NOAA Technical Memorandum NMFS-NWFSC-146

Seabird Mortality in U.S. West Coast Groundfish Fisheries, 2002–16

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Note:

Due to the amount of data they contain, the following tables have been typeset on legal-sized pages: 2, 3, 4, 5, 6, 8, 9, 10, 11, 13, 14, 15, A-1, A-2, A-3, A-4, A-5, A-6, A-7, A-10, A-11, A-12, A-13, A-14, B-12, B-13, B-14, B-15, B-16, B-17, and B-29. Printing them on regular, letter-sized paper may result in reduced legibility.

Contents

Figures

Tables

Seabird Bycatch 2002-2016
U.S. West Coast Groundfish Fisheries

Seabird Conservation Status

Species	Number Killed 2002-2016 Hook & Line	Trawl	Pot
Short-tailed Albatross	1		
Pink-footed Shearwater	2	2	
Leach's Storm-Petrel		2	
Black-footed Albatross	4	2	1
Sooty Shearwater	3	3	
Laysan Albatross	1	1	
Cassin's Auklet		1	
Western Gull	3	2	
Northern Fulmar	2	3	1
Arctic Herring Gull	2	1	
Brown Pelican	3		
Glaucous-winged Gull	2		
Common Murre	2	3	
Brandts Cormorant	2	2	2
California Gull	1	1	
Double-crested Cormorant	2		2
Common Loon	2		
Mew Gull	1		
Red-necked Phalarope	1		
Ring-billed Gull	1		
Green-winged Teal		1	
White-winged Scoter		1	
Shearwater Unidentified	3	2	
Gull Unidentified	3	2	
Bird Unidentified	2	2	
Cormorant Unidentified	2	2	2
Alcid Unidentified	1	1	
Tubenoses Unidentified		1	
Storm-Petrel Unidentified		1	1
Murre Unidentified		1	

Number of birds

1	1-10
2	11-100
3	101-1000
4	1000+

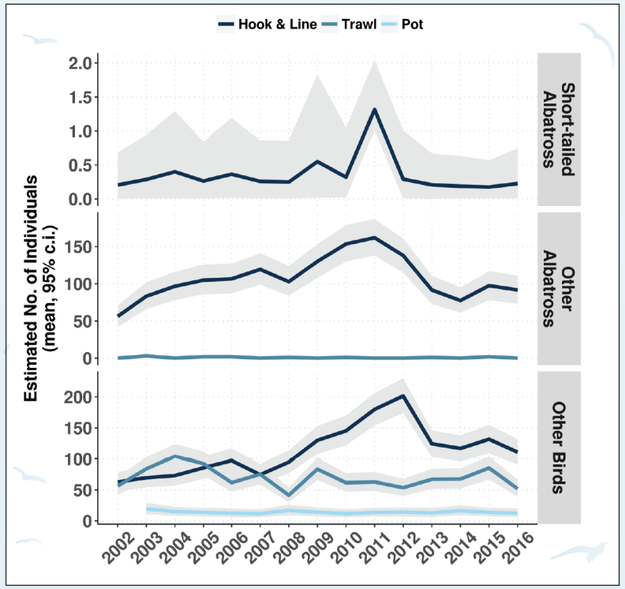
Conservation status

- Endangered
- Vulnerable
- Near threatened
- Least concern
- Unknown

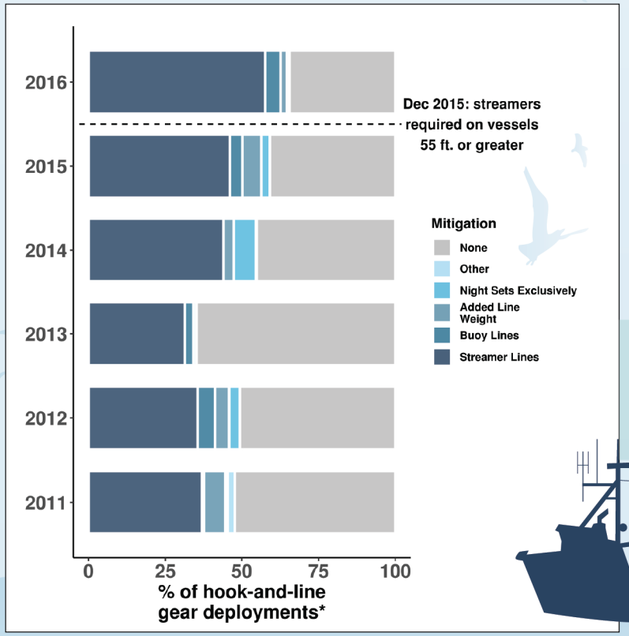
*Endangered under US ESA; all other categories are IUCN

ESA = Endangered Species Act
IUCN = International Union for the Conservation of Nature

Temporal Trends

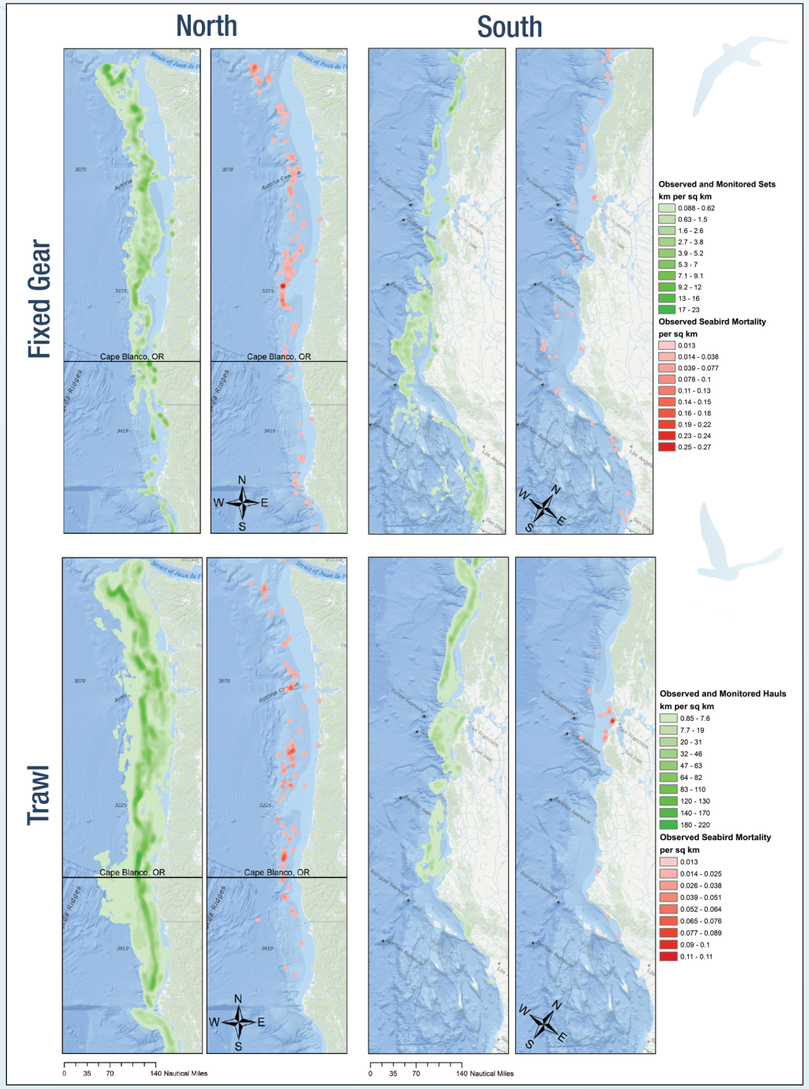


Mitigation Strategies in Hook & Line Fisheries



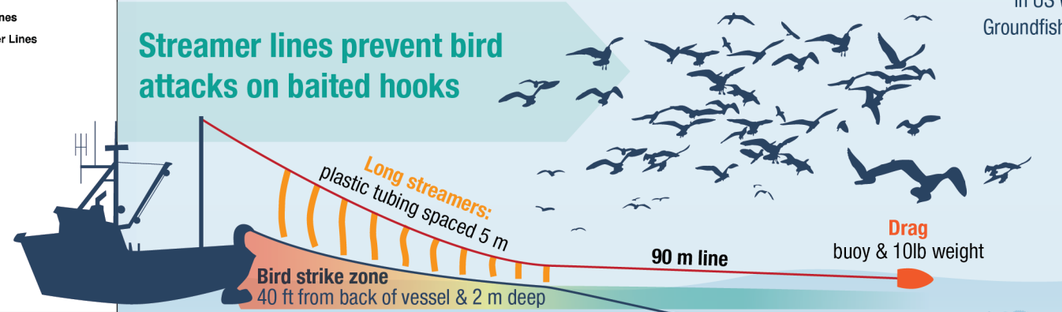
*Includes vessels using hook & line gears in the Sablefish, Daily Trip Limits, and Open Access Fixed Gear fisheries.

Spatial Distribution



Maps created by K. Somers, FRAM/FOS, NWFSC

Streamer lines prevent bird attacks on baited hooks



Management & Policy

NOV 2018
PFMC discussed streamer line use on longline vessels 26 to 55 ft in length.

MAY 2017
USFWS issues second Biological Opinion regarding Short-tailed Albatross in US West Coast Groundfish Fisheries.

DEC 2015
PFMC and NOAA regulation requires streamer lines on non-tribal longline vessels 55 ft and larger (80 FR 71975).

JUN 2013
PFMC convenes Groundfish Endangered Species Work Group.

NOV 2012
U.S. Fish & Wildlife issues first Biological Opinion regarding Short-tailed Albatross in US West Coast Groundfish Fisheries.

APR 2011
ESA-listed Short-tailed Albatross take on a hook-and-line vessel in the Sablefish fishery.

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Executive Summary

The California Current Ecosystem on the U.S. West Coast (Washington, Oregon, and California) supports a diversity of marine organisms, including seabirds. This report summarizes interactions between the U.S. West Coast groundfish fishery and seabirds, and presents estimates of fleetwide seabird bycatch based on data from the fishery and federal observer programs for the years 2002–16.

Lethal and nonlethal 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 2002–16 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 either not listed, or categorized as *Least Concern* (i.e., not at risk).

Three albatross species interact with these fisheries: black-footed, Laysan, and the ESA-listed short-tailed albatross.[1] 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 one individual per year (Figure ES-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 ES-1). The 2016 mean estimate of other (non-short-tailed) albatross was about 90 individuals. Other birds (i.e., not albatross) also showed a peak in mortality during the 2009–11 period of about 180–200 birds killed. The 2016 mean estimated mortality of other birds was about 120.

Hook-and-line fisheries account for the largest number of albatross taken among the three gear categories (hook-and-line, trawl, and pot). Hook-and-line fisheries account for 58–83% of seabird mortality in a given year, followed by trawl fisheries at 13–37%, and pot fisheries at 0–8% of bycatch in a given year (Table ES-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.

[1] Scientific names of species and/or groups of species mentioned in this report appear in the List of Species.

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 fleetwide estimates even in years when no seabirds were reported killed by fisheries observers. Comparsions between the ratio and Bayesian estimates are provided in Appendix C. 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.

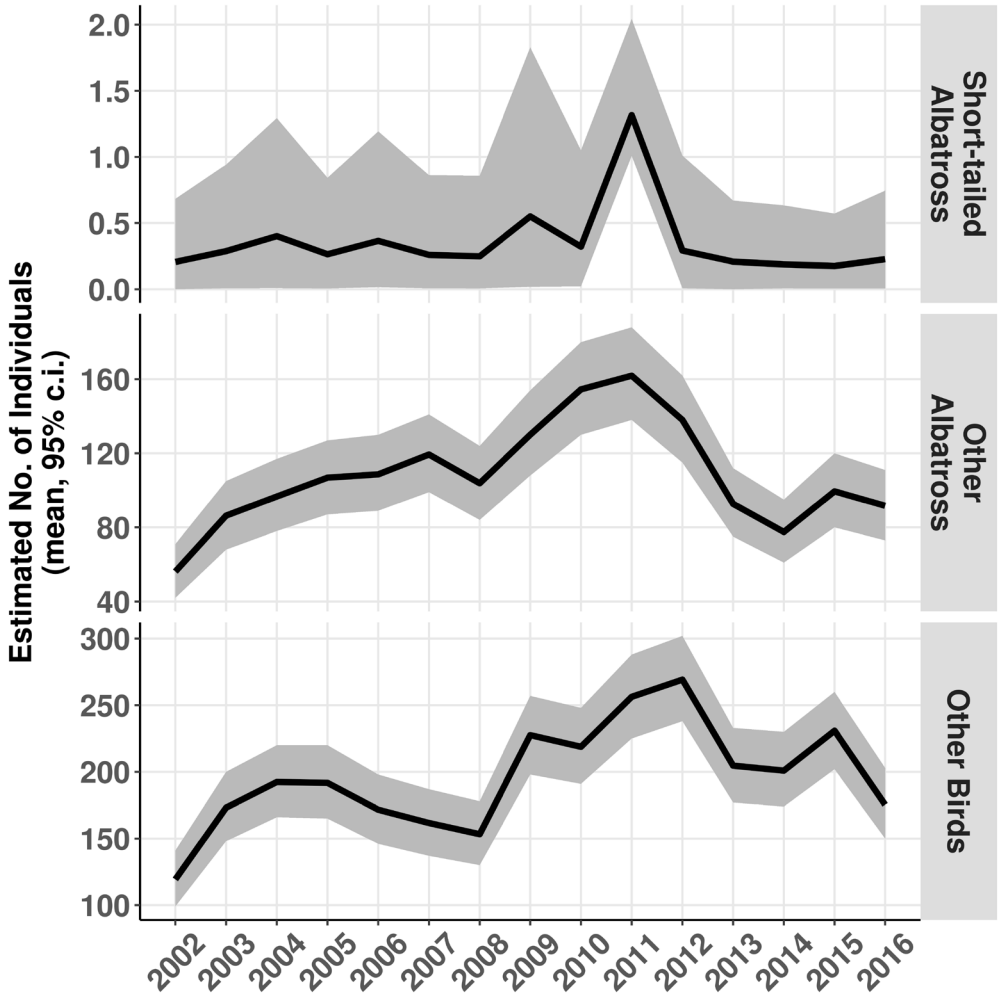

Figure ES-1. Estimated short-tailed albatross, other albatross, and other birds mortality (mean number of individuals ±95% confidence interval [c.i.]) in U.S. West Coast groundfish fisheries for the period 2002–16.

Table ES-1. Estimated mean seabird mortality (numbers of individuals) and the percent of total mortality by gear type and year in U.S. West Coast groundfish fisheries, 2002–16.

	Hook & 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

Acknowledgments

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 FOS Program staff for their hard work and dedication. This report benefited from 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 citation pages. We thank our partners at the Pacific States Marine Fisheries Commission, who provide us with data from the IFQ Electronic Monitoring EFP and landings data from PacFIN.

Introduction

The California Current Ecosystem on the U.S. West Coast (Washington, Oregon, and 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 U.S. Exclusive Economic Zone (EEZ) on the U.S. West Coast, which can cause incidental human-induced mortality of these species, a.k.a. bycatch. This report summarizes interactions between the U.S. West Coast groundfish fishery and seabirds, and presents estimates of fleetwide bycatch for seabirds based on data from the fishery and federal observer programs for the years 2002–16.

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 direct 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 sublethal effects of fisheries on seabirds is the first step toward understanding the impact of fisheries on seabird populations and developing solutions to minimize seabird bycatch. The U.S. Fish and Wildlife Service (USFWS) manages seabird populations in the U.S. by enforcing laws and regulations pertaining to seabirds and other migratory birds. NOAA's Northwest Fisheries Science Center (NWFSC) and West Coast Region (WCR), in collaboration with USFWS, gather data on fishery-related mortality of seabirds in U.S. West Coast groundfish fisheries to aid USFWS and other agencies in their efforts to quantify and mitigate seabird bycatch.

The U.S. West Coast supports a diversity of seabird species, of both national and international importance, exhibiting a wide range of life history characteristics. Seabirds interacting with the U.S. West Coast groundfish fishery include species that breed locally. For example, U.S. West Coast populations of nesting Brandt's cormorants[1] and western gulls 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 is listed as endangered under the U.S. Endangered Species Act (ESA), and the black-footed and Laysan albatrosses are listed as near-threatened on the International Union for Conservation of Nature (IUCN) Red List. Other west coast seabirds that are ESA-listed include California least terns and the marbled murrelet (Table 1). 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 U.S. West Coast groundfish fisheries (Table 1).

[1] Scientific names of species and/or groups of species mentioned in this report appear in the List of Species.

Table 1. U.S. Endangered Species Act (ESA) and International Union for the Conservation of Nature (IUCN) status and numbers of observed mortalities (takes), nonlethal interactions, and sightings for all birds recorded by observers on U.S. West Coast fishing vessels observed by the NWFSC Observer Program, 2002–16. Estimated mean fishing mortality by year for each species is given in Table 2.

	Conservation status		Observed		
Common name	**ESA**	**IUCN**	**Takes**	**Interactions**	**Sightings**
Short-tailed albatross	Endangered	Vulnerable	1	43	160
California least tern	Endangered	Not assessed	0	0	2
Marbled murrelet	Threatened	Endangered	0	1	154
Pink-footed shearwater	Not listed	Vulnerable	5	5	48
Leach's storm-petrel	Not listed	Vulnerable	26	10	30
Black-legged kittiwake	Not listed	Vulnerable	0	0	1
Sooty shearwater	Not listed	Near threatened	40	26	7858
Snowy plover	Not listed	Near threatened	0	1	0
Heermann's gull	Not listed	Near threatened	0	3	34
Laysan albatross	Not listed	Near threatened	3	48	83
Black-footed albatross	Not listed	Near threatened	333	2527	4318
Cassin's auklet	Not listed	Near threatened	9	37	3
Green-winged teal	Not listed	Not assessed	10	0	0
Short-tailed shearwater	Not listed	Least concern	0	1	0
Wilson's warbler	Not listed	Least concern	0	1	0
South polar skua	Not listed	Least concern	0	1	0
Pigeon guillemot	Not listed	Least concern	0	0	99
Rhinoceros auklet	Not listed	Least concern	0	2	2
Semipalmated plover	Not listed	Least concern	0	1	0
Tufted puffin	Not listed	Least concern	0	1	16
Northern fulmar	Not listed	Least concern	263	2558	193
Common loon	Not listed	Least concern	1	1	0
Pacific loon	Not listed	Least concern	0	0	2
Fork-tailed storm-petrel	Not listed	Least concern	0	101	6
California gull	Not listed	Least concern	2	1	32
Mew gull	Not listed	Least concern	1	0	0
Ring-billed gull	Not listed	Least concern	1	0	0
Glaucous-winged gull	Not listed	Least concern	4	4	7
Western gull	Not listed	Least concern	71	7654	157
Arctic herring gull	Not listed	Least concern	13	0	1
Orange-crowned warbler	Not listed	Least concern	0	3	0
White-winged scoter	Not listed	Least concern	3	0	0
American white pelican	Not listed	Least concern	0	0	1
Brown pelican	Not listed	Least concern	6	11	101
Double-crested cormorant	Not listed	Least concern	2	2	0
Pelagic cormorant	Not listed	Least concern	0	0	7
Brandt's cormorant	Not listed	Least concern	7	0	0
Red-necked phalarope	Not listed	Least concern	1	1	0
Lesser goldfinch	Not listed	Least concern	0	1	0
Brown booby	Not listed	Least concern	0	4	3
Ancient murrelet	Not listed	Least concern	0	0	1
Common murre	Not listed	Least concern	62	6	96

All seabirds in the California Current Ecosystem 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 U.S. 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 U.S. West Coast, upwelling is most intense south of Cape Blanco, Oregon (lat 42°50'N; Bakun, McLain, and Mayo 1974, Barth, Pierce, and Smith 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 Ecosystem are also most abundant in areas of strong upwelling intensity and high productivity (Briggs and Chu 1986, Hyrenbach, Fernandez, and Anderson 2002).

This upwelling not only varies by latitude, but also by season, thereby influencing both the latitudinal and seasonal distribution of seabirds. The U.S. 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 Ecosystem (Tyler et al. 1993, Ford et al. 2004). However, during this time, productivity and prey abundance associated with upwelling bring visiting species to the U.S. West Coast which outnumber the breeding species. Commonly observed visiting species in summer include the sooty shearwater, Northern fulmar, and black-footed albatross (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 in Mexico and southern California move northward, including the brown pelican and storm-petrel. 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 U.S. West Coast. Seabird abundance during this time is generally low (Tyler et al. 1993).

Seabird Management

NOAA Fisheries is responsible for managing marine ecosystems; this mandate includes 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 and regulations, in addition to NOAA policies, that govern seabird bycatch in commercial fisheries:

- The Migratory Bird Treaty Act (MBTA).
- The Endangered Species Act (ESA).
- The 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.
- The Magnuson–Stevens Fishery Conservation and Management Act.
- The National Environmental Policy Act.
- The Fish and Wildlife Coordination Act.
- The National Marine Sanctuaries Act.
- USFWS's List of Birds of Conservation Concern (USFWS 2008).

The MBTA, passed in 1918, affirms and implements the U.S.'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 U.S. coastal waters extending three miles from shore, and violations carry criminal penalties.

The purpose of the ESA, passed in 1973, is to protect and recover imperiled species and the ecosystems upon which they depend. Currently, there are over 1,400 U.S. species listed as threatened or endangered under the ESA. The ESA offers seabirds additional protective measures beyond the MBTA. 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 U.S., including the short-tailed albatross, which is found along the U.S. West Coast and overlaps and interacts with U.S. West Coast groundfish fisheries.

U.S. West Coast Fisheries Management

Fishery Descriptions

The U.S. West Coast groundfish fishery is a multispecies fishery that utilizes a variety of gear types (Appendix E). 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 state (0–4.8 km offshore) and federal waters (4.8 km to the EEZ). Groundfish are both targeted and caught incidentally by trawl nets, hook-and-line gears, and fish pots. Under the FMP, the groundfish fishery comprises four management components:

- Limited Entry (LE): Encompasses all commercial fisheries that 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.
- Open Access (OA): 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.
- Recreational: Includes recreational anglers who target or incidentally catch groundfish species. This report does not cover estimates of seabird bycatch in recreational fisheries.
- Tribal: Includes native tribal commercial fishers in Washington State who have treaty rights to groundfish. This report does not include estimates of seabird bycatch from tribal fisheries.

The LE and OA components can be further subdivided into sectors based on gear type, target species, permits, and other regulatory factors. A description of each fishery sector, permits, gears, target species, vessel length, fishing depths and management is given in Appendix E. In 2011, the LE bottom trawl sector of the U.S. 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 (16 U.S.C. 1802(23)). The implementation of the IFQ management program in 2011 resulted in a mandate that vessels must carry NOAA Fisheries 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, both bottom and midwater trawl, as well as hook-and-line and pot gears, are allowed under this permit.

NWFSC Groundfish Observer Program

The Northwest Fisheries Science Center's Groundfish Observer Program places at-sea observers on commercial vessels in sectors that target or take groundfish as bycatch in the U.S. West Coast EEZ. At-sea observers provide 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). WCGOP and A-SHOP observe distinct sectors of the groundfish fishery.

A-SHOP observes the fishery that catches and delivers Pacific hake (a.k.a. Pacific whiting, henceforth referred to as hake) at sea, including nontribal catcher–processor and mothership vessels. A-SHOP has conducted observations of the U.S. West Coast at-sea hake fishery since 2001. Prior to 2001, observer coverage of this fishery was conducted by the North Pacific Groundfish Observer Program. Current 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 onboard 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 30–60% 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.

WCGOP was established in May 2001 by NOAA Fisheries in accordance with the Pacific Coast Groundfish Fishery Management Plan (USOFR 2001). This regulation requires all vessels that catch groundfish in the U.S. EEZ (from 4.8 to 322 km offshore) to carry an observer when notified to do so by NOAA Fisheries or its designated agent. Subsequent state rule-making has extended NOAA Fisheries's ability to require vessels fishing in the state territorial zone (0–4.8 km) to carry observers as well.

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 U.S. West Coast. WCGOP observes multiple federal groundfish fisheries, including the IFQ shoreside delivery of groundfish and Pacific hake and LE and OA fixed gear. 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.

Like 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, so the amount of observer coverage varies among sectors and within sectors among years (Somers et al. 2018). In these sectors, permits are selected for observation by WCGOP using a random sampling design without replacement. First, 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, WCGOP aggregates locations along the U.S. 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. Of the fishery sectors, LE bottom trawl prior to the IFQ program (2002–10), LE sablefish fixed gear nonendorsed (nonprimary), OA fixed gear, Oregon and California nearshore, California halibut, and pink shrimp are selected for one- or two-month periods, which coincide with cumulative trip limit periods used in management. LE sablefish fixed

gear endorsed (primary) permits are selected for the entire sablefish season (1 April–31 October) 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, WCGOP attempts to observe all trips and sets that vessel makes during the coverage period.

The annual percentage of observer coverage in nonhake fishery sectors ranges from 0–30% (Somers et al. 2018), as defined by the proportion of fishery landings that are observed. Coverage varies among sectors based on priority. Higher-priority sectors, based in part on the amount of groundfish bycatch and U.S. federal mandates, receive the highest observer coverage (see Appendix B). A list of fishery 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 the 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 A-SHOP sampling methodology) and sample anywhere from 30–100% 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 any of the following occurs:

- Fishing gear catches any seabird, regardless of whether the individual lives or dies.
- A seabird interacts with the fishing vessel but is 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 1). 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 (e.g., hull, mast, rigging, 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 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 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 bird(s) 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 U.S.C. 1532). We identified any ESA-listed seabird species (Table 1) 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 any 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 nonlethal and were excluded from mortality estimations.

For ESA-listed seabirds, observers are instructed to collect and freeze the carcass of any dead bird(s) and transfer them to USFWS. Regulations also require observers to care for any injured short-tailed albatross brought on board until USFWS takes possession. 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. In some cases, observers witness seabird interactions that occur outside of the sampled catch (e.g., are informed of an interaction by the crew, observe an interaction while on deck, a bird strikes vessel or rigging, etc.). Observers record these nonrandom, opportunistic observations of seabird takes whenever they occur. Opportunistic data are excluded from bycatch expansion because they are not randomly sampled. However, opportunistic takes are included in the bycatch estimate by simply adding the number of opportunistic takes to the expanded take estimate. Tables in Appendix B present both the randomly sampled and opportunistically sampled seabird takes by year, fishery sector, and gear type. Figure D-1 in Appendix D presents opportunistic takes as a proportion of all takes 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. Fleetwide 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 (±95% confidence intervals).

Even though ratio estimators have been widely used in discard estimation (Stratoudakis et al. 1999, Borges et al. 2005, Walmsley, Leslie, and Sauer 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 (Rochet and Trenkel 2005, Carretta and Moore 2014, Martin et al. 2015). 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 fleetwide bycatch of protected species (Carretta and Moore 2014, Martin et al. 2015).

As noted above, seabird bycatch can occur by a variety of means. 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 2018). Because albatross are one of the most threatened groups of seabirds and the most frequently caught group along the U.S. West Coast (Table 2, Figure 1), we present results for the three albatross species combined and compare those results with patterns of bycatch for nonalbatross birds combined.

Table 2. Estimated mean seabird mortality in U.S. West Coast groundfish fisheries for all sectors and gears, 2010–16. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002–09 can be found in Table A-1. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2010		2011		2012		2013		2014		2015		2016	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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
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, unidentified	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	29.33	19.7–42	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
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
Storm-petrel, unidentified	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
Tubenose, unidentified	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
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
Brandt's 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, unidentified	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
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
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, unidentified	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
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
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, unidentified	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
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
Alcid, unidentified	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
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
Bird, unidentified	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

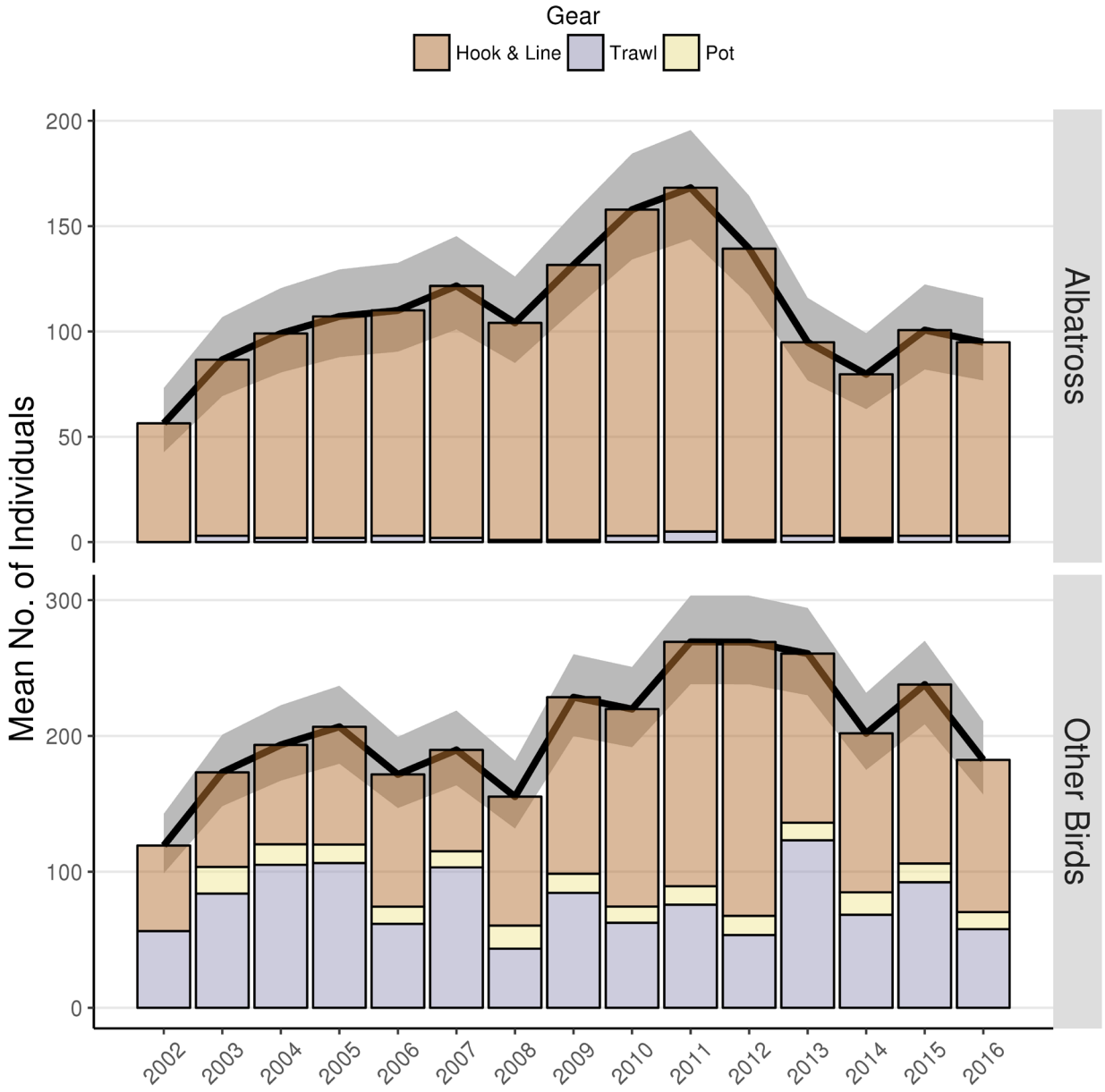

Figure 1. Total estimated mean seabird mortality (black line = number of individuals, gray ribbon = 95% confidence interval) for all sectors, by gear type, observed by the NWFSC Groundfish Observer Program. Values are reported in Tables 2 and A-1.

Total Fishing Mortality

Total seabird mortality for all species across all fisheries is shown by year in Table 2. Estimates in Table 2 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 "LCI–UCI" (lower to upper 95% confidence intervals) in the adjacent columns of Table 2, and as a gray ribbon around the lines in Figure 1. Details of the confidence interval calculations can be found under Methods.

Black-footed albatross (BFAL) are the single most-frequently caught species (Table 2). 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 BFAL killed (LCI = 90.41, UCI = 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 2002–16.

Seabird Bycatch in Hook-and-Line Fisheries

Groundfish fisheries using hook-and-line gear on the U.S. West Coast account for the majority of seabird bycatch among U.S. 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 1. 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 nonalbatross mortality (Figure 1). Nonalbatross seabirds also show a similar increase, from about 60 nonalbatross birds killed in 2002 to about 210 nonalbatross seabirds killed in 2012. Nonalbatross bird deaths decline from roughly 210 in 2012 to about 125 in 2013, and hover between 125 to 150 birds per year in 2013–16. After black-footed albatross, annual bird bycatch on hook-and-line vessels largely comprised, in decreasing order, shearwaters, gulls, and cormorants (Tables 3, A-2). 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.

Observed bycatch rates in hook-and-line fisheries are shown in Figure 5. These rates are calculated from the observed vessels and are not extrapolated to the fleet. Hook-and-line vessels fishing on the U.S. West Coast are not required to maintain or submit logbooks, and therefore hook counts for these fleets are not available. The international standard for reporting seabird bycatch on hook-and-line vessels is dead birds per 1,000 hooks. To be able to compare 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 fleetwide 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 fleetwide estimate.

Table 3. Estimated mean seabird mortality in U.S. West Coast groundfish fishery sectors, 2010–16, for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002–09 can be found in Table A-2. Key: *LCI*/*UCI* = lower/upper 95% confidence interval.

	2010		2011		2012		2013		2014		2015		2016	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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
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
Brandt's 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, unidentified	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
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
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, unidentified	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
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
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, unidentified	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
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
Bird, unidentified	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

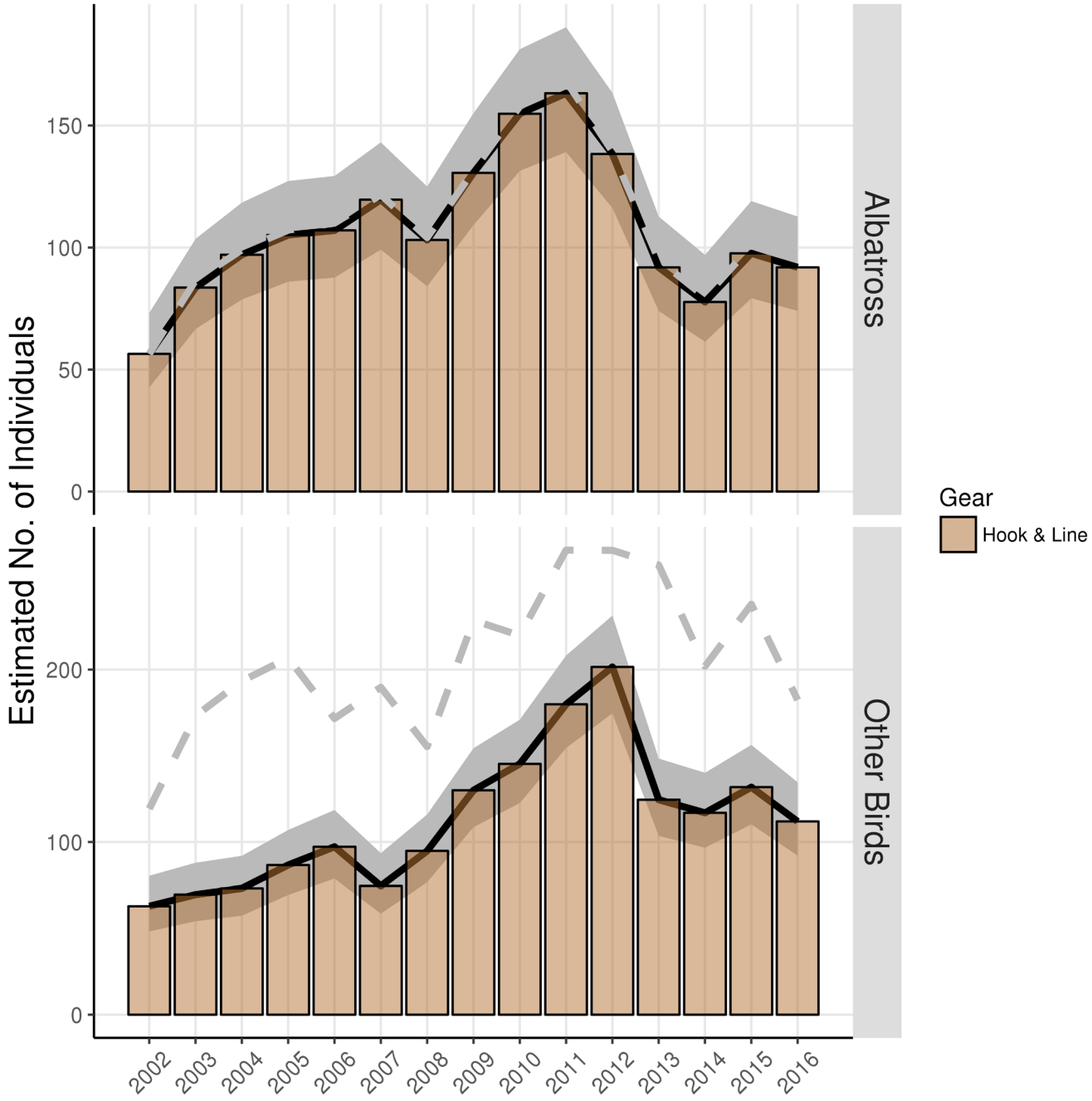

Figure 2. Total estimated mean seabird mortality from vessels using hook-and-line gear observed by the NWFSC Groundfish Observer Program. Dashed gray lines represent total bird mortality from all gear types and are the same as those shown in Figure 1. Solid black lines represent mortality from hook-and-line gears. Tables 3 and A-2 report the values plotted here.

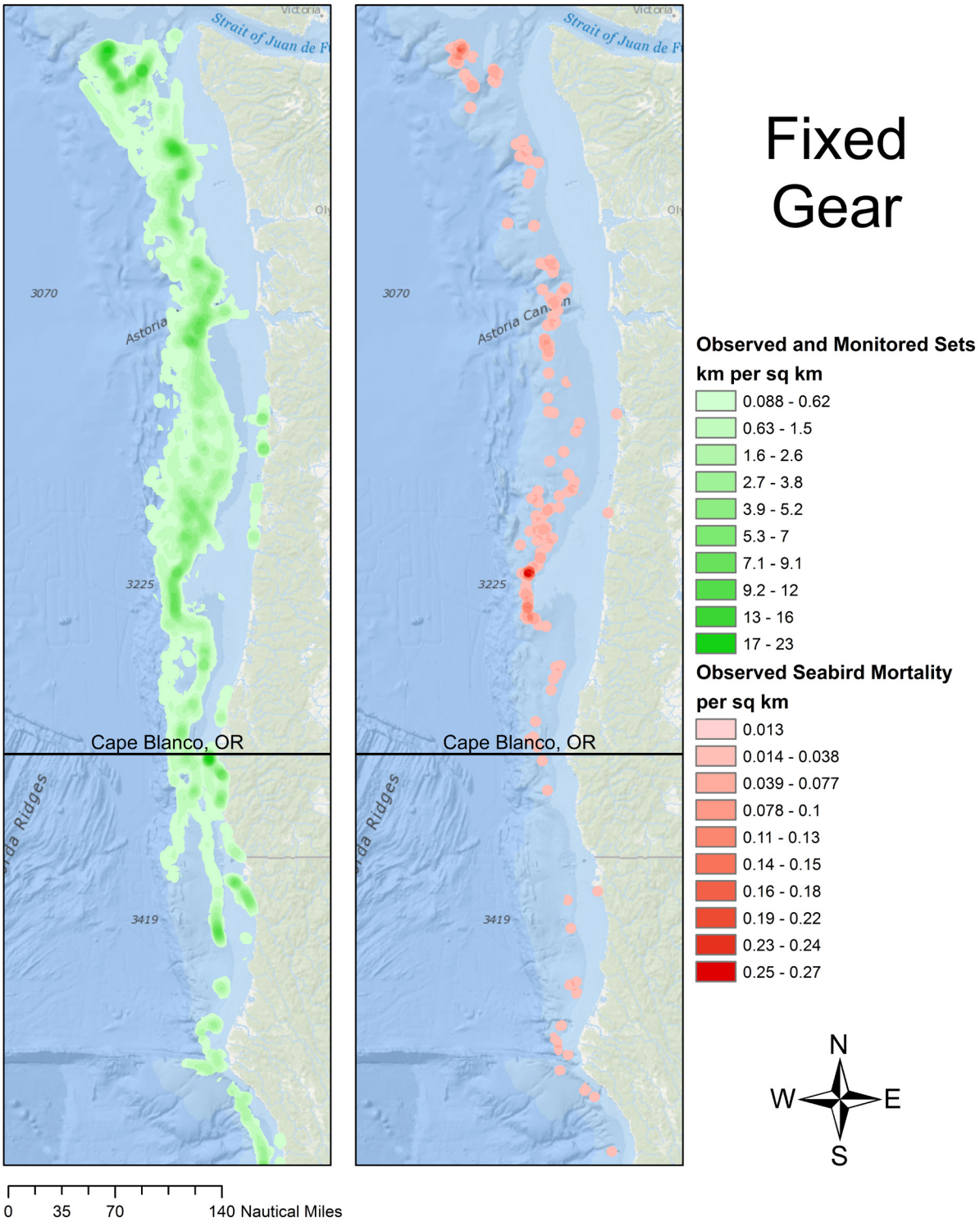

Figure 3. Spatial distribution of seabird bycatch (mt/km^2) observed by NWFSC Observer Programs (2002–16) and the PSMFC Electronic Monitoring Program (2015–16) on fixed gear vessels (hook-and-line and pot) off the coasts of Washington, Oregon, and northern California. The ten catch classifications were defined by excluding any zero values and then applying the Jenks natural breaks classification method. Cells (200 km^2) with less than three vessels were omitted from the map to maintain confidentiality.

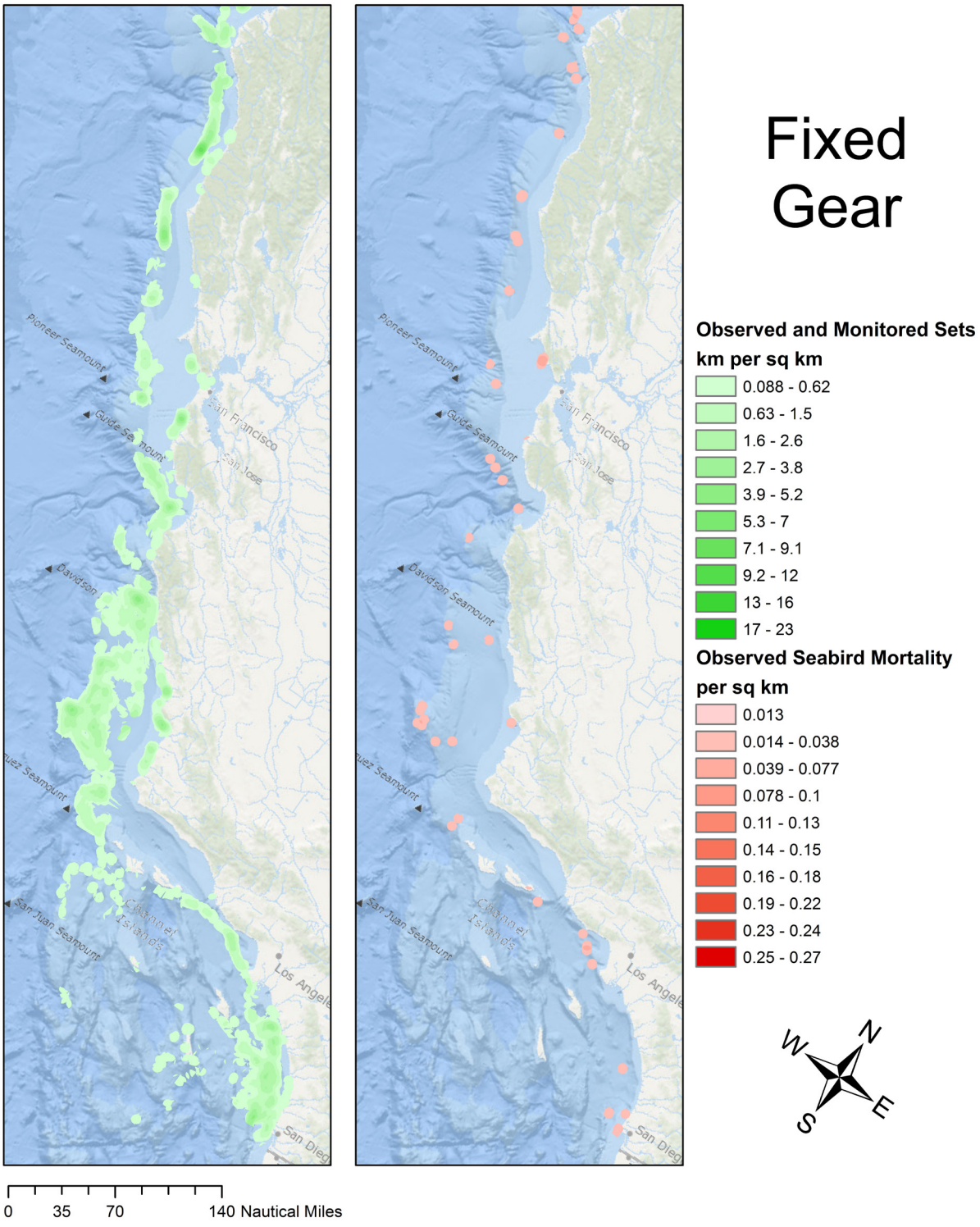

Figure 4. Spatial distribution of seabird bycatch (mt/km^2) observed by NWFSC Observer Programs (2002–16) and the PSMFC Electronic Monitoring Program (2015–16) on fixed gear vessels (hook-and-line and pot) off the southern coast of California. The ten catch classifications were defined by excluding any zero values and then applying the Jenks natural breaks classification method. Cells (200 km^2) with less than three vessels were omitted from the map to maintain confidentiality.

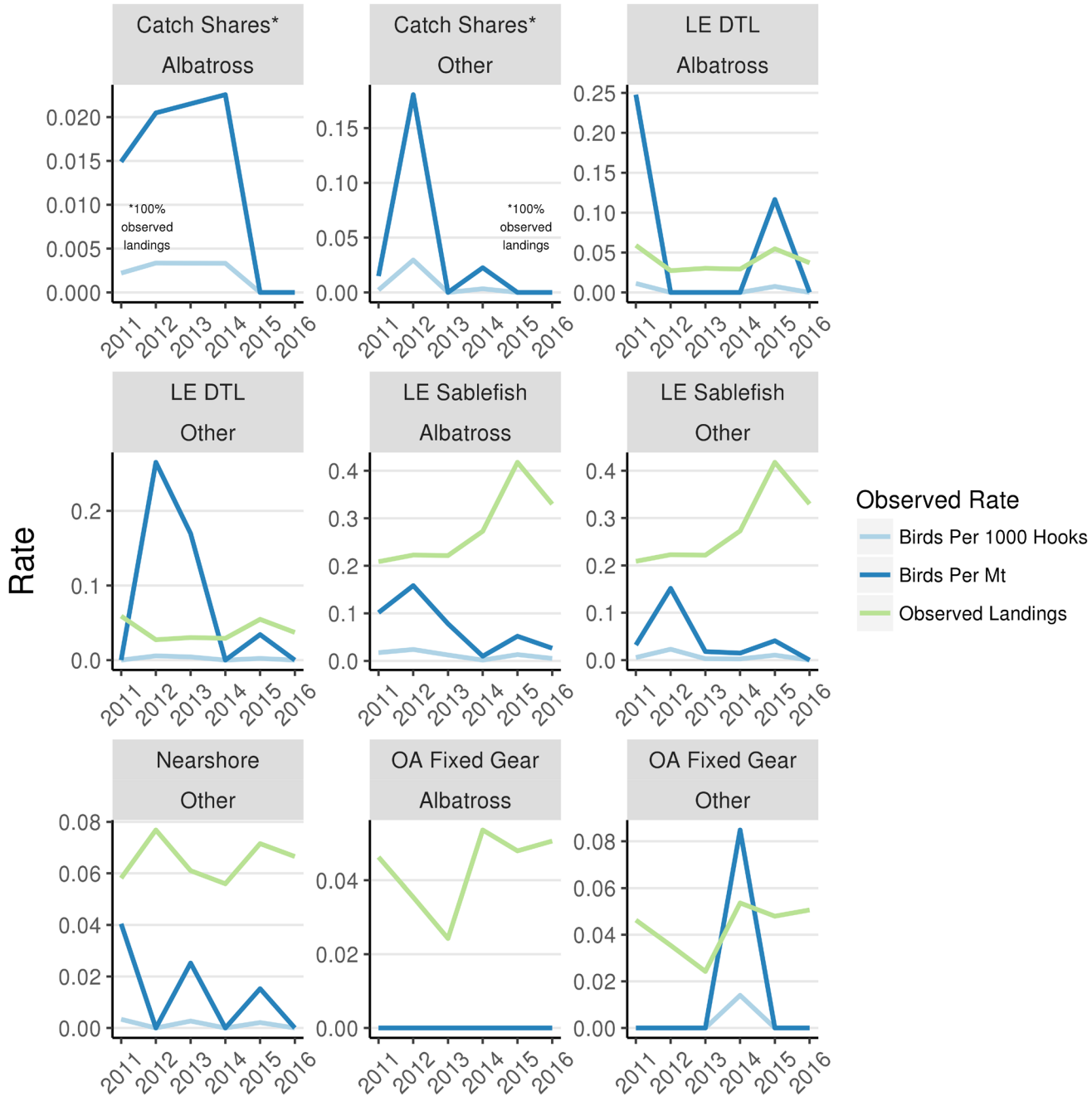

Figure 5. Albatross and other birds' observed bycatch rates, as either number of observed birds per 1,000 hooks or per metric ton of landed fish, from hook-and-line vessels observed by the NWFSC Groundfish Observer Program. Birds per 1,000 hooks is the international standard for reporting seabird bycatch. Caution is necessary in interpreting observed birds per 1,000 hooks in this figure, because this is the observed hook rate. Key: *LE* = limited entry, *DTL* = daily trip limits, *OA* = open access.

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 from April to October.

Black-footed albatross were the main species caught in the LE sablefish fishery. Mean annual bycatch in this fishery over the 15-year period was 74 BFAL (LCI = 58.11, UCI = 92.90; Tables 4, A-3). A single ESA-endangered short-tailed albatross was taken in the LE sablefish endorsed fishery in 2011 (Table 4), the only such take of this species observed in any U.S. 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, giving an estimate of 2.51 Laysan killed (LCI = 0.4, UCI = 8.0) in 2012 by this fishery.

Nonalbatross species comprise a small amount of LE sablefish bird bycatch, mostly dominated by western and unidentified gulls and, more recently, northern fulmars and shearwaters. A total of 16 albatross and nonalbatross species or taxa have been observed as bycatch in the LE sablefish fishery over the 15-year period.

Limited Entry Daily Trip Limits

Limited entry daily trip limits (LE 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. They catch and land sablefish and other groundfish up to the daily trip limits for these species. Catch is delivered to shore-based processors or sold alive.

Unidentified shearwaters top the list of species that are caught in the LE DTL fishery, followed by black-footed albatross, unidentified gulls, sooty shearwaters, brown pelicans, western gulls, unidentified cormorants, double-crested cormorants, and pink-footed shearwaters (Tables 5, A-4).

Open Access Fixed Gears

Open access 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 6, A-5).

Catch Share 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 7). This fishery has observers present on 100% of trips.

Table 4. Estimated mean seabird mortality in the U.S. West Coast limited entry sablefish fishery, 2010–16, for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002–09 can be found in Table A-3. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2010		2011		2012		2013		2014		2015		2016	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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
Cormorant, unidentified	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
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
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, unidentified	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
Alcid, unidentified	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
Bird, unidentified	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

Table 5. Estimated mean seabird mortality in the U.S. West Coast limited entry daily trip limits fishery, 2010–16, for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002–09 can be found in Table A-4. Key: *LCI*/*UCI* = lower/upper 95% confidence interval.

	2010		2011		2012		2013		2014		2015		2016	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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
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
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, unidentified	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, unidentified	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

Table 6. Estimated mean seabird mortality in the U.S. West Coast open access fixed gear fishery, 2010–16, for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002–09 can be found in Table A-5. Key: *LCI*/*UCI* = lower/upper 95% confidence interval.

	2010		2011		2012		2013		2014		2015		2016	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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

Table 7. Seabird mortality in the U.S. West Coast catch share fishery, 2011–16, for vessels fishing with hook-and-line gears. Numbers include both randomly and opportunistically sampled birds (see text for full explanation.)

Species	2011	2012	2013	2014	2015	2016
Black-footed albatross	6	5	0	3	0	0
Northern fulmar	0	0	0	3	0	0
Mew gull	1	0	0	0	0	0
Western gull	4	42	0	0	0	0
Gull, unidentified	2	2	0	0	0	0

Nearshore

Nearshore fixed gear vessels use a variety of hook-and-line gear, including longline, fishing poles, stick gear, etc., and target 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. Data from nearshore pot vessels are combined with data from other pot fisheries and presented under Seabird Bycatch in Pot Gear Fisheries (and in Table B-19). Catch is delivered to shore-based processors or sold live. Washington does not allow commercial nearshore fixed gear fishing.

Historically, WCGOP has split the fishery by state, but combined hook-and-line and pot gears within states (Jannot et al. 2011, Somers et al. 2018). However, our work here shows that seabird mortality risk from hook-and-line is much greater than from pot gears (Tables 3, 15). 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. The Oregon nearshore fishery has only ever caught common murres, unidentified cormorants, and unidentified birds (Tables 8, A-6). In the California nearshore fishery, common murres, cormorants (Brandt's, double-crested, and unidentified), western gulls, and common loons have all been observed as bycatch.

Seabird Bycatch in Trawl Fisheries

Early estimates indicated that potentially up to 45% of 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 in the air or on the water that collide with trawl transponder or warp cables often go unwitnessed by fishery observers and 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). Seabird cable strikes have been documented on midwater trawl nets fishing for hake in the U.S. West Coast (Washington and Oregon) at-sea hake catcher–processor fleet (J. Jannot, unpublished data), as well as in similar trawl fisheries around the globe (Williams and Capdeville 1996, Melvin et al. 2011, Parker et al. 2013, Tamini et al. 2015).

Table 8. Estimated mean seabird mortality in the U.S. West Coast nearshore fishery, 2010–16, for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002–09 can be found in Table A-6. Key: *LCI/UCI* = lower/upper 95% confidence interval.

		2010		2011		2012		2013		2014		2015		2016	
State	**Species**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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	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	Brandt's 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	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	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

Table 9. Estimated mean seabird mortality in the U.S. West Coast fishery for vessels fishing with trawl gears, 2010–16. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002–09 can be found in Table A-7. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2010		2011		2012		2013		2014		2015		2016	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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
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, unidentified	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	25.00	16.2–36.9	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
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
Storm-petrel, unidentified	0.68	0–5	0.00	0	0.00	0	1.04	0–5.6	0.00	0	0.00	0	0.00	0
Tubenose, unidentified	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
Brandt's 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, unidentified	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
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

Table 9 (continued). Estimated mean seabird mortality in the U.S. West Coast fishery for vessels fishing with trawl gears, 2010–16. Estimates for 2002–09 can be found in Table A-7.

	2010		2011		2012		2013		2014		2015		2016	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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
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, unidentified	0.00	0	0.00	0	1.07	0–5.7	0.00	0	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
Alcid, unidentified	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
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, unidentified	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

Table 10. Seabird mortality in U.S. West Coast at-sea hake catcher–processor vessels fishing with midwater trawl gear, 2010–16, for vessels fishing with hook-and-line gears. Numbers include both randomly and opportunistically sampled birds (see text for full explanation). Numbers for 2002–09 can be found in Table A-8.

Species	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Black-footed albatross	3	5	1	2	1	1	2
Sooty shearwater	0	0	0	1	0	0	0
Shearwater, unidentified	0	0	0	3	0	0	2
Northern fulmar	17	25	2	52	2	12	9
Leach's storm-petrel	0	0	0	2	0	2	2
Tubenose, unidentified	0	4	0	0	0	0	0
Arctic herring gull	0	0	0	4	0	0	0
Gull, unidentified	0	8	0	1	0	4	4
Common murre	2	0	0	0	0	0	0
Cassin's auklet	0	0	0	2	0	0	0
Alcid, unidentified	0	0	0	0	0	0	0
Bird, unidentified	0	0	0	1	1	0	0

Table 11. Seabird mortality in U.S. West Coast at-sea hake catcher vessels fishing with midwater trawl gear and delivering to motherships, 2010–16. Numbers include both randomly and opportunistically sampled birds (see text for full explanation). Numbers for 2002–09 can be found in Table A-9.

Species	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
Northern fulmar	0	0	2	0	0	0	0
Common murre	0	0	0	0	0	2	0
Cassin's auklet	0	0	0	0	2	0	1
Bird, unidentified	0	0	0	0	0	0	0

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 9, A-7). A smaller number of individuals from 18 other species or taxa were observed in these trawl fisheries over the 15-year period. 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 6, Table A-7). However, preliminary data from the at-sea hake fishery indicate that black-footed albatross frequently strike the transponder cable used in this fishery (Jannot, unpublished). Therefore, mortalities of albatross reported here are likely an underestimate, because these species might be more susceptible to cryptic mortality from cable strikes.

At-sea Hake Fisheries

The at-sea hake fishery comprises 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 Pacific hake and deliver unsorted catch to motherships for processing at sea. The catch is sorted and processed aboard the mothership. At-sea tribal catcher vessels use midwater trawl nets to catch Pacific hake and deliver unsorted catch to Native American tribal motherships for processing at sea. The tribes must operate within defined boundaries in waters off northwest Washington. Seabird bycatch from at-sea tribal fisheries is not included in this report.

Black-footed albatross was the only species observed taken on at-sea catcher–processor vessels, with between one and five BFALs recorded during 2010–16 (Table 10). The most frequently caught nonalbatross species on these vessels were northern fulmars and gulls (Tables 10, A-8). Very rarely, one to a few individuals of nine other taxa were observed taken annually on at-sea catcher–processor vessels.

Albatross have not been observed taken on hake catcher vessels delivering to motherships at sea (Tables 11, A-9). 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.

Limited Entry and Catch Share Trawl Fisheries

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

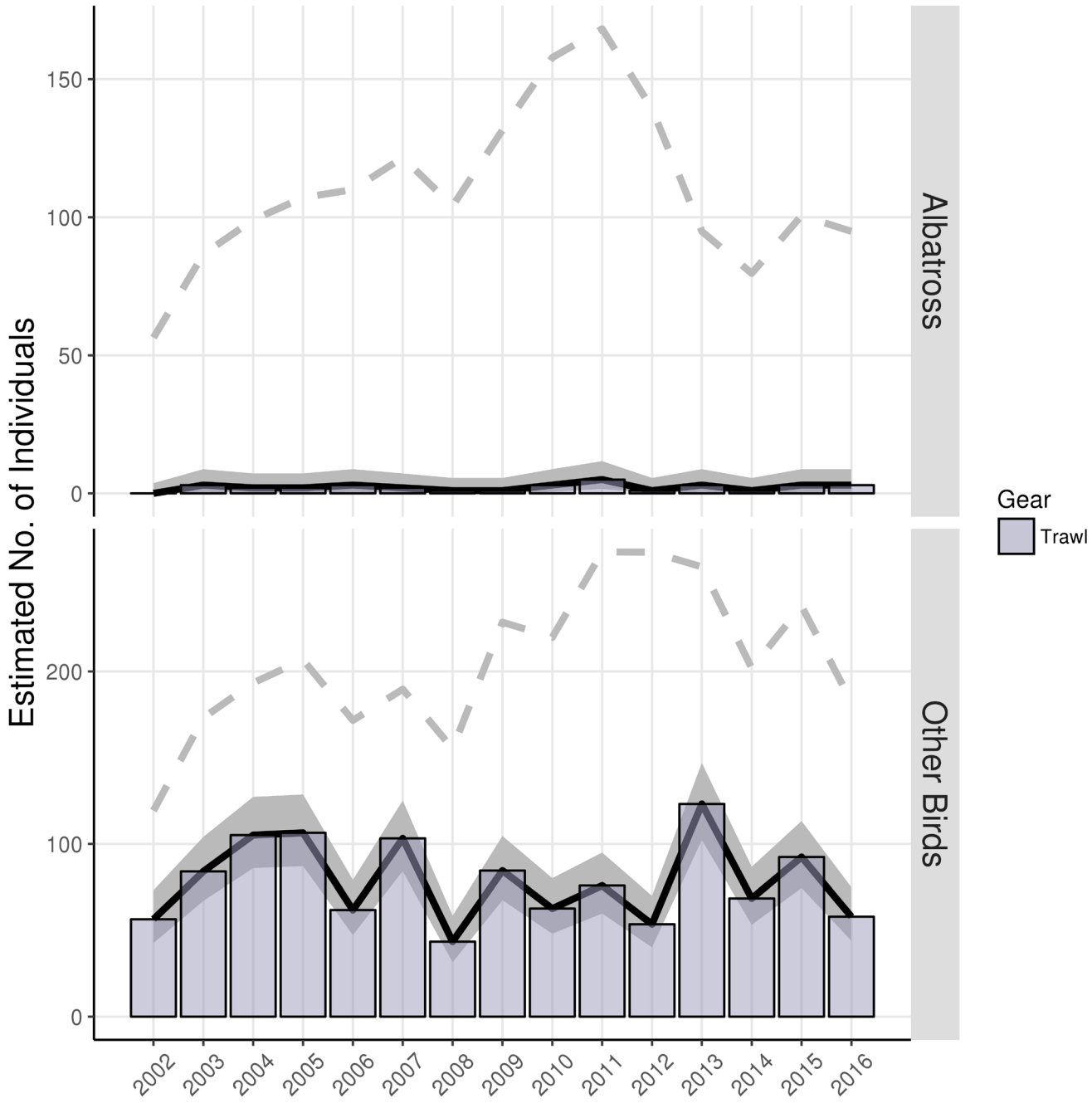

Figure 6. Total estimated mean seabird mortality from vessels using bottom, midwater, or shrimp trawl gear observed by the NWFSC Groundfish Observer Program. Dashed gray lines represent total bird mortality from all gear types and are the same as those shown in Figure 1. Solid black lines represent mortality from trawl gears. Values are reported in Tables 9 and A-7.

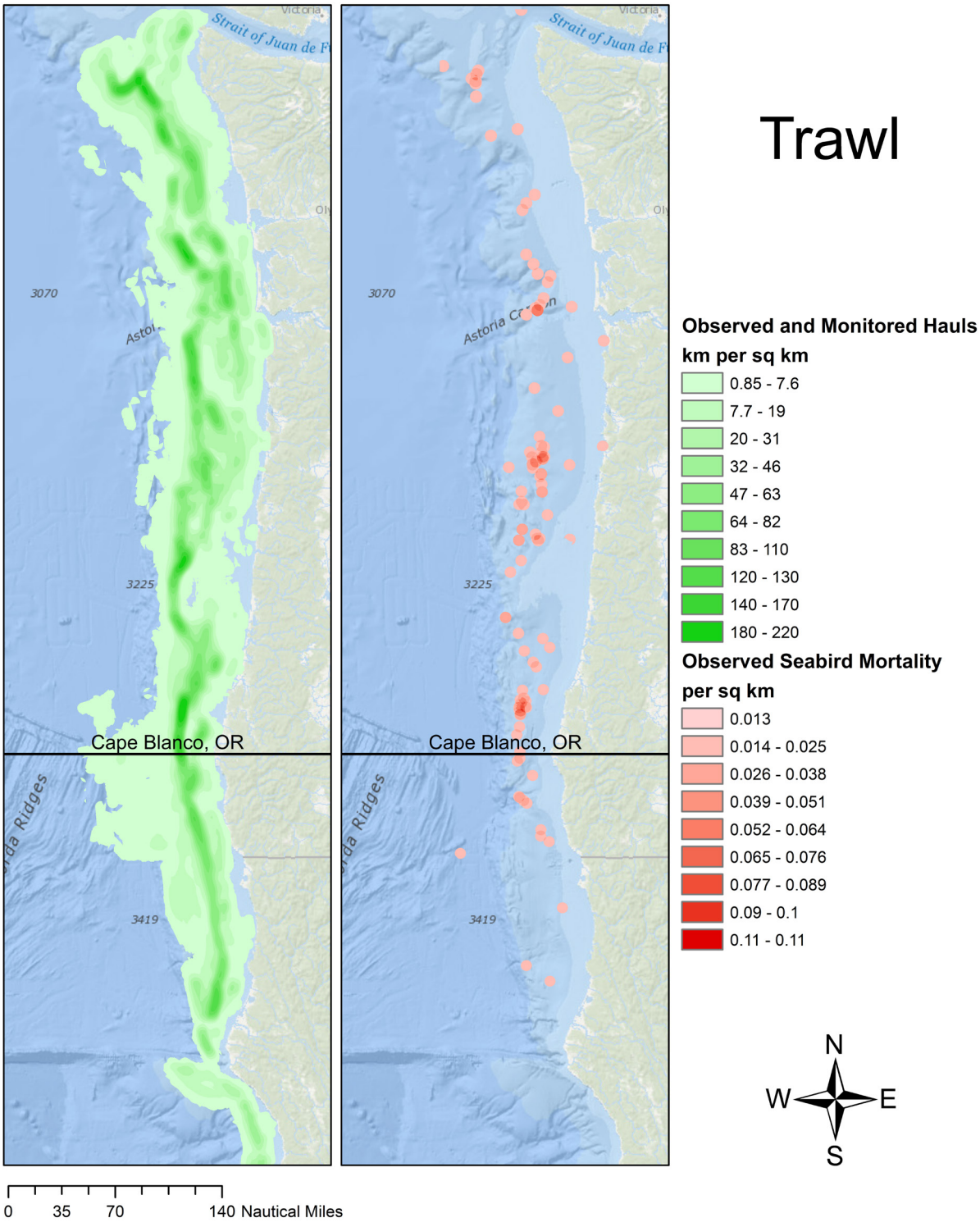

Figure 7. Spatial distribution of seabird bycatch (mt/km^2) observed by the NWFSC Observer Program (2002–16) and the PSMFC Electronic Monitoring Program (2015–16) on bottom, midwater, and shrimp trawl vessels along the Washington, Oregon, and Northern California coasts. The nine catch classifications were defined by excluding any zero values and then applying the Jenks natural breaks classification method. Cells (200 km^2) with less than three vessels were omitted from the map to maintain confidentiality.

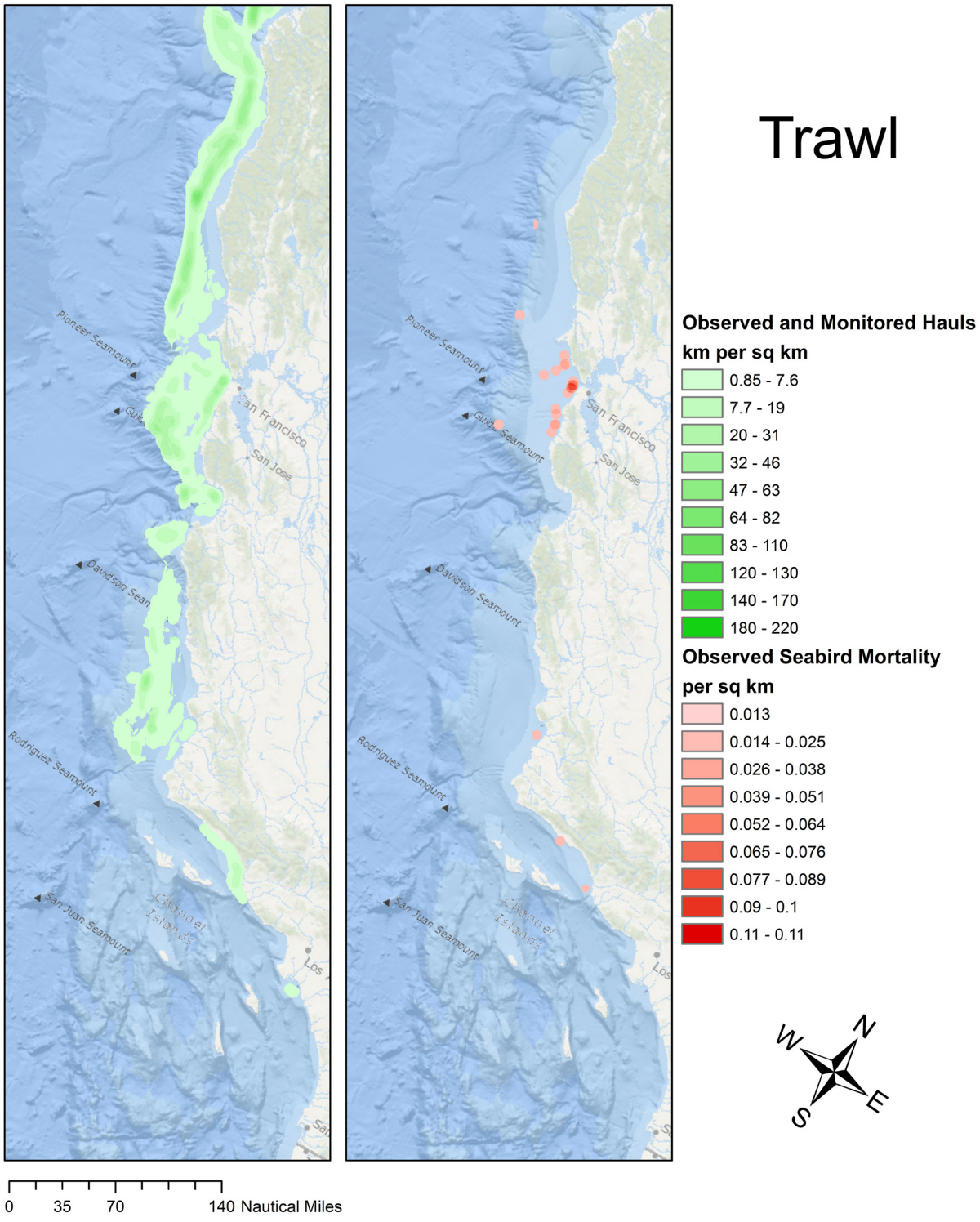

Figure 8. Spatial distribution of seabird bycatch (mt/km^2) observed by the NWFSC Observer Program (2002–16) and the PSMFC Electronic Monitoring Program (2015–16) on bottom, midwater, and shrimp trawl vessels along the Southern California coast. The nine catch classifications were defined by excluding any zero values and then applying the Jenks natural breaks classification method. Cells (200 km^2) with less than three vessels were omitted from the map to maintain confidentiality.

Some catch share vessels use midwater trawl nets to target midwater nonhake species, typically rockfish. Vessels must possess IFQ for all landed/discarded IFQ species. Landings of Pacific hake from these vessels are <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 was included with the catch share trawl estimates shown here.

Both black-footed and Laysan albatross mortalities have been observed on limited entry and catch share 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 share program; and one Laysan albatross was killed in 2013 under catch share management (Tables 12, A-10). The most frequently caught nonalbatross species on these vessels were Leach's and unidentified storm-petrels, followed by, in decreasing numbers, northern fulmars, unidentified murres, Cassin's auklets, and gulls.

California Halibut Fisheries

Limited entry 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 share trawl estimates (Table 12). 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 values to maintain confidentiality.

Albatross have not been observed as bycatch in California halibut fisheries (Tables 13, A-11, A-12). Common murres were by far the most frequently caught species in both the LE and OA California halibut fisheries, followed by unidentified and Brandt's cormorants.

Table 12. Seabird mortality in the U.S. West Coast catch share fishery, 2011–16, for vessels fishing with trawl gears. Numbers include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2002–10 can be found in Table A-10.

Species	2011	2012	2013	2014	2015	2016
Black-footed albatross	0	0	0	0	2	1
Laysan albatross	0	0	1	0	0	0
Sooty shearwater	0	0	2	0	0	0
Northern fulmar	0	1	0	0	0	0
Leach's storm-petrel	0	0	0	0	0	3
Storm-petrel, unidentified	0	0	1	0	0	0
California gull	0	0	0	1	0	0
Murre, unidentified	0	1	0	0	0	0

Table 13. Estimated mean seabird mortality on U.S. West Coast open access (OA) California halibut vessels fishing with trawl gears, 2010–16. 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 2002–09 can be found in Table A-12. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2010		2011		2012		2013		2014		2015		2016	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
Brandt's 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, unidentified	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
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
Bird, unidentified	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 14. Estimated mean seabird mortality in U.S. West Coast open access (OA) pink shrimp vessels fishing with shrimp trawl gears, 2010–16. 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 2004–09 can be found in Table A-13. Key: *LCI/UCI* = lower/upper 95% confidence interval.

		2010		2011		2012		2013		2014		2015		2016	
State	**Species**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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, unidentified	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

Table 15. Estimated mean seabird mortality in U.S. West Coast pot fisheries, 2010–16. Estimates include both randomly and opportunistically sampled birds (see text for full explanation). Estimates for 2004–09 can be found in Table A-14. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2010		2011		2012		2013		2014		2015		2016	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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
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
Storm-petrel, unidentified	0.00	0	0.00	0	0.00	0	1.00	0–5.6	0.00	0	0.00	0	0.00	0
Brandt's 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, unidentified	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

Open Access Pink Shrimp Fisheries

Each of the three U.S. 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 U.S. West Coast pink shrimp fisheries (Tables 14, A-13). 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.

Seabird Bycatch in Pot Gear Fisheries

Very few birds have been observed in U.S. 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. To date, seabird mortalities have been observed on vessels fishing with pot gear in catch share, limited entry sablefish, and Oregon and California nearshore fisheries (Tables 15, A-14).

Seabird Bycatch Mitigation and Avoidance

In response to the 2012 USFWS biological opinion regarding short-tailed albatross interactions with U.S. West Coast groundfish fisheries, PFMC and NOAA implemented a regulation requiring the use of streamer lines on nontribal longline vessels in December 2015 (USOFR 2015). This rule requires:

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

As a result of these regulations, NOAA Fisheries's West Coast Region has asked 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. WCGOP began systematic collection of data regarding these voluntary measures in 2009. Figure 9 presents data from all vessels, regardless of size, and from all years for which WCGOP has collected data.

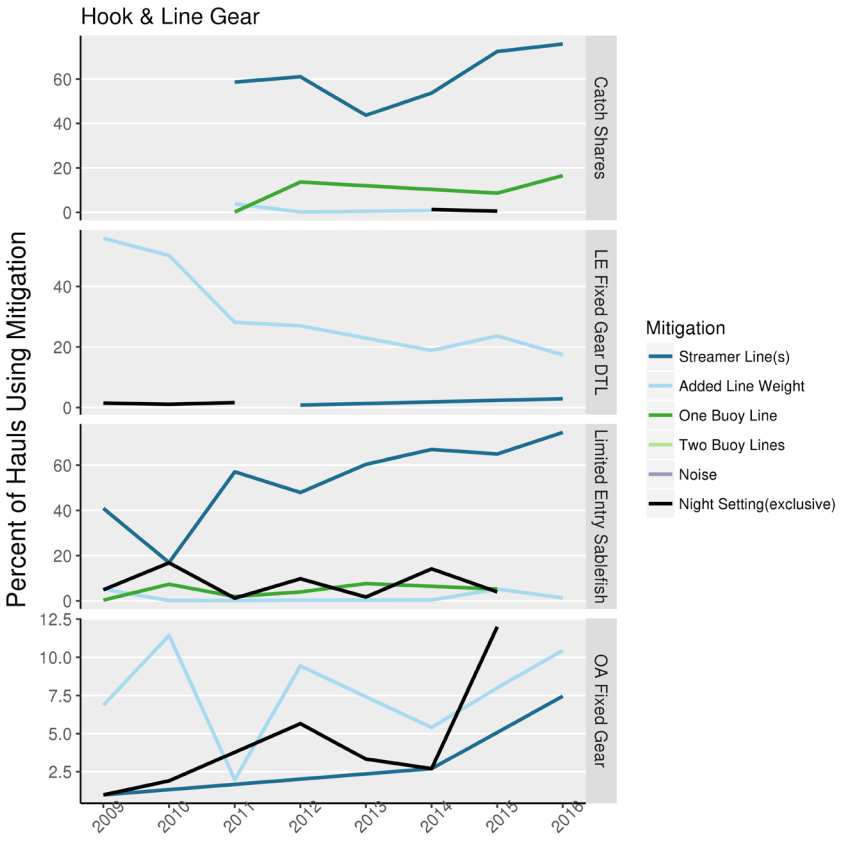

Figure 9. Percentage of observed hauls by seabird mitigation type and year, 2009–16. More than one type could be used on a single haul. Data on seabird mitigation type were not collected prior to 2009. Only vessels using hook-and-line gear are shown. Vessels over 55 ft in length using hook-and-line gear were required to use streamer lines starting in 2015.

Seabird Nonlethal 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 contact with the vessel, gear, catch, or vessel discharge (e.g., offal, discards, vessel trash, etc.) by any bird. This definition excludes sightings of seabirds that do not interact with the vessel in any manner. Documenting sightings of ESA-listed species is a higher priority than recording sightings of nonlisted species. See Table 1 for the number of recorded sightings for each species for all years combined.

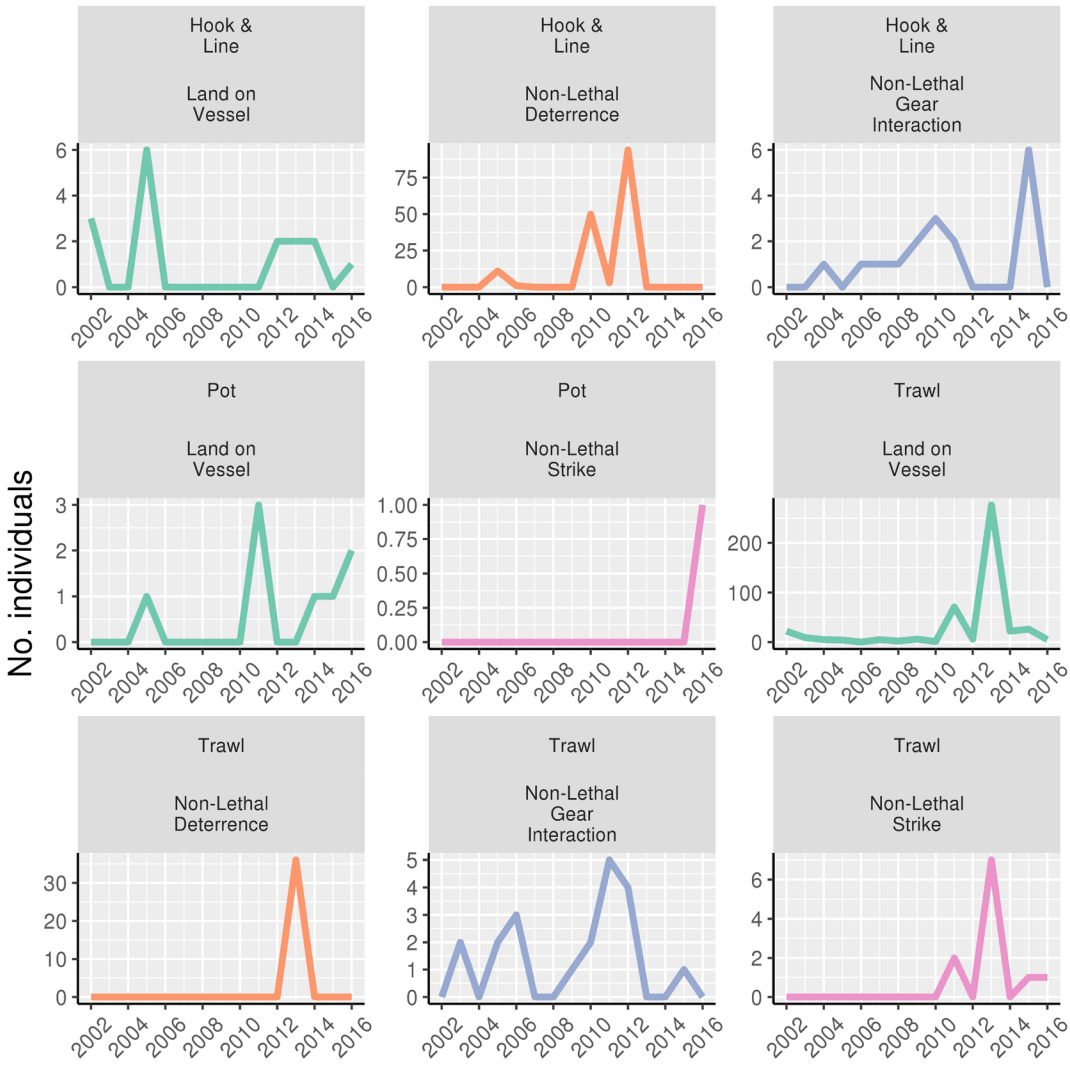

Figure 10. Observed number of nonlethal, nonfeeding seabird interactions by year, gear type, and nonlethal interaction type. Feeding interactions are shown in Figure 11.

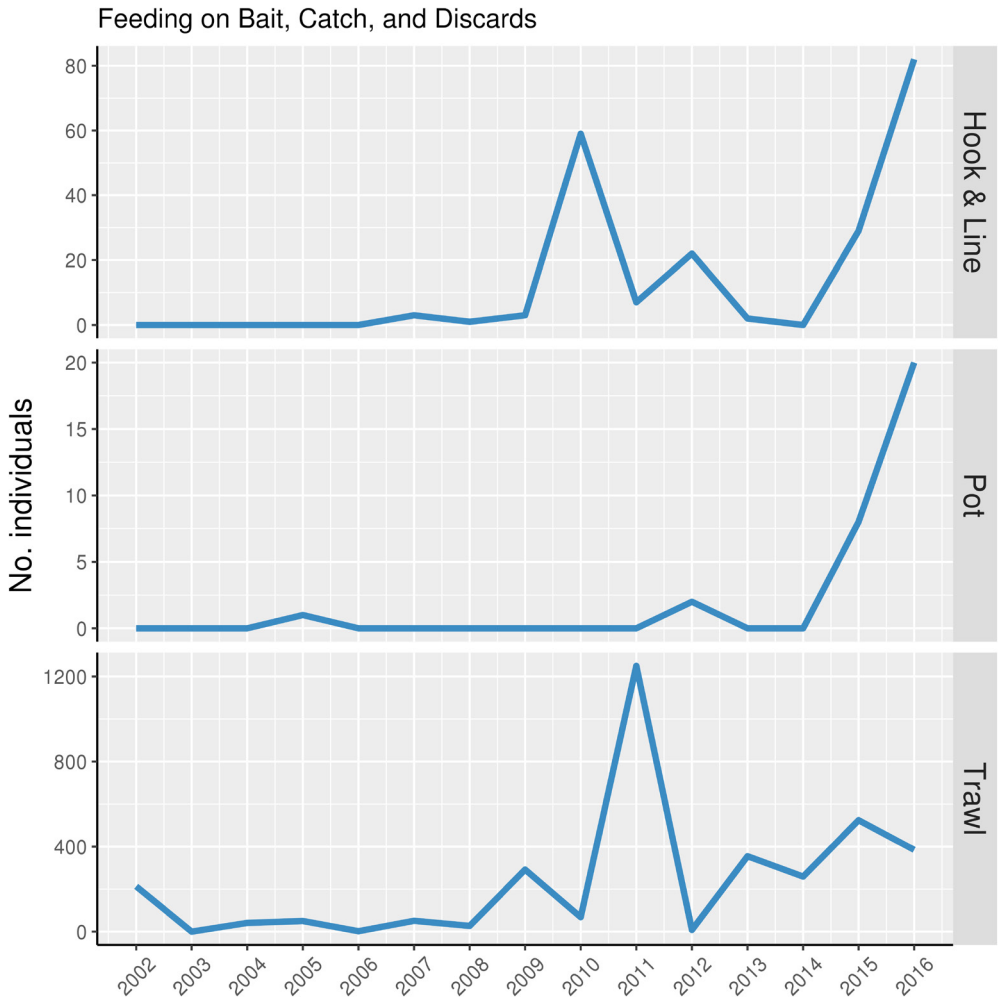

Figure 11. Observed number of seabirds feeding on bait, catch, and discards, by year and gear type.

Methods

Data Sources

Data sources for this analysis include onboard observer data (from A-SHOP and WCGOP), landing receipt data (referred to as fish tickets, obtained from PacFIN), and data generated from vessels carrying electronic monitoring equipment. Currently, only vessels in the IFQ sector fishing on an exempted fishing permit (EFP) carry EM equipment. PSMFC 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 B, Tables B-39 and B-40.

A list of fisheries, coverage priorities, and data collection methods employed by WCGOP in each observed fishery can be found in the WCGOP manual (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 B.

WCGOP observers mainly sample the discarded portion of the catch of each haul. Trip-level fish landing receipts (fish tickets) are used to adjust observer estimates of retained catch, ensuring estimates of retained catch are accurate as described on the WCGOP Data Processing webpage;[2] this was conducted prior to the analyses presented in this report. Estimates of observer coverage and observed catch can be found in Appendix B.

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 tickets 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, and 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 D-1 and in further detail online.[3]

For all PacFIN, WCGOP, and A-SHOP data, we maintain confidentiality of persons and businesses, as required by the MSA, which was most recently reauthorized in 2007. NOAA Fisheries guidance recommends, and the 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" (N. Cyr, 2009 memorandum to NMFS on data aggregation and summarization guidelines).

Bycatch Estimation

For some of these fisheries, there is 100% observer coverage or electronic monitoring on every haul and trip. In these cases, we assume a complete census of seabirds on every haul. Seabird 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.

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

[2] https://www.nwfsc.noaa.gov/research/divisions/fram/observation/data_processing.cfm
[3] https://www.nwfsc.noaa.gov/research/divisions/fram/observation/pdf/PacFIN_processing_details_GM2016.pdf

1. Using a deterministic method employing ratio estimators.
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 to assess how historical estimates might have differed had they adopted the Bayesian method. We provide ratio estimator estimates of seabird mortality for the period 2002–15, and Bayesian estimates of seabird mortality for the period 2002–16.

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 2017b). Observer sampling focuses on discarded catch and supplements existing fish ticket 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 A-SHOP sampling methodology) and sample anywhere from 30–100% 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 explained on the WCGOP Data Processing webpage.[4]

Ratio estimators

The 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. 2018, Somers et al. 2018). 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, Oregon (lat 42°50'N; Bakun, McLain, and Mayo 1974, Barth, Pierce, and Smith 2000). Three seasonal strata were also defined to coincide with the seasonal trends in upwelling and seabird abundance:

1. Winter (January–April).
2. Summer (May–August).
3. Fall (September–December).

For comparisons with historical estimates, we maintain this stratification when applying the ratio estimators. We computed bycatch ratios by sector, year, area (north or south of Cape Blanco), and season (winter, summer, or fall). Post-stratification did not follow the sampling design,

[4] https://www.nwfsc.noaa.gov/research/divisions/fram/observation/data_processing.cfm

with potential, but unknown, consequences (Cochran 1977). 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 fleetwide level based on the total catch or landings from each sector. The only available proxy of total fishing effort in the nonhake 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 coastwide estimates of total seabird mortality.

Bayesian estimation

Despite being widely used in discard estimation (Stratoudakis et al. 1999, Borges et al. 2005, Walmsley, Leslie, and Sauer 2007), ratio estimators rely 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. Many seabirds are rarely encountered by the fisheries reported here, making it difficult to assess whether the number of bycatch events is indeed linked to levels of fishing effort for those species. 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. The Bayesian method is a model-based method intended to model the underlying process (in this case, Poisson) that results in seabird 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 we inferred annual expected mortality given a specified level of effort. Fleetwide bycatch of each seabird species was estimated for each sector and gear type using observer coverage data (Appendix B).

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, and
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 fleetwide 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 and 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 Bayesian 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 C). 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 fleetwide 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, it does not appear 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. The Bayesian method can incorporate covariates (i.e, appropriate spatial, temporal, and other factors) into the modeling process. Preliminary testing and analysis (not presented) suggest that covariates might only moderately improve our estimates. However, results of modeling with covariates are preliminary and this is an area for future research and improvements.

One limitation of this method is that the time series must be complete. The open access California halibut fishery was observed from 2003–05, but not in 2006. To create a complete series (2003–present), we used the average across 2004–08 to fill in the missing 2006 data. This method was employed just to create a complete series, and not as an attempt to estimate 2006 bycatch levels. Therefore, we do not report the bycatch estimates from 2006.

Sectors with 100% Observer Coverage

The at-sea hake fishery, observed by A-SHOP, and the catch share (IFQ) fishery, observed by WCGOP, both require 100% observers on every trip. Currently, in the catch share fishery, vessels that participate in the electronic monitoring program can 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 on trips for scientific data collection, 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 also collect any seabirds at this time if any are 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 are 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 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, and
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 formula

$$B = \sum_{t} Y_t \times \left(\frac{C_{total}}{c_{obs}} \right) \quad (3)$$

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, and
Y_t = total number of takes 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 fleetwide 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 nonrandom observations are excluded from bycatch expansion. All randomly and opportunistically sampled seabird data from A-SHOP fisheries are presented in Tables B-22 and B-23. The proportions of randomly to opportunistically sampled mortalities are provided in Figure D-1.

Shore-based IFQ sectors

Fleetwide seabird bycatch estimates for the shore-based IFQ sectors were derived from WCGOP observer data and fish ticket data (Figure F-1). 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 trips 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 lb of California halibut were 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 lat 40°10'N.

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. Since 2015, however, no limited entry California halibut tows have occurred.

Since 2011, all IFQ trips (100%) 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. We provide the methods for expanding this very small amount, below.

Infrequently, entire hauls, including species that would normally have been retained, are discarded at sea—either because of errors (e.g., the net rips before landing) 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 individuals of a species (B) when the entire haul or set was unsampled, the unsampled weight was multiplied by a ratio. The numerator of the ratio was the number of individuals of a species in the bycatch. The denominator was the weigt of all species, which was defined slightly differently depending on whether the haul was completely discarded at sea or the data failed quality control. Thus:

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

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, and
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 was 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, and 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.

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Appendix A: Historical Bycatch Estimates

Table A-1. Estimated mean seabird mortality in the U.S. West Coast groundfish fishery, 2002–09. Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2002		2003		2004		2005		2006		2007		2008		2009	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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
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, unidentified	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
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
Storm-petrel, unidentified	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
Tubenose, unidentified	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
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
Brandt's 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, unidentified	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
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
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, unidentified	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
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
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, unidentified	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
Alcid, unidentified	0.36	0–4.4	0.47	0–4.6	3.69	0.9–9.8	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
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
Bird, unidentified	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

Hook-and-Line Gears, All Sectors

Table A-2. Estimated mean seabird mortality in the U.S. West Coast groundfish fishery, 2002–09, for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2002		2003		2004		2005		2006		2007		2008		2009	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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	10–Jan	3.90	1–10.1	5.31	1.8–12.1	8.13	3.5–15.9
Shearwater, unidentified	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
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
Brandt's 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, unidentified	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
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
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, unidentified	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
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
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, unidentified	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
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
Bird, unidentified	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

Limited Entry Sablefish

Table A-3. Estimated mean seabird mortality in the U.S. West Coast limited entry sablefish fishery, 2002–09, for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2002		2003		2004		2005		2006		2007		2008		2009	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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
Cormorant, unidentified	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
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
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, unidentified	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
Alcid, unidentified	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
Bird, unidentified	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

Limited Entry Daily Trip Limits

Table A-4. Estimated mean seabird mortality in the U.S. West Coast limited entry daily trip limits fishery, 2002–09, for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2002		2003		2004		2005		2006		2007		2008		2009	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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
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
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, unidentified	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, unidentified	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

Open Access Fixed Gear

Table A-5. Estimated mean seabird mortality in the U.S. West Coast open access fixed gear fishery, 2003–09, for vessels fishing with hook-and-line gears. Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2003		2004		2005		2006		2007		2008		2009	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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 A-6. Estimated mean 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. Key: *LCI/UCI* = lower/upper 95% confidence interval.

		2003		2004		2005		2006		2007		2008		2009	
State	**Species**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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, unidentified	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	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	Brandt's 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	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	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 A-7. Estimated mean seabird mortality in U.S. West Coast fisheries, 2002–09, for vessels fishing with trawl gears. Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2002		2003		2004		2005		2006		2007		2008		2009	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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
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, unidentified	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
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
Storm-petrel, unidentified	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
Tubenose, unidentified	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
Brandt's 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, unidentified	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
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
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, unidentified	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
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, unidentified	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
Alcid, unidentified	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
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, unidentified	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

At-sea Hake Catcher–Processors

Table A-8. Seabird mortality in U.S. West Coast at-sea hake catcher processor vessels fishing with midwater trawl gear, 2002–09. Estimates include both randomly and opportunistically sampled birds.

Species	2002	2003	2004	2005	2006	2007	2008	2009
Black-footed albatross	0	3	1	2	3	2	1	1
Sooty shearwater	0	0	0	2	0	0	0	0
Shearwater, unidentified	0	0	8	0	0	1	0	0
Northern fulmar	0	0	21	0	0	62	4	32
Leach's storm-petrel	0	0	0	0	0	0	0	0
Tubenose, unidentified	0	0	0	0	0	0	2	0
Arctic herring gull	0	0	0	0	0	0	0	0
Gull, unidentified	0	0	0	0	0	15	0	0
Common murre	0	0	3	0	0	0	0	0
Cassin's auklet	0	0	0	0	0	0	0	2
Alcid, unidentified	0	0	3	0	0	0	0	0
Bird, unidentified	0	0	0	0	0	0	2	0

At-sea Hake Catcher Vessels

Table A-9. Seabird mortality in U.S. West Coast at-sea hake catcher vessels fishing with midwater trawl gear and delivering to motherships, 2002–09. Estimates include both randomly and opportunistically sampled birds.

Species	2002	2003	2004	2005	2006	2007	2008	2009
Northern fulmar	0	0	0	2	0	0	0	0
Common murre	0	0	0	2	0	0	0	0
Cassin's auklet	0	0	0	0	0	0	0	0
Bird, unidentified	0	0	0	2	0	0	2	0

Limited Entry Trawl

Table A-10. Estimated mean seabird mortality in the U.S. West Coast limited entry (LE) fishery, 2002–10, for vessels fishing with trawl gears. The LE trawl fishery became the catch share trawl fishery in 2011. Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2002		2003		2004		2005		2006		2007		2008		2009		2010	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
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	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	0.78	0–5.2
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	0.6–8.8	4.54	1.4–11	3.97	1.1–10.2	4.11	1.1–10.4	3.76	1–9.9
Storm-petrel, unidentified	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	0.68	0–5
Gull, unidentified	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	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	1.00	0–5.6
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	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	0.00	0

California Halibut

Table A-11. Estimated mean seabird mortality on U.S. West Coast limited entry (LE) California halibut vessels fishing with trawl gears, 2002–09. The 2010 LE California halibut estimates are included in the 2010 open access California halibut values to maintain confidentiality (Table 13). Since 2011, LE California halibut values have been included with catch share trawl values (Table 12). Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2002		2003		2004		2005		2006		2007		2008		2009	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
Brandt's 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, unidentified	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
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

Table A-12. Estimated mean seabird mortality on U.S. West Coast open access (OA) California halibut vessels fishing with trawl gears, 2002–09. This fishery was not observed in 2006. Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval; — = fishery not observed.

	2003		2004		2005		2006		2007		2008		2009	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
Brandt's 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, unidentified	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
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
Bird, unidentified	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

Washington, Oregon, and California Pink Shrimp

Table A-13. Estimated mean seabird mortality on U.S. West Coast open access (OA) pink shrimp vessels fishing with shrimp trawl gears, 2004–09. WCGOP began observing Oregon and California pink shrimp fisheries in 2004, and Washington pink shrimp in 2010. Estimates include both randomly and opportunistically sampled birds Key: *LCI/UCI* = lower/upper 95% confidence interval.

		2004		2005		2006		2007		2008		2009	
State	**Species**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
OR	Sooty shearwater	3.71	1.7–6	4.95	2.3–8.3	5.63	2.7–9.6	6.12	2.9–10.1	7.90	3.9–12.8	6.65	3.2–11
OR	Shearwater, unidentified	0.70	0.1–2	0.94	0.1–2.9	1.02	0.1–2.9	1.10	0.1–2.9	1.40	0.2–3.7	1.20	0.2–3.2
CA	Pink-footed shearwater	0.49	0–1.5	0.73	0–2.3	0.44	0–1.3	0.23	0–0.7	0.40	0–1.3	0.55	0–1.8

Pot Gears, All Sectors

Table A-14. Estimated mean seabird mortality in U.S. West Coast pot fisheries, 2003–09. Estimates include both randomly and opportunistically sampled birds. Key: *LCI/UCI* = lower/upper 95% confidence interval.

	2003		2004		2005		2006		2007		2008		2009	
Species	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**	**Mean**	**LCI–UCI**
Black-footed albatross	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
Storm-petrel, unidentified	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0	0.00	0
Brandt's 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, unidentified	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

Appendix B: Observer Coverage, Observed Takes, Nonlethal Interactions, and Sightings

Limited Entry Sablefish

Table B-1. U.S. West Coast limited entry sablefish vessels using hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes, 2002–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*).

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Number units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
2002	Black-footed albatross	25	68	391	779624	190.79	788.54	0.24	1.00	0
2002	Cormorant, unidentified	25	68	391	779624	190.79	788.54	0.24	1.00	0
2002	Western gull	25	68	391	779624	190.79	788.54	0.24	4.00	0
2003	Bird, unidentified	15	48	351	733602	222.85	1034.90	0.22	1.00	0
2003	Black-footed albatross	15	48	351	733602	222.85	1034.90	0.22	8.00	0
2004	Black-footed albatross	17	45	326	492009	180.02	1309.36	0.14	4.50	0
2005	Black-footed albatross	26	101	678	1456102	481.45	1293.13	0.37	23.50	0
2005	Gull, unidentified	26	101	678	1456102	481.45	1293.13	0.37	0.00	1
2006	Black-footed albatross	19	68	470	939951	295.93	1377.29	0.21	13.58	0
2006	Gull, unidentified	19	68	470	939951	295.93	1377.29	0.21	2.00	0
2007	Black-footed albatross	22	75	517	1034046	298.49	1080.66	0.28	48.40	0
2007	Northern fulmar	22	75	517	1034046	298.49	1080.66	0.28	2.00	0
2008	Black-footed albatross	18	77	540	1244141	338.15	1094.65	0.31	25.90	0
2009	No birds observed	8	45	287	648980	97.81	1447.59	0.07	0.00	0
2010	Black-footed albatross	21	143	762	1761173	345.77	1304.18	0.27	33.19	0
2010	Glaucous-winged gull	21	143	762	1761173	345.77	1304.18	0.27	1.94	0
2011	Alcid, unidentified	23	98	673	1405444	240.74	1153.50	0.21	2.00	0
2011	Bird, unidentified	23	98	673	1405444	240.74	1153.50	0.21	1.67	0
2011	Black-footed albatross	23	98	673	1405444	240.74	1153.50	0.21	23.44	0

Table B-1 (continued). U.S. West Coast limited entry sablefish vessels using hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes, 2002–16.

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Number units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
2011	Short-tailed albatross	23	98	673	1405444	240.74	1153.50	0.21	1.00	0
2011	Sooty shearwater	23	98	673	1405444	240.74	1153.50	0.21	1.00	0
2011	Western gull	23	98	673	1405444	240.74	1153.50	0.21	3.00	0
2012	Arctic herring gull	17	88	532	1580075	239.32	1075.02	0.22	7.60	0
2012	Black-footed albatross	17	88	532	1580075	239.32	1075.02	0.22	36.02	0
2012	California gull	17	88	532	1580075	239.32	1075.02	0.22	1.00	0
2012	Glaucous-winged gull	17	88	532	1580075	239.32	1075.02	0.22	2.00	0
2012	Gull, unidentified	17	88	532	1580075	239.32	1075.02	0.22	5.00	0
2012	Laysan albatross	17	88	532	1580075	239.32	1075.02	0.22	1.88	0
2012	Northern fulmar	17	88	532	1580075	239.32	1075.02	0.22	6.99	0
2012	Pink-footed shearwater	17	88	532	1580075	239.32	1075.02	0.22	3.13	0
2012	Ring-billed gull	17	88	532	1580075	239.32	1075.02	0.22	1.00	0
2012	Western gull	17	88	532	1580075	239.32	1075.02	0.22	9.53	0
2013	Black-footed albatross	18	58	353	1047526	166.42	751.11	0.22	13.00	0
2013	Sooty shearwater	18	58	353	1047526	166.42	751.11	0.22	2.00	0
2013	Western gull	18	58	353	1047526	166.42	751.11	0.22	1.00	0
2014	Bird, unidentified	17	85	495	1200615	203.23	745.23	0.27	1.00	0
2014	Black-footed albatross	17	85	495	1200615	203.23	745.23	0.27	2.00	0
2014	Gull, unidentified	17	85	495	1200615	203.23	745.23	0.27	1.00	0
2014	Western gull	17	85	495	1200615	203.23	745.23	0.27	1.00	0
2015	Bird, unidentified	26	97	632	1536820	391.96	938.45	0.42	1.00	0
2015	Black-footed albatross	26	97	632	1536820	391.96	938.45	0.42	20.34	0
2015	Gull, unidentified	26	97	632	1536820	391.96	938.45	0.42	2.00	0
2015	Northern fulmar	26	97	632	1536820	391.96	938.45	0.42	1.00	0
2015	Shearwater, unidentified	26	97	632	1536820	391.96	938.45	0.42	9.00	0
2015	Western gull	26	97	632	1536820	391.96	938.45	0.42	3.00	0
2016	Black-footed albatross	21	94	671	1743233	338.09	1025.26	0.33	9.00	0
2016	Red-necked phalarope	21	94	671	1743233	338.09	1025.26	0.33	0.00	1

Table B-2. U.S. West Coast limited entry sablefish vessels using pot gear, fishery observer coverage, fishing effort, and observed bird takes, 2002–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Number units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
2002	No birds observed	6	23	247	5438	82.47	352.20	0.23	0.00	0
2003	No birds observed	6	35	362	9017	148.31	604.24	0.25	0.00	0
2004	No birds observed	3	13	139	5378	82.68	619.60	0.13	0.00	0
2005	No birds observed	7	39	492	13822	281.18	615.00	0.46	0.00	0
2006	No birds observed	7	39	289	10708	200.47	581.80	0.34	0.00	0
2007	No birds observed	4	30	154	5816	89.97	428.37	0.21	0.00	0
2008	No birds observed	6	24	329	13638	244.87	432.98	0.57	0.00	0
2009	No birds observed	3	27	67	3883	66.48	489.07	0.14	0.00	0
2010	No birds observed	7	43	314	11294	140.39	503.54	0.28	0.00	0
2011	No birds observed	3	22	227	9029	137.42	371.93	0.37	0.00	0
2012	No birds observed	5	19	351	14218	101.10	285.98	0.35	0.00	0
2013	No birds observed	3	14	47	1934	40.52	283.13	0.14	0.00	0
2014	Black-footed albatross	4	16	195	7574	104.01	338.09	0.31	0.00	1
2015	No birds observed	9	35	299	11329	218.78	358.21	0.61	0.00	0
2016	No birds observed	7	55	596	21219	254.27	359.00	0.71	0.00	0

Table B-3. U.S. West Coast limited entry sablefish fishery, nonlethal seabird interactions, all gear types, 2002–16.

			Observed	
Year	**Gear**	**Species**	**Interaction category**	**Number**
2002	Hook & Line	Black-footed albatross	Boarded Vessel	1
2002	Hook & Line	Storm-petrel, unidentified	Boarded Vessel	2
2005	Hook & Line	Cassin's auklet	Boarded Vessel	5
2005	Hook & Line	Gull, unidentified	Deterrence Used	11
2005	Hook & Line	Semipalmated plover	Boarded Vessel	1
2007	Hook & Line	Black-footed albatross	Feeding on Catch	3
2008	Hook & Line	Black-footed albatross	Feeding on Catch	1
2010	Hook & Line	Black-footed albatross	Deterrence Used	50
2010	Hook & Line	Black-footed albatross	Entangled in Gear—Trailing Gear	1
2010	Hook & Line	Black-footed albatross	Feeding on Catch	52
2010	Hook & Line	Laysan albatross	Feeding on Catch	1
2010	Hook & Line	Short-tailed albatross	Feeding on Bait—Floating Free	1
2011	Hook & Line	Short-tailed albatross	Feeding on Discarded Catch	2
2011	Hook & Line	Western gull	Deterrence Used	3
2012	Hook & Line	Black-footed albatross	Deterrence Used	93
2012	Hook & Line	Black-footed albatross	Feeding on Catch	1
2012	Hook & Line	Laysan albatross	Feeding on Catch	1
2012	Hook & Line	Northern fulmar	Boarded Vessel	2
2012	Hook & Line	Western gull	Deterrence Used	1
2013	Hook & Line	Cassin's auklet	Boarded Vessel	1
2013	Hook & Line	Northern fulmar	Boarded Vessel	1
2014	Hook & Line	Northern fulmar	Boarded Vessel	2
2015	Hook & Line	Black-footed albatross	Feeding on Bait—Attached to Hook	2
2015	Hook & Line	Black-footed albatross	Feeding on Discarded Catch	25
2015	Hook & Line	Laysan albatross	Feeding on Bait—Floating Free	2
2015	Hook & Line	Shearwater, unidentified	Killed by Gear	4
2016	Hook & Line	Black-footed albatross	Feeding on Bait—Attached to Hook	28
2016	Hook & Line	Black-footed albatross	Feeding on Bait—Floating Free	50
2016	Hook & Line	Black-footed albatross	Feeding on Discarded Catch	1
2016	Hook & Line	Laysan albatross	Feeding on Discarded Catch	1
2016	Hook & Line	Red-necked phalarope	Boarded Vessel	1
2016	Hook & Line	Short-tailed albatross	Feeding on Offal	1
2005	Pot	Brown booby	Boarded Vessel	1
2005	Pot	Laysan albatross	Feeding on Bait—Floating Free	1
2011	Pot	Heermann's gull	Boarded Vessel	3
2014	Pot	Northern fulmar	Boarded Vessel	1

Table B-4. U.S. West Coast limited entry sablefish seabird sightings, all gear types, 2002–16. It is a higher priority to document sightings of ESA-listed species than nonlisted species.

Year	Gear	Species	Number of sightings
2002	Hook & Line	Black-footed albatross	375
2002	Hook & Line	Guillemot, unidentified	38
2002	Hook & Line	Gull, unidentified	36
2002	Hook & Line	Northern fulmar	8
2002	Hook & Line	Short-tailed albatross	1
2003	Hook & Line	Bird, unidentified	1
2003	Hook & Line	Black-footed albatross	405
2003	Hook & Line	Fork-tailed storm-petrel	4
2003	Hook & Line	Laysan albatross	2
2003	Hook & Line	Northern fulmar	11
2003	Hook & Line	Pink-footed shearwater	6
2003	Hook & Line	Shearwater, unidentified	4
2003	Hook & Line	Short-tailed albatross	1
2003	Hook & Line	Tufted puffin	2
2004	Hook & Line	Black-footed albatross	3
2005	Hook & Line	Black-footed albatross	180
2005	Hook & Line	Brown pelican	4
2005	Hook & Line	Laysan albatross	1
2005	Hook & Line	Short-tailed albatross	3
2006	Hook & Line	Black-footed albatross	50
2006	Hook & Line	Short-tailed albatross	3
2007	Hook & Line	Black-footed albatross	3
2007	Hook & Line	Short-tailed albatross	2
2008	Hook & Line	Black-footed albatross	301
2008	Hook & Line	Short-tailed albatross	1
2009	Hook & Line	Black-footed albatross	5
2009	Hook & Line	Short-tailed albatross	1
2010	Hook & Line	Black-footed albatross	2
2010	Hook & Line	Short-tailed albatross	4
2011	Hook & Line	Laysan albatross	1
2011	Hook & Line	Short-tailed albatross	1
2012	Hook & Line	Black-footed albatross	1
2012	Hook & Line	Short-tailed albatross	1
2013	Hook & Line	Bird, unidentified	1
2013	Hook & Line	Black-footed albatross	80
2014	Hook & Line	Black-footed albatross	20
2014	Hook & Line	Laysan albatross	1
2014	Hook & Line	Storm-petrel, unidentified	1
2015	Hook & Line	Black-footed albatross	2
2016	Hook & Line	Short-tailed albatross	1
2002	Pot	Bird, unidentified	1
2002	Pot	Black-footed albatross	191
2002	Pot	Laysan albatross	2
2002	Pot	Pigeon guillemot	99
2002	Pot	Shearwater, unidentified	99
2003	Pot	Black-footed albatross	139
2003	Pot	Common murre	4
2003	Pot	Gull, unidentified	74
2003	Pot	Laysan albatross	2
2005	Pot	Black-footed albatross	61
2005	Pot	Laysan albatross	2
2008	Pot	Short-tailed albatross	1
2009	Pot	Black-footed albatross	60
2009	Pot	Glaucous-winged gull	4
2009	Pot	Heermann's gull	1
2009	Pot	Laysan albatross	3
2009	Pot	Northern fulmar	6
2009	Pot	Pink-footed shearwater	3
2009	Pot	Sooty shearwater	3
2009	Pot	Western gull	40
2010	Pot	Short-tailed albatross	2
2011	Pot	Laysan albatross	1
2011	Pot	Leach's storm-petrel	30
2011	Pot	Short-tailed albatross	2

Limited Entry Daily Trip Limits

Table B-5. U.S. West Coast limited entry daily trip limits vessels using hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes, 2002–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Number units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
2002	No birds observed	4	11	22	46000	1.66	231.89	0.01	0.00	0
2003	Cormorant, unidentified	17	130	219	537817	14.32	213.49	0.07	1.00	0
2003	Western gull	17	130	219	537817	14.32	213.49	0.07	1.00	0
2004	No birds observed	14	62	130	318048	3.74	161.08	0.02	0.00	0
2005	Brown pelican	11	35	60	198150	2.43	245.34	0.01	1.00	0
2006	Shearwater, unidentified	21	121	201	533830	6.96	200.53	0.03	19.00	0
2007	No birds observed	36	158	304	724389	16.50	241.63	0.07	0.00	0
2008	Gull, unidentified	32	122	221	631689	9.32	323.53	0.03	3.00	0
2008	Shearwater, unidentified	32	122	221	631689	9.32	323.53	0.03	1.00	0
2009	Western gull	34	138	273	669091	11.97	484.03	0.02	1.00	0
2010	No birds observed	38	226	472	1103073	33.84	699.87	0.05	0.00	0
2011	Black-footed albatross	38	201	426	1154241	52.47	889.35	0.06	13.00	0
2012	Brown pelican	26	128	252	706437	15.09	552.93	0.03	2.00	0
2012	Double-crested cormorant	26	128	252	706437	15.09	552.93	0.03	1.00	0
2012	Gull, unidentified	26	128	252	706437	15.09	552.93	0.03	1.00	0
2013	Sooty shearwater	22	124	248	705827	17.67	584.94	0.03	3.00	0
2014	No birds observed	18	77	154	493845	15.71	537.51	0.03	0.00	0
2015	Black-footed albatross	21	65	144	453472	29.21	534.29	0.05	3.40	0
2015	Pink-footed shearwater	21	65	144	453472	29.21	534.29	0.05	1.00	0
2016	No birds observed	16	41	70	247067	19.38	522.32	0.04	0.00	0

Table B-6. U.S. West Coast limited entry daily trip limits fishery, nonlethal seabird interactions, all gear types, 2002–16.

			Observed	
Year	Gear	Species	Interaction category	Number
2009	Hook & Line	Black-footed albatross	Feeding on Catch	1
2009	Hook & Line	Laysan albatross	Feeding on Bait—Floating Free	2
2010	Hook & Line	Brown pelican	Feeding on Catch	5
2012	Hook & Line	Black-footed albatross	Feeding on Catch	20
2013	Hook & Line	Double-crested cormorant	Feeding on Catch	2

Table B-7. U.S. West Coast limited entry daily trip limits fishery, seabird sightings, all gear types, 2002–16. It is a higher priority to document sightings of ESA-listed species than nonlisted species.

Year	Gear	Species	Number of sightings
2008	Hook & Line	Brown pelican	2
2008	Hook & Line	Laysan albatross	1
2009	Hook & Line	Black-footed albatross	17
2009	Hook & Line	Brown pelican	2
2011	Hook & Line	Black-footed albatross	7
2011	Hook & Line	Pink-footed shearwater	1
2011	Hook & Line	Sooty shearwater	100
2013	Hook & Line	Black-footed albatross	19
2015	Hook & Line	Black-footed albatross	32
2015	Hook & Line	Sooty shearwater	1

Open Access Fixed Gear

Table B-8. U.S. West Coast open access fixed gear vessels using hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes, 2002–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Number units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
2003	No birds observed	13	41	49	86518	16.59	548.42	0.03	0.00	0
2004	No birds observed	14	42	52	85895	16.25	477.88	0.03	0.00	0
2005	No birds observed	10	34	37	58384	9.79	632.60	0.02	0.00	0
2006	No birds observed	7	10	11	29296	4.50	491.44	0.01	0.00	0
2007	Black-footed albatross	25	51	67	55215	10.52	267.33	0.04	1.00	0
2008	No birds observed	33	58	68	73885	16.31	409.91	0.04	0.00	0
2009	No birds observed	34	69	104	119849	22.28	650.13	0.03	0.00	0
2010	Black-footed albatross	37	70	105	160570	23.08	758.15	0.03	1.86	0
2011	No birds observed	40	69	101	162419	20.19	436.25	0.05	0.00	0
2012	No birds observed	24	34	53	82597	11.48	324.04	0.04	0.00	0
2013	No birds observed	14	23	30	51870	4.71	194.04	0.02	0.00	0
2014	Gull, unidentified	21	28	39	71459	11.78	219.77	0.05	1.00	0
2015	No birds observed	20	38	54	124895	17.47	364.28	0.05	0.00	0
2016	No birds observed	31	57	78	111092	15.66	309.34	0.05	0.00	0

Table B-9. U.S. West Coast open access fixed gear vessels using pot gear, fishery observer coverage, fishing effort, and observed bird takes, 2002–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Number units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
2003	No birds observed	7	16	50	345	2.94	186.59	0.02	0.00	0
2004	No birds observed	17	96	185	1950	16.99	186.03	0.09	0.00	0
2005	No birds observed	14	43	50	835	10.67	379.37	0.03	0.00	0
2006	No birds observed	15	38	39	666	7.90	443.29	0.02	0.00	0
2007	No birds observed	21	46	75	624	8.75	257.89	0.03	0.00	0
2008	No birds observed	20	55	75	833	10.43	240.87	0.04	0.00	0
2009	No birds observed	18	30	45	540	8.53	372.63	0.02	0.00	0
2010	No birds observed	26	40	71	646	10.66	318.29	0.03	0.00	0
2011	No birds observed	29	61	85	831	18.94	255.80	0.07	0.00	0
2012	No birds observed	19	35	70	610	9.13	127.21	0.07	0.00	0
2013	No birds observed	17	25	48	590	6.30	72.18	0.09	0.00	0
2014	No birds observed	21	41	63	686	11.67	147.81	0.08	0.00	0
2015	No birds observed	17	49	64	604	14.61	234.25	0.06	0.00	0
2016	No birds observed	28	56	74	717	15.41	206.47	0.07	0.00	0

Table B-10. U.S. West Coast open access fixed gear fishery, nonlethal seabird interactions, all gear types, 2002–16.

			Observed	
Year	Gear	Species	Interaction category	Number
2011	Hook & Line	Black-footed albatross	Feeding on Catch	3
2016	Hook & Line	Black-footed albatross	Feeding on Bait—Floating Free	1
2016	Pot	Black-footed albatross	Feeding on Discarded Catch	13
2016	Pot	Laysan albatross	Feeding on Discarded Catch	2

Table B-11. U.S. West Coast open access fixed gear fishery, seabird sightings, all gear types, 2002–16. It is a higher priority to document sightings of ESA-listed species than nonlisted species.

Year	Gear	Species	Number of sightings
2003	Hook & Line	Black-footed albatross	2
2009	Hook & Line	Black-footed albatross	113
2009	Hook & Line	Rhinoceros auklet	1
2011	Hook & Line	Black-legged kittiwake	1
2011	Hook & Line	Laysan albatross	1
2012	Hook & Line	Black-footed albatross	60
2012	Hook & Line	Fork-tailed storm-petrel	2
2012	Hook & Line	Heermann's gull	4
2012	Hook & Line	Laysan albatross	1
2012	Hook & Line	Northern fulmar	1
2012	Hook & Line	Pink-footed shearwater	1
2012	Hook & Line	Western gull	12
2013	Hook & Line	Black-footed albatross	40
2014	Hook & Line	Black-footed albatross	1
2003	Pot	Black-footed albatross	10
2009	Pot	Black-footed albatross	6
2009	Pot	Laysan albatross	10
2010	Pot	Black-footed albatross	42
2010	Pot	Short-tailed albatross	1
2011	Pot	California gull	2
2011	Pot	Glaucous-winged gull	2
2011	Pot	Northern fulmar	5
2011	Pot	Rhinoceros auklet	1
2011	Pot	Western gull	80
2012	Pot	Herring gull	1
2016	Pot	Black-footed albatross	15
2016	Pot	Laysan albatross	2
2016	Pot	Sooty shearwater	1
2016	Pot	Tufted puffin	2

Catch Share Fixed Gear Fisheries

Catch Share Hook-and-Line Gears

Table B-12. U.S. West Coast catch share vessels fishing with hook-and-line gear and not participating in the Electronic Monitoring Exempted Fishing Permit, fishery observer coverage, fishing effort, and observed bird takes, 2011–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*).

					Sets			Catch			Observed	Estimated	
Year	Species	Vessels	Trips	Units	Sampled	Unsampled	Proportion	Sampled	Unsampled	Proportion	number	number	Opp.
2011	Black-footed albatross	11	94	2265264	630	1.00	1.00	335.56	0.00	1.00	5.00	5.00	0
2011	Gull, unidentified	11	94	2265264	630	1.00	1.00	335.56	0.00	1.00	1.00	1.00	0
2011	Mew gull	11	94	2265264	630	1.00	1.00	335.56	0.00	1.00	1.00	1.00	0
2011	Western gull	11	94	2265264	630	1.00	1.00	335.56	0.00	1.00	3.00	3.00	0
2012	Black-footed albatross	8	32	1472865	506	0.00	1.00	241.30	0.00	1.00	4.94	4.94	0
2012	Gull, unidentified	8	32	1472865	506	0.00	1.00	241.30	0.00	1.00	2.00	2.00	0
2012	Western gull	8	32	1472865	506	0.00	1.00	241.30	0.00	1.00	41.55	41.55	0
2013	No birds observed	8	29	587238	215	0.00	1.00	79.48	0.00	1.00	0.00	0.00	0
2014	Black-footed albatross	8	31	601654	227	32.00	0.88	88.68	9.84	0.90	2.00	2.38	0
2014	Northern fulmar	8	31	601654	227	32.00	0.88	88.68	9.84	0.90	2.00	2.38	0
2015	No birds observed	5	16	592919	185	0.00	1.00	137.84	0.00	1.00	0.00	0.00	0
2016	No birds observed	5	30	1110926	351	0.00	1.00	192.79	0.00	1.00	0.00	0.00	0

Table B-13. U.S. West Coast catch share vessels fishing with hook-and-line gear and not participating in the Electronic Monitoring Exempted Fishing Permit, nonlethal seabird interactions, all gear types, 2011–16.

			Observed	
Year	Gear	Species	Interaction category	Number
2011	Hook & Line	Short-tailed albatross	Feeding on Discarded Catch	1

Table B-14. U.S. West Coast catch share vessels fishing with hook-and-line gear and not participating in the Electronic Monitoring Exempted Fishing Permit, seabird sightings, all gear types, 2011–16. It is a higher priority to document sightings of ESA-listed species than nonlisted species.

Year	Gear	Species	Number of sightings
2012	Hook & Line	Short-tailed albatross	3

Catch Share Pot Gears

Table B-15. U.S. West Coast catch share vessels fishing with pot gear and not participating in the Electronic Monitoring Exempted Fishing Permit, fishery observer coverage, fishing effort, and observed bird takes, 2011–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

					Sets			Catch			Observed	Estimated	
Year	Species	Vessels	Trips	Units	Sampled	Unsampled	Proportion	Sampled	Unsampled	Proportion	number	number	Opp.
2011	Northern fulmar	17	233	41307	1536	18.00	0.99	813.82	3.41	1.00	1.00	1.00	0
2012	No birds observed	19	278	52248	1709	0.00	1.00	740.69	0.00	1.00	0.00	0.00	0
2013	Storm-petrel, unidentified	10	100	30097	1086	0.00	1.00	470.84	0.00	1.00	1.00	1.00	0
2014	No birds observed	14	118	31876	1288	0.00	1.00	681.15	0.00	1.00	0.00	0.00	0
2015	No birds observed	8	62	18808	584	0.00	1.00	405.29	0.00	1.00	0.00	0.00	0
2016	No birds observed	8	61	15785	584	0.00	1.00	387.05	0.00	1.00	0.00	0.00	0

Table B-16. U.S. West Coast catch share vessels fishing with pot gear and not participating in the Electronic Monitoring Exempted Fishing Permit, nonlethal seabird interactions, all gear types, 2011–16.

			Observed	
Year	Gear	Species	Interaction category	Number
2012	Pot	Short-tailed albatross	Feeding on Catch	2
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	Black-footed albatross	Vessel Strike	1
2016	Pot	Short-tailed albatross	Feeding on Bait—Floating Free	5

Table B-17. U.S. West Coast catch share vessels fishing with pot gear and not participating in the Electronic Monitoring Exempted Fishing Permit, seabird sightings, all gear types, 2011–16. It is a higher priority to document sightings of ESA-listed species than nonlisted species.

Year	Gear	Species	Number of sightings
2011	Pot	Short-tailed albatross	2
2012	Pot	Brown booby	1
2012	Pot	Short-tailed albatross	2
2016	Pot	Bird, unidentified	100

Oregon and California Nearshore Fisheries

Nearshore Hook-and-Line Gears

Table B-18. Oregon and California nearshore fisheries vessels fishing with hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes, 2002–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

			Observed						Observed		
State	Year	Species	Vessels	Trips	Sets	Number units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
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, unidentified	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

Table B-18 (continued). Oregon and California nearshore fisheries vessels fishing with hook-and-line gear, fishery observer coverage, fishing effort, and observed bird takes, 2002–16.

			Observed						Observed		
State	Year	Species	Vessels	Trips	Sets	Number units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
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	Brandt's 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 B-19. Oregon and California nearshore fisheries vessels fishing with pot gear, fishery observer coverage, fishing effort, and observed bird takes, 2003–16. States are combined to maintain confidentiality. Observed bird takes are either randomly sampled (observed takes) or opportunistically sampled.

			Observed						Observed		
State	Year	Species	Vessels	Trips	Sets	Number units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
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, unidentified	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	Cormorant, unidentified	2	11	30	364	0.58	39.47	0.01	1.00	0
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, unidentified	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	Brandt's 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, unidentified	17	37	61	3890	4.05	44.17	0.09	1.07	0

Nearshore Pot Gears

Table B-20. Oregon and California nearshore fisheries vessels fishing with hook-and-line gear, nonlethal seabird interactions, 2002–16. There were no nonlethal seabird interactions observed on nearshore vessels fishing with pot gear.

				Observed	
State	Year	Gear	Species	Interaction category	Number
OR	2006	Hook & Line	Murre, unidentified	Entangled in Gear—Not Trailing Gear	1
OR	2008	Hook & Line	Common murre	Entangled in Gear—Not Trailing Gear	1
OR	2009	Hook & Line	Common murre	Entangled in Gear—Not Trailing Gear	1
OR	2011	Hook & Line	Common murre	Entangled in Gear—Not Trailing Gear	2
OR	2015	Hook & Line	Tufted puffin	Entangled in Gear—Not Trailing Gear	1
CA	2004	Hook & Line	Common murre	Entangled in Gear—Not Trailing Gear	1
CA	2006	Hook & Line	Brown pelican	Deterrence Used	1
CA	2007	Hook & Line	Northern fulmar	Entangled in Gear—Not Trailing Gear	1
CA	2009	Hook & Line	Murre, unidentified	Entangled in Gear—Not Trailing Gear	1
CA	2010	Hook & Line	Western gull	Entangled in Gear—Not Trailing Gear	2
CA	2011	Hook & Line	Common loon	Feeding on Catch	1
CA	2015	Hook & Line	Common murre	Entangled in Gear—Not Trailing Gear	1

Table B-21. Oregon and California nearshore fisheries vessels fishing with hook-and-line or pot gear (combined), seabird sightings, 2002–16. Sightings are haphazardly collected, often only for ESA-listed species.

Year	Species	Number of sightings
2003	Brown pelican	4
2003	Common murre	60
2003	Cormorant, unidentified	2
2003	Gull, unidentified	28
2007	Cormorant, unidentified	1
2008	Brown pelican	7
2010	Heermann's gull	2
2011	Glaucous-winged gull	1
2011	Heermann's gull	6
2011	Pelagic cormorant	7
2012	Brown pelican	2
2012	Marbled murrelet	154
2013	Ancient murrelet	1
2014	Northern fulmar	2
2015	Tufted puffin	1

At-sea Hake Fishery

Table B-22. U.S. West Coast at-sea hake catcher–processor vessels, observer coverage, fishing effort, and observed bird takes, 2002–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*).

				Tows			Catch			Observed	
Year	Species	Vessels	Tow hours	Sampled	Unsampled	Proportion	Sampled	Unsampled	Proportion	number	Opp.
2002	No birds observed	5	1061.35	556	1	1.00	36529.70	89.52	1.00	0	0
2003	Black-footed albatross	6	911.03	766	1	1.00	41408.12	25.05	1.00	3	0
2004	Alcid, unidentified	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	3	0
2004	Black-footed albatross	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	0	1
2004	Common murre	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	3	0
2004	Northern fulmar	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	21	0
2004	Shearwater, unidentified	6	1973.37	1492	4	1.00	74589.04	186.53	1.00	8	0
2005	Black-footed albatross	6	2238.80	1332	2	1.00	79310.60	22.18	1.00	2	0
2005	Sooty shearwater	6	2238.80	1332	2	1.00	79310.60	22.18	1.00	2	0
2006	Black-footed albatross	9	2980.68	1488	2	1.00	79917.44	28.41	1.00	2	1
2007	Black-footed albatross	9	4403.67	1566	4	1.00	74214.50	89.06	1.00	0	2
2007	Gull, unidentified	9	4403.67	1566	4	1.00	74214.50	89.06	1.00	0	15
2007	Northern fulmar	9	4403.67	1566	4	1.00	74214.50	89.06	1.00	51	11
2007	Shearwater, unidentified	9	4403.67	1566	4	1.00	74214.50	89.06	1.00	0	1
2008	Bird, unidentified	8	5557.86	1864	18	0.99	109939.76	1086.35	0.99	2	0
2008	Black-footed albatross	8	5557.86	1864	18	0.99	109939.76	1086.35	0.99	1	0
2008	Northern fulmar	8	5557.86	1864	18	0.99	109939.76	1086.35	0.99	2	2
2008	Tubenose, unidentified	8	5557.86	1864	18	0.99	109939.76	1086.35	0.99	2	0
2009	Black-footed albatross	5	1932.42	863	0	1.00	38495.22	0.00	1.00	0	1
2009	Cassin's auklet	5	1932.42	863	0	1.00	38495.22	0.00	1.00	2	0
2009	Northern fulmar	5	1932.42	863	0	1.00	38495.22	0.00	1.00	32	0
2010	Black-footed albatross	6	2653.10	1063	1	1.00	54750.79	29.24	1.00	1	2
2010	Common murre	6	2653.10	1063	1	1.00	54750.79	29.24	1.00	2	0
2010	Northern fulmar	6	2653.10	1063	1	1.00	54750.79	29.24	1.00	17	0

Table B-22 (continued). U.S. West Coast at-sea hake catcher–processor vessels, observer coverage, fishing effort, and observed bird takes, 2002–16.

Year	Species	Vessels	Tow hours	Tows			Catch			Observed number	Opp.
				Sampled	Unsampled	Proportion	Sampled	Unsampled	Proportion		
2011	Black-footed albatross	9	4761.93	1530	4	1.00	72600.76	157.61	1.00	0	5
2011	Gull, unidentified	9	4761.93	1530	4	1.00	72600.76	157.61	1.00	0	8
2011	Northern fulmar	9	4761.93	1530	4	1.00	72600.76	157.61	1.00	22	3
2011	Tubenose, unidentified	9	4761.93	1530	4	1.00	72600.76	157.61	1.00	0	4
2012	Black-footed albatross	9	3545.57	1100	2	1.00	55534.53	133.70	1.00	0	1
2012	Northern fulmar	9	3545.57	1100	2	1.00	55534.53	133.70	1.00	2	0
2013	Arctic herring gull	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0	4
2013	Bird, unidentified	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0	1
2013	Black-footed albatross	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0	2
2013	Cassin's auklet	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	2	0
2013	Gull, unidentified	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0	1
2013	Leach's storm-petrel	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	2	0
2013	Northern fulmar	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	4	48
2013	Shearwater, unidentified	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	2	1
2013	Sooty shearwater	9	3293.92	1439	4	1.00	78216.47	226.66	1.00	0	1
2014	Bird, unidentified	9	4731.41	1683	1	1.00	103546.79	89.47	1.00	0	1
2014	Black-footed albatross	9	4731.41	1683	1	1.00	103546.79	89.47	1.00	0	1
2014	Northern fulmar	9	4731.41	1683	1	1.00	103546.79	89.47	1.00	2	0
2015	Black-footed albatross	9	5690.86	1503	4	1.00	69076.94	129.21	1.00	0	1
2015	Gull, unidentified	9	5690.86	1503	4	1.00	69076.94	129.21	1.00	2	2
2015	Leach's storm-petrel	9	5690.86	1503	4	1.00	69076.94	129.21	1.00	2	0
2015	Northern fulmar	9	5690.86	1503	4	1.00	69076.94	129.21	1.00	7	5
2016	Black-footed albatross	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	0	2
2016	Gull, unidentified	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	2	2
2016	Leach's storm-petrel	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	2	0
2016	Northern fulmar	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	9	0
2016	Shearwater, unidentified	9	7291.41	2188	1	1.00	109679.48	60.42	1.00	2	0

Table B-23. U.S. West Coast at-sea hake catcher vessels delivering to motherships at sea, observer coverage, fishing effort, and observed bird takes, 2002–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*).

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

Table B-24. U.S. West Coast at-sea hake fishery, both vessel types, nonlethal seabird interactions, 2002–16. Key: *CP* = catcher–processor; *MS* = mothership catcher vessel; *MT* = midwater trawl gear.

				Observed	
Year	**Sector**	**Gear**	**Species**	**Interaction category**	**Number**
2002	CP	MT	Black-footed albatross	Foraging, Not Bait	80
2005	CP	MT	Cassin's auklet	Boarded Vessel	1
2005	CP	MT	Sooty shearwater	Entangled in Gear—Not Trailing Gear	1
2006	CP	MT	Sooty shearwater	Entangled in Gear—Not Trailing Gear	3
2009	CP	MT	Northern fulmar	Entangled in Gear—Not Trailing Gear	1
2010	CP	MT	Gull, unidentified	Entangled in Gear—Not Trailing Gear	1
2011	CP	MT	Cassin's auklet	Rig Strike	1
2011	CP	MT	Northern fulmar	Entangled in Gear—Not Trailing Gear	3
2011	CP	MT	Northern fulmar	Boarded Vessel	2
2013	CP	MT	Bird, unidentified	Boarded Vessel	1
2013	CP	MT	Glaucous-winged gull	Boarded Vessel	4
2013	CP	MT	Gull, unidentified	Boarded Vessel	2
2013	CP	MT	Leach's storm-petrel	Boarded Vessel	1
2013	CP	MT	Leach's storm-petrel	Rig Strike	1
2013	CP	MT	Northern fulmar	Boarded Vessel	1
2013	CP	MT	Northern fulmar	Third Wire, Paravane, or Warp Cable Contact	5
2013	CP	MT	Short-tailed shearwater	Boarded Vessel	1
2014	CP	MT	Shearwater, unidentified	Boarded Vessel	1
2015	CP	MT	Northern fulmar	Entangled in Gear—Not Trailing Gear	1
2015	CP	MT	Storm-petrel, unidentified	Boarded Vessel	1
2011	MS	MT	Short-tailed albatross	Feeding on Catch	1
2012	MS	MT	Cassin's auklet	Boarded Vessel	1
2012	MS	MT	Northern fulmar	Boarded Vessel	2
2013	MS	MT	Black-footed albatross	Feeding on Catch	75
2013	MS	MT	Northern fulmar	Boarded Vessel	1650
2013	MS	MT	Northern fulmar	Feeding on Catch	100
2013	MS	MT	Western gull	Boarded Vessel	2600
2013	MS	MT	Western gull	Feeding on Catch	5000
2014	MS	MT	Cassin's auklet	Boarded Vessel	1

Table B-25. U.S. West Coast at-sea hake fishery, both vessel types, seabird sightings, 2002–16. Sightings are haphazardly collected, often only for ESA-listed species.

Year	**Sector**	**Species**	**Number of sightings**
2002	CP	Black-footed albatross	1
2003	CP	Black-footed albatross	1
2011	MS	Laysan albatross	1
2011	MS	Short-tailed albatross	1
2012	MS	Short-tailed albatross	1
2013	MS	Black-footed albatross	50
2013	MS	Sooty shearwater	175
2013	MS	Western gull	20
2014	MS	Gull, unidentified	1

Limited Entry (2002–10) and Catch Share (2011–16) Trawl Fisheries

Limited Entry Trawl, 2002–10

Table B-26. U.S. West Coast limited entry fishery using trawl gear, observer coverage, fishing effort, and observed bird takes, 2002–10. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*). Bottom and midwater trawl gears are combined.

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Tow hours	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
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, unidentified	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, unidentified	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

Table B-27. U.S. West Coast limited entry fishery using trawl gear, nonlethal seabird interactions, 2002–10. Bottom and midwater trawl gears are combined.

		Observed	
Year	**Species**	**Interaction category**	**Number**
2002	Bird, unidentified	Boarded Vessel	3
2002	Black-footed albatross	Feeding on Catch	130
2002	Cassin's auklet	Boarded Vessel	10
2002	Fox sparrow	Boarded Vessel	1
2002	Laysan albatross	Feeding on Discarded Catch	1
2002	Leach's storm-petrel	Boarded Vessel	1
2002	Lesser goldfinch	Boarded Vessel	1
2002	Marbled murrelet	Boarded Vessel	1
2002	Northern fulmar	Boarded Vessel	2
2002	Orange-crowned warbler	Boarded Vessel	3
2002	Short-tailed albatross	Feeding on Catch	2
2003	Fork-tailed storm-petrel	Boarded Vessel	1
2003	Leach's storm-petrel	Boarded Vessel	1
2003	Northern fulmar	Boarded Vessel	2
2003	Rhinoceros auklet	Boarded Vessel	1
2003	Shearwater, unidentified	Boarded Vessel	1
2003	Storm-petrel, unidentified	Boarded Vessel	1
2003	Storm-petrel, unidentified	Entangled in Gear—Not Trailing Gear	1
2004	Bird, unidentified	Boarded Vessel	1
2004	Black-footed albatross	Feeding on Catch	40
2004	Fork-tailed storm-petrel	Boarded Vessel	1
2004	Laysan albatross	Feeding on Catch	1
2004	Storm-petrel, unidentified	Boarded Vessel	1
2005	Black-footed albatross	Entangled in Gear—Not Trailing Gear	1
2005	Black-footed albatross	Feeding on Catch	50
2005	Brown booby	Boarded Vessel	1
2005	Laysan albatross	Boarded Vessel	1
2006	Black-footed albatross	Feeding on Catch	1
2006	Laysan albatross	Feeding on Catch	1
2007	Black-footed albatross	Boarded Vessel	1
2007	Black-footed albatross	Feeding on Catch	50
2007	Laysan albatross	Feeding on Catch	1
2007	Leach's storm-petrel	Boarded Vessel	2
2007	Northern fulmar	Boarded Vessel	1
2007	Shearwater, unidentified	Boarded Vessel	1
2008	Bird, unidentified	Boarded Vessel	1
2008	Black-footed albatross	Feeding on Catch	27
2008	Cassin's auklet	Boarded Vessel	1

Table B-27 (continued). U.S. West Coast limited entry fishery using trawl gear, nonlethal seabird interactions, 2002–10.

		Observed	
Year	Species	Interaction category	Number
2009	Black-footed albatross	Feeding on Catch	261
2009	Brown pelican	Feeding on Catch	1
2009	Cassin's auklet	Boarded Vessel	1
2009	Laysan albatross	Feeding on Catch	5
2009	Northern fulmar	Boarded Vessel	1
2009	Rhinoceros auklet	Boarded Vessel	1
2009	Short-tailed albatross	Feeding on Catch	2
2009	Storm-petrel, unidentified	Boarded Vessel	1
2009	Western gull	Boarded Vessel	2
2009	Western gull	Feeding on Discarded Catch	23
2010	Black-footed albatross	Feeding on Catch	65
2010	Short-tailed albatross	Feeding on Catch	3

Table B-28. U.S. West Coast limited entry fishery using trawl gear, seabird sightings, 2002–10. Sightings are haphazardly collected, often only for ESA-listed species. Bottom and midwater trawl gears are combined.

Year	Species	Number of sightings
2002	Albatross, unidentified	2
2002	Black-footed albatross	399
2002	Brown pelican	1
2002	Common murre	2
2002	Guillemot, unidentified	2
2002	Gull, unidentified	99
2002	Laysan albatross	1
2002	Northern fulmar	12
2002	Pacific loon	1
2002	Shearwater, unidentified	1
2002	Short-tailed albatross	12
2002	Western gull	5
2002	Black-footed albatross	1
2003	Black-footed albatross	919
2003	Brown pelican	2
2003	Common murre	8
2003	Gull, unidentified	2596
2003	Heermann's gull	12
2003	Laysan albatross	2
2003	Northern fulmar	105
2003	Pink-footed shearwater	1
2003	Short-tailed albatross	4
2004	Alcid, unidentified	1
2004	American white pelican	1
2004	Bird, unidentified	1
2004	Black-footed albatross	95
2004	Common murre	12
2004	Gull, unidentified	21
2004	Laysan albatross	19
2004	Northern fulmar	31
2004	Shearwater, unidentified	2
2004	Short-tailed albatross	4
2005	Black-footed albatross	82
2005	Laysan albatross	2
2005	Short-tailed albatross	3
2006	Laysan albatross	3
2006	Short-tailed albatross	1
2007	Black-footed albatross	1
2007	Brown booby	1
2007	Laysan albatross	3
2007	Short-tailed albatross	1
2008	Brown pelican	4
2008	Laysan albatross	2

Table B-28 (continued). U.S. West Coast limited entry fishery using trawl gear, seabird sightings, 2002–10.

Year	Species	Number of sightings
2009	Black-footed albatross	38
2009	Brown pelican	21
2009	California gull	30
2009	Laysan albatross	7
2009	Short-tailed albatross	17
2010	Cassin's auklet	1
2010	Laysan albatross	3
2010	Pink-footed shearwater	3
2010	Short-tailed albatross	5
2010	Sooty shearwater	2

Catch Share Trawl (2011–16)

Table B-29. U.S. West Coast catch share vessels using bottom (CS) or midwater (MH/MR) trawl gear, observer coverage, fishing effort, and observed bird takes, 2011–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*). Key: *CS* = catch share, *MH* = midwater hake, *MR* = midwater rockfish.

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

Table B-30. U.S. West Coast catch share vessels using bottom (CS) or midwater (MH/MR) trawl gear, nonlethal seabird interactions, 2011–16. Key: *CS* = catch share, *MH* = midwater hake, *MR* = midwater rockfish.

			Observed	
Year	**Sector**	**Species**	**Interaction category**	**Number**
2011	CS	Black-footed albatross	Boarded Vessel	40
2011	CS	Black-footed albatross	Feeding on Catch	122
2011	CS	Cassin's auklet	Boarded Vessel	2
2011	CS	Leach's storm-petrel	Boarded Vessel	1
2011	CS	Northern fulmar	Boarded Vessel	21
2011	CS	Short-tailed albatross	Feeding on Catch	4
2011	CS	Storm-petrel, unidentified	Entangled In Gear—Not Trailing Gear	1
2012	CS	Brown pelican	Boarded Vessel	1
2012	CS	Brown pelican	Feeding on Catch	1
2012	CS	Short-tailed albatross	Feeding on Catch	3
2013	CS	Black-footed albatross	Boarded Vessel	8
2013	CS	Black-footed albatross	Deterrence Used	36
2013	CS	Black-footed albatross	Feeding on Catch	176
2013	CS	Short-tailed albatross	Feeding on Catch	3
2013	CS	Storm-petrel, unidentified	Vessel Strike	1
2014	CS	Black-footed albatross	Feeding on Catch	253
2014	CS	Black-footed albatross	Feeding on Discarded Catch	1
2014	CS	Brown booby	Boarded Vessel	1
2014	CS	Northern fulmar	Boarded Vessel	10
2014	CS	Short-tailed albatross	Feeding on Catch	4
2015	CS	Black-footed albatross	Feeding on Catch	69
2015	CS	Black-footed albatross	Feeding on Discarded Catch	80
2015	CS	Gull, unidentified	Boarded Vessel	20
2015	CS	Gull, unidentified	Feeding on Catch	265
2015	CS	Gull, unidentified	Feeding on Discarded Catch	35
2015	CS	Laysan albatross	Feeding on Discarded Catch	3
2015	CS	Short-tailed albatross	Feeding on Catch	2
2015	CS	Short-tailed albatross	Feeding on Discarded Catch	1
2016	CS	Black-footed albatross	Boarded Vessel	1
2016	CS	Black-footed albatross	Feeding on Catch	130
2016	CS	Black-footed albatross	Feeding on Discarded Catch	150
2016	CS	Brown booby	Boarded Vessel	1
2016	CS	Cassin's auklet	Vessel Strike	1
2016	CS	Laysan albatross	Feeding on Catch	5
2016	CS	Laysan albatross	Feeding on Discarded Catch	7
2016	CS	Northern fulmar	Boarded Vessel	2
2016	CS	Short-tailed albatross	Feeding on Catch	2

Table B-30 (continued). U.S. West Coast catch share vessels using bottom or midwater trawl gear, nonlethal seabird interactions, 2011–16.

			Observed	
Year	Sector	Species	Interaction category	Number
2011	MH	Black-footed albatross	Feeding on Catch	242
2011	MH	Fork-tailed storm-petrel	Feeding on Catch	98
2011	MH	Northern fulmar	Boarded Vessel	1
2011	MH	Northern fulmar	Feeding on Catch	740
2011	MH	Northern fulmar	Vessel Strike	1
2011	MH	Parasitic jaeger	Feeding on Catch	1
2011	MH	Pink-footed shearwater	Feeding on Catch	4
2011	MH	Shearwater, unidentified	Entangled In Gear—Not Trailing Gear	1
2011	MH	Short-tailed albatross	Feeding on Catch	1
2011	MH	Jaeger, unidentified	Feeding on Catch	1
2011	MH	Sooty shearwater	Feeding on Catch	12
2011	MH	South polar skua	Feeding on Catch	1
2011	MH	Western gull	Feeding on Catch	23
2012	MH	Short-tailed albatross	Feeding on Catch	2
2013	MH	Short-tailed albatross	Feeding on Catch	1
2014	MH	Laysan albatross	Feeding on Catch	1
2016	MH	Black-footed albatross	Feeding on Catch	1
2015	MR	Gull, unidentified	Feeding on Catch	70

Table B-31. U.S. West Coast catch share vessels using bottom (CS) or midwater (MH/MR) trawl gear, seabird sightings, 2011–16. Sightings are haphazardly collected, often only for ESA-listed species.

Year	Sector	Species	Number of sightings
2011	CS	Black-footed albatross	160
2011	CS	Heermann's gull	9
2011	CS	Northern fulmar	12
2011	CS	Short-tailed albatross	33
2012	CS	Laysan albatross	1
2012	CS	Short-tailed albatross	8
2013	CS	Black-footed albatross	36
2013	CS	Short-tailed albatross	13
2014	CS	Black-footed albatross	25
2014	CS	Short-tailed albatross	3
2015	CS	Black-footed albatross	2
2015	CS	Laysan albatross	2
2015	CS	Short-tailed albatross	1
2016	CS	Black-footed albatross	170
2016	CS	Brown booby	1
2016	CS	Laysan albatross	3
2016	CS	Short-tailed albatross	3
2011	MH	Gull, unidentified	20
2011	MH	Pink-footed shearwater	30
2011	MH	Short-tailed albatross	2
2012	MH	Black-footed albatross	50
2012	MH	Laysan albatross	1
2012	MH	Short-tailed albatross	1
2013	MH	Short-tailed albatross	1
2013	MR	Cassin's auklet	1

Limited Entry (2002–09) and Open Access (2003–16) California Halibut Fishery

Table B-32. California limited entry (LE) California halibut fishery, observer coverage, fishing effort, and observed bird takes, 2002–09. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*). Confidentiality rules require combining LE and OA California halibut fisheries in 2010. Starting in 2011, the LE CA halibut fishery was combined with the catch share bottom trawl vessels.

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Tow hours	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
2002	No birds observed	7	19	52	4824.29	3.59	108.27	0.03	0.00	0
2003	Brandt's 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, unidentified	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, unidentified	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 B-33. California open access (OA) California halibut fishery, observer coverage, fishing effort, and observed bird takes, 2003–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*). The OA CA halibut fishery was not observed in 2006. Confidentiality rules require combining limited entry and OA California halibut fisheries in 2010.

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Tow hours	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
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, unidentified	6	59	362	7752.13	7.43	64.51	0.12	1.00	0
2006	Fishery not observed	0	0	0	—	—	—	—	—	—
2007	Cormorant, unidentified	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, unidentified	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	Brandt's cormorant	6	51	145	5484.31	18.14	81.44	0.22	1.00	0
2015	Bird, unidentified	8	100	339	11546.38	30.61	92.05	0.33	1.00	0
2015	Brandt's 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, unidentified	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

Table B-34. California limited entry (LE) and open access (OA) California halibut fisheries, nonlethal seabird interactions, 2002–16. Confidentiality rules require combining LE and OA California halibut fisheries in 2010. Starting in 2011, the LE CA halibut fishery was combined with the catch share bottom trawl vessels.

			Observed	
Year	**Sector**	**Species**	**Interaction category**	**Number**
2010	LE & OA	Cormorant, unidentified	Boarded Vessel	1
2010	LE & OA	Cormorant, unidentified	Entangled in Gear—Not Trailing Gear	1
2015	OA	Brown pelican	Boarded Vessel	1

Table B-35. California limited entry (LE) and open access (OA) California halibut bottom trawl fisheries seabird sightings, 2002–16. 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 was combined with the catch share bottom trawl vessels.

Year	**Sector**	**Species**	**Number of sightings**
2003	LE	Brown pelican	40
2003	LE	Common murre	10
2003	LE	Gull, unidentified	40

Year	**Sector**	**Species**	**Number of sightings**
2012	OA	Pacific loon	1
2016	OA	California least tern	2

Washington, Oregon, and California Pink Shrimp

Table B-36. Washington, Oregon, and California pink shrimp fisheries, observer coverage, fishing effort, and observed bird takes, 2002–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*). Asterisks (*) indicate confidential data; dashes (—) indicate years when the particular fishery was not observed.

			Observed						Observed		
State	Year	Species	Vessels	Trips	Sets	Tow hours	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
WA	2002	Fishery not observed	0	0	0	—	—	—	—	—	—
WA	2003	Fishery not observed	0	0	0	—	—	—	—	—	—
WA	2004	No birds observed	*	*	*	*	*	*	*	0.00	0
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	4295.60	0.09	0.00	0
WA	2011	No birds observed	11	35	578	12142.38	697.24	4312.14	0.16	0.00	0
WA	2012	Sooty shearwater	10	31	522	9751.98	625.95	4239.40	0.15	14.00	0
WA	2013	No birds observed	13	29	386	5731.42	626.82	6157.86	0.10	0.00	0
WA	2014	Gull, unidentified	17	44	401	6536.66	980.85	13876.25	0.07	1.00	0
WA	2015	No birds observed	24	100	1458	31290.56	2151.09	18814.34	0.11	0.00	0
WA	2016	No birds observed	17	59	974	21828.61	1107.93	6395.87	0.17	0.00	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	0.00	0

Table B-36 (continued). Washington, Oregon, and California pink shrimp fisheries, observer coverage, fishing effort, and observed bird takes, 2002–16.

			Observed						Observed		
State	Year	Species	Vessels	Trips	Sets	Tow hours	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
OR	2005	No birds observed	22	36	533	12441.05	402.89	7159.42	0.06	0.00	0
OR	2006	Fishery not observed	0	0	0	—	—	—	—	—	—
OR	2007	No birds observed	28	61	929	19047.50	649.98	9128.60	0.07	0.00	0
OR	2008	No birds observed	30	49	785	17144.57	672.49	11575.86	0.06	0.00	0
OR	2009	No birds observed	34	52	672	10586.31	751.20	10048.69	0.07	0.00	0
OR	2010	No birds observed	39	94	1233	19055.05	1706.84	14290.37	0.12	0.00	0
OR	2011	No birds observed	41	132	1892	36261.35	2985.96	21915.06	0.14	0.00	0
OR	2012	No birds observed	52	154	2122	28754.77	3014.22	22291.59	0.14	0.00	0
OR	2013	Sooty shearwater	46	107	1403	20142.96	2313.24	21604.27	0.11	13.54	0
OR	2014	Shearwater, unidentified	38	106	1463	25802.88	2291.35	23573.30	0.10	2.00	0
OR	2015	No birds observed	42	131	1990	31465.94	2282.09	24273.62	0.09	0.00	0
OR	2016	No birds observed	54	157	2467	46138.74	2309.36	16115.58	0.14	0.00	0
CA	2002	Fishery not observed	0	0	0	—	—	—	—	—	—
CA	2003	Fishery not observed	0	0	0	—	—	—	—	—	—
CA	2004	No birds observed	*	*	*	*	*	*	*	0.00	0
CA	2005	No birds observed	*	*	*	*	*	*	*	0.00	0
CA	2006	Fishery not observed	0	0	0	—	—	—	—	—	—
CA	2007	No birds observed	*	*	*	*	*	*	*	0.00	0
CA	2008	No birds observed	*	*	*	*	*	*	*	0.00	0
CA	2009	No birds observed	*	*	*	*	*	*	*	0.00	0
CA	2010	No birds observed	8	14	134	1193.87	265.53	1770.87	0.15	0.00	0

Table B-36 (continued). Washington, Oregon, and California pink shrimp fisheries, observer coverage, fishing effort, and observed bird takes, 2002–16.

			Observed						Observed		
State	Year	Species	Vessels	Trips	Sets	Tow hours	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
CA	2011	Pink-footed shearwater	8	19	203	1720.44	420.59	3332.92	0.13	1.00	0
CA	2012	No birds observed	7	15	175	1178.01	347.60	2790.62	0.12	0.00	0
CA	2013	No birds observed	10	17	188	1357.95	359.77	3915.31	0.09	0.00	0
CA	2014	No birds observed	11	26	337	3666.42	597.53	3844.99	0.16	0.00	0
CA	2015	No birds observed	9	23	335	4976.99	334.66	3452.95	0.10	0.00	0
CA	2016	No birds observed	11	28	406	8103.87	313.38	1337.21	0.23	0.00	0

Table B-37. Washington, Oregon, and California pink shrimp fisheries, nonlethal seabird interactions, 2002–16.

			Observed	
State	Year	Species	Interaction category	Number
WA	2012	Sooty shearwater	Entangled in Gear—Not Trailing Gear	4
WA	2014	Cassin's auklet	Boarded Vessel	1
WA	2014	Sooty shearwater	Boarded Vessel	1
WA	2015	Fork-tailed storm-petrel	Boarded Vessel	1
WA	2015	Pink-footed shearwater	Vessel Strike	1
OR	2004	Northern fulmar	Boarded Vessel	1
OR	2005	Wilson's warbler	Boarded Vessel	1
OR	2011	Cassin's auklet	Boarded Vessel	3
OR	2011	Northern fulmar	Boarded Vessel	1
OR	2012	Laysan albatross	Feeding on Catch	2
OR	2012	Sooty shearwater	Boarded Vessel	2
OR	2013	Cassin's auklet	Boarded Vessel	2
OR	2013	Leach's storm-petrel	Boarded Vessel	1
OR	2013	Sooty shearwater	Boarded Vessel	3
OR	2013	Storm-petrel, unidentified	Boarded Vessel	3
OR	2014	California gull	Boarded Vessel	1
OR	2014	Cassin's auklet	Boarded Vessel	6
OR	2015	Snowy plover	Boarded Vessel	1

Table B-38. Washington, Oregon, and California pink shrimp fisheries, seabird sightings, 2002–16. Sightings are haphazardly collected, often only for ESA-listed species.

Year	Species	Number of sightings
2004	Laysan albatross	2
2004	Short-tailed albatross	1
2004	Tufted puffin	4
2005	Pink-footed shearwater	3
2005	Sooty shearwater	175
2007	Bird, unidentified	1
2009	Tufted puffin	1
2010	Short-tailed albatross	1
2011	Black-footed albatross	32
2013	Sooty shearwater	1
2014	Cassin's auklet	1
2015	Black-footed albatross	10
2015	Tufted puffin	1
2016	Black-footed albatross	1
2016	Tufted puffin	2

Exempted Fishing Permits

Electronic Monitoring

Table B-39. U.S. West Coast catch share vessels fishing with bottom and midwater trawl gear and participating in the Electronic Monitoring Exempted Fishing Permit, fishery observer coverage, fishing effort, and observed bird takes, 2015–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled (*Opp.*).

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Tow hours	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
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 B-40. U.S. West Coast catch share vessels fishing with pot gear and participating in the Electronic Monitoring Exempted Fishing Permit, fishery observer coverage, fishing effort, and observed bird takes, 2015–16. Observed bird takes are either randomly sampled (observed number) or opportunistically sampled.

		Observed						Observed		
Year	Species	Vessels	Trips	Sets	Units	Retained (mt)	Landed (mt)	Coverage rate	Takes	Opp.
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 B-41. U.S. West Coast catch share vessels participating in the Electronic Monitoring Exempted Fishing Permit, nonlethal seabird interactions, 2015–16.

			Observed	
Year	Gear	Species	Interaction category	Number
2015	Trawl	Northern fulmar	Boarded Vessel	1
2015	Trawl	Storm-petrel, unidentified	Boarded Vessel	1
2016	Trawl	Black-footed albatross	Feeding on Catch	90
2016	Trawl	Laysan albatross	Boarded Vessel	1
2016	Pot	Leach's storm-petrel	Boarded Vessel	2

Table B-42. U.S. West Coast catch share vessels participating in the Electronic Monitoring Exempted Fishing Permit, seabird sightings, all gear types, 2015–16. It is a higher priority to document sightings of ESA-listed species than nonlisted species.

Year	Gear	Species	Number of sightings
2015	Pot	Black-footed albatross	2

Non-EM Exempted Fishing Permit

Table B-43. Observed seabird interactions and sightings from Exempted Fishing Permit (EFP) fisheries not participating in electronic monitoring, 2002–16. These fisheries have had observers collecting data on every trip (100% observer coverage).

			Observed	
Year	**Gear**	**Species**	**Interaction category**	**Number**
2015	Trawl	Northern fulmar	Boarded Vessel	1
2015	Trawl	Storm-petrel, unidentified	Boarded Vessel	1
2016	Trawl	Black-footed albatross	Feeding on Catch	90
2016	Trawl	Laysan albatross	Boarded Vessel	1
2016	Pot	Leach's storm-petrel	Boarded Vessel	2

Other Fishery Observations

Table B-44. Observed seabird interactions and sightings from fisheries no longer observed by NWFSC or where the fishery was unknown, 2002–16.

			Observed	
Year	**Sector**	**Species**	**Interaction category**	**Number**
2003	Prawn	Brown pelican	Sighting Only	9
2003	Prawn	Cormorant, unidentified	Entangled in Gear—Not Trailing Gear	1
2004	Prawn	Brown pelican	Boarded Vessel	1
2016	Unknown	Black-footed albatross	Boarded Vessel	1

Appendix C:
Bayesian and Ratio Estimator Comparisons

Limited Entry Sablefish

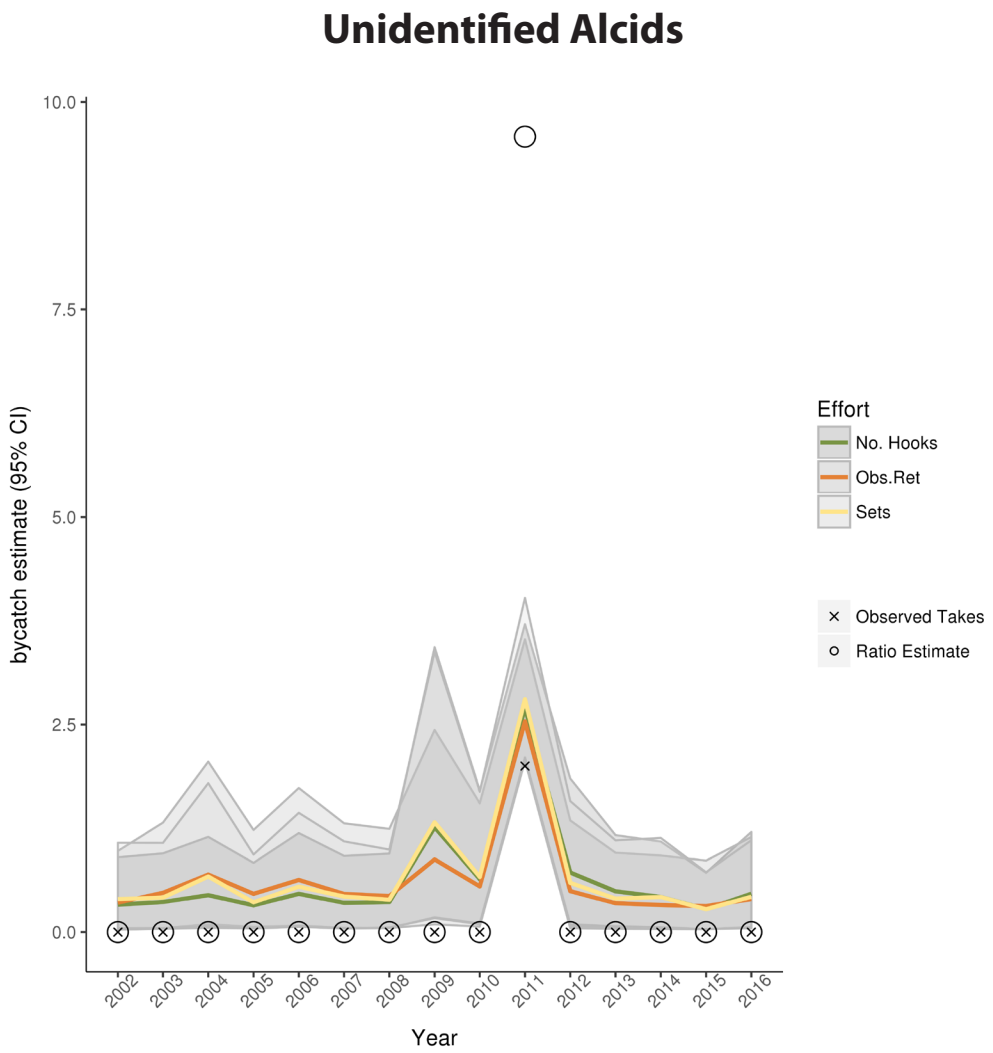

Figure C-1. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified alcids for hook-and-line vessels in the limited entry sablefish fishery.

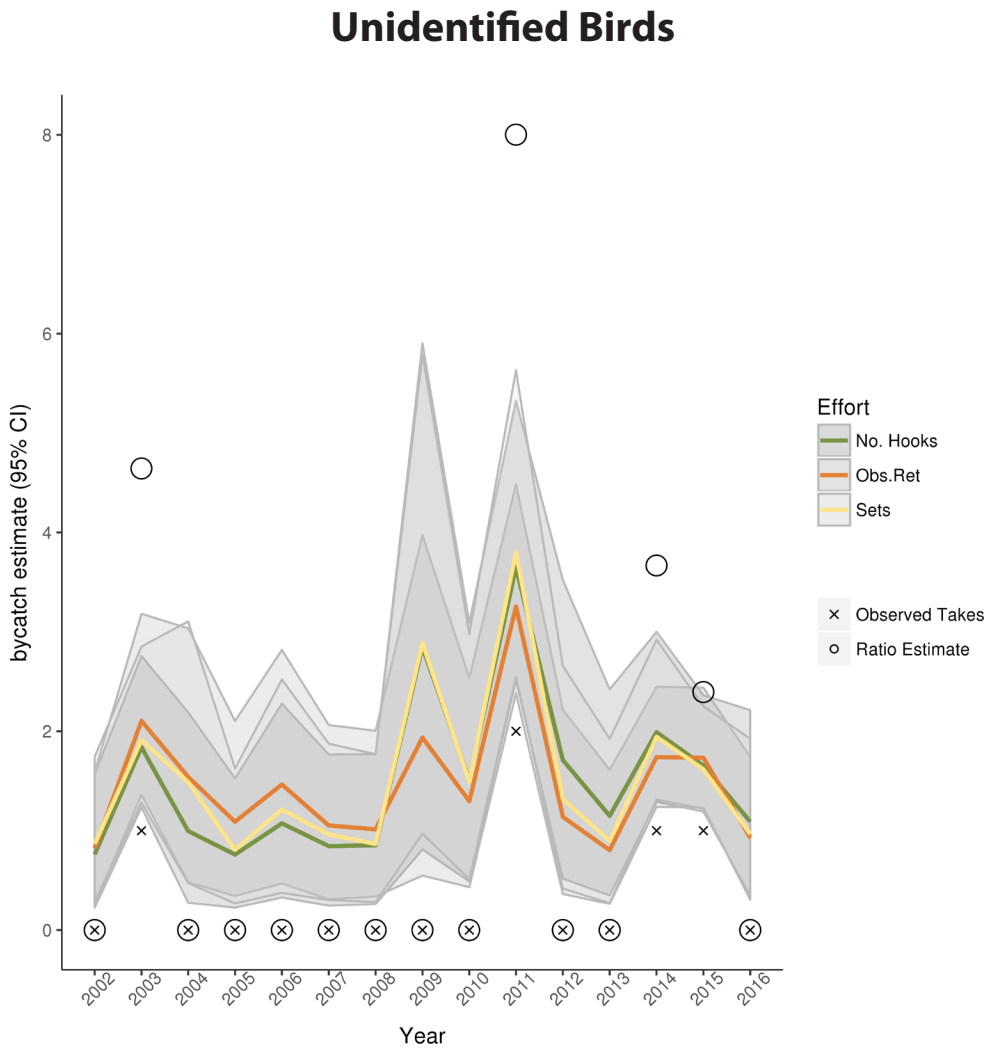

Figure C-2. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified birds for hook-and-line vessels in the limited entry sablefish fishery.

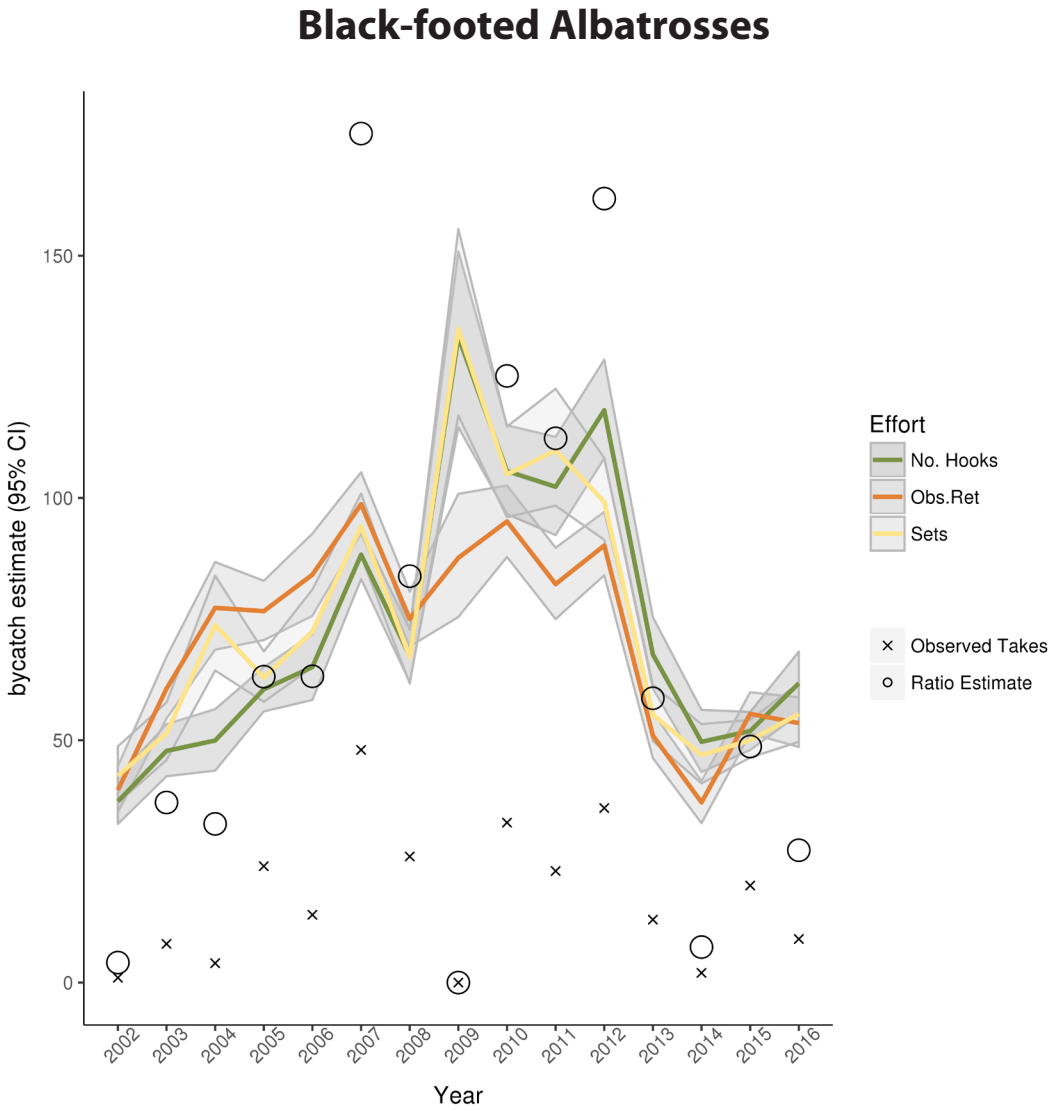

Figure C-3. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for black-footed albatrosses for hook-and-line vessels in the limited entry sablefish fishery.

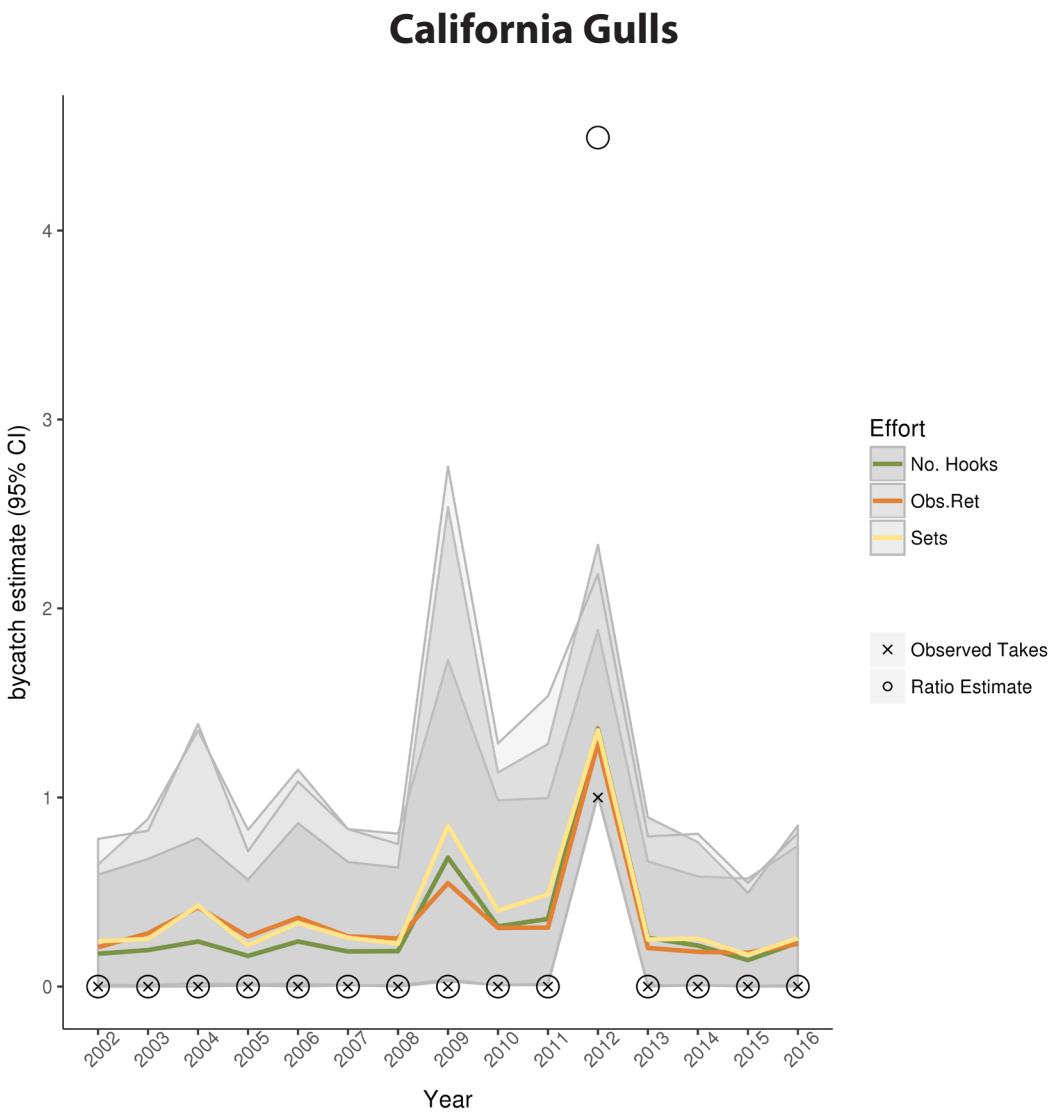

Figure C-4. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for California gulls for hook-and-line vessels in the limited entry sablefish fishery.

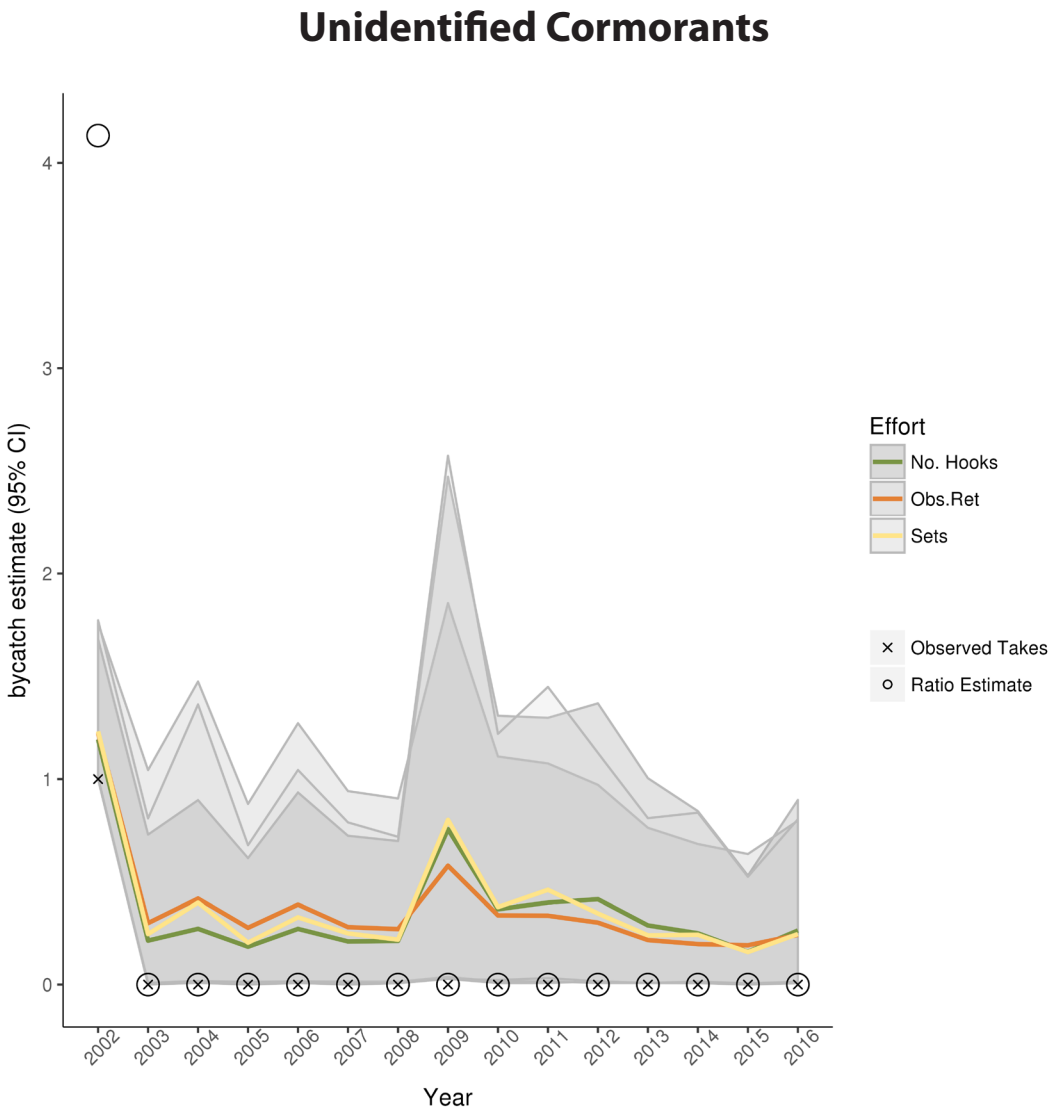

Figure C-5. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified cormorants for hook-and-line vessels in the limited entry sablefish fishery.

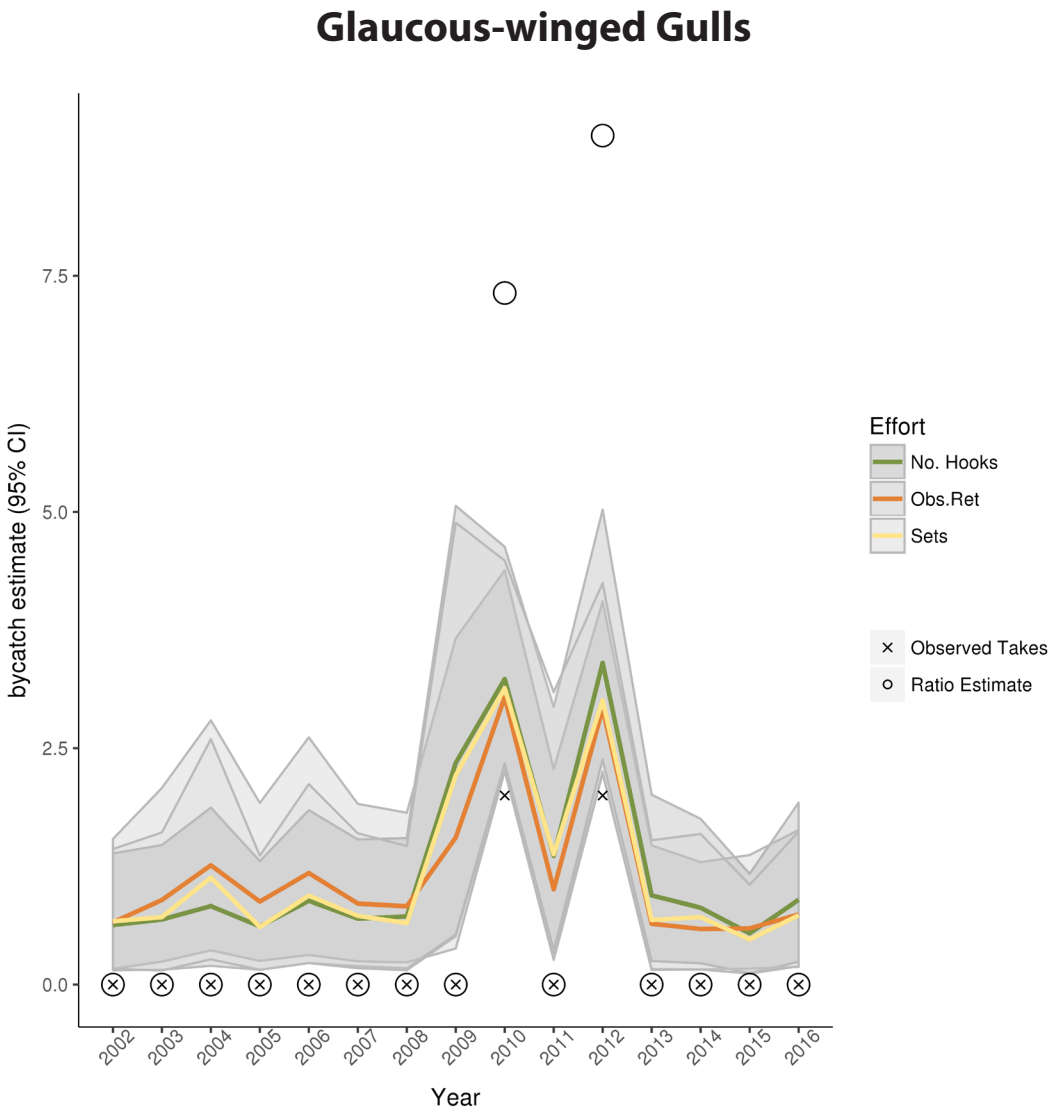

Figure C-6. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for glaucous-winged gulls for hook-and-line vessels in the limited entry sablefish fishery.

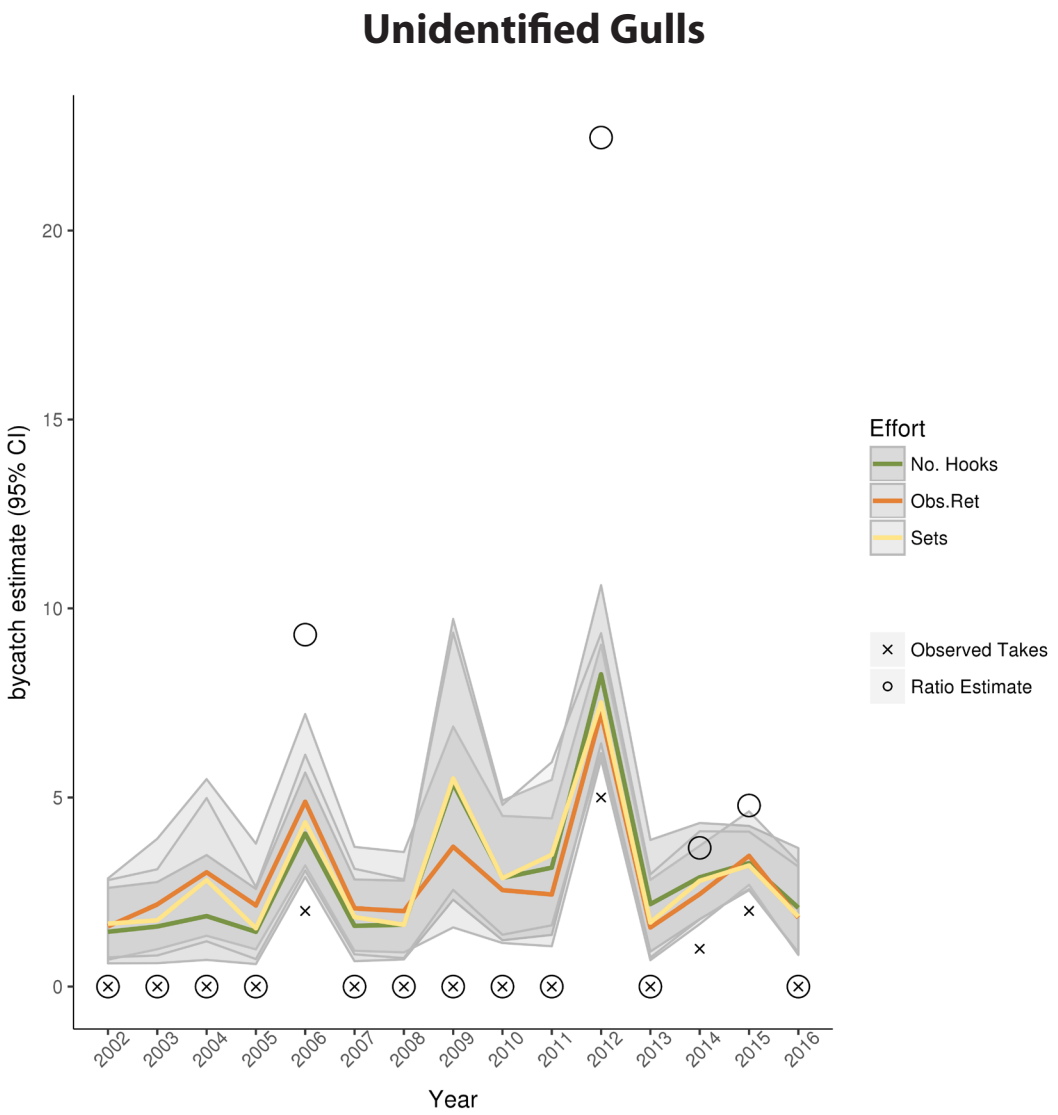

Figure C-7. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified gulls for hook-and-line vessels in the limited entry sablefish fishery.

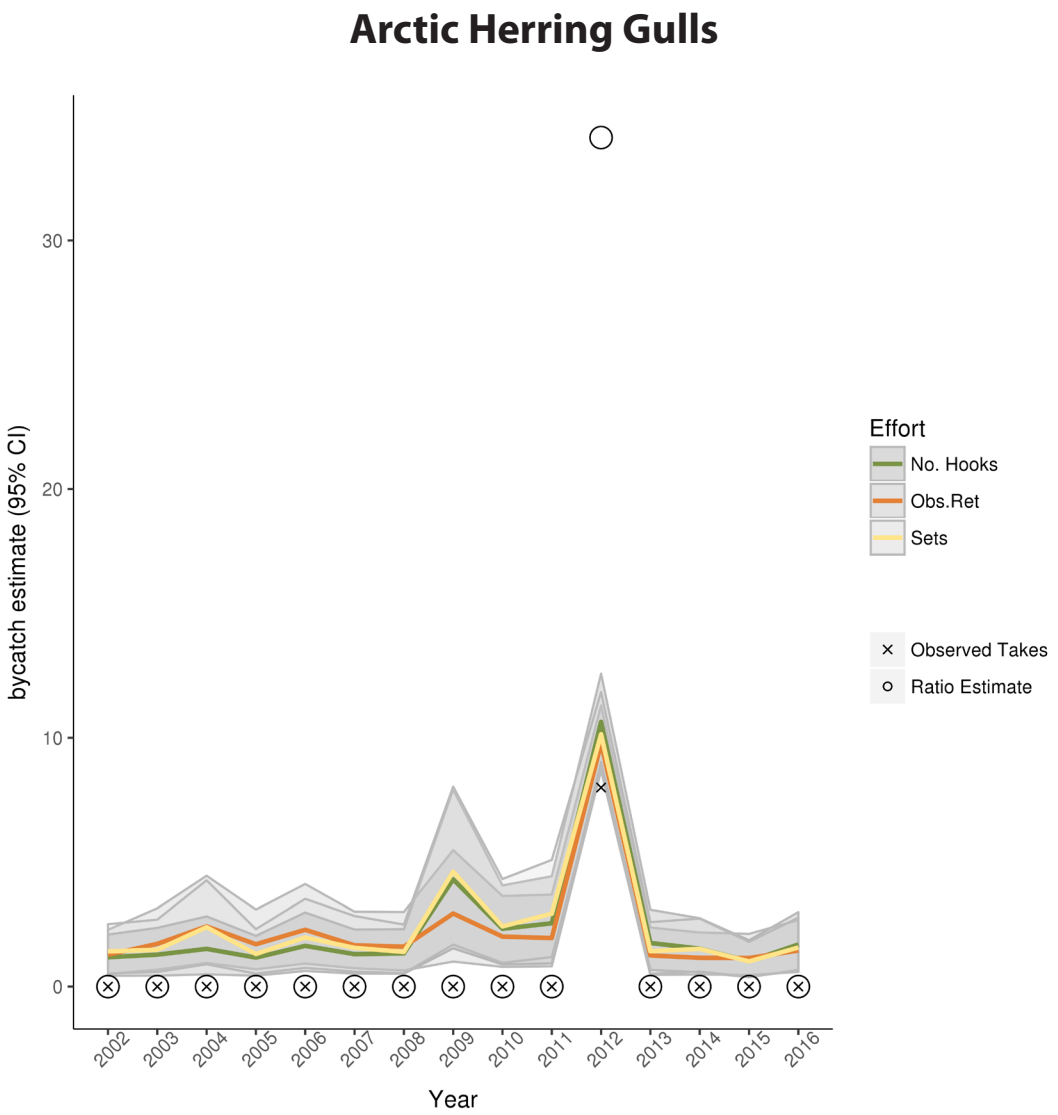

Figure C-8. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for Arctic herring gulls for hook-and-line vessels in the limited entry sablefish fishery.

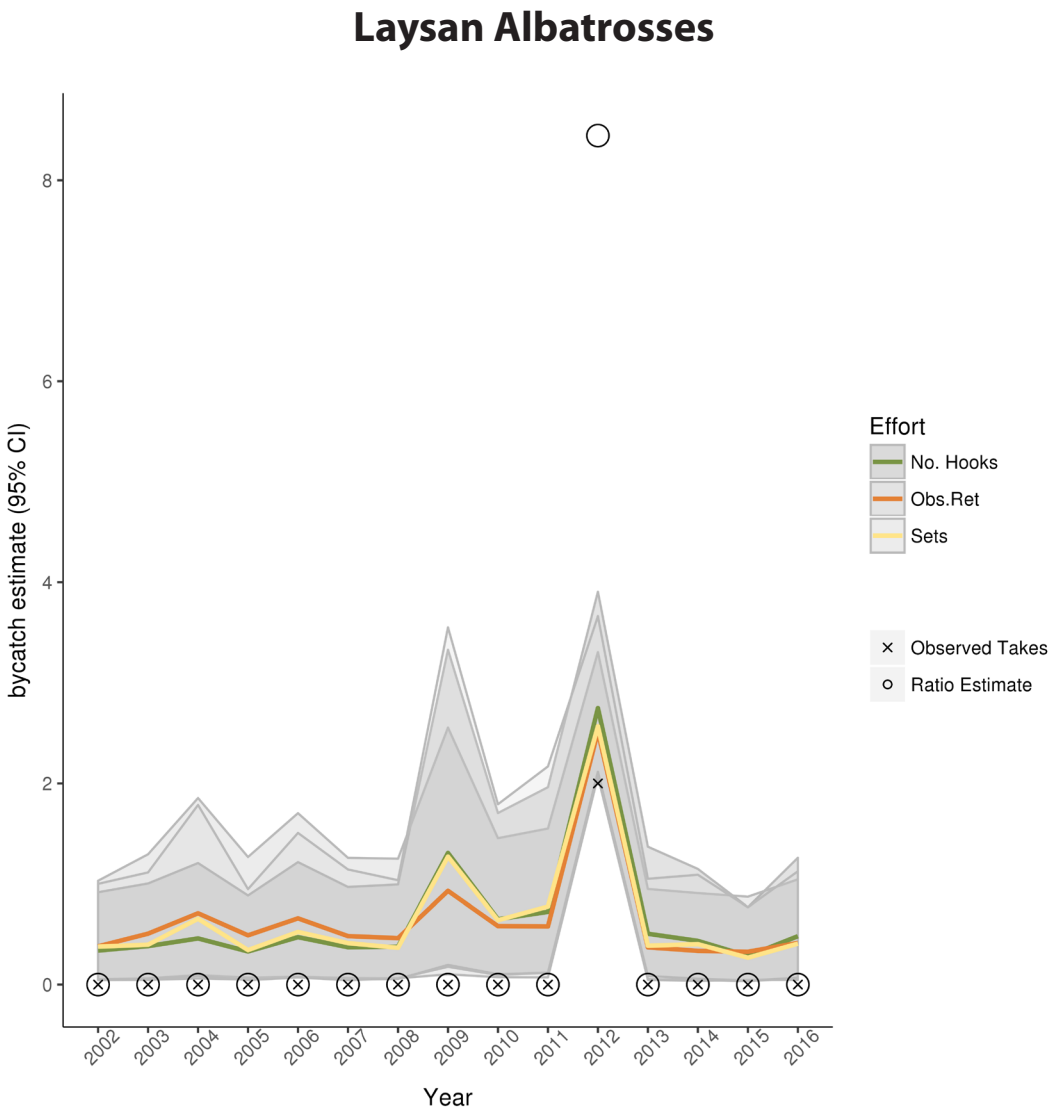

Figure C-9. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for Laysan albatrosses for hook-and-line vessels in the limited entry sablefish fishery.

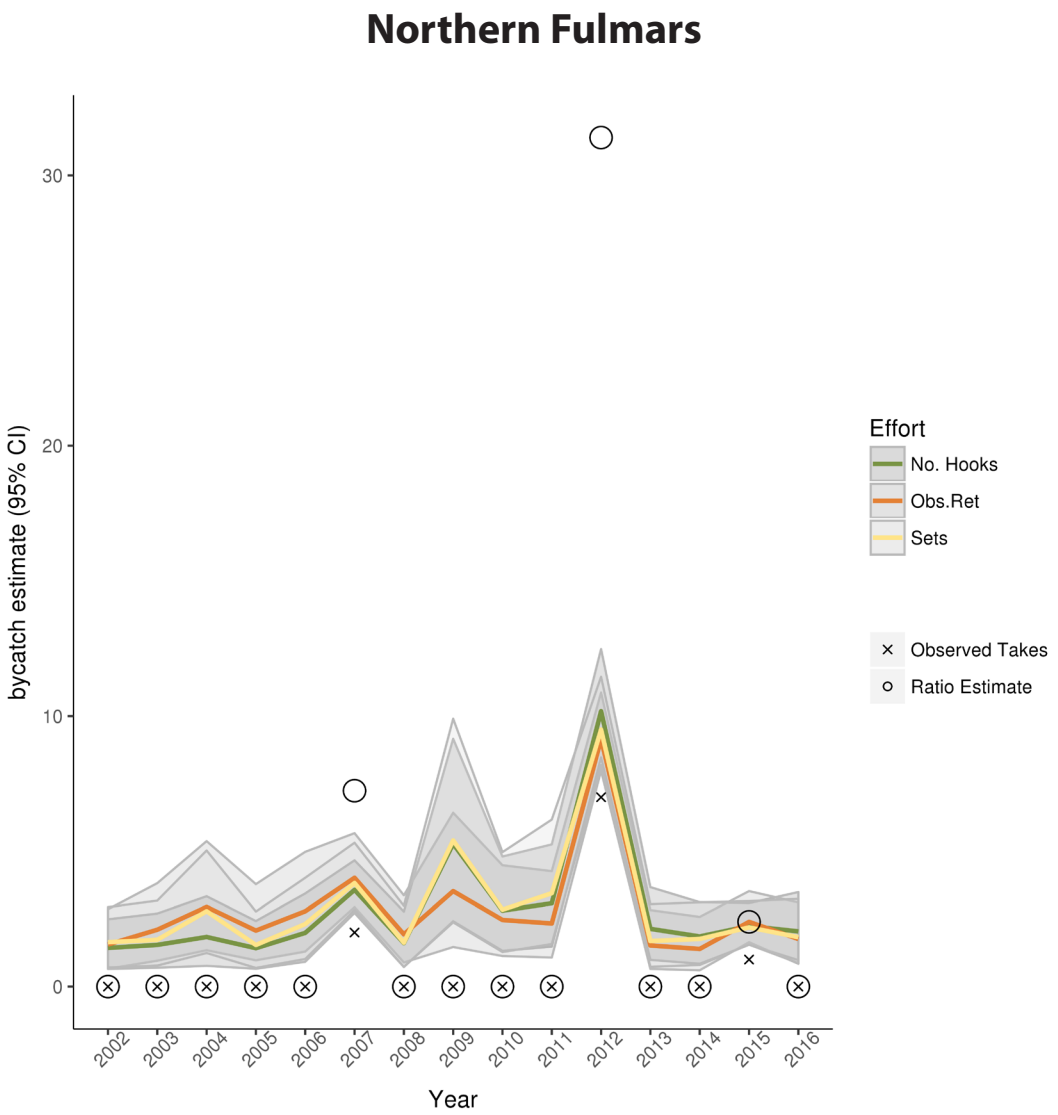

Figure C-10. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for northern fulmars for hook-and-line vessels in the limited entry sablefish fishery.

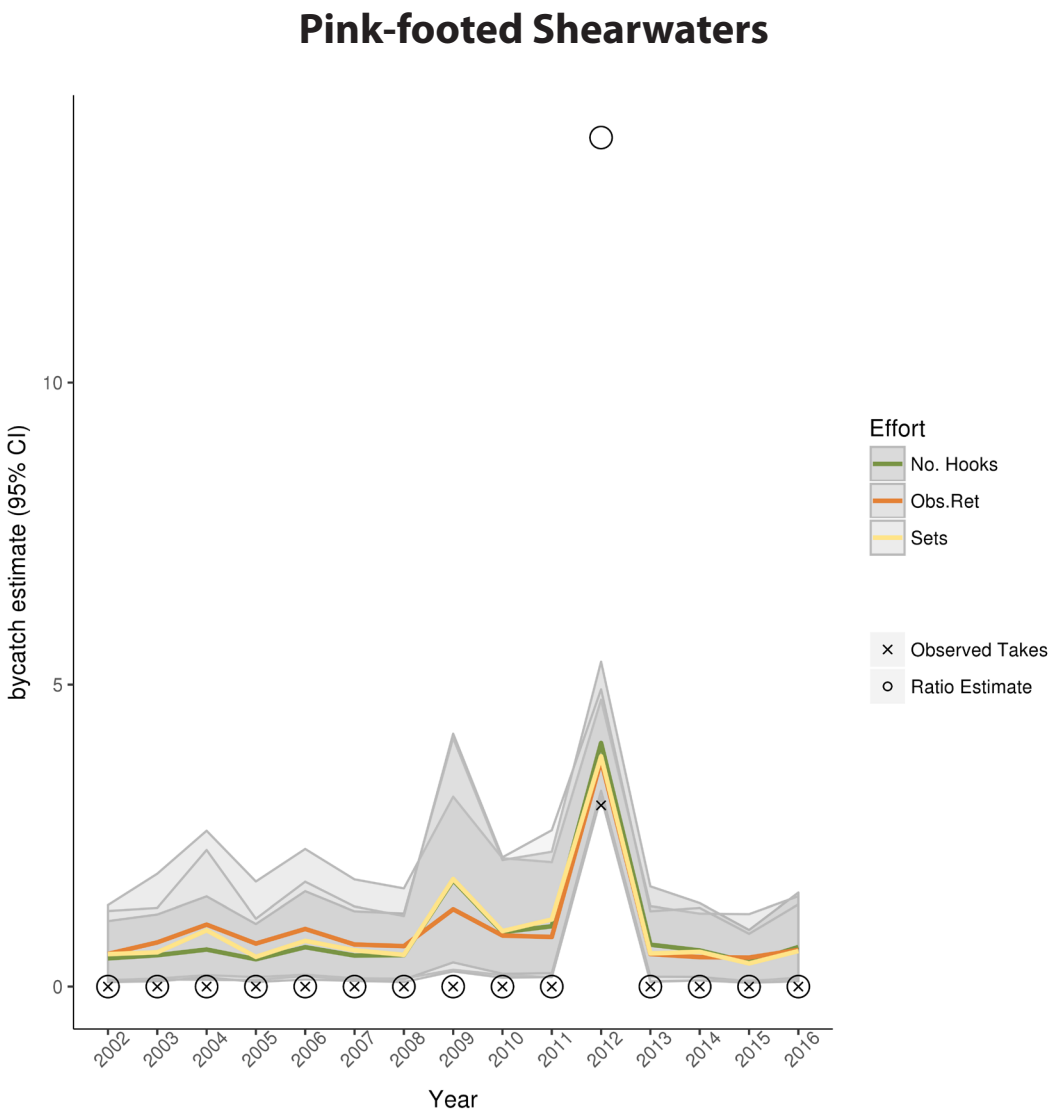

Figure C-11. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for pink-footed shearwaters for hook-and-line vessels in the limited entry sablefish fishery.

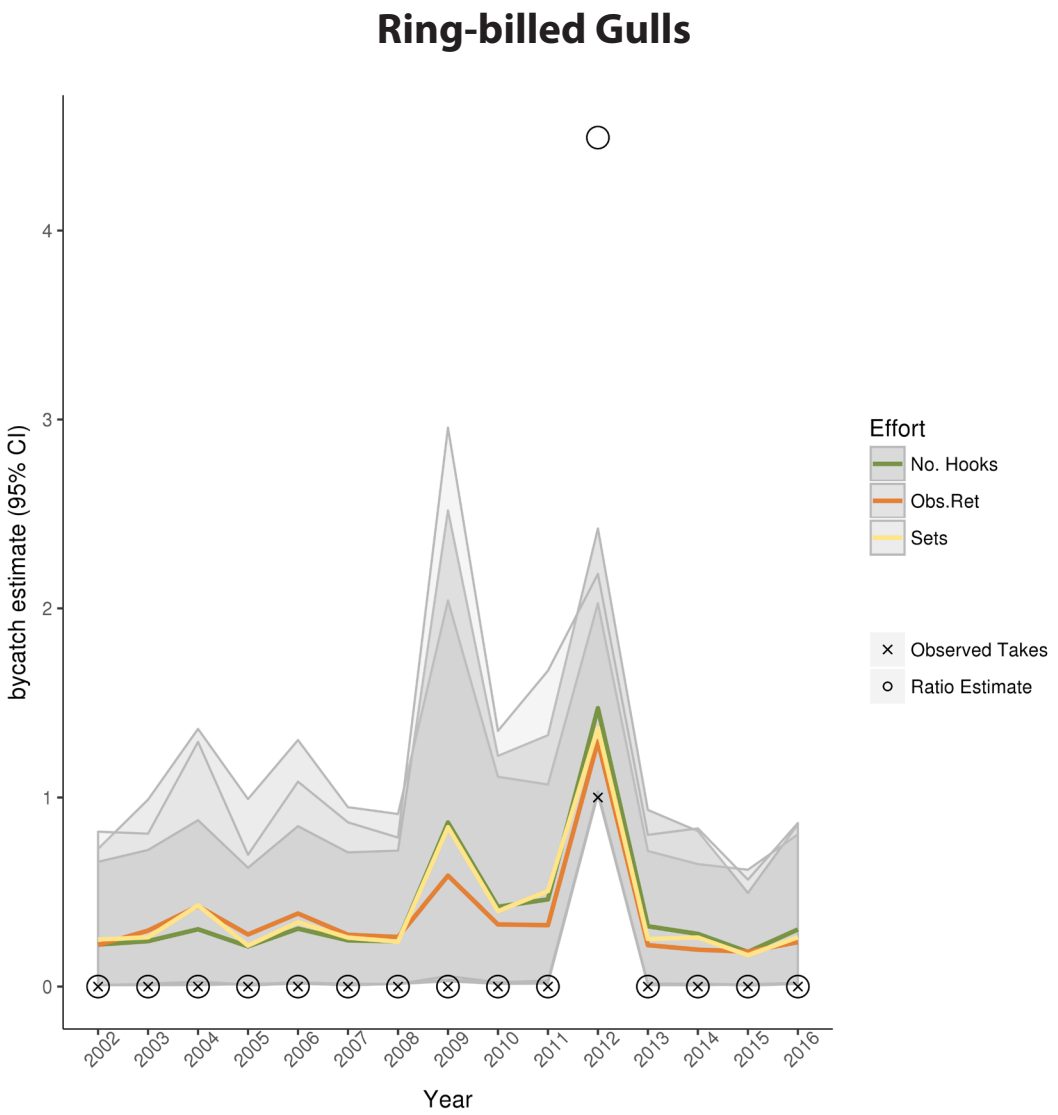

Figure C-12. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for ring-billed gulls for hook-and-line vessels in the limited entry sablefish fishery.

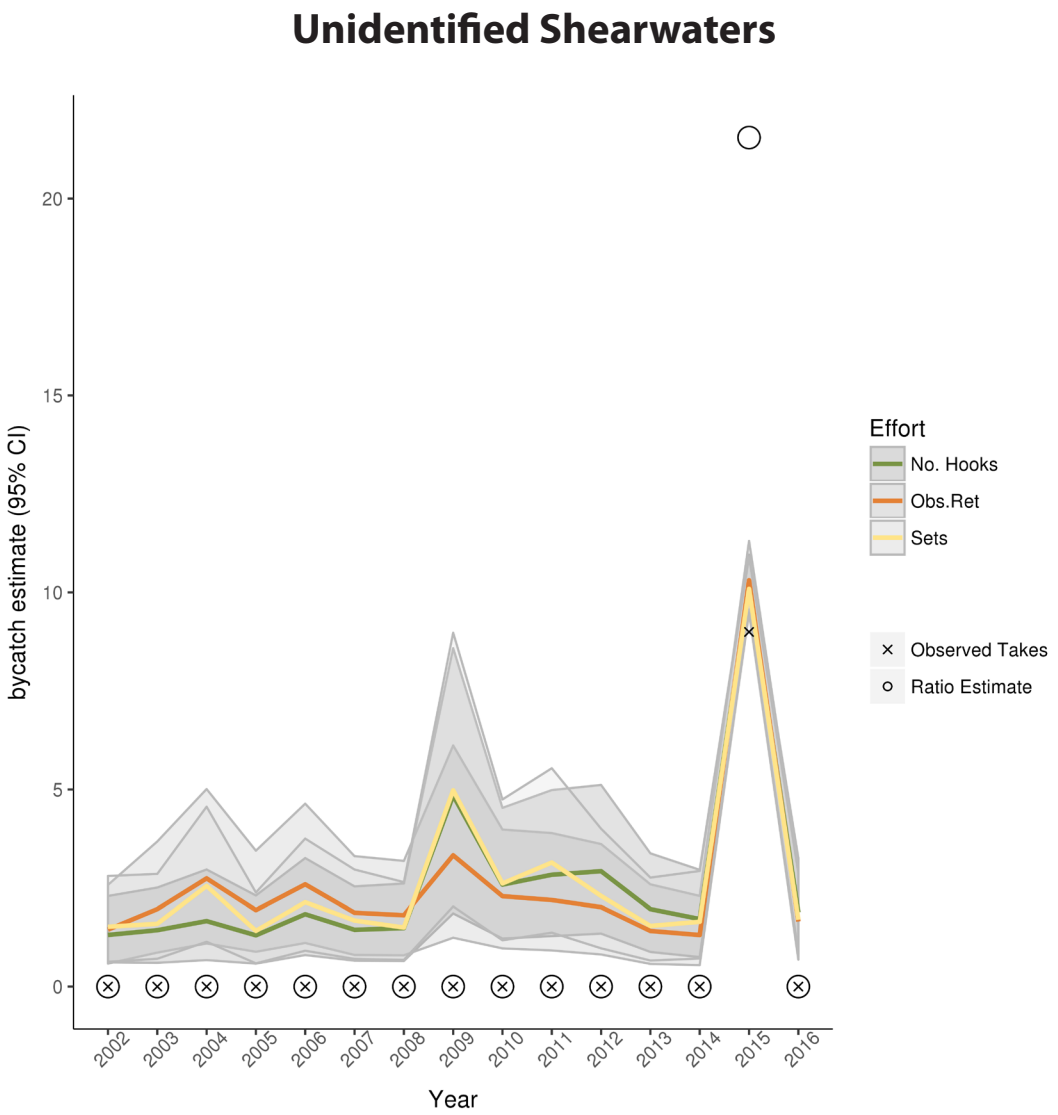

Figure C-13. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified shearwaters for hook-and-line vessels in the limited entry sablefish fishery.

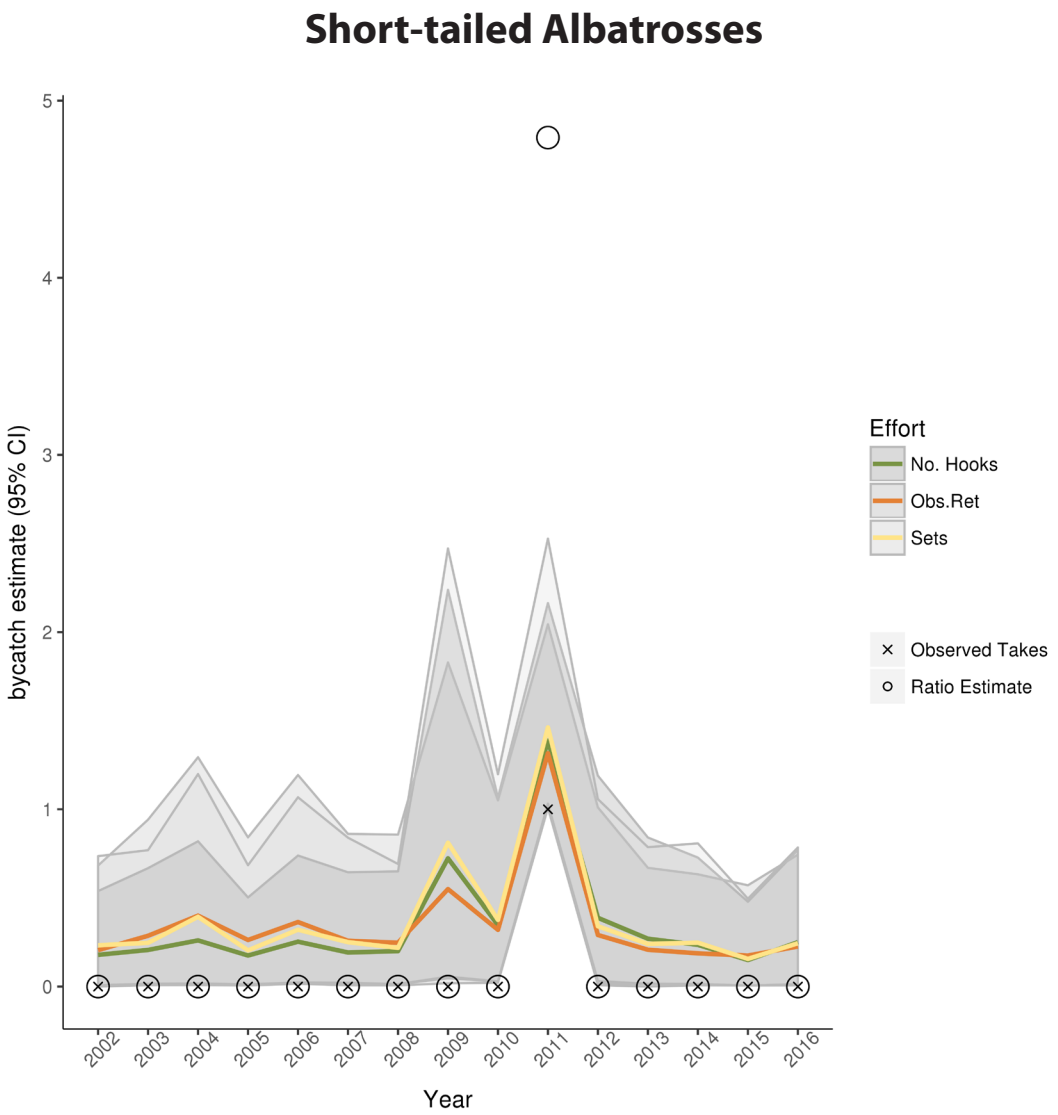

Figure C-14. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for short-tailed albatrosses for hook-and-line vessels in the limited entry sablefish fishery.

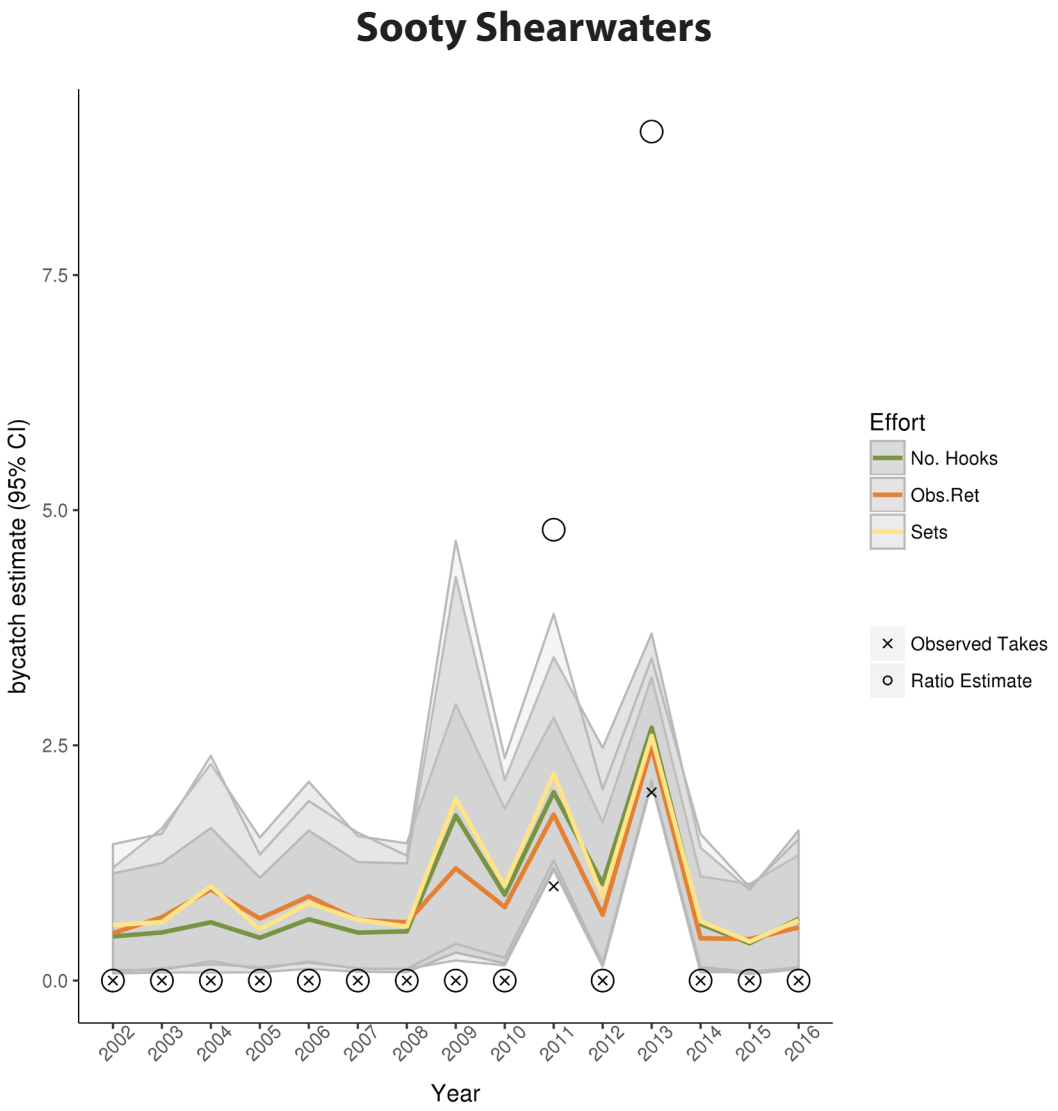

Figure C-15. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for sooty shearwaters for hook-and-line vessels in the limited entry sablefish fishery.

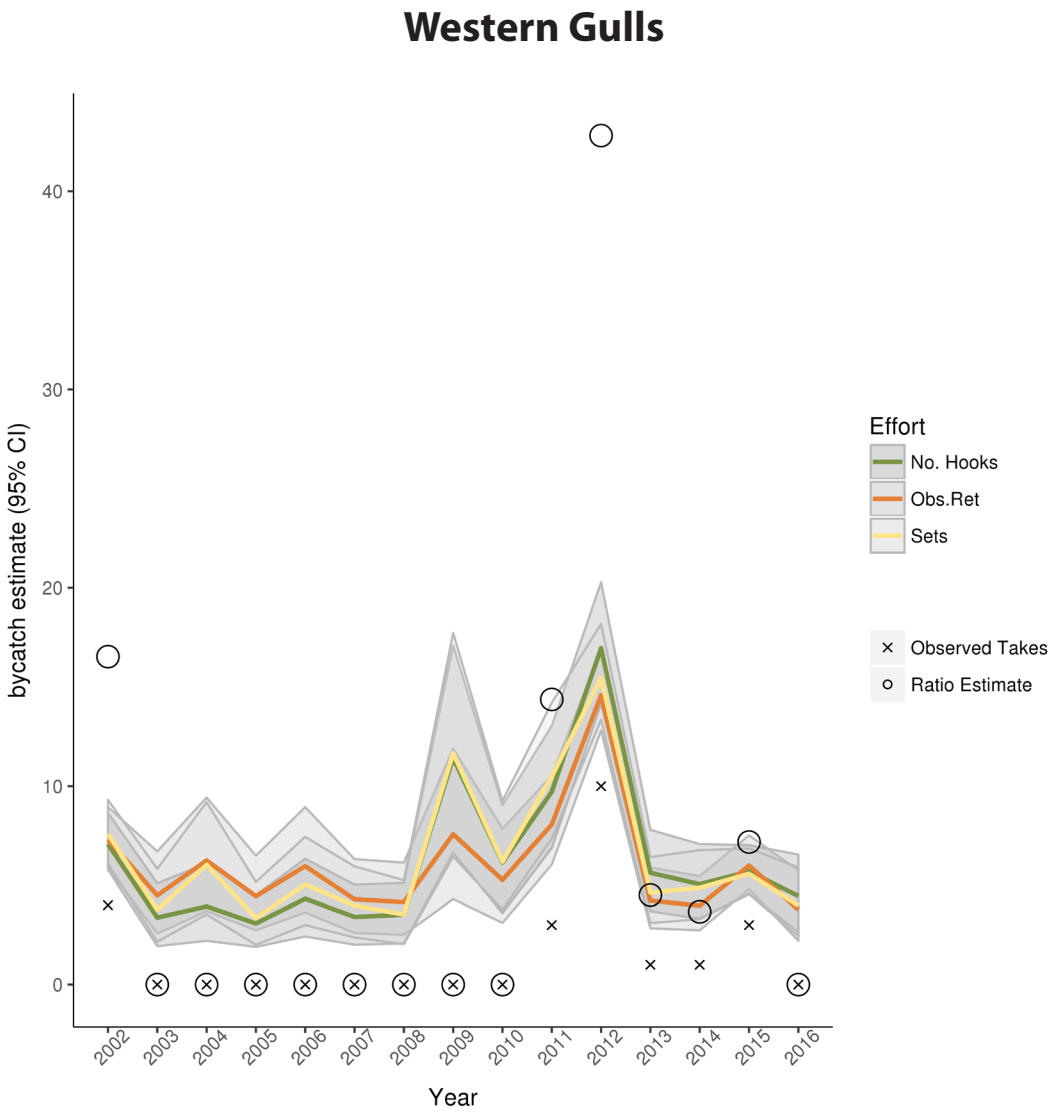

Figure C-16. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for western gulls for hook-and-line vessels in the limited entry sablefish fishery.

Limited Entry Fixed Gear Daily Trip Limits

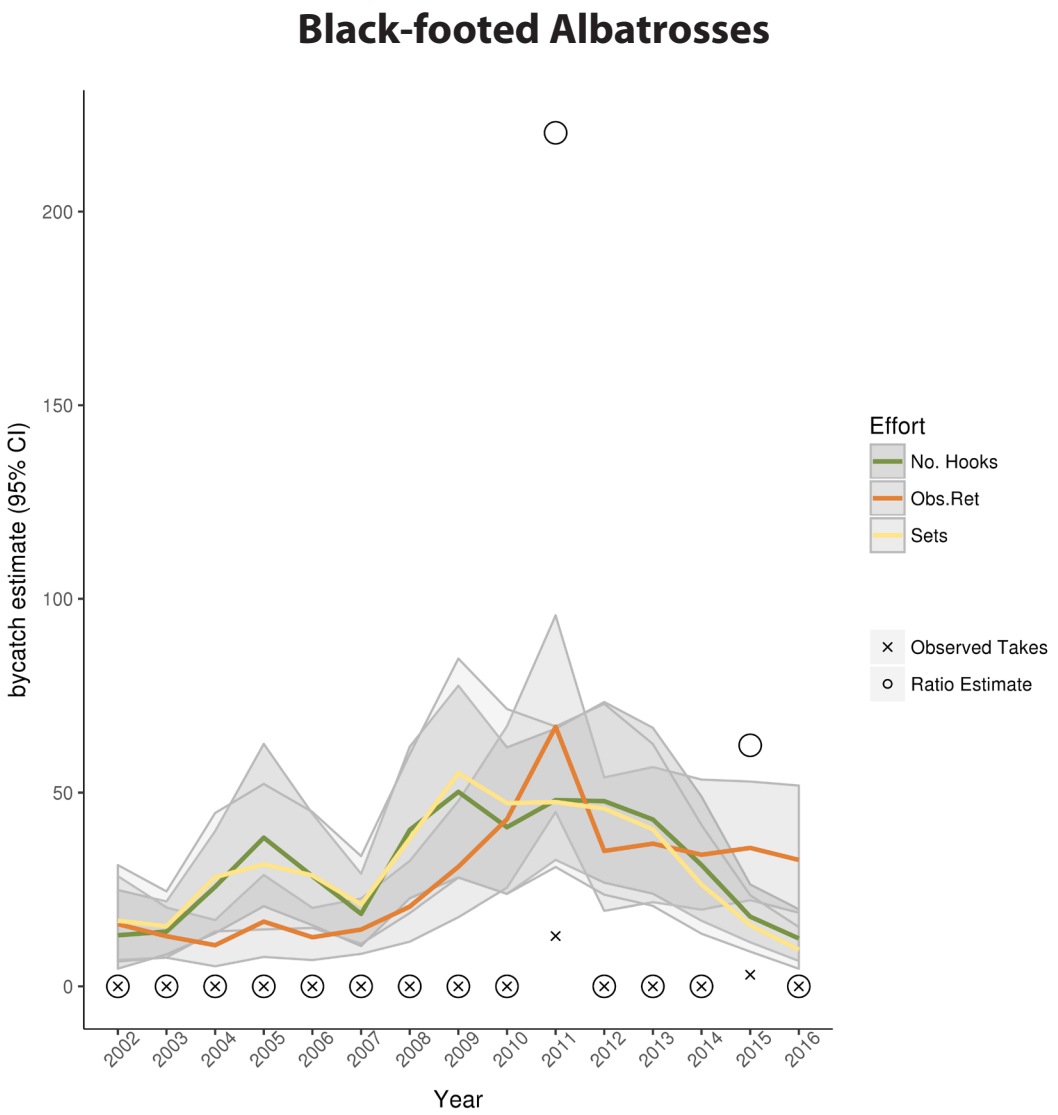

Figure C-17. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for black-footed albatrosses for hook-and-line vessels in the limited entry fixed gear daily trip limits fishery.

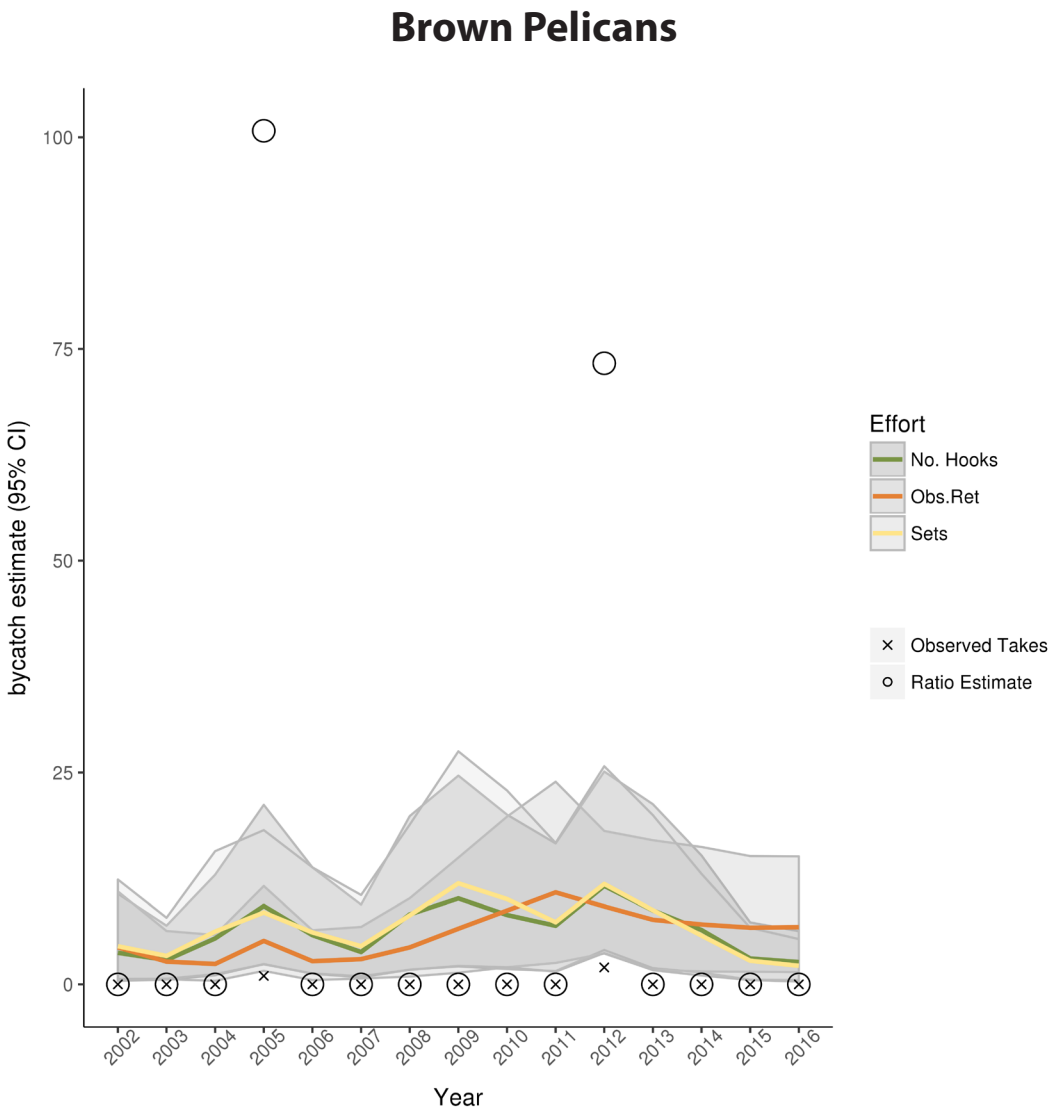

Figure C-18. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for brown pelicans for hook-and-line vessels in the limited entry fixed gear daily trip limits fishery.

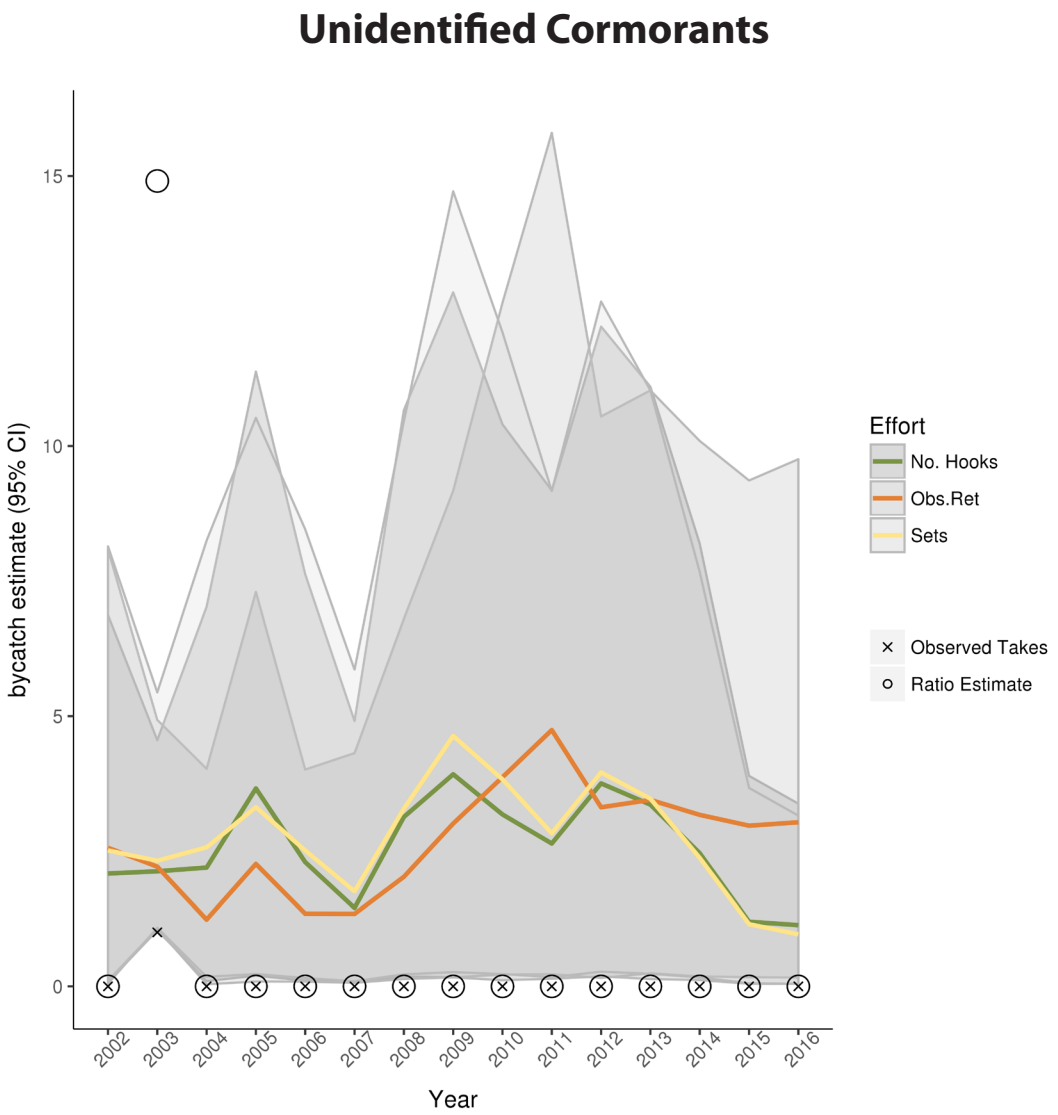

Figure C-19. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified cormorants for hook-and-line vessels in the limited entry fixed gear daily trip limits fishery.

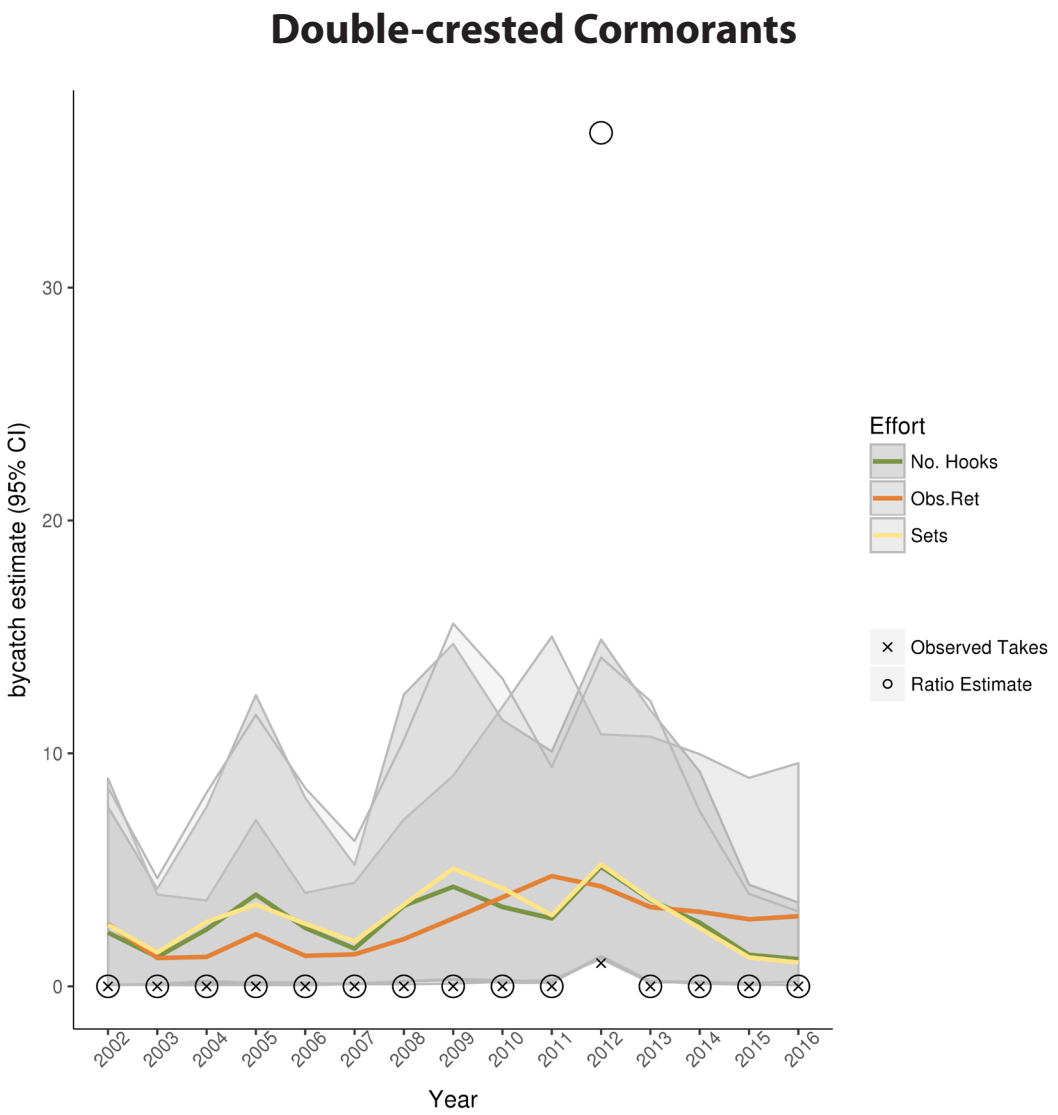

Figure C-20. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for double-crested cormorants for hook-and-line vessels in the limited entry fixed gear daily trip limits fishery.

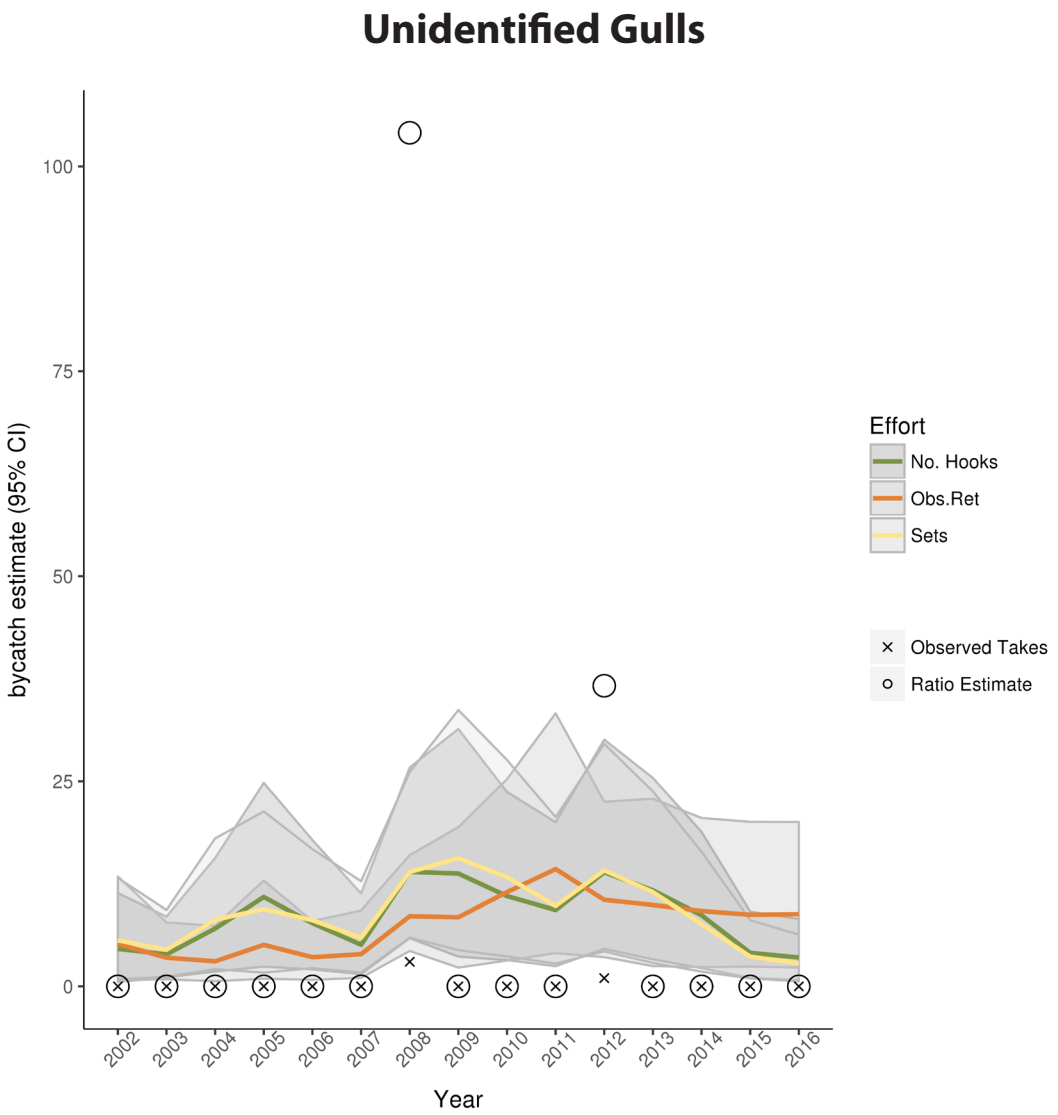

Figure C-21. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified gulls for hook-and-line vessels in the limited entry fixed gear daily trip limits fishery.

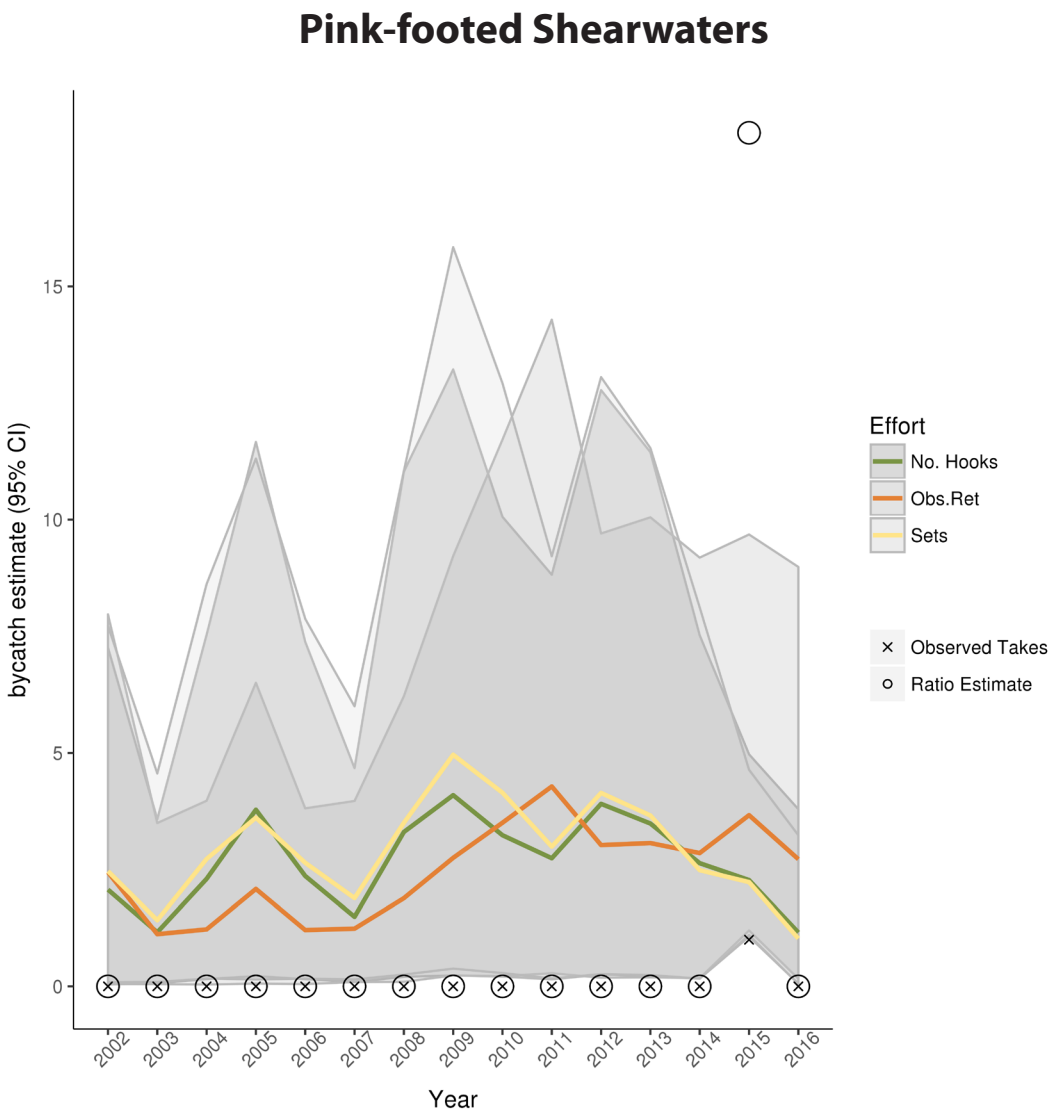

Figure C-22. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for pink-footed shearwaters for hook-and-line vessels in the limited entry fixed gear daily trip limits fishery.

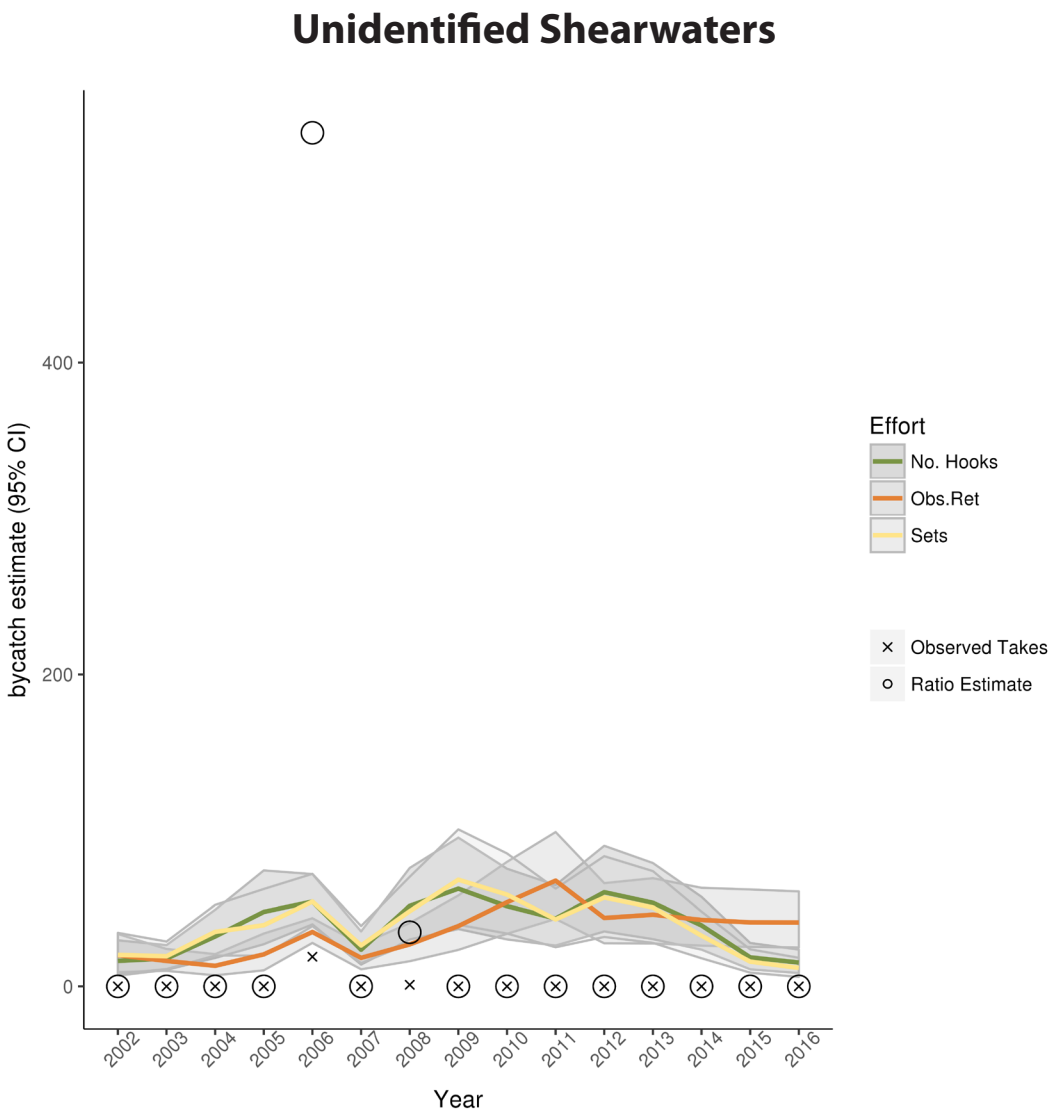

Figure C-23. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified shearwaters for hook-and-line vessels in the limited entry fixed gear daily trip limits fishery.

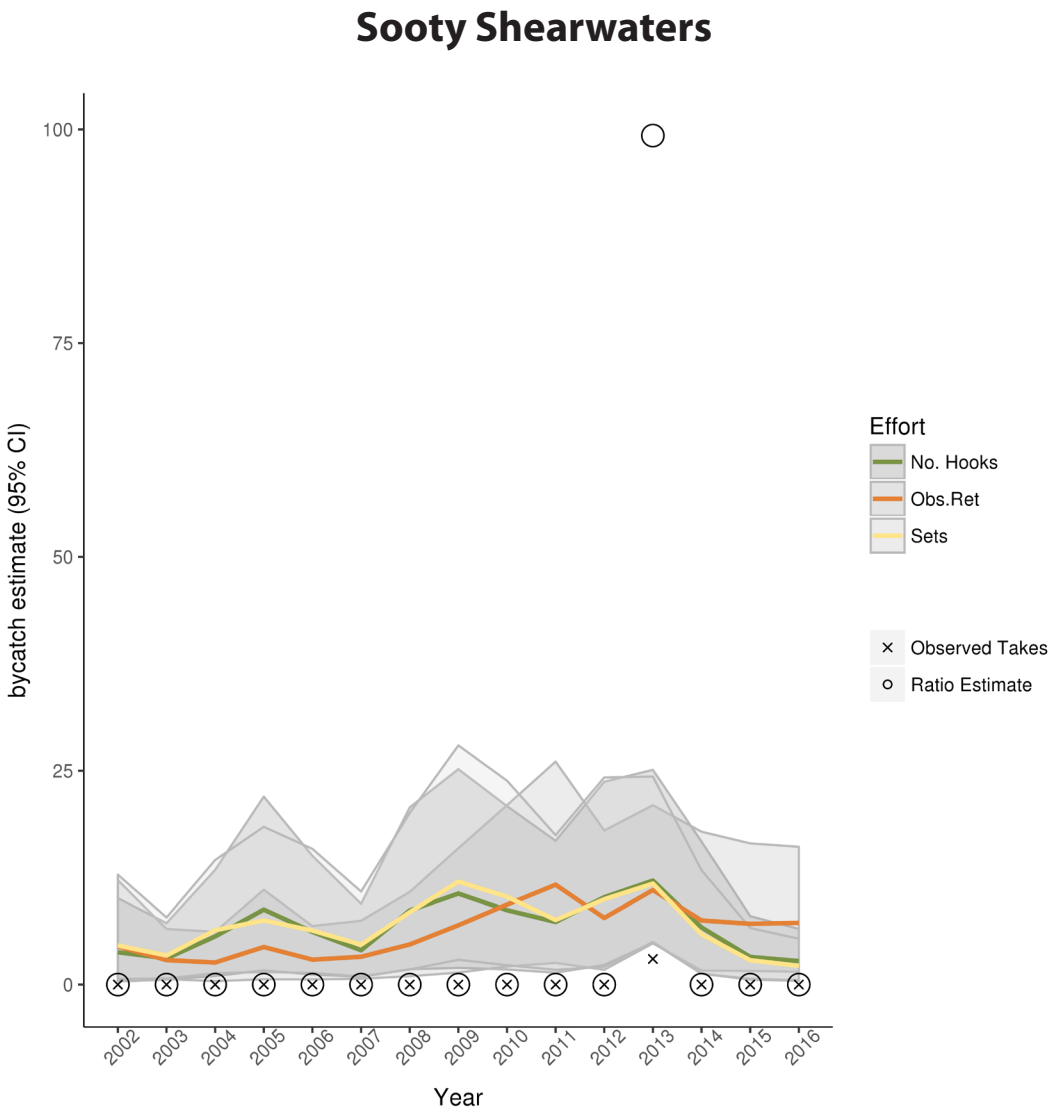

Figure C-24. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for sooty shearwaters for hook-and-line vessels in the limited entry fixed gear daily trip limits fishery.

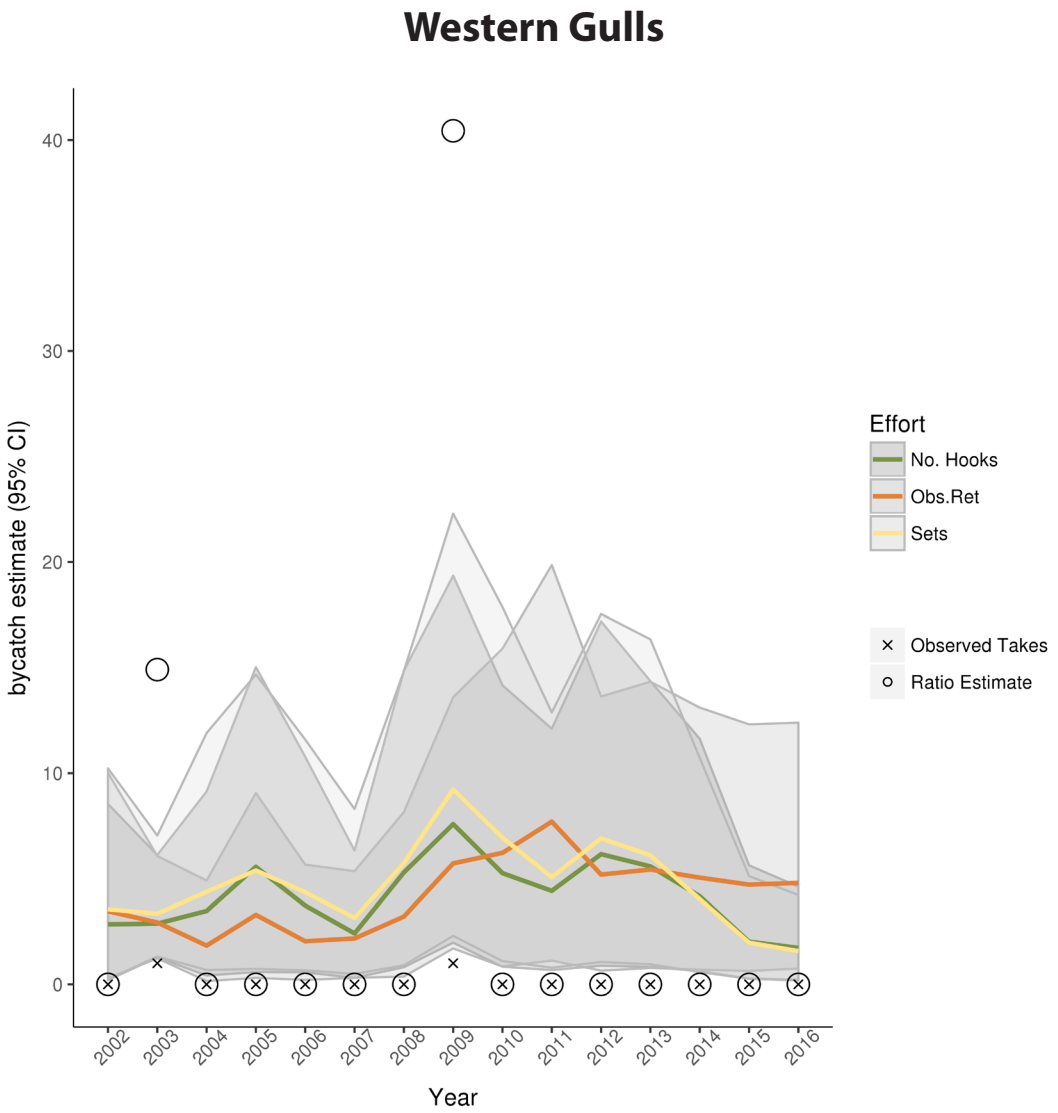

Figure C-25. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for western gulls for hook-and-line vessels in the limited entry fixed gear daily trip limits fishery.

Open Access Fixed Gear

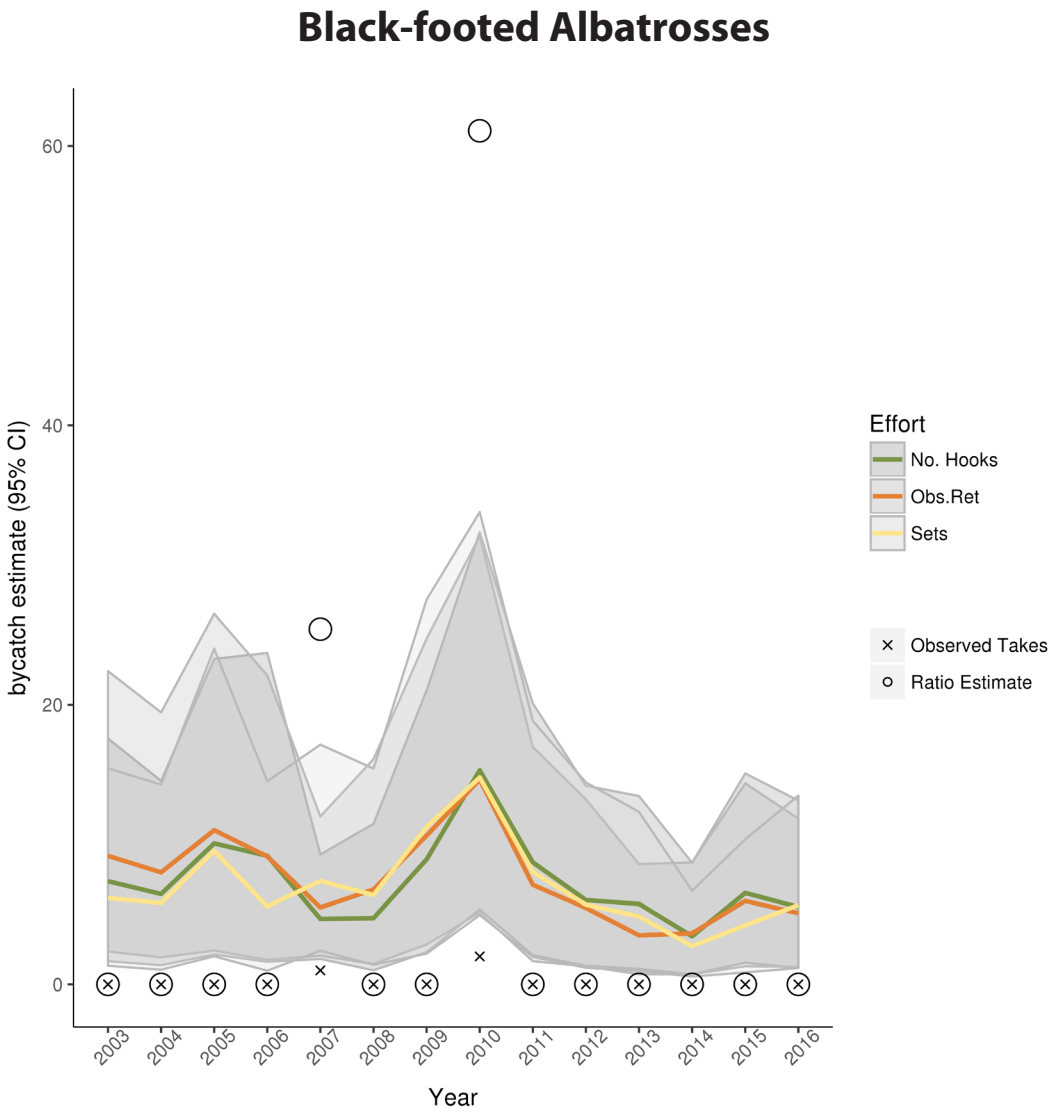

Figure C-26. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for black-footed albatrosses for hook-and-line vessels in the open access fixed gear fishery.

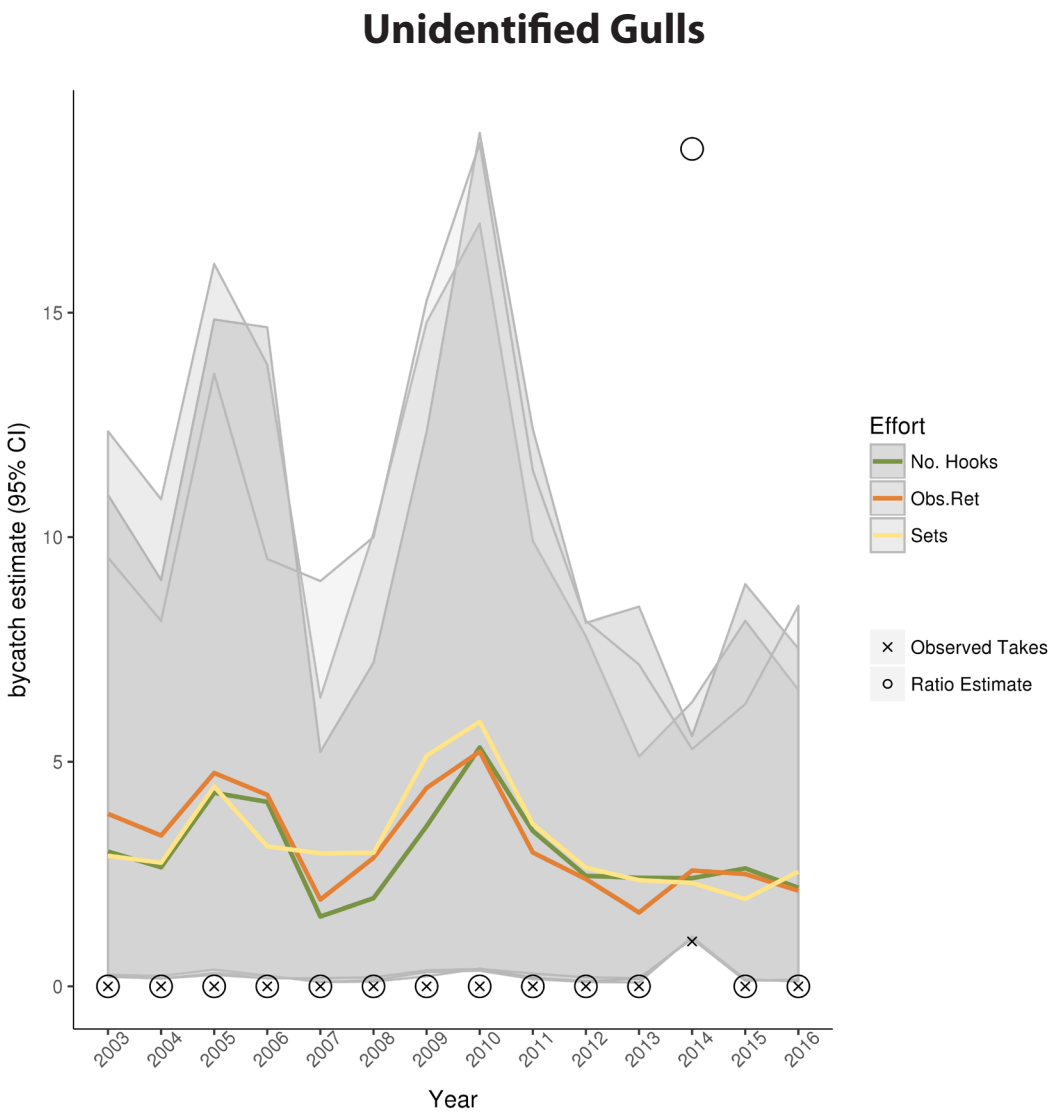

Figure C-27. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified gulls for hook-and-line vessels in the open access fixed gear fishery.

Oregon and California Nearshore

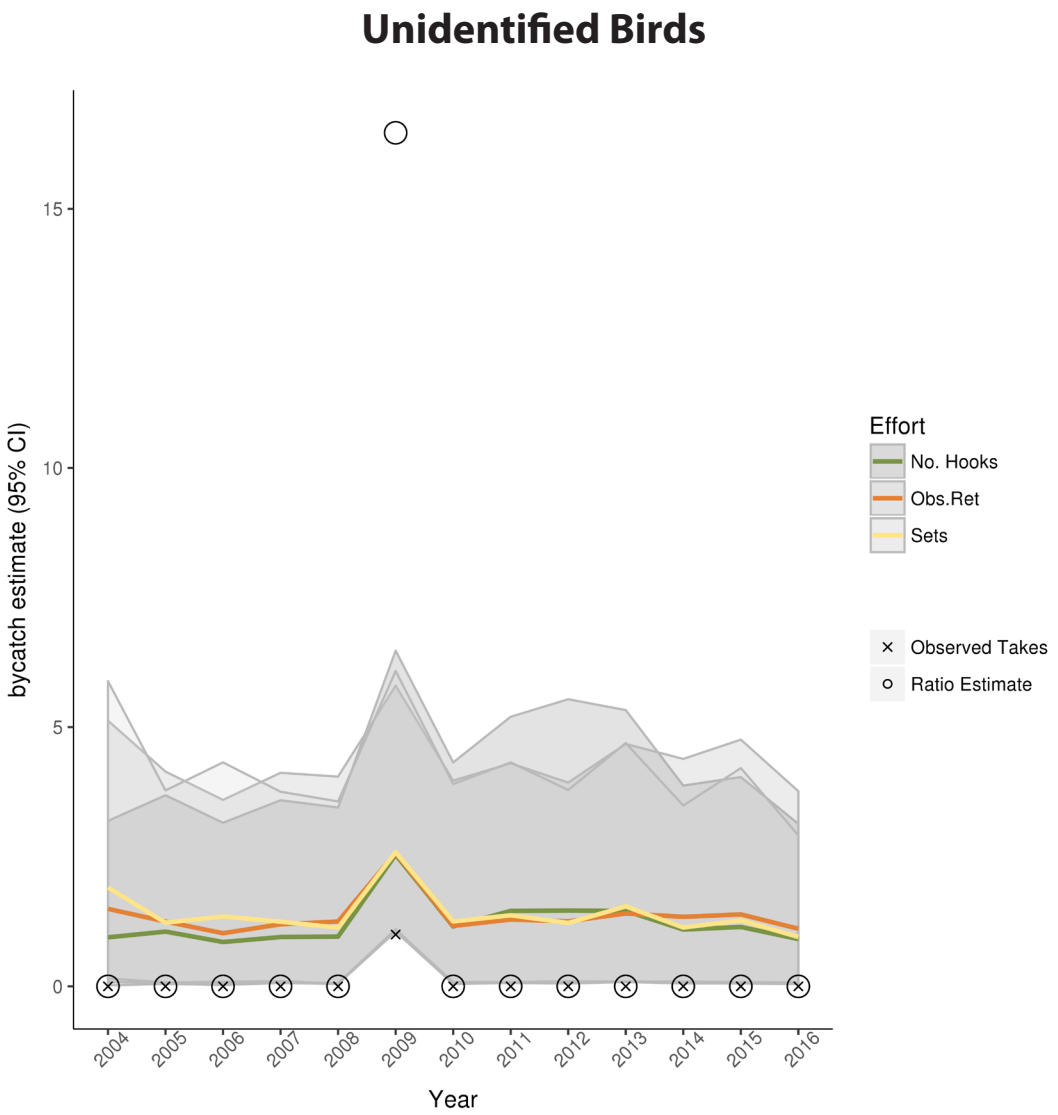

Figure C-28. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified birds for hook-and-line vessels in the Oregon nearshore fishery.

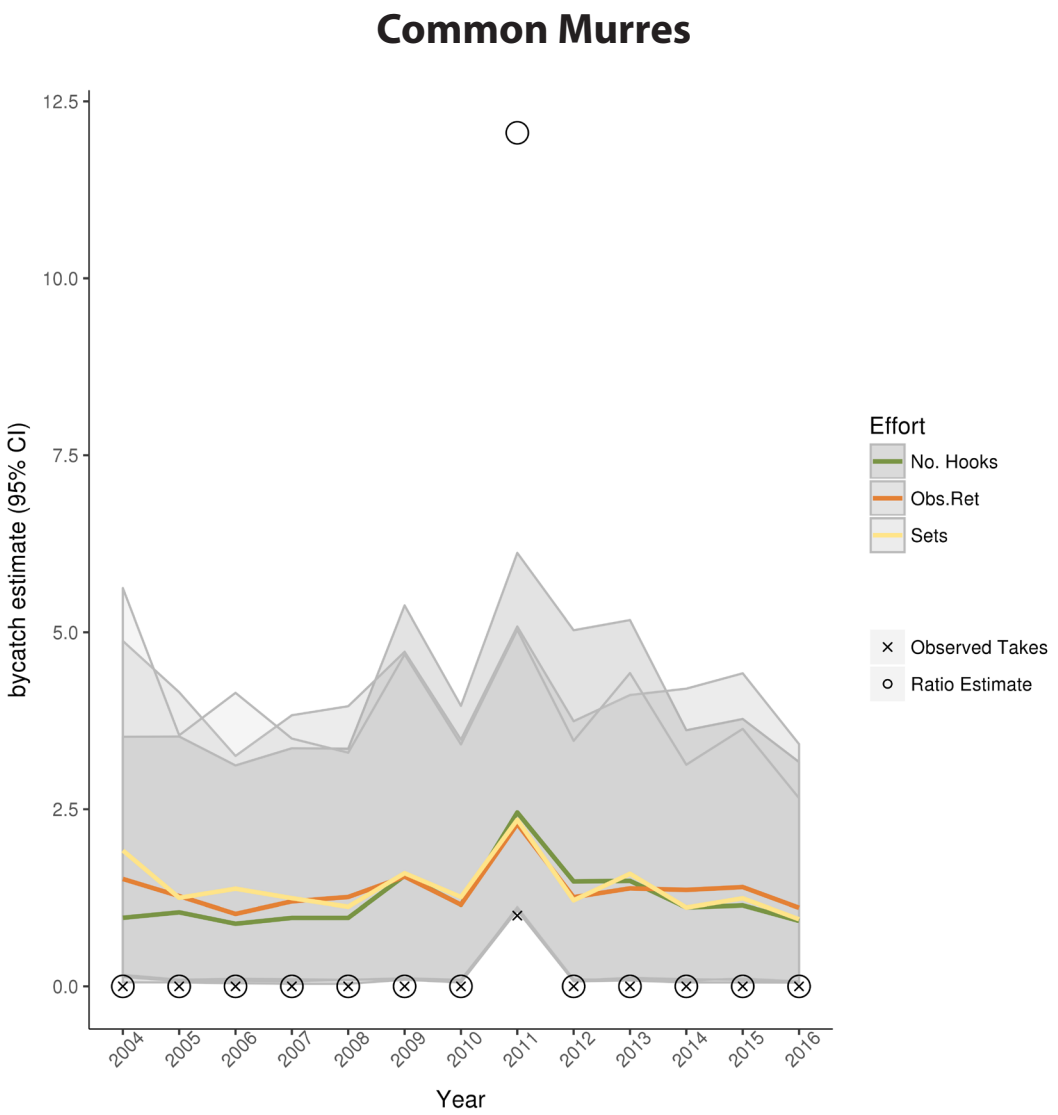

Figure C-29. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for common murres for hook-and-line vessels in the Oregon nearshore fishery.

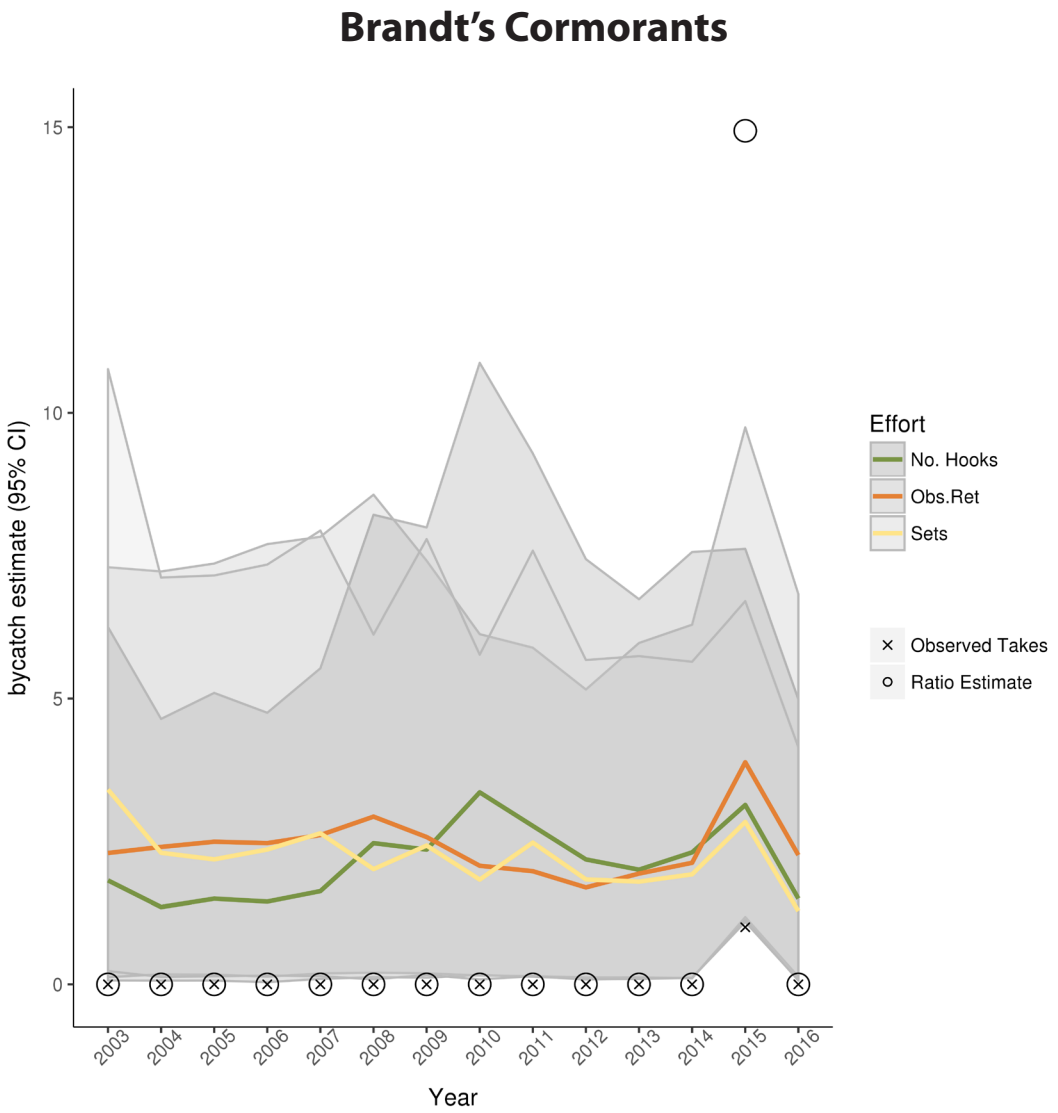

Figure C-30. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for Brandt's cormorants for hook-and-line vessels in the California nearshore fishery.

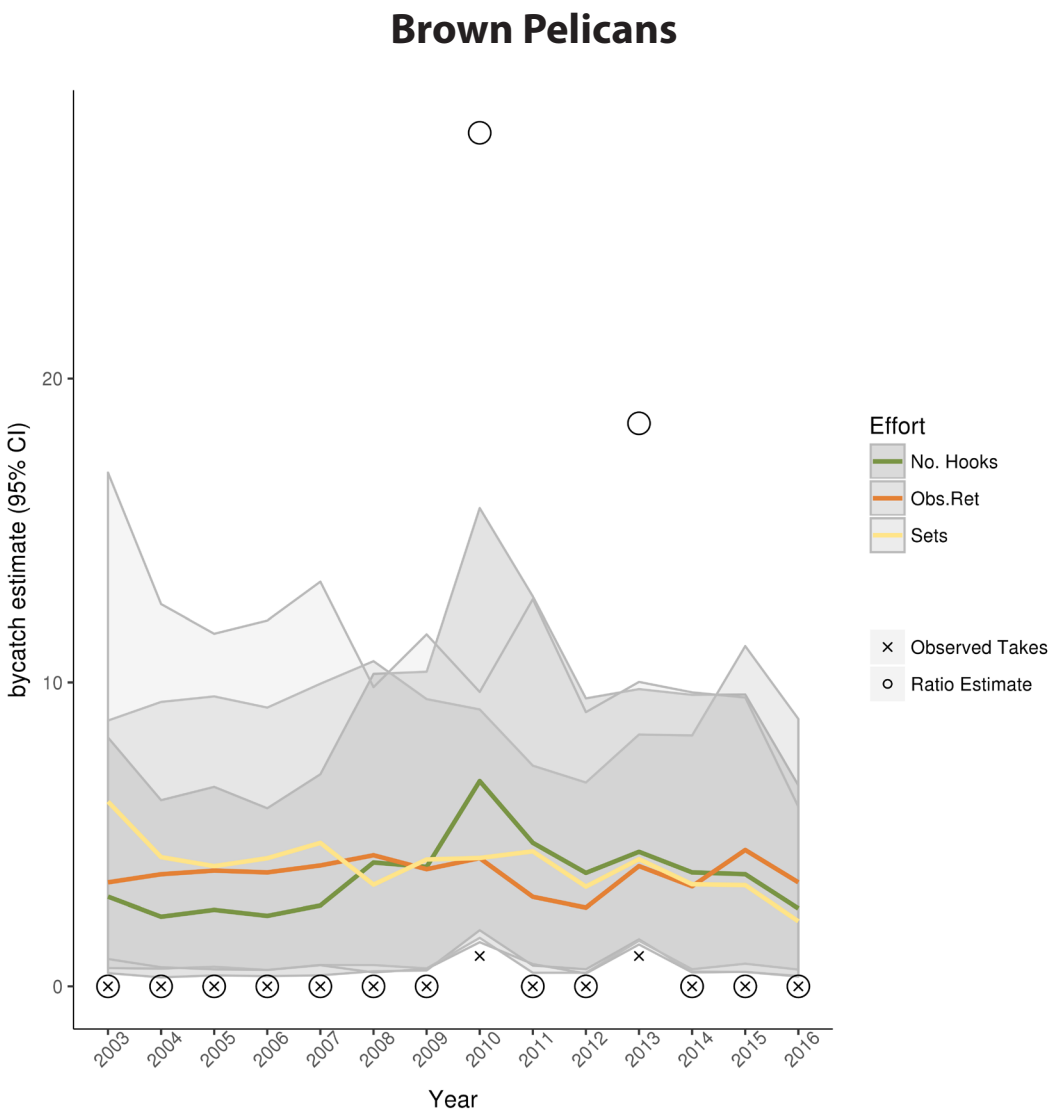

Figure C-31. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for brown pelicans for hook-and-line vessels in the California nearshore fishery.

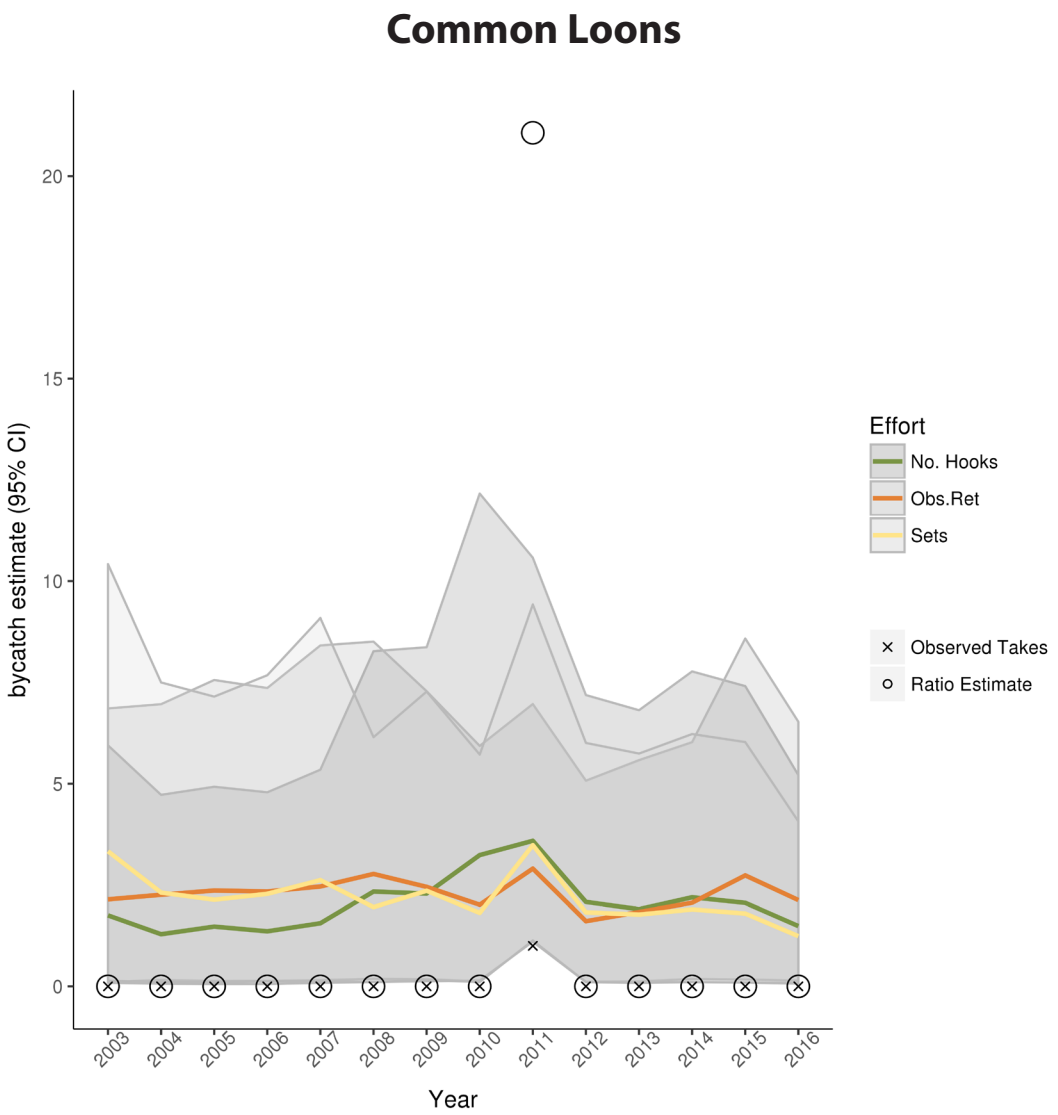

Figure C-32. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for common loons for hook-and-line vessels in the California nearshore fishery.

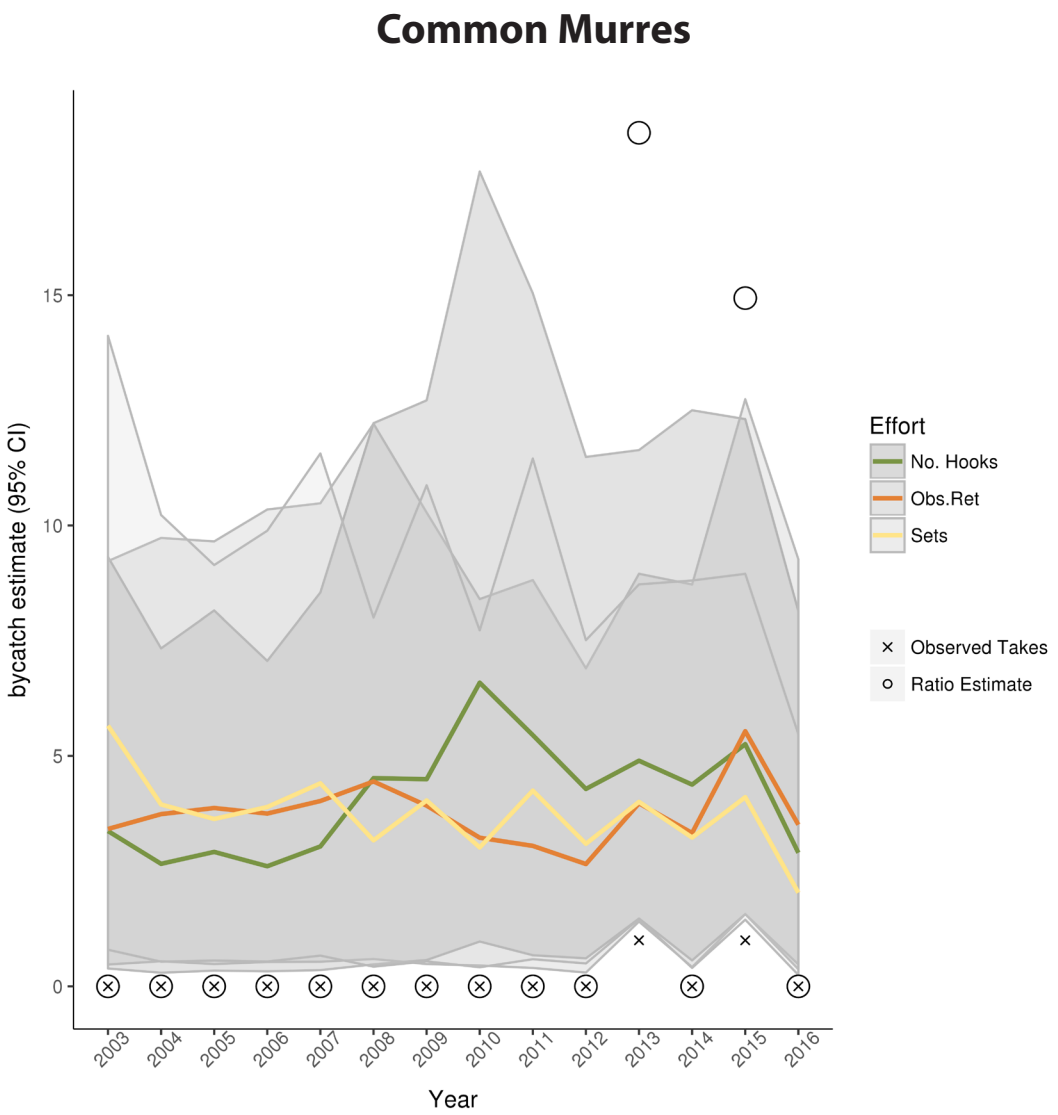

Figure C-33. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for common murres for hook-and-line vessels in the California nearshore fishery.

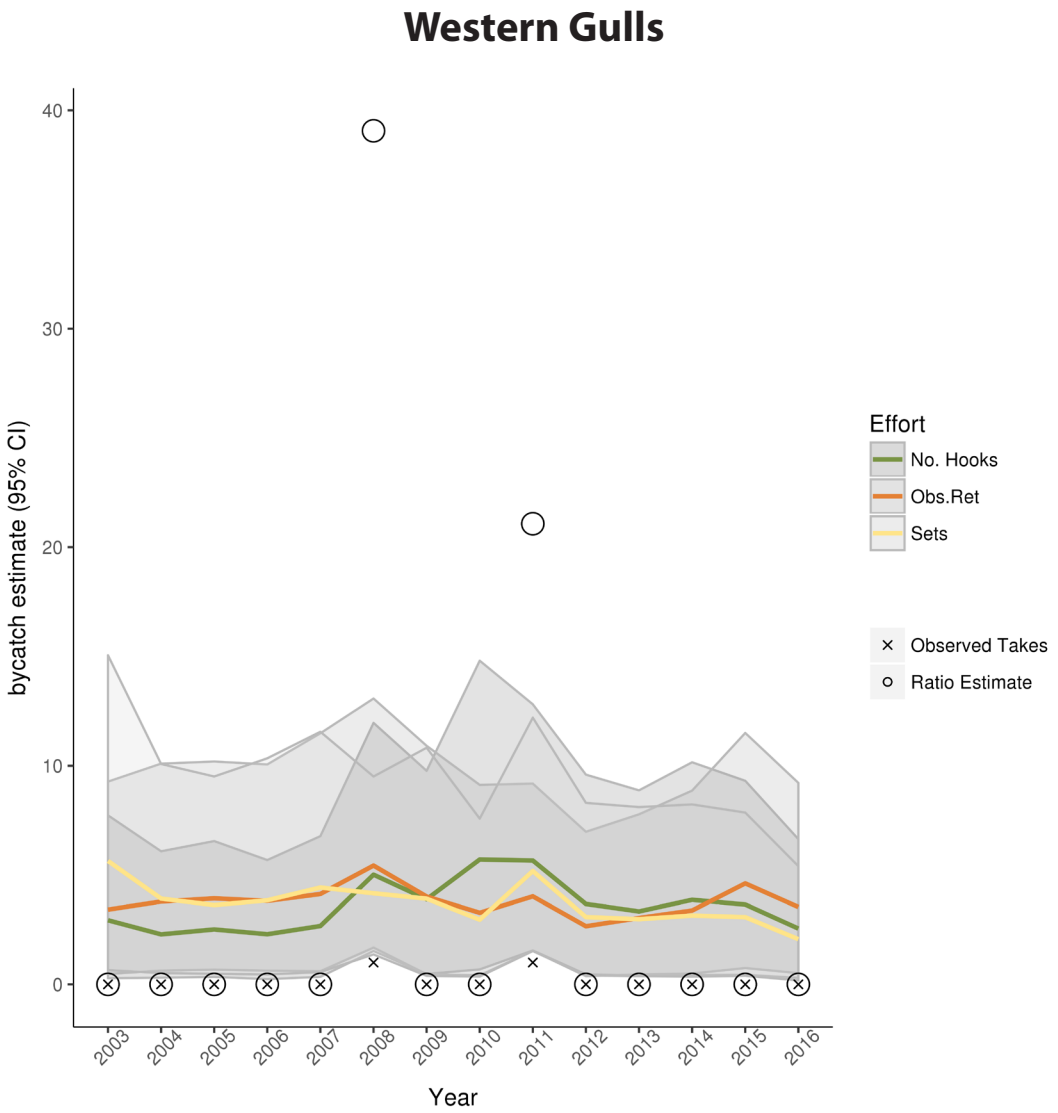

Figure C-34. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for western gulls for hook-and-line vessels in the California nearshore fishery.

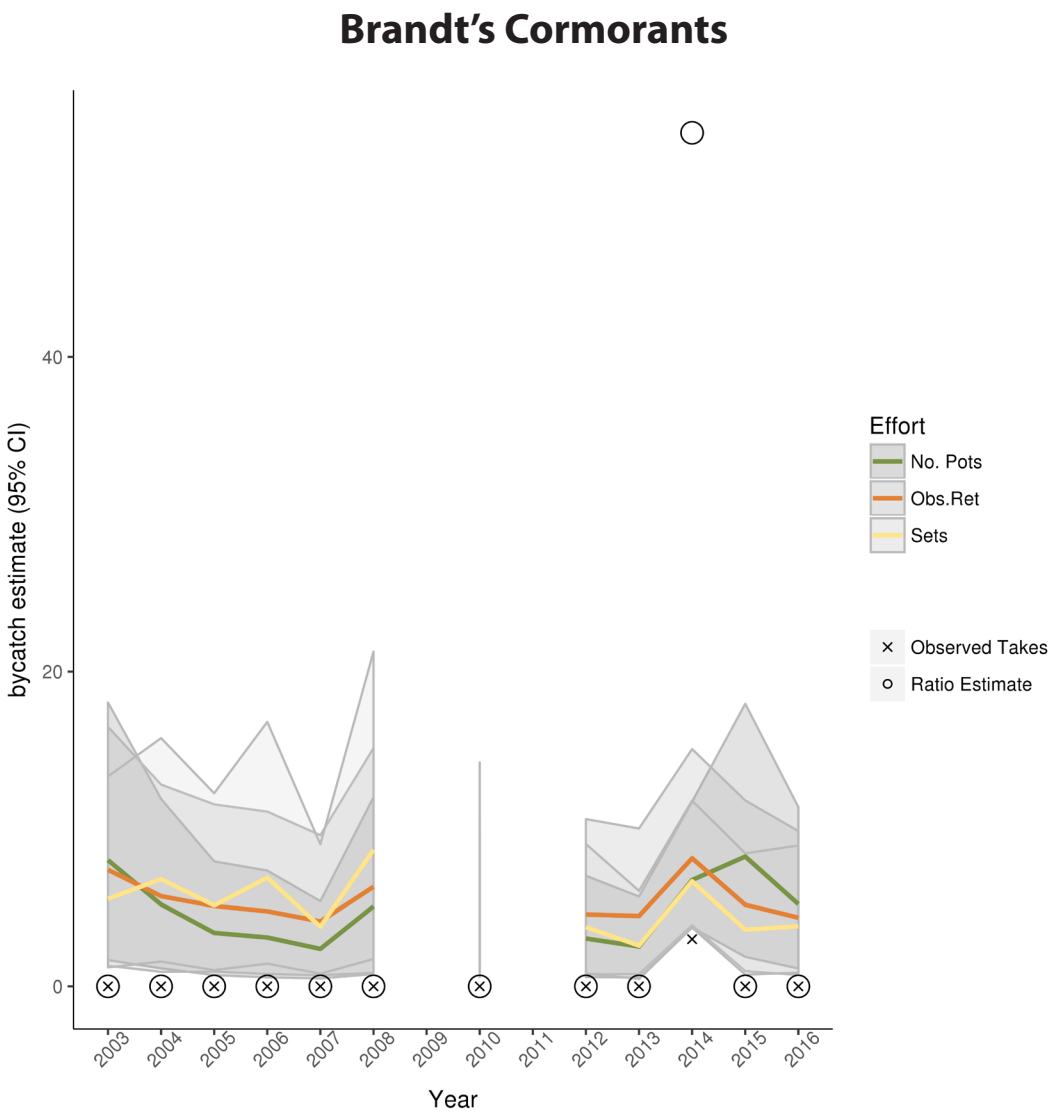

Figure C-35. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for Brandt's cormorants for pot gear vessels in the Oregon and California nearshore fisheries combined. Data for 2009 were removed to ensure confidentiality. In 2011, no pot vessels were observed in the nearshore fishery.

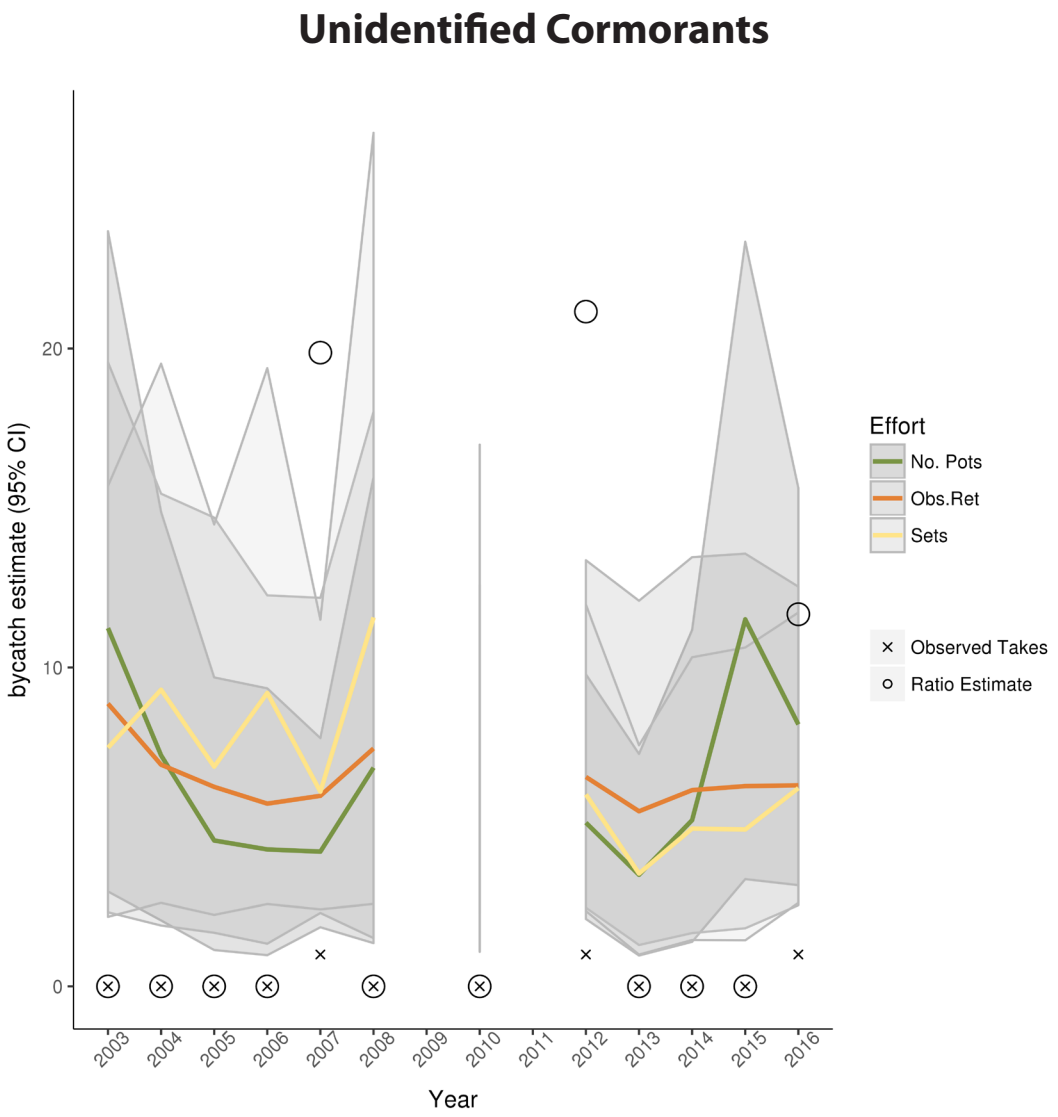

Figure C-36. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified cormorants for pot gear vessels in the Oregon and California nearshore fisheries combined. Data for 2009 were removed to ensure confidentiality. In 2011, no pot vessels were observed in the nearshore fishery.

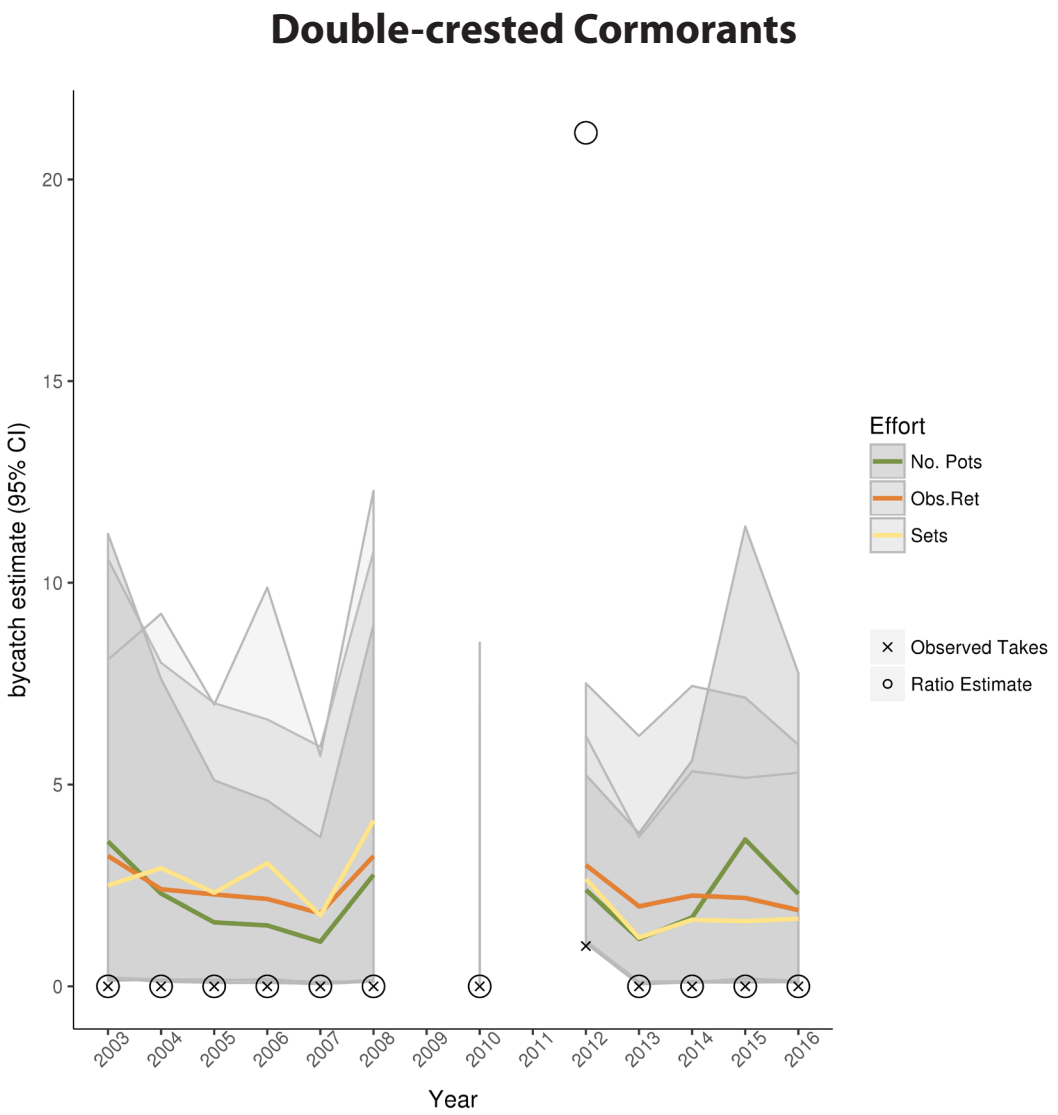

Figure C-37. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for double-crested cormorants for pot gear vessels in the Oregon and California nearshore fisheries combined. Data for 2009 were removed to ensure confidentiality. In 2011, no pot vessels were observed in the nearshore fishery.

Limited Entry Bottom Trawl

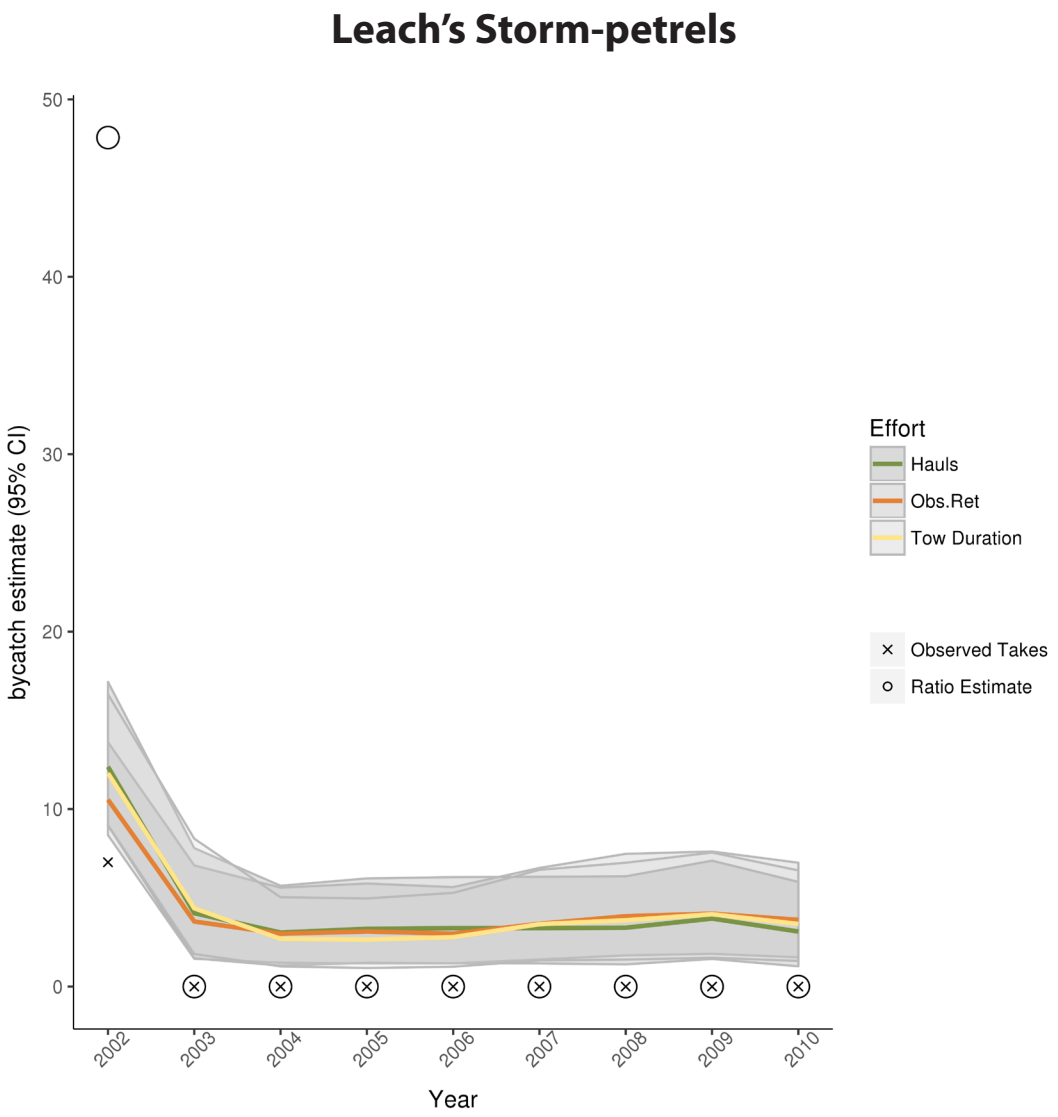

Figure C-38. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for Leach's storm-petrels for bottom trawl vessels in the limited entry fishery, 2002–10.

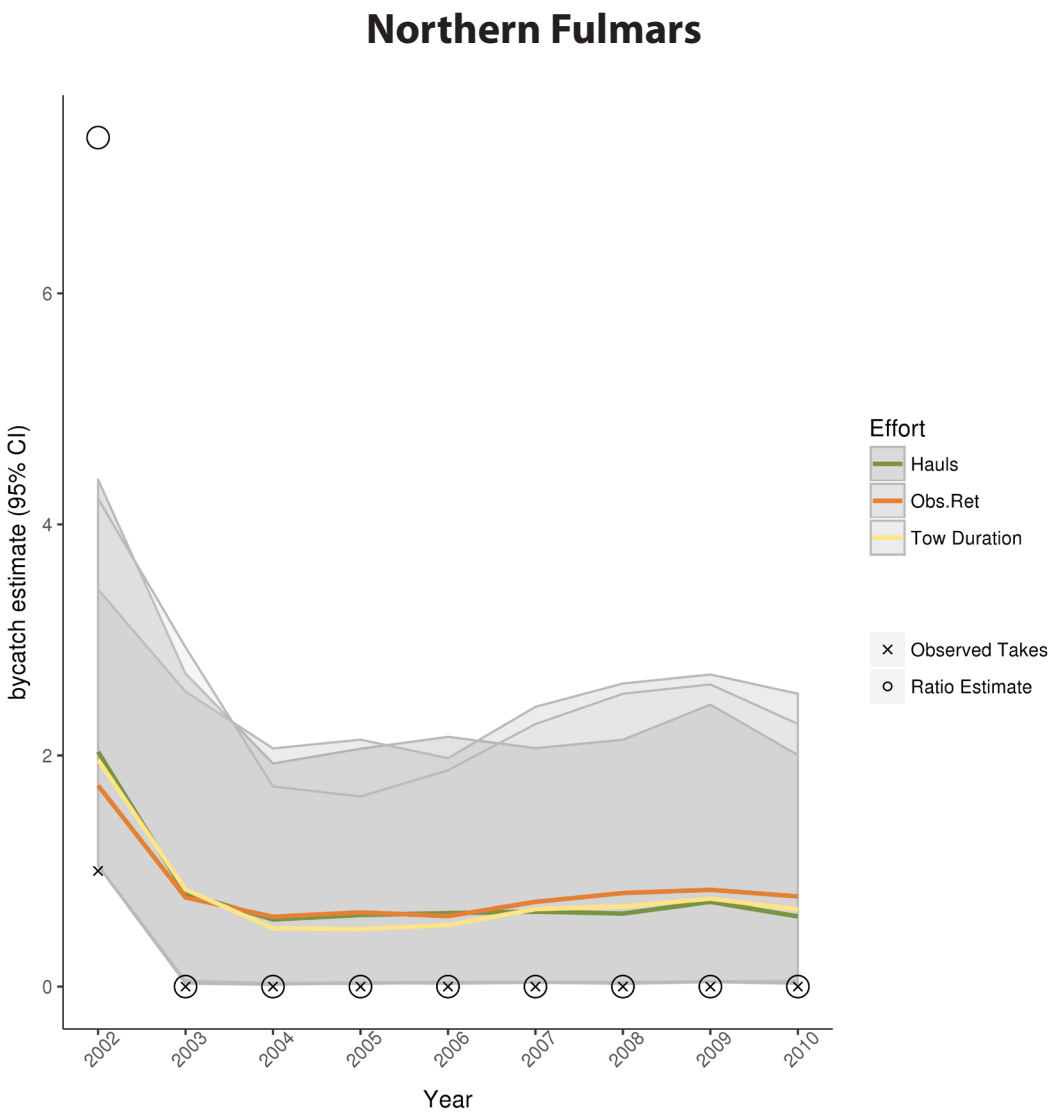

Figure C-39. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for northern fulmars for bottom trawl vessels in the limited entry fishery, 2002–10.

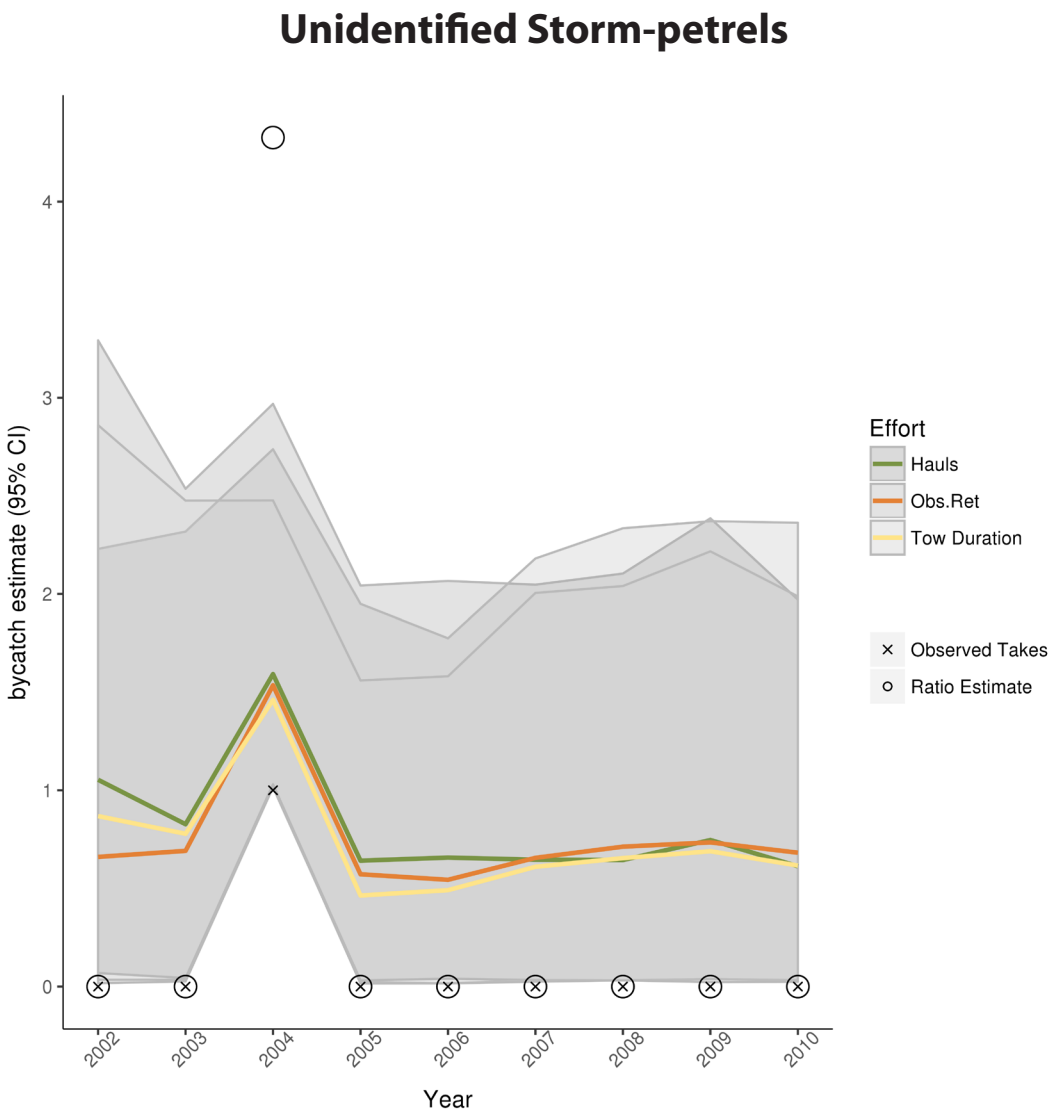

Figure C-40. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified storm-petrels for bottom trawl vessels in the limited entry fishery, 2002–10.

California Halibut

Bottom Trawl

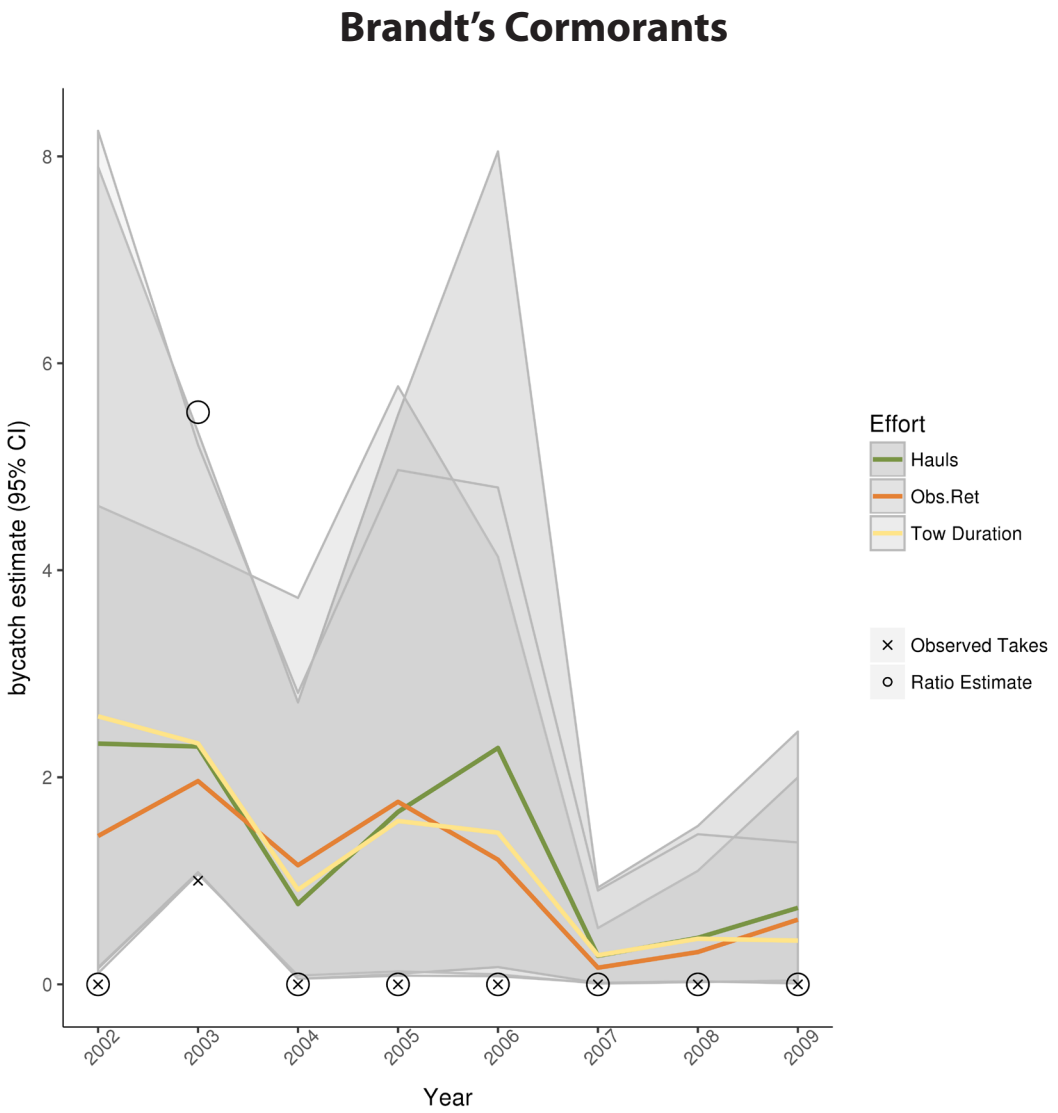

Figure C-41. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for Brandt's cormorants for bottom trawl vessels in the limited entry California halibut fishery, 2002–09. LE California halibut 2010 seabird bycatch is included in the 2010 open access California halibut fishery to maintain confidentiality. From 2011 forward, all LE California halibut seabird bycatch is reported under catch share bottom trawl vessels.

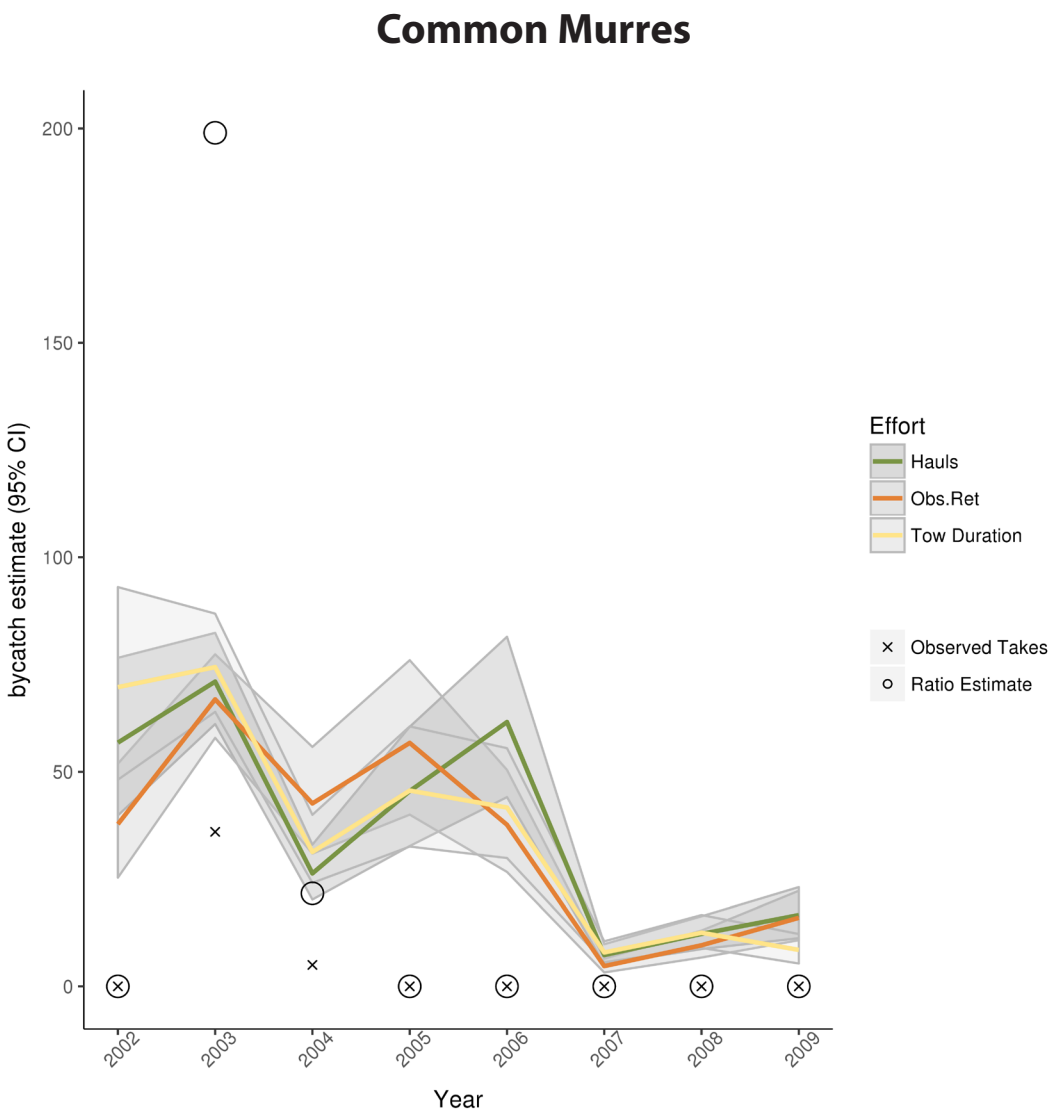

Figure C-42. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for common murres for bottom trawl vessels in the limited entry California halibut fishery, 2002–09. LE California halibut 2010 seabird bycatch is included in the 2010 open access California halibut fishery to maintain confidentiality. From 2011 forward, all LE California halibut seabird bycatch is reported under catch share bottom trawl vessels.

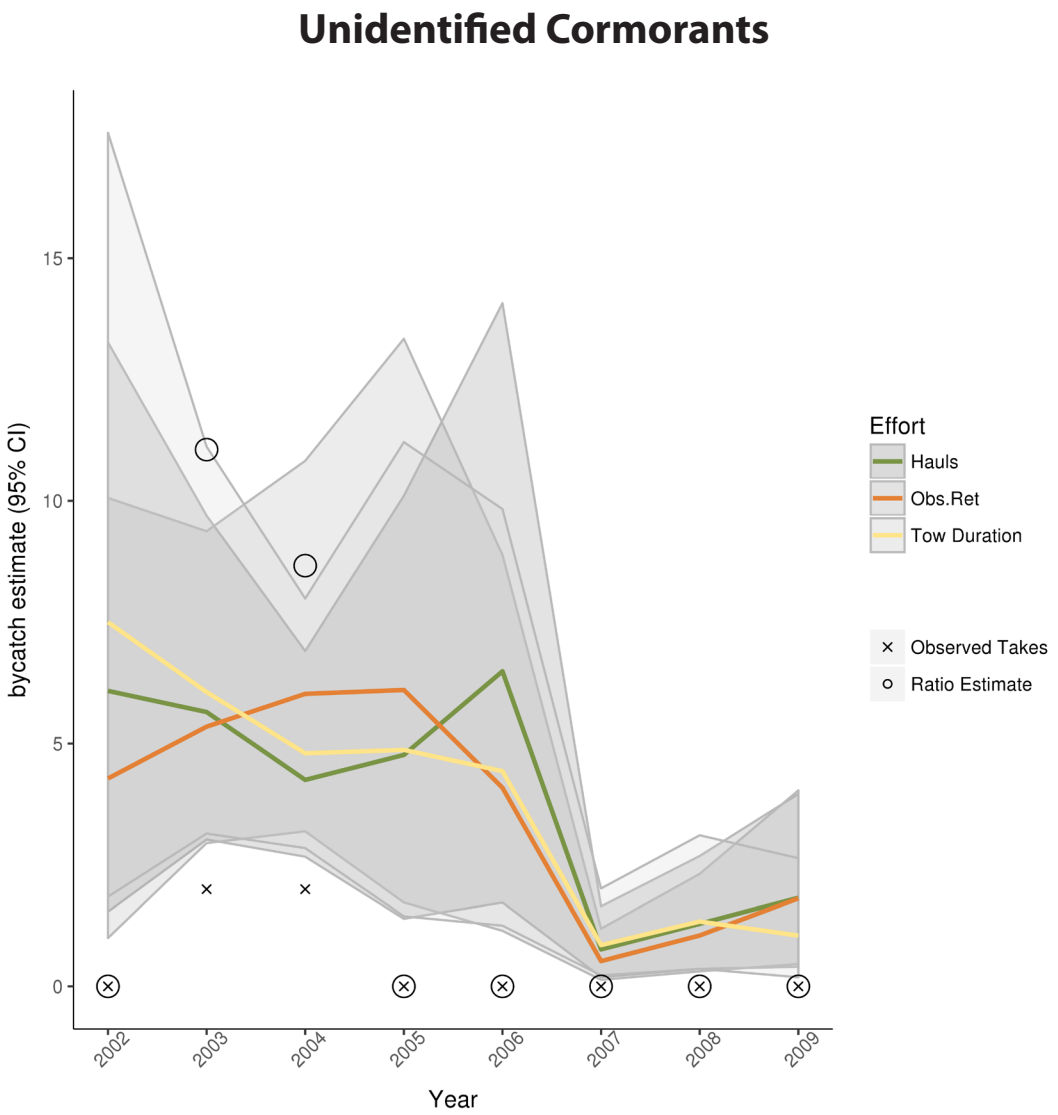

Figure C-43. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified cormorants for bottom trawl vessels in the limited entry California halibut fishery, 2002–09. LE California halibut 2010 seabird bycatch is included in the 2010 open access California halibut fishery to maintain confidentiality. From 2011 forward, all LE California halibut seabird bycatch is reported under catch share bottom trawl vessels.

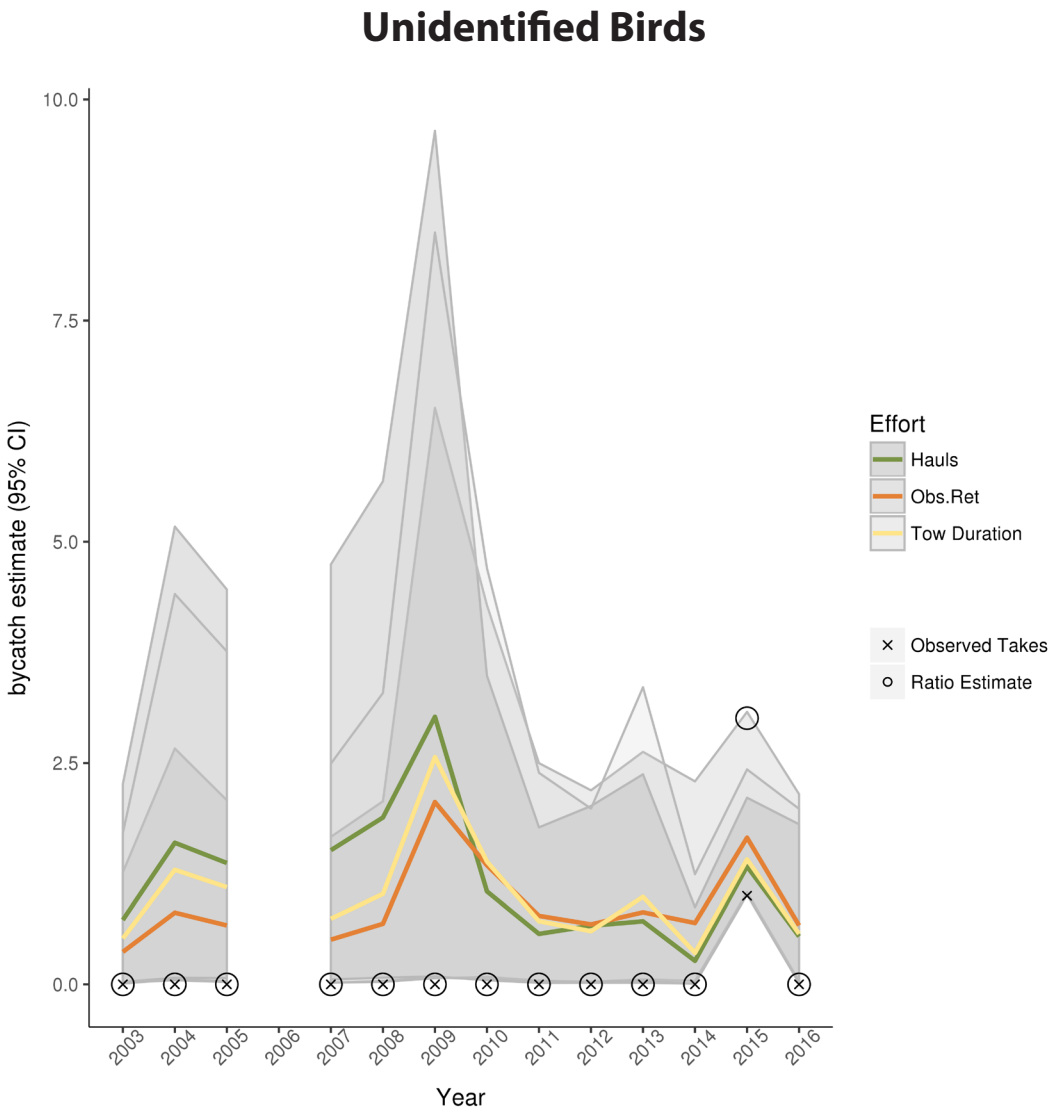

Figure C-44. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified birds for bottom trawl vessels in the open access (OA) California halibut fishery from 2003–16. 2010 LE California halibut seabird bycatch is included in the 2010 OA California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006.

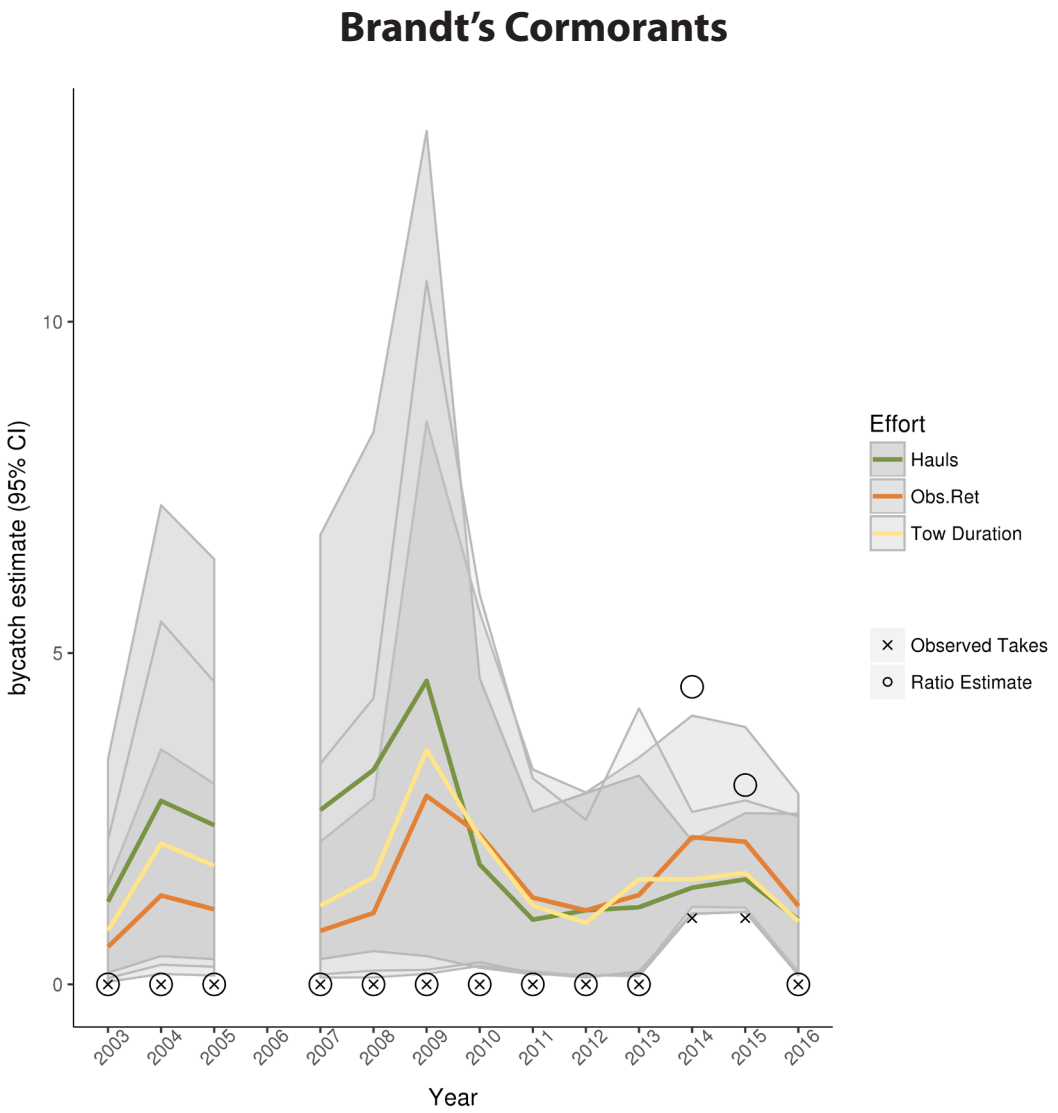

Figure C-45. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for Brandt's cormorants for bottom trawl vessels in the open access (OA) California halibut fishery from 2003–16. 2010 LE California halibut seabird bycatch is included in the 2010 OA California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006.

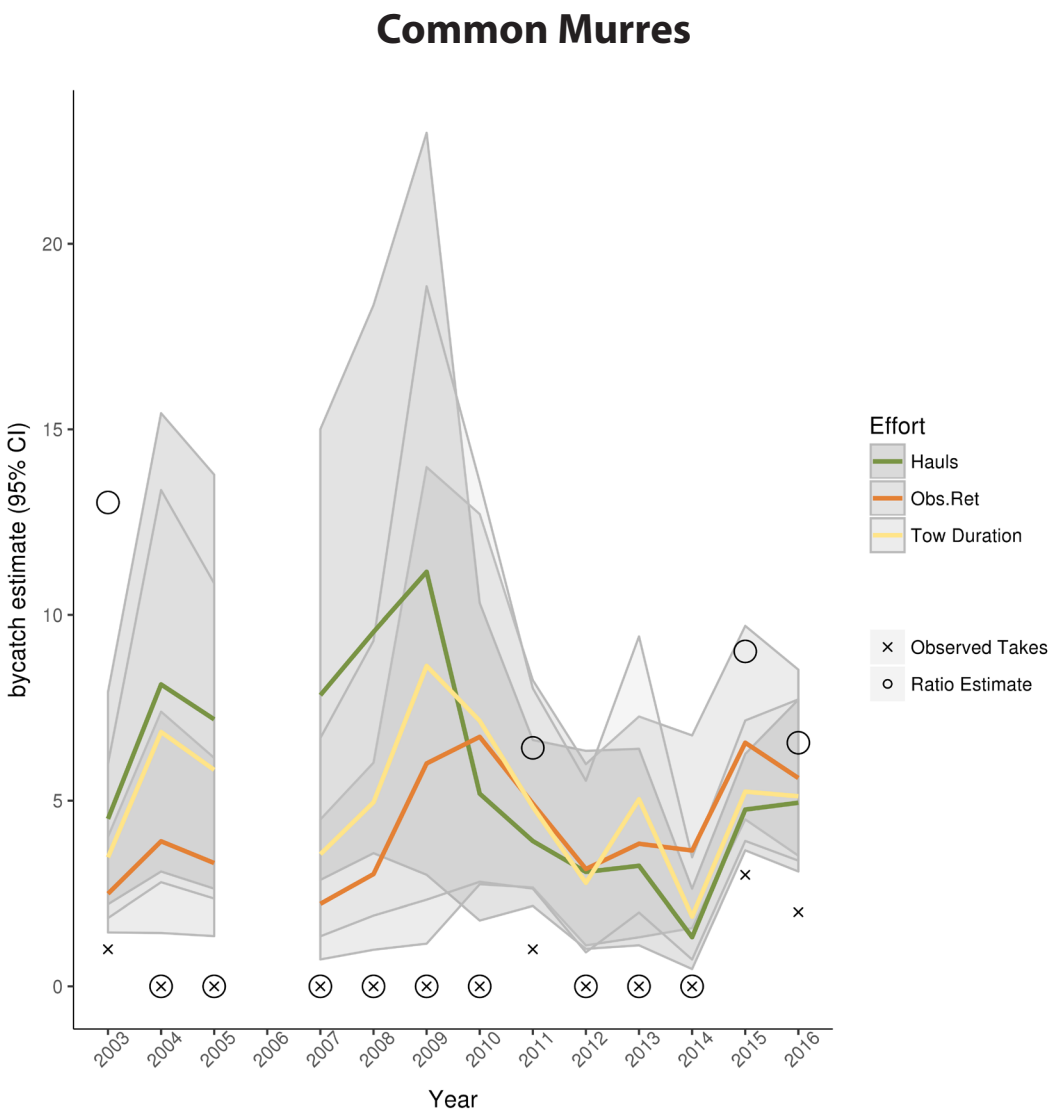

Figure C-46. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for common murres for bottom trawl vessels in the open access (OA) California halibut fishery from 2003–16. 2010 LE California halibut seabird bycatch is included in the 2010 OA California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006.

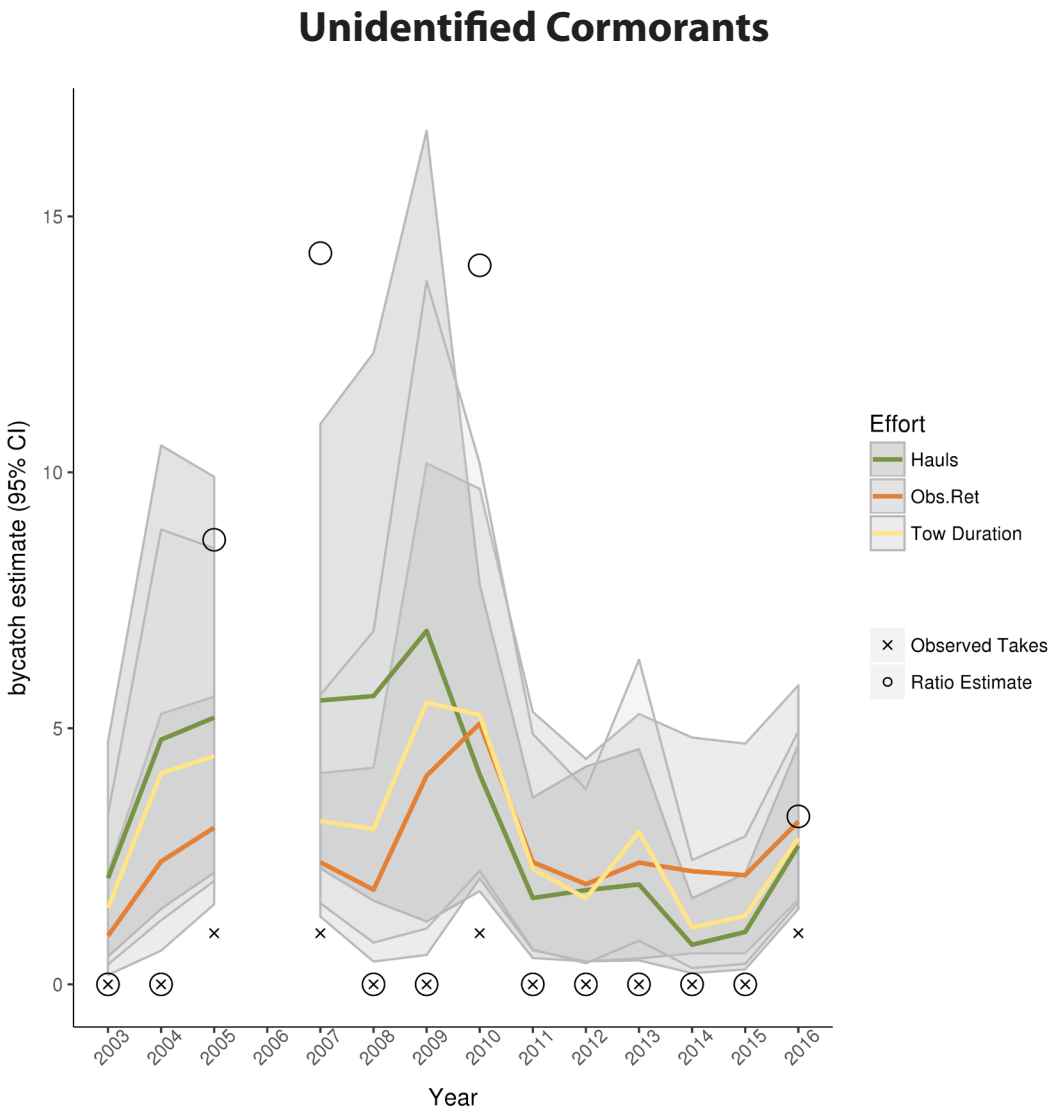

Figure C-47. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified cormorants for bottom trawl vessels in the open access (OA) California halibut fishery from 2003–16. 2010 LE California halibut seabird bycatch is included in the 2010 OA California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006.

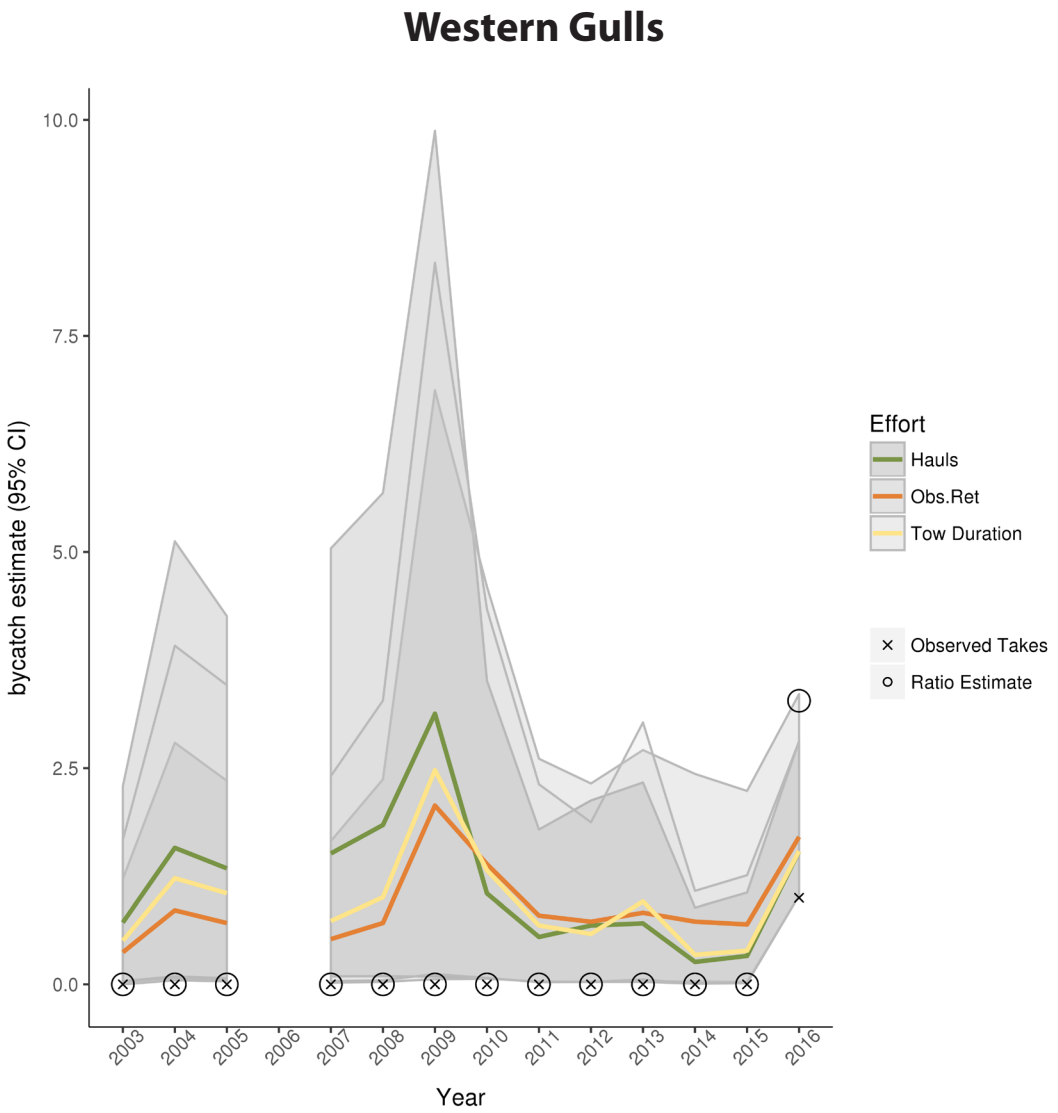

Figure C-48. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for western gulls for bottom trawl vessels in the open access (OA) California halibut fishery from 2003–16. 2010 LE California halibut seabird bycatch is included in the 2010 OA California halibut fishery to maintain confidentiality. The OA California halibut fishery was not observed in 2006.

Washington, Oregon, and California Pink Shrimp

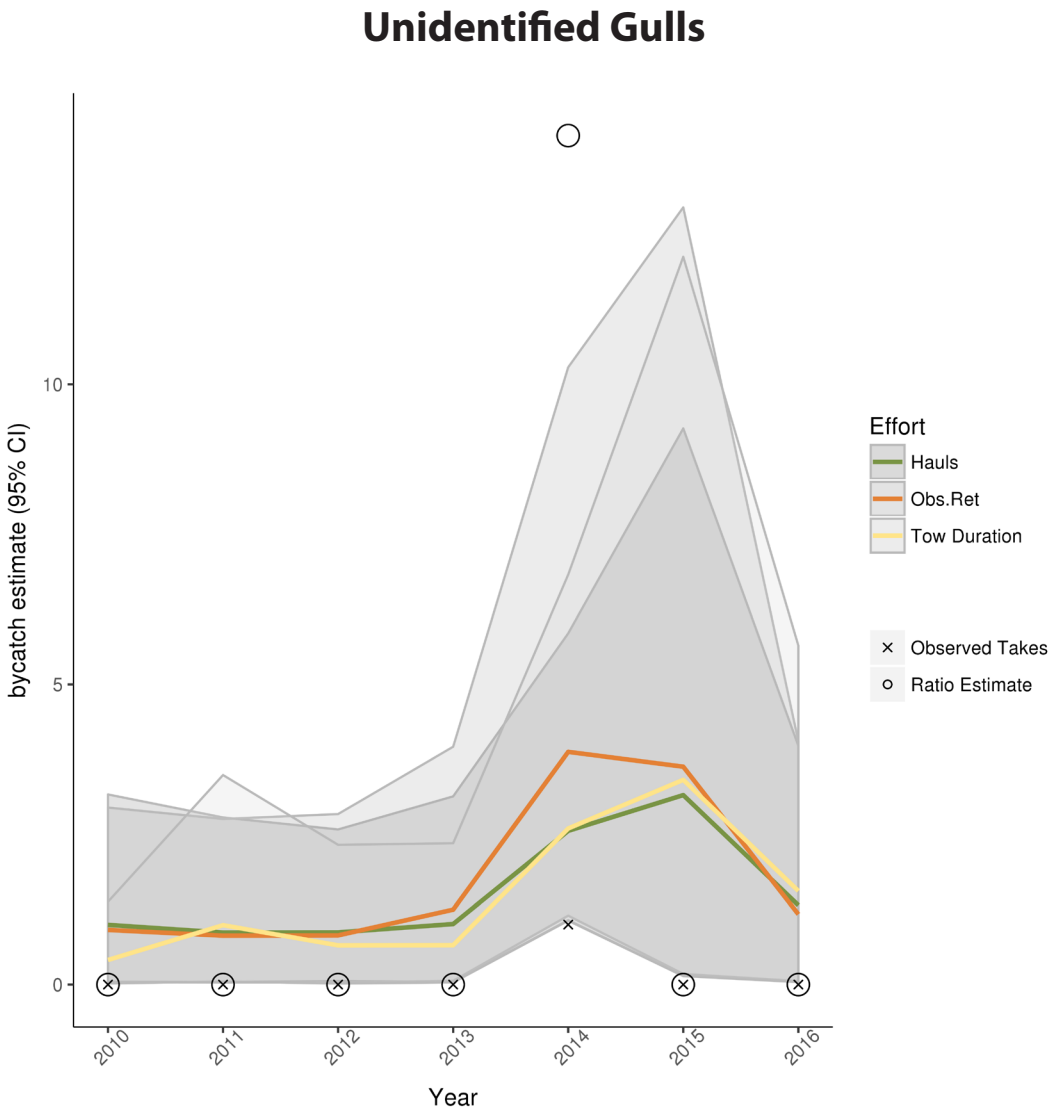

Figure C-49. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified gulls for shrimp trawl vessels in the Washington pink shrimp fishery, 2010–16.

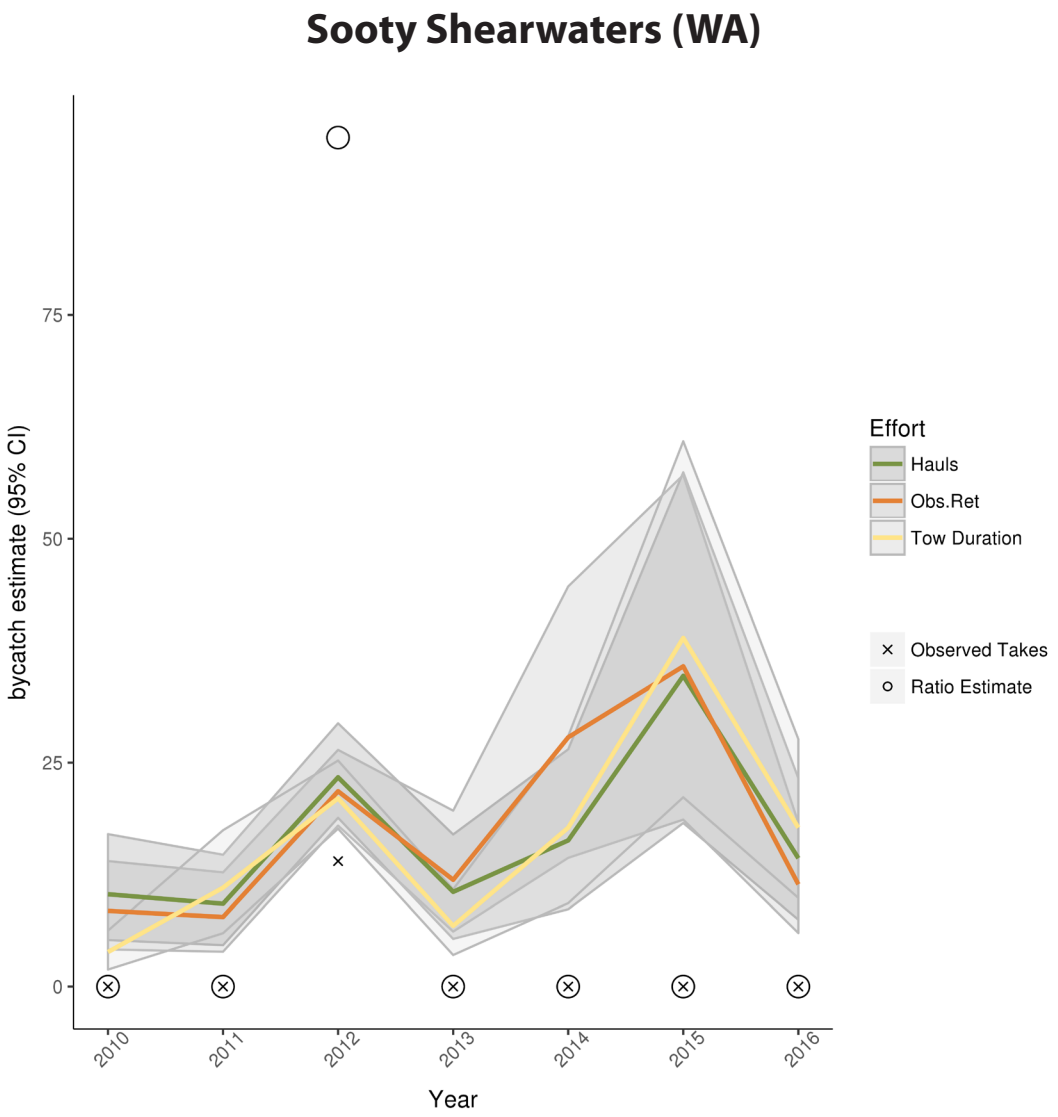

Figure C-50. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for sooty shearwaters for shrimp trawl vessels in the Washington pink shrimp fishery, 2010–16.

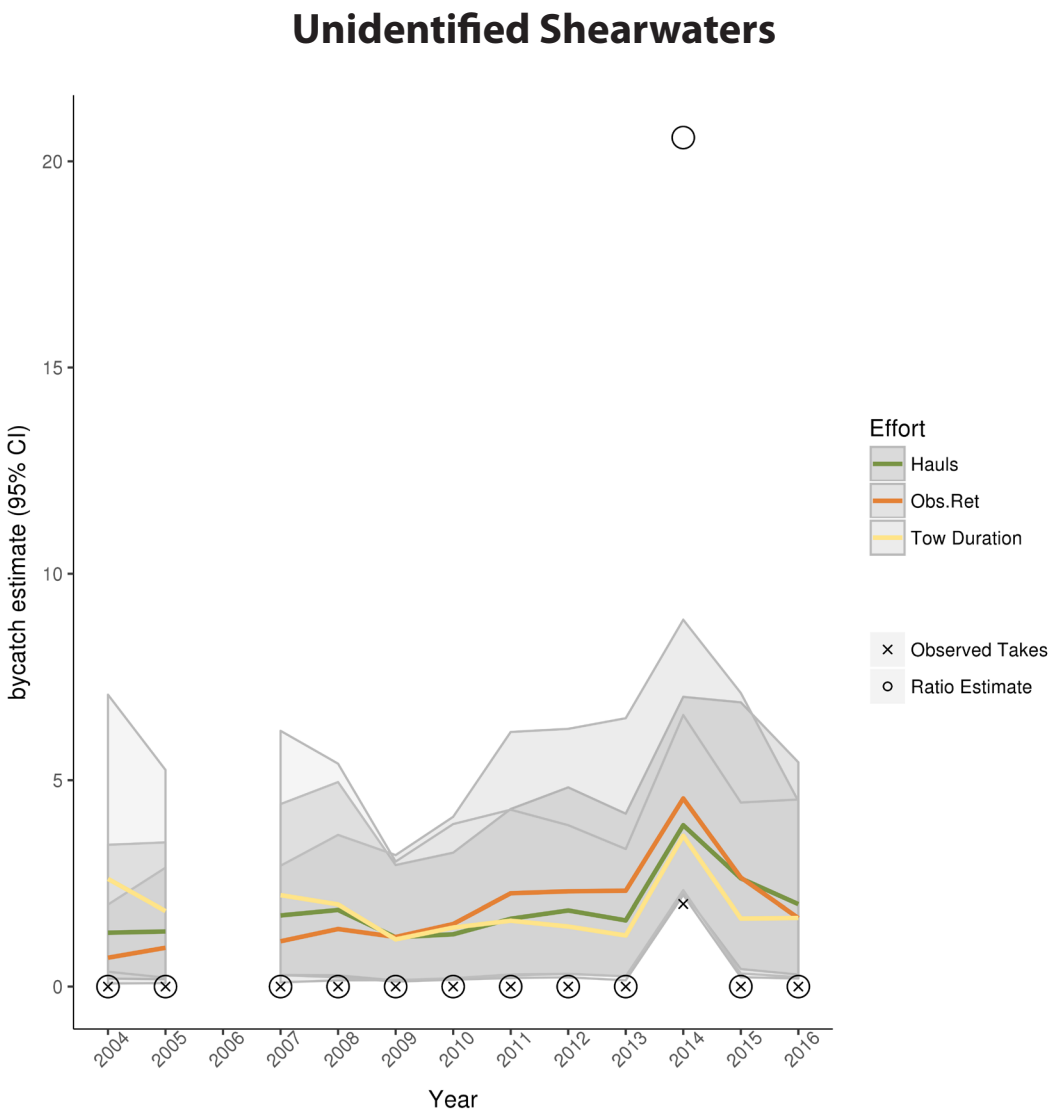

Figure C-51. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for unidentified shearwaters for shrimp trawl vessels in the Oregon pink shrimp fishery, 2004–16. The Oregon pink shrimp fishery was not observed in 2006.

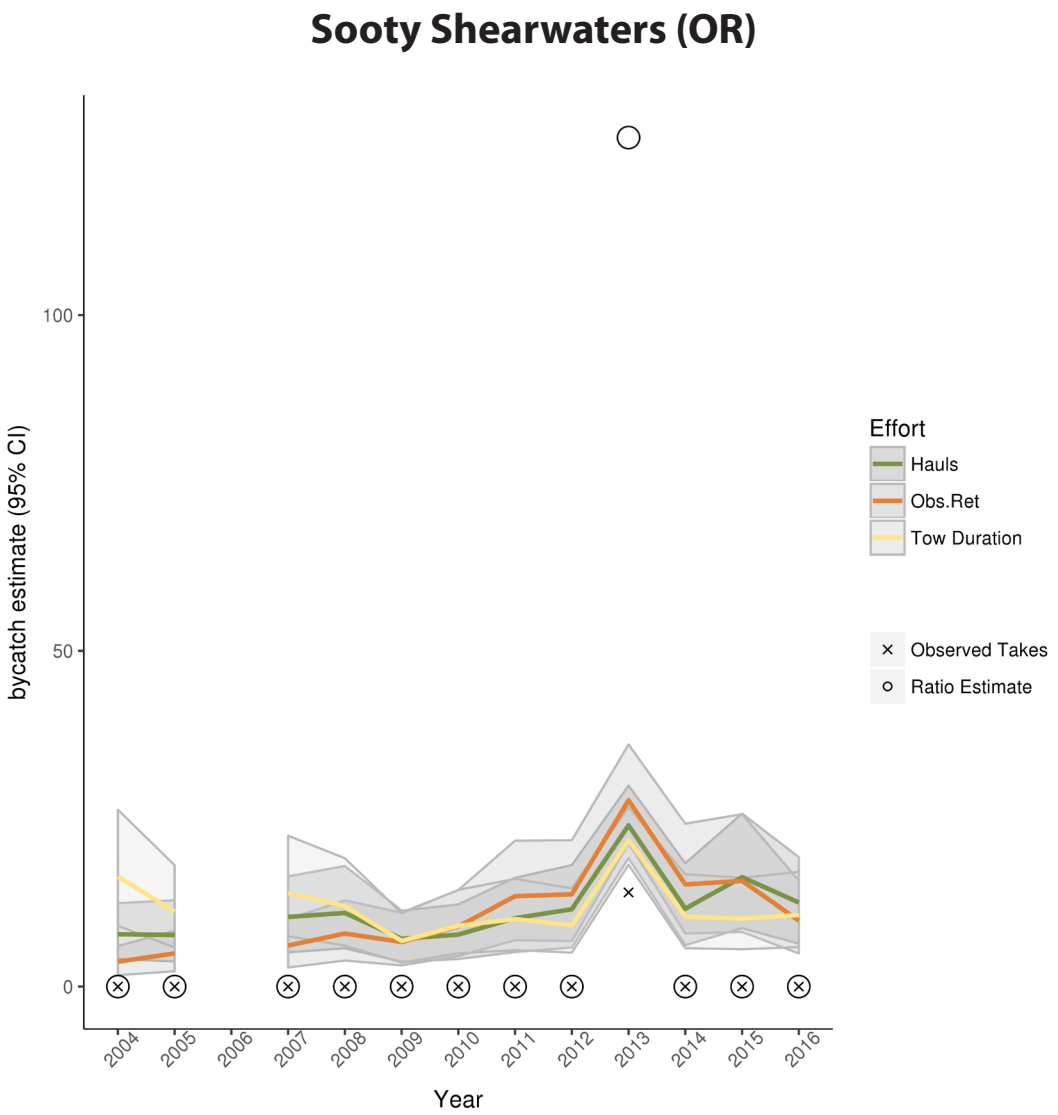

Figure C-52. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for sooty shearwaters for shrimp trawl vessels in the Oregon pink shrimp fishery, 2004–16. The Oregon pink shrimp fishery was not observed in 2006.

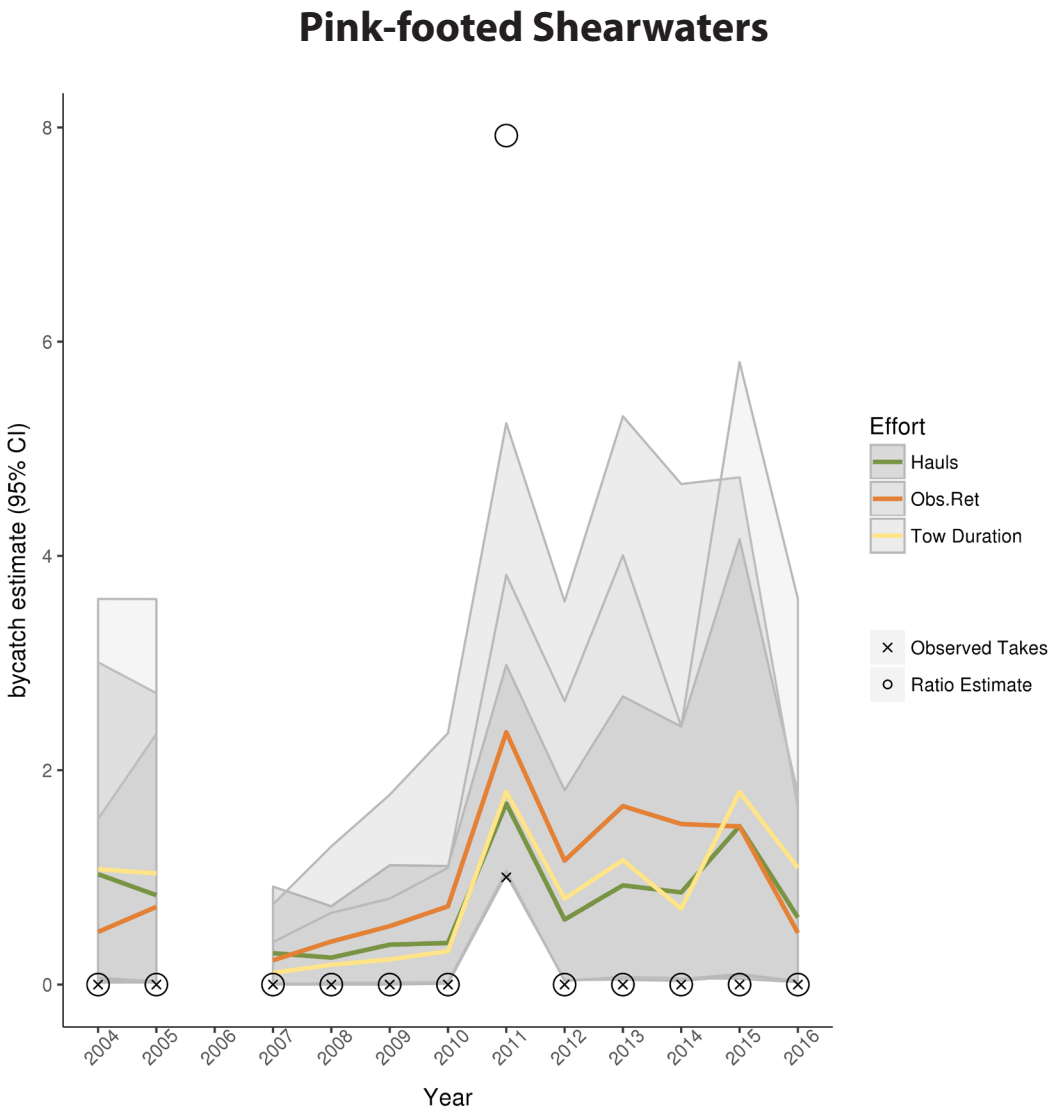

Figure C-53. Observed takes, Bayesian mean bycatch estimate with ±95% confidence intervals (shaded polygons), and ratio bycatch estimate for pink-footed shearwaters for shrimp trawl vessels in the California pink shrimp fishery, 2004–16. The California pink shrimp fishery was not observed in 2006.

Appendix D:
Opportunistic and Random Samples

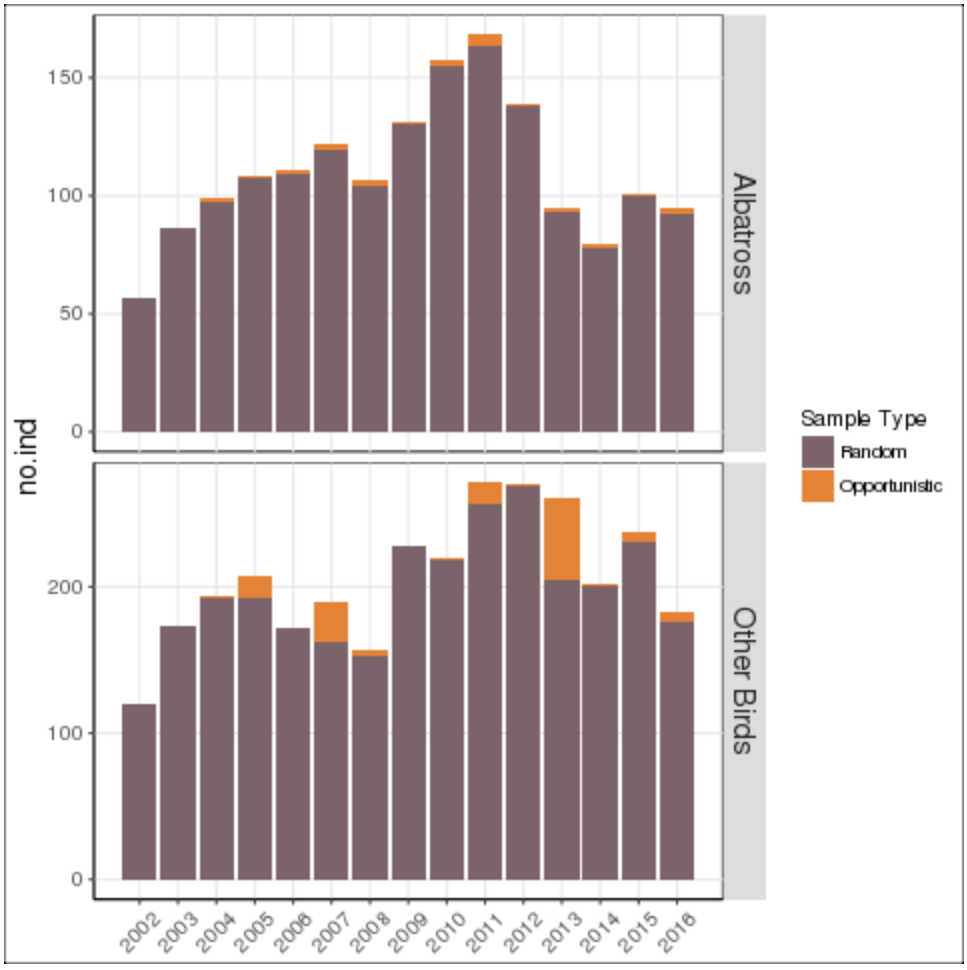

Figure D-1. Randomly sampled and opportunistic samples as a fraction of total samples, by year.

Appendix E: Fishery Sector Descriptions

Table E-1a. A description of permits, gears used, target groups, vessel length range, fishing depth range, and management of fishery sectors and subsectors in federally managed U.S. West Coast groundfish catch share fisheries. For brevity, management descriptors are generalized for the given time period and are not meant to be complete or comprehensive.

Sector	Subsector	Permit(s)	Gear(s)	Target(s)	Vessel Length (m)	Depth (m)	Management period	
							2002–10	2011–present
Limited Entry (LE) Trawl	Limited Entry (LE) Trawl	Federal LE permit[a] with trawl endorsement	Bottom trawl (after 1 Jan 2011); hook-and-line; pot	Ground-fish assemblage	11–29	Wide range	Cumulative two-month trip limits; depth-based closures; 14–23% observer coverage	Individual Fishing Quotas (IFQs); 100% observer coverage
	LE California Halibut	CA halibut permit[b] and LE permit with trawl endorsement[a]	Bottom trawl	California halibut	9–22	<55	Cumulative two-month trip limits; depth-based closures; 3–23% observer coverage	IFQs; 100% observer coverage
At-Sea Hake	Mother-ship Catcher Vessel (MSCV)	LE permit with MSCV endorsement[a]	Midwater trawl	Pacific hake	26–45[c]	53–460[c]	Seasonal quotas for target and bycatch species of concern; 100% observer coverage	IFQs; seasonal; 100% observer coverage
	Catcher–processor (CP)	LE permit with CP endorsement[a]	Midwater trawl	Pacific hake	82–115	60–570	Seasonal quotas for target and bycatch species of concern; 100% observer coverage	IFQs; seasonal; 100% observer coverage
	Tribal	(none)	Midwater trawl	Pacific hake	<38	53–460	Tribal; 100% observer coverage	Tribal; 100% observer coverage
Shoreside Hake	n/a	LE permit with trawl endorsement[a]	Midwater trawl	Pacific hake	17–29	Wide range	Seasonal quotas for target and bycatch species of concern; electronic monitoring	IFQs; seasonal; 100% observer coverage

[a] All LE permits are issued by federal agency (NOAA).
[b] Issued by the state of California.
[c] Average value for catcher vessels delivering catch to motherships.

Table E-1b. A description of permits, gears used, target groups, vessel length range, fishing depth range, and management of fishery sectors and subsectors in other federally managed 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.

Sector	Subsector	Permit(s)	Gear(s)	Target(s)	Vessel Length (m)	Depth (m)	Management period 2002–present
Non-nearshore Fixed Gear	Sablefish endorsed	LE permit with fixed gear endorsement[a] and sablefish quota	Longlines; pots	Sablefish	11–32	>145	Sablefish tier quotas; seven-month season; 9–27% observer coverage
	Sablefish non-endorsed (a.k.a., Zero Tier)	LE permit with fixed gear endorsement[a] without sablefish quota	Longlines; pots	Sablefish; rockfish; flatfish	5–18	>145	Trip limits; 1–12% observer coverage
	Open Access	(none)	Longlines; pots	Sablefish; other groundfish	3–30	>64	Trip limits; 1–6% observer coverage

[a] All LE permits are issued by federal agency (NOAA).

Table E-1c. A description of permits, gears used, target groups, vessel length range, fishing depth range, and management of fishery sectors and subsectors in state-managed 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.

Sector	Permit(s)	Gear(s)	Target(s)	Vessel Length (m)	Depth (m)	Management period 2002–present
Open Access California Halibut	CA halibut permit[b]	Bottom trawl	California halibut	9–22	<55	All fishing occurs within CA waters, most in the California Halibut Trawl Grounds where minimum mesh sizes, seven-month season, and minimum size requirements hold; 1–16% observer coverage
Nearshore Fixed Gear[a]	OR or CA state nearshore permits and endorsements	Hand lines; pot gear; stick gear; rod-and-reel	Rockfish; cabezon; greenling	3–15	<110 (usually <55 in OR waters)	Federal and OR or CA state nearshore regulations; area closures; two-month trip limits; minimum size limits; 2–8% observer coverage
Pink Shrimp	WA, OR, or CA state pink shrimp permits	Shrimp trawl	Pink shrimp	11.5–33	91–256	WA, OR, or CA state pink shrimp regulations; Bycatch Reduction Devices required; trip limits on groundfish landed; 4–14% observer coverage

[a] The state of Washington does not conduct a nearshore fishery.
[b] Issued by the state of California.

Appendix F: Fish Ticket Processing

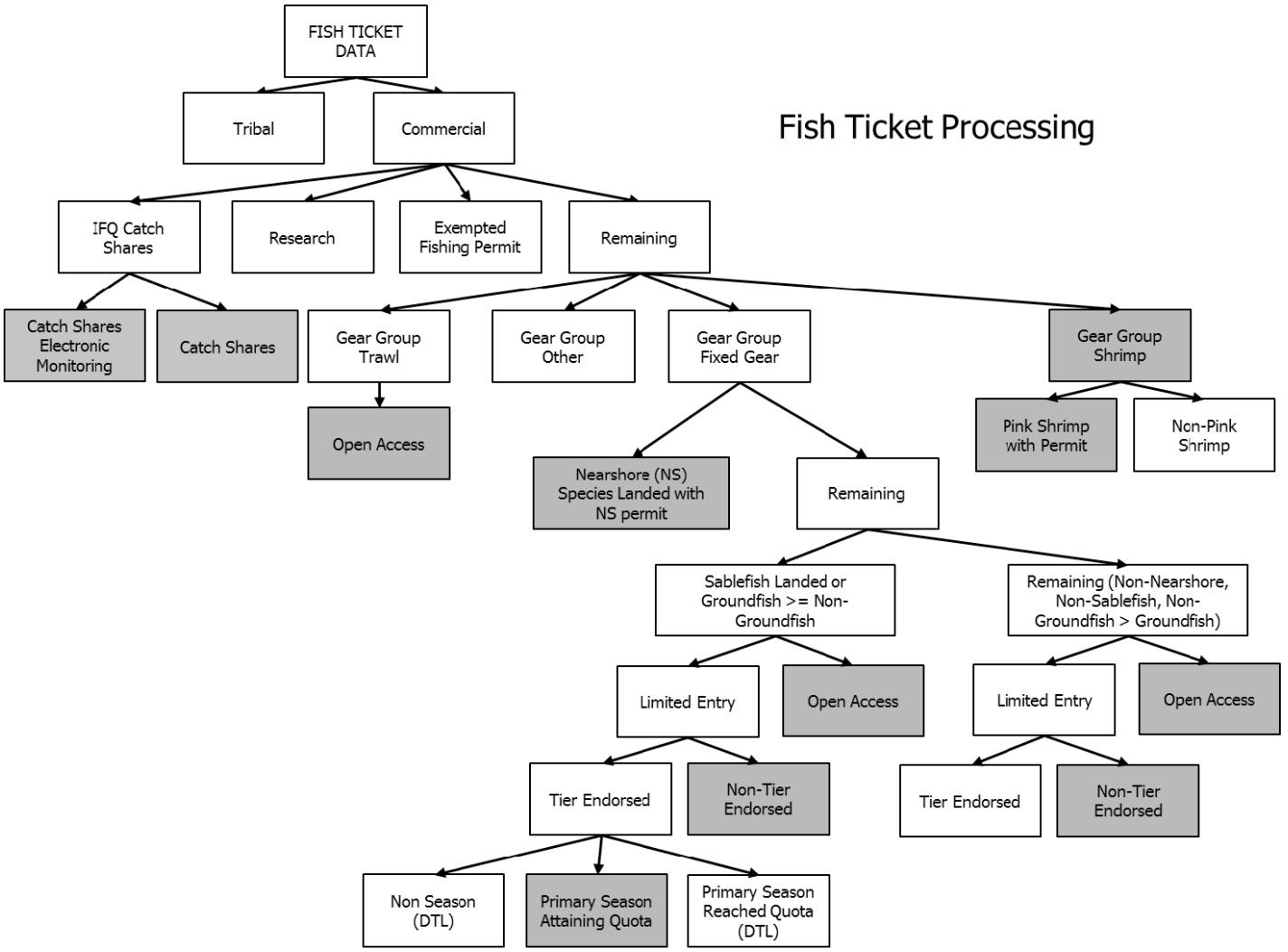

Figure F-1. Fish ticket data processing for division into 2016 groundfish fishery sectors after retrieval from the Pacific Fisheries Information Network (PacFIN) database. Gray boxes indicate sectors for which federal observer data are available. Fish ticket processing methods are updated annually; thus, this figure might differ from similar figures in previous reports.

List of Species

The following species are mentioned in this report. To save space, particularly in the tables, their scientific names are listed here. **Bold** text = common name of species.

In general

alcids		Charadriiformes
cetaceans	dolphins	Delphinidae
	porpoises	Phocoenidae
	whales	Mysticeti, Odontoceti
flatfish		Pleuronectiformes
greenlings		Hexagrammidae
pinnipeds		Odobenidae, Otariidae, Phocidae
rockfish		*Sebastes* spp.
sea turtles		Cheloniidae
sharks		Chondrichthyes
skates		Rajiformes
tubenoses		Aulorhynchidae

To species

albatross	black-footed	*Phoebastria nigripes*
	Laysan	*Phoebastria immutabilis*
	short-tailed	*Phoebastria albatrus*
auklet	Cassin's	*Ptychoramphus aleuticus*
	rhinoceros	*Cerorhinca monocerata*
brown **booby**		*Sula leucogaster*
cabezon		*Scorpaenichthys marmoratus*
cormorant	Brandt's	*Phalacrocorax penicillatus*
	double-crested	*Phalacrocorax auritus*
	pelagic	*Phalacrocorax pelagicus*
northern **fulmar**		*Fulmarus glacialis*
lesser **goldfinch**		*Spinus psaltria*
pigeon **guillemot**		*Cepphus columba Pallas*
gull	Arctic herring	*Larus smithsonianus*
	California	*Larus californicus*
	glaucous-winged	*Larus glaucescens*
	Heermann's	*Larus heermanni*
	mew	*Larus canus*
	ring-billed	*Larus delawarensis*
	western	*Larus occidentalis*
Pacific **hake**/Pacific **whiting**		*Merluccius productus*
California **halibut**		*Paralichthys californicus*
parasitic **jaeger**		*Stercorarius parasiticus*
black-legged **kittiwake**		*Rissa tridactyla*

List of species, continued

California **least tern**		*Sternula antillarum browni*
loon	common	*Gavia immer*
	Pacific	*Gavia pacifica*
common **murre**		*Uria aalge*
murrelet	ancient	*Synthliboramphus antiquus*
	marbled	*Brachyramphus marmoratus*
pelican	American white	*Pelecanus erythrorhynchos*
	brown	*Pelecanus occidentalis*
red-necked **phalarope**		*Phalaropus lobatus*
plover	semipalmated	*Charadrius semipalmatus*
	snowy	*Charadrius nivosus*
tufted **puffin**		*Fratercula cirrhata*
sablefish		*Anoplopoma fimbria*
white-winged **scoter**		*Melanitta deglandi*
shearwater	pink-footed	*Ardenna creatopus*
	short-tailed	*Ardenna tenuirostris*
	sooty	*Ardenna grisea*
California **sheephead**		*Semicossyphus pulcher*
pink **shrimp**		*Pandalus jordani*
south polar **skua**		*Catharacta maccormicki*
fox **sparrow**		*Passerella iliaca*
storm-petrel	Leach's	*Hydrobates leucorhous*
	fork-tailed	*Hydrobates furcatus*
green-winged **teal**		*Anas crecca carolinensis*
warbler	orange-crowned	*Leiothlypis celata*
	Wilson's	*Cardellina pusilla*

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NOAA Technical Memorandum NMFS-NWFSC-

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139 Harvey, C., N. Garfield, G. Williams, K. Andrews, C. Barceló, K. Barnas, S. Bograd, R. Brodeur, B. Burke, J. Cope, L. deWitt, J. Field, J. Fisher, C. Greene, T. Good, E. Hazen, D. Holland, M. Jacox, S. Kasperski, S. Kim, A. Leising, S. Melin, C. Morgan, S. Munsch, K. Norman, W. T. Peterson, M. Poe, J. Samhouri, I. Schroeder, W. Sydeman, J. Thayer, A. Thompson, N. Tolimieri, A. Varney, B. Wells, T. Williams, and J. Zamon. 2017. Ecosystem Status Report of the California Current for 2017: A Summary of Ecosystem Indicators Compiled by the California Current Integrated Ecosystem Assessment Team (CCIEA). U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-139. NTIS number PB2018-100477. https://doi.org/10.7289/V5/TM-NWFSC-139

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