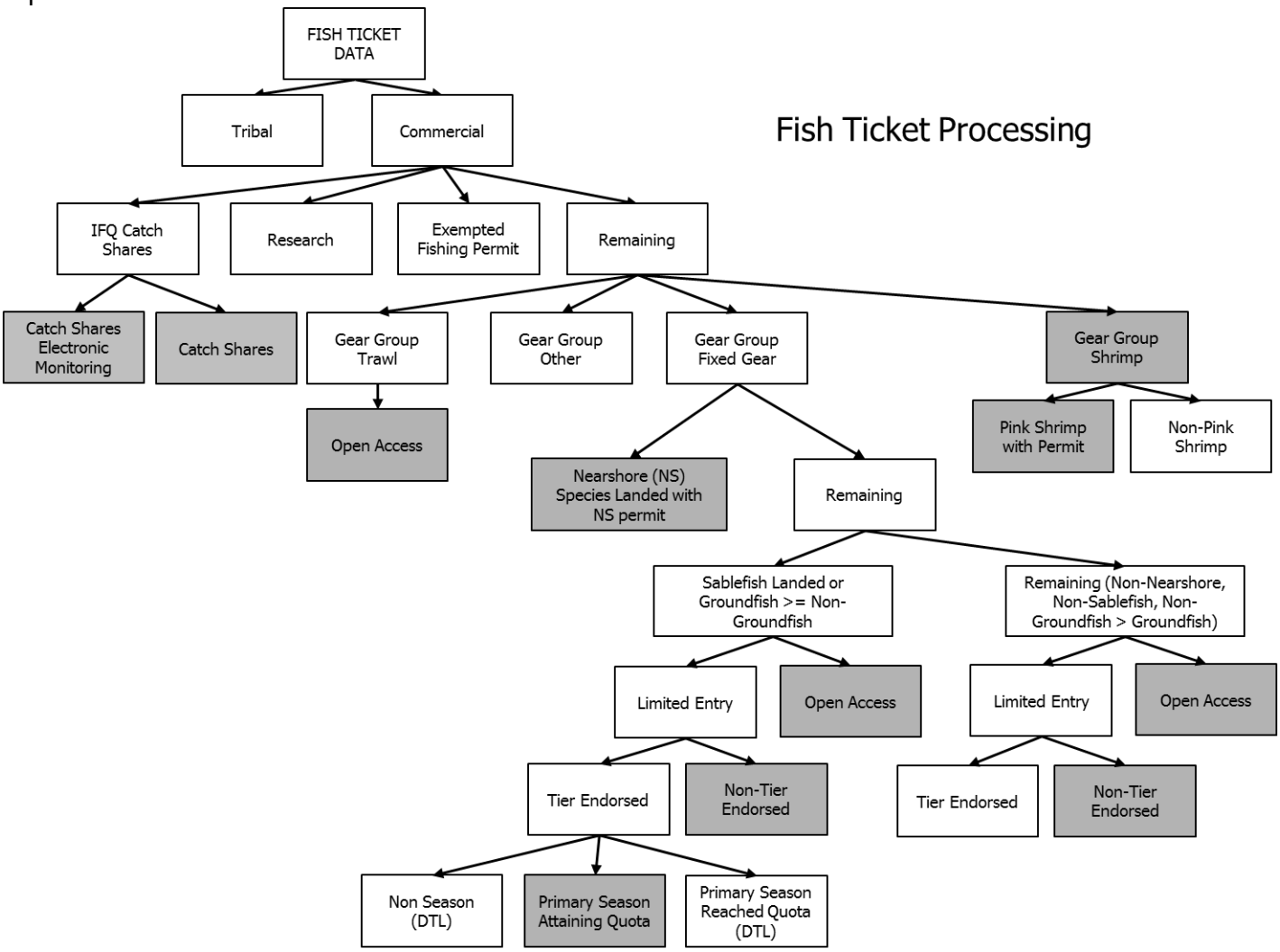
							Management	
Sector	**Sub-Sector**	**Permits**	**Gear(s)**	**Target(s)**	**Length (m)**	**Depths (m)**	**2002-2010**	**2011-2013**
Limited Entry (LE) Trawl		Federal LE permit[1] with trawl endorsement	Bottom Trawl, after Jan 1, 2011 also Hook & Line and Pot gear	Species assemblages	11-29	Wide range	Cumulative two-month trip limits; depth-based closures	Individual Fishing Quotas (IFQ)
LE California Halibut		CA Halibut permit[2] and LE permit with trawl endorsement	Bottom Trawl	California halibut[5]	9-22	< 55	Cumulative two-month trip-limits; depth-based closures	IFQ
At-Sea Hake	Motherships	LE permit with trawl endorsement	Midwater Trawl	Pacific hake[6]	26-45[4]	53-460[4]	Seasonal (May-Dec) quotas for target and bycatch species of concern	IFQ; Seasonal
	Catcher-processors	LE permit with trawl endorsement	Midwater Trawl	Pacific hake	82-115	60-570	Same as At-Sea Hake Motherships	IFQ; Seasonal
	Tribal		Midwater Trawl	Pacific hake				
Shoreside Hake		LE permit with trawl endorsement	Midwater Trawl	Pacific hake	17-29	Wide range	Same as At-Sea Hake Motherships	IFQ; Seasonal
Non-Nearshore Fixed Gear	Sablefish endorsed	LE permit with fixed gear endorsement and sablefish quota	Longlines, Pots	Sablefish[7]	11-32	> 145	Sablefish tier quotas; seven month season	
	Sablefish non-endorsed (a.k.a. DTL)	LE permit with fixed gear endorsement w/o sablefish quota	Longlines, Pots	Sablefish, rockfish[8] and flatfish[9]	5-18	> 145	Daily Trip Limits (DTL)	
	Open Access	(none)	Longlines, Pots	Sablefish and other groundfish	3-30	> 64	Trip limits	
Open Access (OA) California Halibut		CA Halibut permit[2]	Bottom Trawl	California halibut	9-22	< 55	Most fishing occurs within CA waters in the California Halibut Trawl Grounds where minimum mesh sizes	

Sector	**Permits**	**Gear(s)**	**Target(s)**	**Length (m)**	**Depths (m)**	**Management**
Nearshore Fixed Gear[3]	CA or OR state nearshore permits and endorsements	Variety of hand lines, pot gear, stick gear, rod and reel	Rockfish, Cabezon[10], Greenlings[11]	3-15	< 110 (usu. < 55 in OR waters)	Federal and CA or OR state nearshore regulations; area closures; two-month trip limits; minimum size limits
Pink Shrimp	WA, OR, or CA state pink shrimp permit	Shrimp trawl	Pink shrimp[12]	11.5-33	91-256	WA, OR, or CA state pink shrimp regulations; Bycatch Reduction Devices required; trip limits on groundfish landed

[1] a.k.a., LE permit; all LE permits are issued by Federal agency (NOAA).
[2] Issued by the state of California.
[3] The state of WA does not conduct a nearshore fishery.
[4] Average values for catcher vessels delivering catch to motherships.
[5] *Paralichthys californicus*
[6] *Merluccius productus*
[7] *Anoplopoma fimbria*
[8] *Sebastes* spp.
[9] Pleuronectiformes
[10] *Scorpaenichthys marmoratus*
[11] Hexagrammidae
[12] *Pandalus jordani*

Fish Ticket Processing

Figure 63: Fish ticket data processing for division into 2016 groundfish fishery sectors after retrieval from the Pacific Fisheries Information Network (PacFIN) database. Grey boxes indicate sectors for which federal observer data is available. Fish ticket processing methods are updated annually, thus, this figure might differ from similar figures in previous reports.



This document was processed by KnitR version 1.20 on R version 3.4.3 (2017-11-30). It was generated by jjannot@nwctantalus.nmfs.local running with Intel(R) Xeon(R) CPU X7550 @ 2.00GHz . Processing was completed 2018-08-09 18:05:39.