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ESTIMATES OF CETACEAN MORTALITY AND INJURY IN TWO U.S. PACIFIC LONGLINE FISHERIES, 1994-2002

by

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ABSTRACT

This report presents estimates of annual mortality and serious injury of cetaceans for the Hawaii-based longline fishery during 1994-2002, and for the California-based fishery between August 2001 and December 2002. Hawaii-based vessels primarily targeted tunas and swordfish, until a 2001 ban on swordfish fishing north of the equator was implemented. Subsequently, a portion of the swordfish fleet relocated to California, where the restrictions on swordfish fishing did not apply, and continued to target swordfish in some of the same areas as the previous Hawaii-based swordfish fleet. Observer coverage in the California-based fleet during 2001-2002 was limited (9 trips including 198 sets, representing about 5.5% of the estimated 3,612 sets made), and no marine mammals were reported injured or killed. Observer coverage in the Hawaii-based fleet ranged from 3.5% to 24.9% during 1994-2002, and fishing effort totaled an estimated 10,323 trips encompassing 110,336 sets. Annual effort was roughly constant at about 1,100 trips encompassing 12,000 sets. During the 905 observed Hawaii-based trips, 44 cetaceans were observed hooked or entangled. Four of the cetaceans (two short-finned pilot whales, *Globicephala macrorhynchus,* one pan-tropical spotted dolphin, *Stenella attenuata*, and one Blainville's beaked whale, *Mesoplodon densirostris)* were observed killed. The 40 other interactions involved injuries of 10 false killer whales, *Pseudorca crassidens*, seven Risso's dolphin, *Grampus griseus*, three short-finned pilot whales, two bottlenose dolphins, *Tursiops truncatus*, two spinner dolphins, *Stenella longirostris*, two humpback whales, *Megaptera novaeangliae*, one sperm whale, *Physeter macrocephalus*, one short-beaked common dolphin, *Delphinus delphis*, and 12 unidentified cetaceans. One sperm whale was additionally injured in an experimental longline set, but this set was not included in the estimation of fleet-wide mortality and serious injury.

The severity of injuries sustained by cetaceans was evaluated based on observer descriptions of the nature of the interaction, using previously established guidelines. Interactions with insufficient information to make a determination of the severity of injury were prorated based on the severity of known interactions for each species. Ten cetaceans were categorized as not seriously injured and 30 as seriously injured. Total (cumulative) mortality and serious injury

during the 9-year period was estimated as: 130 (CV=0.40) Risso's dolphins, 50 (CV=0.71) bottlenose dolphins, 4 (CV=1.0) pantropical spotted dolphins, 81 (CV=0.38) false killer whales, 44 (CV=0.47) short-finned pilot whales, 4 (CV=1.0) Blainville's beaked whales, 4 (CV=1.0) humpback whales, and 118 (CV=0.40) unidentified cetaceans. Estimates for sperm whales and spinner dolphins are zero because injuries for these species were categorized as not serious. Cetacean mortality and injury were also calculated separately for waters within and outside of U.S. Exclusive Economic Zones to facilitate management of cetaceans in U.S. waters.

INTRODUCTION

In 1994, concern over sea turtle bycatch led the National Marine Fisheries Service (NMFS) to initiate a mandatory observer program for the Hawaii-based longline fishery, which operated in the central North Pacific in an area extending roughly from 10N to 45N and 170E to 140W (see Figure 1). During the mid 1990s, the fishery targeted primarily bigeye tuna (*Thunnus obesus*), yellowfin tuna (*Thunnus albacares*), and swordfish (*Xiphias gladius*), although albacore tuna (*Thunnus alalunga*), marlins, and other bony fishes were also occasionally targeted. Bycatch documented with roughly 4% observer coverage included several species of sea turtles, seabirds, and a variety of cetaceans (Kleiber 1999, McCracken 2000). The total annual estimated mortality and serious injury of the Hawaiian stock of false killer whale (*Pseudorca crassidens*), has exceeded the level allowable under the Marine Mammal Protection Act (MMPA), and this stock has been considered strategic under the MMPA since 2000 (Forney et al. 2000, Carretta et al. 2001, Carretta et al. 2002). In recent years, the fishery has undergone several regulatory changes to reduce bycatch of sea turtles and seabirds, including a 2001 ban on swordfish-style fishing north of the equator by vessels based in Hawaii[1]. Subsequently, a portion of the Hawaii-based swordfish fleet moved their base of operations to California, where the swordfish prohibitions did not apply. Observer data and estimates of total fleet effort are analyzed to estimate levels of mortality and injury for cetaceans during 1994-2002 in these two related fisheries. Information is provided separately for Hawaii and California-based vessels, and for waters within and outside of U.S. Exclusive Economic Zones (EEZs). Potential factors that may influence rates of cetacean mortality and serious injury are also summarized, although sample sizes are insufficient for meaningful statistical analyses.

METHODS

For purposes of this analysis, 'take' is defined as the injury or mortality of a cetacean during fishing operations, generally caused by hooking and/or entanglement. Incidental take data were collected between the years of 1994 and 2002 by onboard observers trained in the collection of longline fishery data on catch, bycatch, species interaction, gear characteristics, and relevant environmental variables[2]. Longline fishing vessels operating out of Hawaii were assigned observers to achieve a fleet-wide target level of coverage (about 4% from 1994-98, then increasing to a minimum of 20%). During the initial years of lower coverage, observer coverage

[1] See Final Rule, Federal Register Vol. 67, No. 113, pages 40232-40238, June 12, 2002.
[2] National Marine Fisheries Service, Pacific Islands Region Observer Program (Honolulu, HI) and Southwest Region Observer Program (Long Beach, CA).

was intentionally biased towards swordfish trips because of concern over sea turtle bycatch in this component of the fleet. This may introduce a bias in estimates of cetacean mortality and serious injury for these early years, although the direction of bias will vary by species. Beginning in 1999, observer coverage for the Hawaii-based fleet was more representative of total effort, and estimates of mortality and serious injury are not expected to exhibit such a bias. Observer coverage in the California-based fleet was representative of total effort and achieved about 5.5% coverage during 2001-2002. Following each trip, data were edited, processed and entered according to established NMFS protocols. For the present analysis, relevant data fields were extracted and re-processed to estimate mortality, serious injury and non-serious injury for all observed cetacean species both within and outside of the U.S. EEZs.

The physical condition of hooked or entangled marine mammals was determined at sea by the on-board observer as one of the following (PIAO 2001):

D = dead,
I = injured, swimming/breathing abnormally, or released with gear attached,
A = released with no gear attached and swimming/breathing normally, or
U = unknown, if the animal is lost from sight before a determination can me made.

These physical condition categories do not distinguish between serious injuries, defined by NMFS[3] as those likely to result in mortality, and non-serious injuries, from which the animal is expected to recover. Under the MMPA, marine mammal stock assessments must evaluate both human-caused mortality and serious injury of marine mammals. Therefore, for this analysis, a determination regarding the seriousness of injuries was made based on the observer's written description of each interaction and guidelines established by a 1997 workshop on differentiating serious and non-serious injury of marine mammals taken incidental to commercial fishing operations (Angliss and DeMaster 1998). Injuries were considered serious if the animal ingested the hook, was hooked in the head or mouth, or was released with substantial gear attached (e.g. a long segment of line trailing or wrapped around the body, sometimes including attached floats). Injuries were considered non-serious if the animal was hooked in a region other than the head and released with no or minimal gear attached (e.g. a single hook and a short segment of line) or completely freed from all gear prior to release. In cases where the observer's written comments were insufficient to make a clear determination based on these criteria, the seriousness was initially scored as unknown, and later pro-rated by species based on the proportion of other observed injuries that could be determined to be either serious or non-serious.

Analytical methods of mortality estimation were limited to simple ratio calculations because of the small number of interactions observed during the 9-year observer program. Previous analyses of 1994-98 Hawaii longline observer data (Kleiber 1998) indicated that total mortality estimates were similar whether calculations were based on trips, sets or number of hooks fished. In the present analysis, sets were used as the unit of effort, and annual mortality and serious injury for each species, M_s, was estimated as:

$$M_s = E_t * r_s \qquad (1)$$

[3] Code of Federal Regulations; 50 CFR part 229.2

where E_t = Total fishing effort by the fleet (# sets), and
r_s = the observed rate of mortality and serious injury of species *s*, calculated as

$$r_s = (m_s + s_s) / E_o \quad (2)$$

where m_s = Number of mortalities of species *s* during all observed sets
s_s = Number of serious injuries of species *s* during all observed sets
E_o = Observed fishing effort (# sets)

Estimation was performed separately for the Hawaii-based and California-based fleets because of differences in the distribution of fishing effort. Coefficients of variation (CV) for M_s were calculated on the basis of the likelihood function of the Poisson (rare event) distribution.

Total fishing effort, E_t, was estimated from logbook data (for Hawaii-based vessels, 1994-2002) and from dock rounds that identified when vessels were in port or at sea and presumably fishing (for California-based vessels, August 2001-December 2002). For purposes of mortality estimation by calendar year, all sets were considered to have taken place during the calendar year in which the vessel departed. Estimates of observed and total effort by calendar year in this report may, therefore, vary slightly from those published in other summaries based on the date of vessel landings or arrival (e.g., Ito and Machado 2001)[4].

Within each trip, sets were categorized based on gear characteristics and target species, according to the following criteria:

Swordfish-targeting (shallow sets): If the target species was listed as swordfish and the number of hooks per float was less than 15 and the hook size was less than 12 (i.e., 12/0 or less, indicating a swordfish/mustad/J-hook)[5].

Swordfish-style (shallow sets): If the target species was not swordfish, but the number of hooks per float was less than 15 and the hook size was less than 12 (i.e., 12/0 or less, indicating a swordfish/mustad/J-hook). Target species on observed sets in this category included yellowfin, bigeye, albacore, other tuna, blue marlin (*Makaira mazara*), and 'other bony fishes'.

Tuna-style (deep sets): If the target species was not swordfish, and the number of hooks per float was >= 15 or the hook size is >=33 (i.e., 3.3mm or greater, indicating a tuna hook). Target species on observed sets in this category included bigeye, yellowfin, albacore, other tuna, and striped marlin (*Tetrapturus audax*).

[4] Annual reports summarizing logbook data for the Hawaii longline fishery are available from the Pacific Islands Science Center at http://www.nmfs.hawaii.edu; Quarterly and annual reports for the Hawaii longline observer program are available from the Pacific Islands Region at http://swr.nmfs.noaa.gov/pir

[5] For details of gear characteristics recorded by observers (e.g. hook size), see the Hawaii Longline Observer Program Observer Field Manual, Pacific Islands Regional Office, 08 August 2003 (available from NMFS Pacific Islands Regional Office, 1601 Kapiolani Blvd. Suite #1110, Honolulu, HI 96814, USA).

All sets could be unambiguously assigned based on the above criteria. Trips were subsequently categorized as either *swordfish* (if only swordfish-targeting sets were made), *tuna* (if only tuna-style sets were made), or *mixed* (if swordfish-style sets or a mixture of set types were made).

Mortality and serious injury of marine mammals were estimated separately for U.S. EEZ waters of the Hawaiian Islands and Palmyra Atoll, and for non-EEZ waters (Figure 1), because mortality and serious injury of marine mammals in fisheries within U.S. waters are required to be below the Potential Biological Removal (PBR) of each stock. No marine mammal takes were observed during 1994-2002 in U.S. EEZs of other central Pacific islands within the range of the fishery, but the number of observed sets in these other EEZs was relatively small (see Figure 1). Mortality and serious injury were calculated based only on the number of mortalities observed within each EEZ category. This assumes that the proportion of trips within each EEZ region is the same for observed and unobserved trips. Other factors relating to set and gear characteristics that either changed during the study period or could potentially affect entanglement rates, including trip type, latitude of set, depth of set, and sea surface temperature were examined for possible effects using the observer data (Table 2); however, sample sizes were not sufficient to model potential effects of these variables using regression techniques. A stratified analysis of mortality and serious injury was also considered but determined to be infeasible, because data on potential stratification variables were not consistently recorded for unobserved trips (from logbook data) or because relationships (e.g. with latitude) were not adequately captured with simple stratification.

RESULTS

Observed Effort and Cetacean Take Rates

Hawaii-based fleet

Observer coverage rates for the fishery varied during the study period, ranging from a low of 3.5% of sets observed in 1999 to a high of 24.9% of sets observed in 2002 (Table 1). Coverage levels were similar when measured on a per trip basis: 3.3% of trips were observed in 1999 and 23.3% of trips were observed in 2002. Marine mammal takes (all cetaceans) were observed on 44 occasions during 905 trips with 11,014 sets, yielding an average take rate of one cetacean per 20 trips (or one per 250 sets). Takes occurred throughout the area of the fishery (Figure 1), and on trips targeting swordfish, tunas or a combination of target species (Tables 2, 3). Overall cetacean take rates appeared to be lowest during trips targeting tunas (one cetacean per 31 trips or 372 sets), highest during sets targeting swordfish (one cetacean per 6 trips or 87 sets), and intermediate during mixed trips (one cetacean per 16 trips or 191 sets) (Table 2). A larger sample size will be required to evaluate whether this apparent difference is statistically significant. Sets made during tuna trips tended to be set deeper in warmer water and at lower latitudes than swordfish trips or mixed trips (Table 2). The likelihood of an interaction resulting in the observed death of a cetacean did not exhibit any apparent pattern with water depth or trip type (Table 3), but only four deaths were observed. Apparent species-specific differences by trip type are likely related to the distribution of each species, with tropical species taken primarily on lower-latitude tuna trips, and higher-latitude species taken primarily on swordfish or mixed trips.

California-based fleet

Observer coverage represented about 5.5% of total effort during 2001-2002, with two trips observed during 2001 and seven trips observed during 2002. Observed effort included 365 days at sea and 198 sets, averaging 0.54 sets per day at sea. Dock-rounds indicated that the California-based fleet spent 6660 days at sea, yielding in an estimated 3,613 sets. No marine mammal takes were observed during the nine observed trips. Effort occurred mostly north of 26N and west of 150W, within the area closed to swordfish fishing for the Hawaii-based fleet beginning in 2001, and overlapping with a subset of the previous Hawaii-based effort (Figure 2).

Cetacean Species Observed Taken

Marine mammal species taken by the Hawaii-based fleet (with number of takes observed) included short-beaked common dolphin, *Delphinus delphis* (n=1); spinner dolphin, *Stenella longirostris* (n=2); pantropical spotted dolphin, *Stenella attenuata* (n=1); bottlenose dolphin, *Tursiops truncatus* (n=2); Risso's dolphin, *Grampus griseus* (n=7); false killer whale, *Pseudorca crassidens* (n=10); short-finned pilot whale, *Globicephala macrorhynchus* (n=5); Blainville's beaked whale, *Mesoplodon densirostris* (n=1); humpback whale, *Megaptera novaeangliae* (n=2); and sperm whale, *Physeter macrocephalus* (n=1). One additional sperm whale was taken in an experimental set during April 2002; this trip was not included in the mortality estimation analysis. On 12 occasions, the observer was not able to identify the species of cetacean, generally because the animal broke free or disappeared before sufficient characteristics could be seen, or because of poor weather or darkness. Based on the observers description and probable/possible identification, candidate species for each of these interactions were identified (Table 3) to aid in pro-rating of injury types (see below).

Condition of animals taken

Four of the observed cetaceans were dead upon gear retrieval. Injured animals (n=40) were either hooked, entangled or both (Table 3). The seriousness of injury could be determined based on the observer's notes for 27 of the injured animals, resulting in 18 seriously injured and 9 not seriously injured (Table 3). Injured large whales and small dolphins were generally hooked in the tail or fins or lightly entangled and considered not seriously injured. All false killer whales and Risso's dolphins were considered seriously injured, because they were hooked in the mouth or had ingested the hook. Based on these patterns, the six remaining injuries of identified species were prorated as follows (Table 3): three false killer whales (all serious), two Risso's dolphins (both serious), and one spinner dolphin (not serious). Pro-rating of undetermined injury types for the seven unidentified cetaceans included consideration of likely or possible species identification. For example, unidentified cetaceans that were determined to be either false killer whales or short-finned pilot whales were prorated based on the patterns for these two species, taking into account the nature of hookings and entanglements observed. Finally, the single sperm whale taken during the experimental trip was released with line wrapped around its body and no determination or proration could be made regarding the severity of the injury.

Estimates of Mortality and Serious Injury

Estimated rates of cetacean mortality and serious injury for the Hawaii-based fleet (Table 4) are on the order of a few individuals to tens of individuals per year, depending on species. Combining results for EEZ and non-EEZ waters results in the following estimates of total (cumulative) mortality and serious injury during the 9-year period: 130 (CV=0.40) Risso's dolphins, 50 (CV=0.71) bottlenose dolphins, 4 (CV=1.0) pantropical spotted dolphins, 81 (CV=0.38) false killer whales, 44 (CV=0.47) short-finned pilot whales, 4 (CV=1.0) Blainville's beaked whales, 4 (CV=1.0) humpback whales, and 118 (CV=0.40) unidentified cetaceans. Estimates for sperm whales and spinner dolphins are zero because injuries for these species were considered not serious. The impact of these levels of mortality and serious injury depends critically on stock structure and size of the source populations, which are poorly known. False killer whales and Risso's dolphins have the highest estimated mortality, although none of the Risso's dolphin takes were within U.S. territorial waters. The proportion of takes within U.S. waters varies by species, with takes observed both around the Hawaiian Islands and near Palmyra Atoll to the south (Figure 1).

The estimated rate of cetacean mortality and serious injury for the California-based swordfish fleet during 2000-2001 is zero; however, only nine sets were observed. This level of coverage would result in a 19% probability of observing zero takes if rates were, in fact, the same as for the Hawaii-based swordfish-targeting fleet (one cetacean per six trips). Thus, the lack of observed takes does not indicate that the rate of cetacean takes for California-based vessels is zero.

DISCUSSION

The U.S. Pacific longline fisheries for swordfish and tunas have undergone a number of changes during the period of this analysis (1994-2002), complicating the estimation of mortality and serious injury of cetaceans that interact with vessels based in both Hawaii and California. The present analyses assume that observer coverage within each state was representative of the behavior of the remainder of the fleet based in that state. If it was not representative, this could introduce bias into the estimates. Attempts were made to examine potentially important variables, such as trip type, set depth, latitude, and sea surface temperature, but the corresponding data on total effort (derived from logbooks) were not adequate to include these variables explicitly in the mortality estimation. The small number of observed takes also precluded meaningful modeling of covariates that may be associated with higher or lower marine mammal takes, as has been done for turtles (McCracken 2000). Potential bias introduced by this unaccounted for heterogeneity is expected to be higher during the early years of the Hawaii-based observer program, when observer coverage was low (about 4%) and the fleet was the most heterogeneous. Since 2000, however, the potential for such bias is considerably reduced, because the remaining Hawaii-based fleet has shifted almost exclusively towards tuna-style fishing, and fleet behavior is less heterogeneous. Furthermore, the higher percentage (20% or more) of observer coverage provides a more representative sample of total fishing effort. For these reasons, the estimates for the 2-3 most recent years of Hawaii-based fishing may be considered the least biased. Although the estimate of mortality and serious injury by the California-based fleet is zero, this estimate is based on a limited number of observed trips, and it

does not mean that takes rates are zero. Additional observer data are expected to allow improved estimation of cetacean take rates for the California-based longline fishery in the future.

The estimates of mortality and serious injury for the Hawaii-based fleet have high coefficients of variation (Table 4), because takes are rare events and sample sizes for estimation are small. Further uncertainty is introduced by the unknown fate of animals released alive but injured. The guidelines and prorating used in this analysis provide a framework for assigning injuries to a level of seriousness, but the absence of information on the actual fate of the injured animals introduces considerable uncertainty. Finally, the large number of takes that could not be assigned to a particular species, including several determined to have been serious, means that total takes are underestimated for at least some of the species. Estimates presented here should thus be considered minimum estimates of mortality and serious injury, particularly for the 'possible' species listed in Table 3.

The mortality and serious injury estimates presented in this study provide the first measures of potential impacts of the Hawaii-based and California-based longline fishery on cetacean species. Actual population-level impacts will depend each species' population size and stock structure within the area of the fishery. Takes of false killer whales are of particular concern because recent genetic studies have shown that the animals around the Hawaiian Islands are genetically distinct from false killer whales elsewhere in the eastern and western tropical Pacific (S. Chivers, NMFS unpublished data), and this stock has been considered a *strategic* stock under the MMPA since 2000 (Forney et al. 2000). Current levels of mortality and serious injury exceed the most recently calculated PBR – the level of human-caused mortality and serious injury allowed under the MMPA – by a factor of about 4 (an average of 4.4 false killer whales were estimated killed or seriously injured per year within the Hawaiian Islands EEZ during 1998-2002, compared to the PBR = 1.0; Carretta et al. 2004). Recent surveys suggest that the Hawaiian Islands population of false killer whales is small - on the order of a few hundred individuals (Mobley et al. 2001, Barlow 2003), and the cumulative take of even a low number of individuals per year may be unsustainable. Furthermore, the impact of recent takes around Palmyra Atoll, where no information on false killer whale abundance and stock structure is available, is unknown. Further research into stock identity and abundance of cetaceans that interact with U.S. Pacific longline fisheries will be essential for assessment of impacts.

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Table 1. Summary of effort and observer coverage in the Hawaii-based longline fishery. Trips and sets are considered to have taken place in the year in which the vessel departed. Takes are defined as the injury or mortality of a cetacean during fishing operations.

	From logbook data		From observer data						
YEAR	Total # trips	Total # sets	Total # trips observed	Total # sets observed	% trips observed	% sets observed	# Cetacean Takes	Takes per Trip	Takes per Set
All trips									
1994	1,105	10,799	50	520	4.5%	4.8%	0	0.00	0.000
1995	1,170	11,732	47	538	4.0%	4.6%	3	0.06	0.006
1996	1,137	11,638	53	642	4.7%	5.5%	3	0.06	0.005
1997	1,162	11,846	40	531	3.4%	4.5%	4	0.10	0.008
1998	1,181	12,506	48	581	4.1%	4.6%	3	0.06	0.005
1999	1,165	12,805	38	448	3.3%	3.5%	5	0.13	0.011
2000	1,135	12,930	118	1,527	10.4%	11.8%	9	0.08	0.006
2001	1,075	12,169	233	2,768	21.7%	22.7%	8	0.03	0.003
2002	1,193	13,911	278	3,459	23.3%	24.9%	9	0.03	0.003
Sum	**10,323**	**110,336**	**905**	**11,014**	**--**	**--**	**44**	**--**	**--**
Average	**1,147**	**12,260**	**101**	**1,224**	**8.8%**	**10.0%**	**5**	**0.05**	**0.004**

Table 2. Summary of cetacean take rates by trip type, set characteristics, and environmental factors in the Hawaii-based longline fishery observer program, 1994-2002.

TRIP TYPE	Trip year	Total # trips obs	Total # sets obs	# Swordfish targeting sets	# Swordfish-style sets	# Tuna-style sets	# Cetacean takes	Cetacean take rate (per trip)	Cetacean take rate (per set)	Mean latitude (°N)	Mean SST (°C)	Mean target depth (m)	Mean # hooks	Mean hooks per float	Mean haul hour of day
TUNA		**718**	**8,563**	**-**	**-**	**8,563**	**23**	**0.03**	**0.003**	**18.4**	**25.9**	**185**	**1887**	**27**	**16**
	1994	18	170	-	-	170	0	0.00	0.000	19.5	25.3	130	1394	26	16
	1995	25	266	-	-	266	0	0.00	0.000	19.7	25.5	186	1429	26	16
	1996	24	277	-	-	277	1	0.04	0.004	18.6	26.1	125	1597	27	16
	1997	16	186	-	-	186	0	0.00	0.000	19.0	26.0	233	1793	28	16
	1998	23	257	-	-	257	1	0.04	0.004	16.7	26.1	146	1908	28	17
	1999	25	273	-	-	273	0	0.00	0.000	19.5	24.6	179	1964	28	16
	2000	90	1,082	-	-	1,082	5	0.06	0.005	17.7	26.2	138	1985	28	16
	2001	220	2,608	-	-	2,608	7	0.03	0.003	18.3	25.9	192	1895	27	16
	2002	277	3,444	-	-	3,444	9	0.03	0.003	18.5	25.9	203	1932	27	16
SWORDFISH		**89**	**1,308**	**1,308**	**-**	**-**	**15**	**0.17**	**0.011**	**30.9**	**20.1**	**30**	**791**	**4**	**6**
	1994	20	223	223	-	-	0	0.00	0.000	29.7	20.4	21	835	4	7
	1995	8	118	118	-	-	3	0.38	0.025	28.9	20.6	29	828	4	6
	1996	12	156	156	-	-	1	0.08	0.006	30.3	21.7	26	843	5	6
	1997	12	201	201	-	-	3	0.25	0.015	30.7	19.6	26	751	4	6
	1998	11	154	154	-	-	1	0.09	0.006	32.5	19.4	39	786	4	6
	1999	7	106	106	-	-	3	0.43	0.028	30.3	21.3	24	824	4	7
	2000	14	281	281	-	-	3	0.21	0.011	32.4	19.5	35	739	4	6
	2001	4	54	54	-	-	1	0.25	0.019	31.1	18.5	45	755	4	6
	2002	1	15	15	-	-	0	0.00	0.000	31.7	18.2	-	807	15	7
MIXED		**98**	**1,143**	**322**	**781**	**40**	**6**	**0.06**	**0.005**	**26.5**	**23.2**	**38**	**837**	**5**	**8**
	1994	12	127	11	107	9	0	0.00	0.000	25.0	24.1	32	873	7	9
	1995	14	154	23	131	0	0	0.00	0.000	26.3	23.5	28	852	5	7
	1996	17	209	94	115	0	1	0.06	0.005	27.2	22.7	33	837	4	8
	1997	12	144	73	71	0	1	0.08	0.007	27.8	21.7	29	825	4	8
	1998	14	170	42	116	12	1	0.07	0.006	28.0	23.5	35	887	6	8
	1999	6	69	39	30	0	2	0.33	0.029	27.4	21.9	32	798	5	7
	2000	14	164	40	124	0	1	0.07	0.006	25.3	23.6	40	819	5	10
	2001	9	106	0	87	19	0	0.00	0.000	23.9	24.2	91	762	8	9
	2002	-	-	-	-	-	-	-	-	-	0.0	-	-	-	-
ALL TRIPS		**905**	**11,014**	**1,630**	**781**	**8,603**	**44**	**0.05**	**0.004**	**20.7**	**24.8**	**150**	**1648**	**22**	**14**

Table 3. Summary of observed cetacean takes in the Hawaii-based longline fishery, 1994-2002. Key: Trip types: S=swordfish, T=tuna, M=mixed; Set type S=swordfish-targeting, (S) = swordfish-style, T = tuna-style. Species codes: DD = short-beaked common dolphin; SL = spinner dolphin; SA = pan-tropical spotted dolphin; TT = bottlenose dolphin; GG = Risso's dolphin; PC = false killer whale; GM = short-finned pilot whale; MD = Blainville's beaked whale; MN = humpback whale; PM = sperm whale; UC = unidentified cetacean; UW = unidentified whale. Injury determination criteria, and trip/set type definitions are described in text.

Trip-Set Number	Trip Year	Set Date	Latitude (N)	Longitude (W)	Trip Type	Set Type	EEZ	SST (°F)	Set Depth (m)	Species Code	Possible Species IDs	Recorded Animal condition	Injury Severity Determination	*Prorated Injury Severity*	Injury determination criteria / Comments
LL0353-19	2000	Dec-00	35.6	142.1	S	S	Non-EEZ	61.6	30	DD	DD	Injured	Not Serious		Line around fluke, released with minimal line attached
LL0061-02	1995	Mar-95	30.9	150.4	S	S	Non-EEZ	65.0	27	GG	GG	Injured		*Serious*	*5/5 GG serious*
LL0063-01	1995	Mar-95	30.5	148.2	S	S	Non-EEZ	64.7	30	GG	GG	Injured	Serious		Hooked in mouth
LL0160-12	1997	Mar-97	30.7	154.4	S	S	Non-EEZ	66.4	29	GG	GG	Injured	Serious		Hooked in mouth / hook ingested
LL0161-01	1997	Mar-97	30.4	157.6	S	S	Non-EEZ	65.6		GG	GG	Injured	Serious		Hooked in mouth
LL0242-09	1999	Feb-99	31.2	160.9	S	S	Non-EEZ	65.1		GG	GG	Injured	Serious		Hooked in mouth
LL0284-02	2000	Jan-00	31.6	135.9	S	S	Non-EEZ	63.5	25	GG	GG	Injured	Serious		Hook ingested
LL0400-02	2001	Jan-01	33.2	148.0	S	S	Non-EEZ	62.9	30	GG	GG	Injured		*Serious*	*5/5 GG serious*
LL0148-05	1996	Dec-96	35.9	142.1	S	S	Non-EEZ	65.0	22	GM	GM	**Dead**			**Line tangled around caudal peduncle**
LL0305-02	2000	Jul-00	33.1	170.1	S	S	Non-EEZ	75.0	25	GM	GM	Injured	Serious		Hooked in mouth / hook ingested
LL0331-05	2000	Oct-00	15.1	161.5	T	T	Non-EEZ	81.2	60	GM	GM	**Dead**			**Hooked in mouth**
LL0526-01	2001	Aug-01	6.5	163.0	T	T	Other US	85.3		GM	GM	Injured	Not Serious		Entangled, appeared to break free of line
LL0535-11	2001	Sep-01	16.4	162.2	T	T	Non-EEZ	81.5	150	GM	GM	Injured	Serious		Hooked in mouth
LL0725-10	2002	Apr-02	22.8	156.4	T	T	Hawaii	72.9	95	MD	MD	**Dead**			**Hooked in fluke**
LL0433-03	2001	Feb-01	21.6	162.3	T	T	Hawaii	76.0	127	MN	MN	Injured	Serious		Entangled; trailed substantial tangled line and & 2 floats
LL0860-12	2002	Oct-02	24.8	151.6	T	T	Non-EEZ	77.9	250	MN	MN	Injured	Not Serious		Line wrapped around fluke
LL0173-11	1997	Aug-97	19.8	158.8	M	(S)	Hawaii	81.4	24	PC	PC	Injured	Serious		Hooked in mouth / hook ingested
LL0201-20	1998	Apr-98	26.1	165.1	M	S	Hawaii	72.6	27	PC	PC	Injured	Serious		Hooked in mouth / hook ingested
LL0392-03	2000	Jan-01	20.1	164.0	T	T	Non-EEZ	78.8	218	PC	PC	Injured	Serious		Hooked in mouth
LL0418-05	2001	Feb-01	5.2	163.6	T	T	Other US	81.3	91	PC	PC	Injured		*Serious*	*7/7 PC serious*
LL0446-01	2001	May-01	19.1	166.5	T	T	Non-EEZ	76.5		PC	PC	Injured		*Serious*	*7/7 PC serious*
LL0656-17	2002	Feb-02	7.0	161.7	T	T	Other US	82.8	95	PC	PC	Injured		*Serious*	*Hooked; 7/7 PC serious*
LL0663-10	2002	Feb-02	5.2	152.0	T	T	Non-EEZ	81.0	218	PC	PC	Injured	Serious		Hooked in mouth
LL0695-11	2002	Mar-02	6.6	163.2	T	T	Other US	82.9		PC	PC	Injured	Serious		Hooked in mouth
LL0808-03	2002	Jul-02	15.8	161.1	T	T	Non-EEZ	81.1	150	PC	PC	Injured	Serious		Hooked in mouth
LL0850-02	2002	Sep-02	29.0	149.0	T	T	Non-EEZ	76.9	275	PC	PC	Injured	Serious		Hook ingested
EX0745		Apr-02	28.5	164.4	E	E	OUTSIDE			PM	PM	Injured			Experimental set; Not prorated
LL0257-08	1999	May-99	27.7	170.1	S	S	Hawaii	74.3	25	PM	PM	Injured	Not Serious		Entangled, apparently got free
LL0559-05	2001	Oct-01	6.3	164.7	T	T	Other US	85.6	42	SA	SA	**Dead**			**Line wrapped around beak**
LL0164-25	1997	Apr-97	26.3	156.5	S	S	Non-EEZ	71.9	18	SL	SL	Injured	Not Serious		Hooked in fluke
LL0348-08	2000	Nov-00	25.2	157.5	M	(S)	Hawaii	77.0	35	SL	SL	Injured		*Not Serious*	*1/1 other SL not serious*
LL0063-11	1995	Mar-95	29.9	147.6	S	S	Non-EEZ	65.5	30	TT	TT	Injured	Serious		Hooked in mouth
LL0240-06	1999	Jan-99	32.1	145.1	S	S	Non-EEZ	64.8	40	TT	TT	Injured	Serious		Hook ingested
LL0126-03	1996	May-96	14.0	162.0	T	T	Non-EEZ	79.8	78	UC	PC,GM	Injured		*Serious*	*9/10 PC,GM serious; swam away slowly with gear attached*
LL0270-03	1999	Dec-99	33.7	147.5	M	S	Non-EEZ	66.5	29	UC	PC,GG,GM	Injured	Serious		Hooked in mouth
LL0323-13	2000	Oct-00	16.5	165.0	T	T	Non-EEZ	82.4	100	UC	PC,GG,TT	Injured		*Serious*	*Hooked; 14/14 PC,GG,TT serious*
LL0387-16	2000	Jan-01	19.0	159.1	T	T	Hawaii	78.3	146	UC	PC,GM	Injured		*Serious*	*Hooked; 9/10 other PC,GM serious*
LL0558-06	2001	Oct-01	11.7	169.8	T	T	Non-EEZ	83.8	218	UC	PC,GM	Injured		*Serious*	*9/10 other PC,GM serious*
LL0792-08	2002	Jun-02	5.9	161.7	T	T	Other US	84.3	364	UC	UC	Injured	Not Serious		Hooked; swam away with no gear attached
LL0804-04	2002	Jul-02	6.6	164.0	T	T	Other US	84.6		UC	SA,SL,GG,TT	Injured	Not Serious		Hooked in body/tail & entangled; broke free
LL0134-09	1996	Aug-96	36.9	175.8	M	S	Non-EEZ	73.1	30	UW	ZU	Injured	Not Serious		Hooked in fluke
LL0191-03	1998	Jan-98	31.5	153.9	S	S	Non-EEZ	64.0	25	UW	GG,TT	Injured		*Serious*	*7/7 GG,TT serious*
LL0228-10	1998	Nov-98	21.1	164.7	T	T	Hawaii	76.5	50	UW	ZU	Injured		*Not Serious*	*1/1 probable ZU not serious*
LL0239-11	1999	Jan-99	31.9	153.7	M	S	Non-EEZ	66.8	23	UW	PC,GM,GG,TT,ZU	Injured		*Serious*	*16/18 other PC,GG,GM,TT, probable ZU serious*
LL0302-01	2000	May-00	24.6	152.8	T	T	Non-EEZ	75.2	91	UW	PC,GM	Injured	Not Serious		Float line wrapped around tail

Table 4. Observed and estimated injury and mortality of cetaceans in the Hawaii-based longline fishery, 1994-2002, by EEZ category. No takes were observed in the California-based longline fishery during 2001-2002.

Year	% Sets obs	Non-serious Injury			Mortality and Serious Injury											
		All areas combined			Hawaiian EEZ			Palmyra EEZ			Total U.S. EEZ			Non-EEZ		
		# obs	Total Estim.	CV (M)	# Obs (m+s)	Total Estim. (M)	CV (M)	# Obs (m+s)	Total Estim. (M)	CV (M)	# Obs (m+s)	Total Estim. (M)	CV (M)	# Obs (m+s)	Total Estim. (M)	CV (M)
Risso's dolphin																
1994	4.8%															
1995	4.6%													**2**	**44**	**0.71**
1996	5.5%															
1997	4.5%													**2**	**45**	**0.71**
1998	4.6%															
1999	3.5%													**1**	**29**	**1.00**
2000	11.8%													**1**	**8**	**1.00**
2001	22.7%													**1**	**4**	**1.00**
2002	24.9%															
Total	10.0%	0	0		0	0		0	0		**0**	**0**		**7**	**130**	**0.40**
Bottlenose dolphin																
1994	4.8%															
1995	4.6%													**1**	**22**	**1.00**
1996	5.5%															
1997	4.5%															
1998	4.6%															
1999	3.5%													**1**	**29**	**1.00**
2000	11.8%															
2001	22.7%															
2002	24.9%															
Total	10.0%	0	0		0	0		0	0		**0**	**0**		**2**	**50**	**0.71**
Pantropical spotted dolphin																
1994	4.8%															
1995	4.6%															
1996	5.5%															
1997	4.5%															
1998	4.6%															
1999	3.5%															
2000	11.8%															
2001	22.7%							1	4	1.00	**1**	**4**	**1.00**			
2002	24.9%															
Total	10.0%	0	0		0	0		1	4	1.00	**1**	**4**	**1.00**	**0**	**0**	
Spinner dolphin																
1994	4.8%															
1995	4.6%															
1996	5.5%															
1997	4.5%	1	22	1.00												
1998	4.6%															
1999	3.5%															
2000	11.8%	1	8	1.00												
2001	22.7%															
2002	24.9%															
Total	10.0%	2	31	0.71	0	0		0	0		**0**	**0**		**0**	**0**	
False killer whale																
1994	4.8%															
1995	4.6%															
1996	5.5%															
1997	4.5%				1	22	1.00				**1**	**22**	**1.00**			
1998	4.6%				1	22	1.00				**1**	**22**	**1.00**			
1999	3.5%															
2000	11.8%													**1**	**8**	**1.00**
2001	22.7%							1	4	1.00	**1**	**4**	**1.00**	**1**	**4**	**1.00**
2002	24.9%							2	8	0.71	**2**	**8**	**0.71**	**3**	**12**	**0.58**
Total	10.0%	0	0		2	44	0.71	3	12	0.61	**5**	**56**	**0.47**	**5**	**25**	**0.51**

Table 4 (continued). Observed and estimated injury and mortality of cetaceans in the Hawaii-based longline fishery, 1994-2002, by EEZ category. No takes were observed in the California-based longline fishery during 2001-2002.

Year	% Sets obs	Non-serious Injury			Mortality and Serious Injury											
		All areas combined			Hawaiian EEZ			Palmyra EEZ			Total U.S. EEZ			Non-EEZ		
		# obs	Total Est	CV (M)	Obs takes (m+s)	Estim takes (M)	CV (M)	Obs takes (m+s)	Estim takes (M)	CV (M)	Obs takes (m+s)	Estim takes (M)	CV (M)	Obs takes (m+s)	Estim takes (M)	CV (M)
Short-finned pilot whale																
1994	4.8%															
1995	4.6%															
1996	5.5%													**1**	**18**	**1.00**
1997	4.5%															
1998	4.6%															
1999	3.5%															
2000	11.8%													**2**	**17**	**0.71**
2001	22.7%	1	4	1.00				1	4	1.00	**1**	**4**	**1.00**	**1**	**4**	**1.00**
2002	24.9%															
Total	0.0%	1	4	1.00	0	0		1	4	1.00	**1**	**4**	**1.00**	**4**	**39**	**0.53**
Blainville's beaked whale																
1994	4.8%															
1995	4.6%															
1996	5.5%															
1997	4.5%															
1998	4.6%															
1999	3.5%															
2000	11.8%															
2001	22.7%															
2002	24.9%				1	4	1.00				**1**	**4**	**1.00**			
Total	0.0%	0	0		1	4	1.00	0	0		**1**	**4**	**1.00**	**0**	**0**	
Sperm whale (excludes one animal taken in an experimental set)																
1994	4.8%															
1995	4.6%															
1996	5.5%															
1997	4.5%															
1998	4.6%															
1999	3.5%	1	29	1.00												
2000	11.8%															
2001	22.7%															
2002	24.9%															
Total	0.0%	1	29	1.00	0	0		0	0		**0**	**0**		**0**	**0**	
Humpback whale																
1994	4.8%															
1995	4.6%															
1996	5.5%															
1997	4.5%															
1998	4.6%															
1999	3.5%															
2000	11.8%															
2001	22.7%				1	4	1.00				**1**	**4**	**1.00**			
2002	24.9%	1	4	1.00												
Total	0.0%	1	4	1.00	1	4	1.00	0	0		**1**	**4**	**1.00**	**0**	**0**	
Unidentified cetaceans or unidentified whales																
1994	4.8%															
1995	4.6%															
1996	5.5%	1	18	1.00										**1**	**18**	**1.00**
1997	4.5%															
1998	4.6%	1	22	1.00										**1**	**22**	**1.00**
1999	3.5%													**2**	**57**	**0.71**
2000	11.8%	1	8.5	1.00	1	8	1.00				**1**	**8**	**1.00**	**1**	**8**	**1.00**
2001	22.7%													**1**	**4**	**1.00**
2002	24.9%	2	8.0	0.71												
Total	0.0%	5	56.2	0.47	1	8	1.00	0	0		**1**	**8**	**1.00**	**6**	**110**	**0.42**

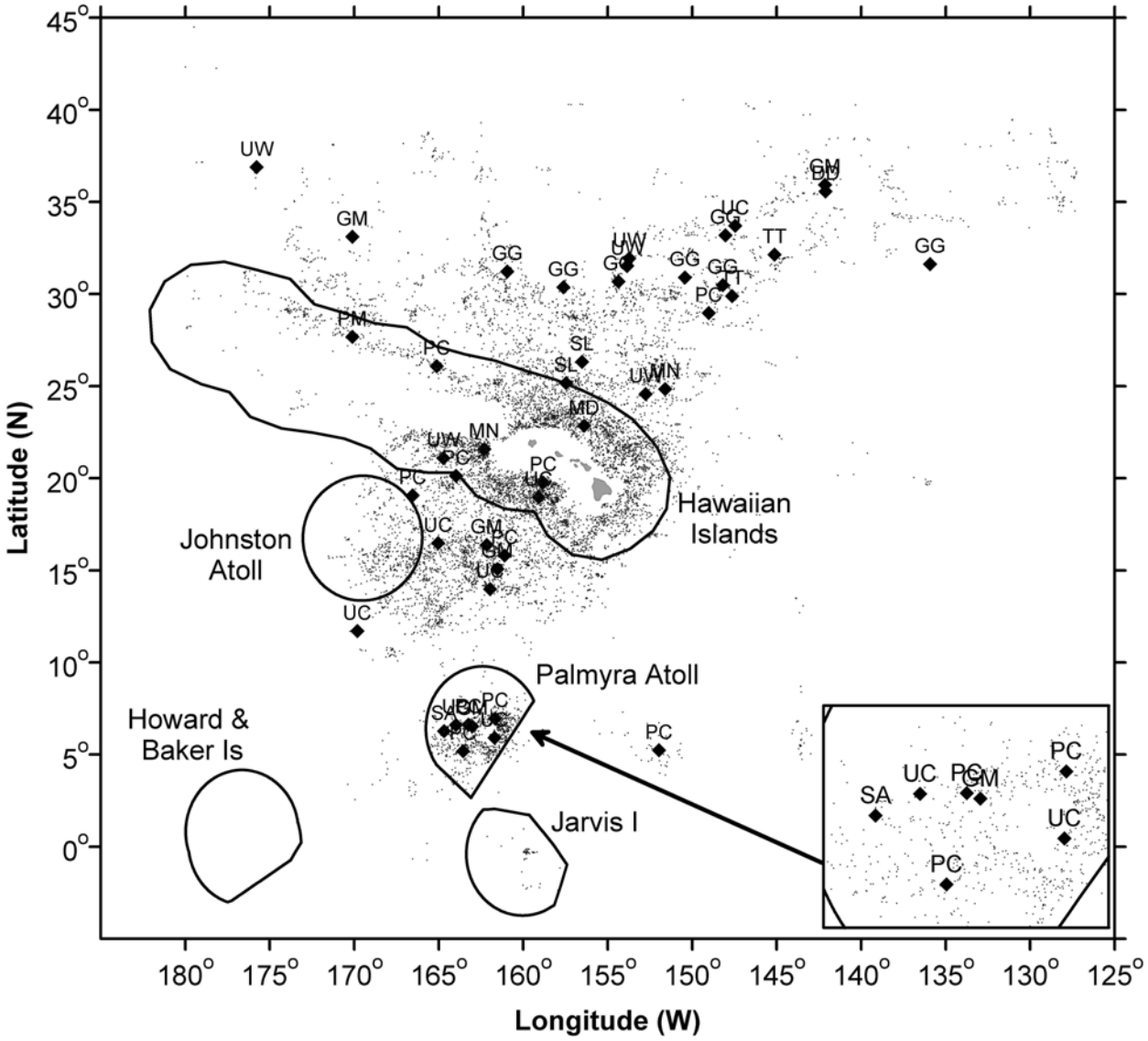

Figure 1. Locations of observed sets (small dots) and cetacean takes (black diamonds) in the Hawaii-based longline fishery, 1994-2002. Lines represent U.S. waters surrounding the Hawaiian Islands and other central Pacific islands within the range of the fishery. Key to species codes: DD = short-beaked common dolphin; SL = spinner dolphin; SA = pan-tropical spotted dolphin; TT = bottlenose dolphin; GG = Risso's dolphin; PC = false killer whale; GM = short-finned pilot whale; MD = Blainville's beaked whale; MN = humpback whale; PM = sperm whale; UC = unidentified cetacean; UW = unidentified whale.

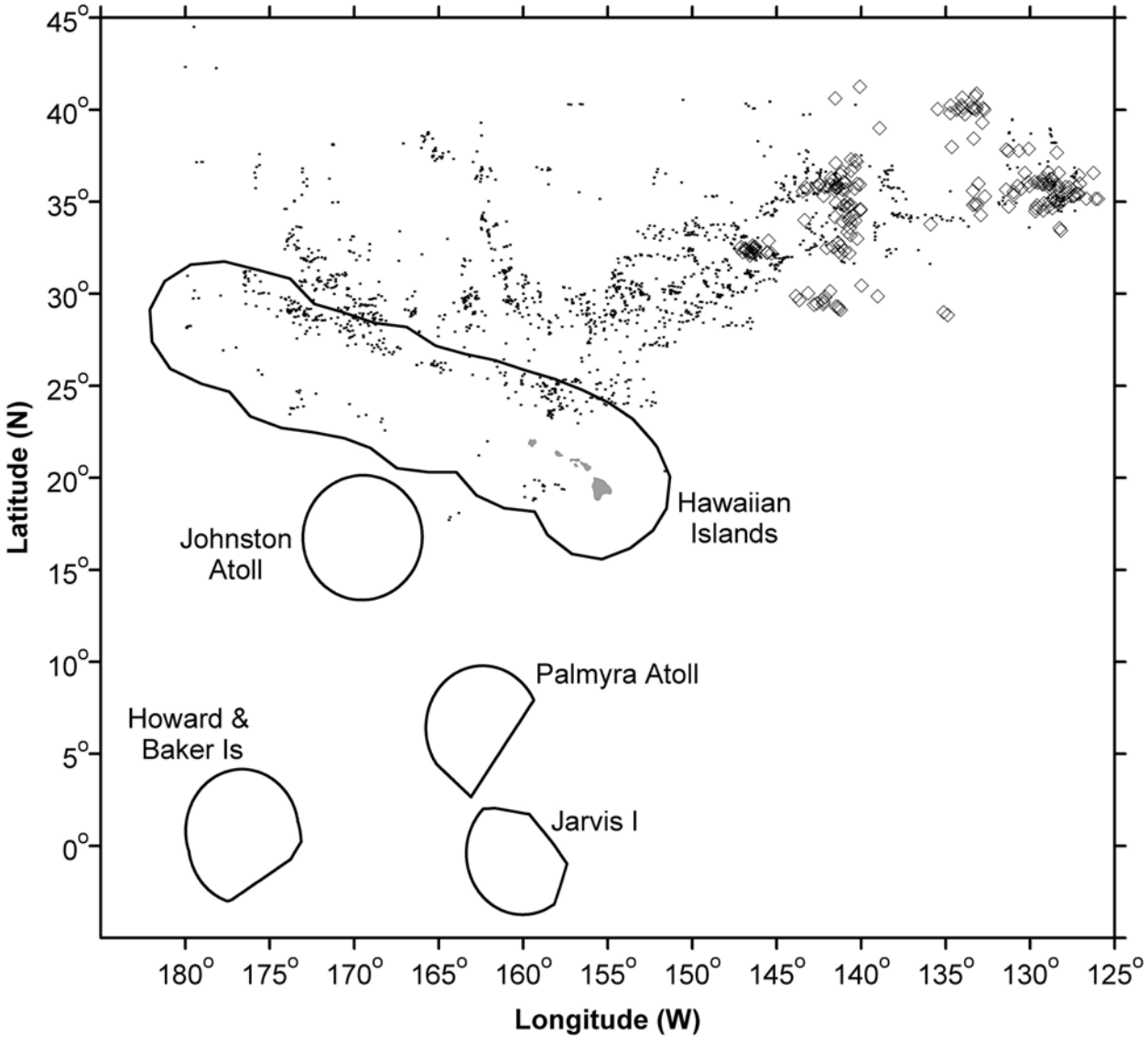

Figure 2. Locations of observed California-based swordfish sets, 2001-2002 (open diamonds), relative to observed Hawaii-based swordfish sets, 1994-2002 (small dots). Lines represent U.S. waters surrounding the Hawaiian Islands and other central Pacific islands within the range of the fishery.