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ESTIMATES OF CETACEAN MORTALITY AND INJURY IN THE HAWAII-BASED LONGLINE FISHERY, 1994-2002.

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ABSTRACT

Annual mortality and serious injury of cetaceans between 1994 and 2002 is estimated for the Hawaii-based longline fishery, which primarily targets tunas and swordfish in the North Pacific Ocean. Fishing effort for the period 1994-2002 totaled an estimated 10,323 trips encompassing 110,336 sets, with annual effort roughly constant at about 1,100 trips encompassing 12,000 sets. In recent years, restrictions on swordfish-style fishing have been implemented to protect sea turtles, and the type of trip has shifted to target primarily tunas. During 905 observed trips encompassing 11,014 sets, 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 take 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. Using these methods, 10 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. Total mortality was also calculated separately for waters within and outside of U.S. Exclusive Economic Zones to facilitate management of cetacean mortality and serious injury 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 Hawaiian longline fishery, which operated in the central North Pacific in an area extending roughly from 10N to 45N and 170E to 140W. During the mid 1990s, the fishery targeted primarily bigeye tuna, yellowfin tuna, and swordfish. Bycatch documented with roughly 4% observer coverage included several species of sea turtles, seabirds, and a variety of cetaceans (Kleiber 1999, McCracken 2000). In recent years, the fishery has undergone several regulatory changes to reduce bycatch of sea turtles and seabirds, including a ban on swordfish-style fishing north of the equator[1]. Observer records indicate that cetacean mortality has continued, although perhaps at a lower rate as the fleet has shifted towards setting deeper to target tunas. In past years, the total estimated mortality and serious injury exceeded the level allowable under the Marine Mammal Protection Act (MMPA) for one species, the false killer whale, *Pseudorca crassidens*, which has been considered a strategic stock under the MMPA since 2000 (Forney et al. 2000, Carretta et al. 2001, Carretta et al. 2002). This paper presents an analysis of mortality and injury levels for cetaceans in this fishery from 1994-2002, determined separately for waters within and outside of the U.S. Exclusive Economic Zone (EEZ). Potential factors that may influence cetacean take rates are also summarized, although sample sizes are insufficient for statistical tests.

METHODS

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 (Pacific Islands Regional Office [PIRO], Observer Program, Honolulu). 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%). Following each trip, data were edited, processed and entered according to protocols developed by PIRO staff. 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. EEZ.

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 injures, defined as those likely to lead to death, and non-serious injuries, from which the animal is expected to recover. For the present analysis, a determination regarding seriousness of injuries was made based the

[1] See Final Rule, Federal Register Vol. 67, No. 113, pages 40232-40238, June 12, 2002.

observer's written descriptions of the interaction and the 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 substantial 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

$$M_s = E_t * r_s$$

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

$$r_s = (m_s + s_s) / E_o$$

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)

Total effort was based on dock rounds that identified when vessels were in port or at sea and presumably fishing. 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)[2]. Because fishery takes of marine mammals within U.S. waters are required to be below the Potential Biological Removal (PBR) of each stock, mortality was estimated separately for U.S. EEZ waters, divided into the Hawaiian EEZ and other territorial waters, and non-EEZ waters (Figure 1). Mortality and serious injury was calculated based only on the number of mortalities observed within each EEZ category. This assumes that the proportion of trips within each EEZ category 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

[2] 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

the observer data (Table 2); however, sample sizes were not sufficient to model potential effects of these variables using regression techniques. Furthermore details on these factors were not consistently available for unobserved trips (from logbook data), and therefore a stratified analysis of mortality and serious injury was not possible. Coefficients of variation (CV) for M_s were calculated on the basis of the likelihood function of the Poisson (rare event) distribution.

RESULTS

Observed Effort and Cetacean Take Rates

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 appear to be lower during sets and trips targeting tunas than during those targeting swordfish or mixed species (Table 2); however, 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). Apparent species-specific differences by type of trip 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 target-species trips.

Cetacean Species Observed Taken

Marine mammal species taken (with species codes used in tables and figures, and number of takes observed) included short-beaked common dolphin, *Delphinus delphis* (DD; n=1); spinner dolphin, *Stenella longirostris* (SL; n=2); pan-tropical spotted dolphin, *Stenella attenuata* (SA; n=1); bottlenose dolphin, *Tursiops truncatus* (TT; n=2); Risso's dolphin, *Grampus griseus (*GG; n=7); false killer whale, *Pseudorca crassidens* (PC; n=10); short-finned pilot whale, *Globicephala macrorynchus* (GM; n=5); Blainville's beaked whale, *Mesoplodon densirostris* (MD; n=1); humpback whale, *Megaptera novaeangliae* (MN; n=2); and sperm whale, *Physeter macrocephalus* (PM; 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. 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 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 entire 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 this level of take depends critically on stock structure and size of the source populations, which is 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 the U.S. waters varies by species, with takes observed both around the Hawaiian Islands and near Palmyra Island to the south (Figure 1).

DISCUSSION

The Hawaii-based longline fishery for swordfish and tunas has 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 this fishery. The present analyses assume that observer coverage was representative of the behavior of the fleet as a whole. 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 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 may be considered the least biased.

The estimates of mortality and serious injury 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, 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 longline fishery on cetacean species. Actual population-level impacts will depend each species' population size and stock structure within the area of the fishery. Although numerically small, the 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 take exceed the most recently calculated Potential Biological Removal (PBR) – the level of human-caused mortality allowed under the MMPA – by a factor of about three (an average of 6.8 false killer whales killed or seriously injured per year during 1998-2002, compared to the PBR = 2.3). Recent surveys suggest that the population of 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. Little is known about other species that interact with the fishery, in this region and further research into stock identity and abundance 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 any interaction that resulted in the hooking or entanglement of a cetacean.

	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
Total	**10,323**	**110,336**	**905**	**11,014**	**8.8%**	**10.0%**	**44**	**0.05**	**0.004**

Table 2. Summary of cetacean interaction rates by trip type, set characteristics, and environmental factors in the Hawaii-based longline fishery observer program, 1994-2002. SST = sea surface temperature.

DECLARED TRIP TYPE	Trip Year	Total # trips obs	Total # sets obs	Cetacean Takes	Take rate (per trip)	Take rate (per set)	Mean Latitude (°N)	Mean SST	Std SST	Mean Target Depth	Std Target Depth
SWORDFISH		**41**	**541**	**4**	**0.10**	**0.007**	**25.9**	**72.5**	**7.0**	**76.6**	**63.8**
	1994	4	57	0	0.00	0.000	27.8	71.0	4.6	43.8	58.0
	1995	4	55	0	0.00	0.000	28.7	73.7	6.6	79.4	59.5
	1996	4	52	0	0.00	0.000	28.6	74.4	6.3	78.2	48.6
	1997	3	36	1	0.33	0.028	26.8	72.3	6.7	104.6	86.9
	1998	7	83	0	0.00	0.000	21.7	76.2	4.9	104.6	64.6
	1999	6	61	0	0.00	0.000	17.6	79.3	2.0	150.3	64.4
	2000	9	143	2	0.22	0.014	26.8	69.8	8.0	56.6	48.1
	2001	4	54	1	0.25	0.019	31.1	65.3	1.9	44.8	27.0
	2002	-	-	-	-	-	-	-	-	-	-
TUNA		**637**	**7,650**	**20**	**0.03**	**0.003**	**18.6**	**78.6**	**3.1**	**187.2**	**109.3**
	1994	13	117	0	0.00	0.000	19.6	78.0	3.6	141.8	138.1
	1995	13	135	0	0.00	0.000	19.1	77.5	2.8	159.0	121.7
	1996	13	149	0	0.00	0.000	18.4	79.3	2.1	137.7	111.6
	1997	5	50	0	0.00	0.000	19.2	77.5	2.5	281.4	256.0
	1998	6	59	0	0.00	0.000	15.7	78.2	3.1	213.1	131.0
	1999	3	36	0	0.00	0.000	21.4	75.5	1.8	203.4	51.6
	2000	77	931	4	0.05	0.004	18.2	79.5	2.6	136.7	100.6
	2001	229	2,714	7	0.03	0.003	18.5	78.5	2.9	188.3	117.3
	2002	278	3,459	9	0.03	0.003	18.6	78.5	3.3	203.5	94.9
MIXED		**227**	**2,823**	**20**	**0.09**	**0.007**	**25.6**	**72.9**	**6.2**	**69.1**	**99.7**
	1994	33	346	0	0.00	0.000	26.7	72.0	6.1	33.3	54.7
	1995	30	348	3	0.10	0.009	24.5	74.0	5.9	91.4	166.6
	1996	36	441	3	0.08	0.007	25.7	73.8	6.4	41.7	36.0
	1997	32	445	3	0.09	0.007	26.5	71.7	6.5	76.7	112.0
	1998	35	439	3	0.09	0.007	25.8	73.6	6.7	66.9	74.8
	1999	29	351	5	0.17	0.014	24.5	73.0	5.0	105.8	118.6
	2000	32	453	3	0.09	0.007	25.6	72.3	6.3	69.0	74.8
	2001	-	-	-	-	-	-	-	-	-	-
	2002	-	-	-	-	-	-	-	-	-	-
ALL TRIPS		**905**	**11,014**	**44**	**0.05**	**0.004**	**20.7**	**76.7**	**5.2**	**149.7**	**118.1**

Table 3. Summary of observed cetacean interactions in the Hawaii-based longline fishery, 1994-2002. Key to trip type codes: S=Swordfish, T=Tuna, M=Mixed. Species codes and injury determination criteria are described in text.

Trip-Set Number	Trip Year	Set Date	Trip Type	EEZ	SST (°F)	Set Depth (m)	Species Code	Possible Species IDs for unidentified cetaceans	Recorded Animal condition	Injury Severity Determination	*Prorated Injury Severity*	Injury determination criteria / Comments
LL0353-19	2000	Dec-00	S	Non-EEZ	61.6	30	DD		Injured	Not Serious		Line around fluke, released with minimal line attached
LL0061-02	1995	Mar-95	M	Non-EEZ	65.0	27	GG		Injured		*Serious*	*5/5 GG serious*
LL0063-01	1995	Mar-95	M	Non-EEZ	64.7	30	GG		Injured	Serious		Hooked in mouth
LL0160-12	1997	Mar-97	S	Non-EEZ	66.4	29	GG		Injured	Serious		Hooked in mouth / hook ingested
LL0161-01	1997	Mar-97	M	Non-EEZ	65.6		GG		Injured	Serious		Hooked in mouth
LL0242-09	1999	Feb-99	M	Non-EEZ	65.1		GG		Injured	Serious		Hooked in mouth
LL0284-02	2000	Jan-00	M	Non-EEZ	63.5	25	GG		Injured	Serious		Hook ingested
LL0400-02	2001	Jan-01	S	Non-EEZ	62.9	30	GG		Injured		*Serious*	*5/5 GG serious*
LL0148-05	1996	Dec-96	M	Non-EEZ	65.0	22	GM		**Dead**			**Line tangled around caudal peduncle**
LL0305-02	2000	Jul-00	M	Non-EEZ	75.0	25	GM		Injured	Serious		Hooked in mouth / hook ingested
LL0331-05	2000	Oct-00	M	Non-EEZ	81.2	60	GM		**Dead**			**Hooked in mouth**
LL0526-01	2001	Aug-01	T	Other US	85.3		GM		Injured	Not Serious		Entangled, appeared to break free of line
LL0535-11	2001	Sep-01	T	Non-EEZ	81.5	150	GM		Injured	Serious		Hooked in mouth
LL0725-10	2002	Apr-02	T	Hawaii	72.9	95	MD		**Dead**			**Hooked in fluke**
LL0433-03	2001	Feb-01	T	Hawaii	76.0	127	MN		Injured	Serious		Entangled; trailed substantial tangled line and & 2 floats
LL0860-12	2002	Oct-02	T	Non-EEZ	77.9	250	MN		Injured	Not Serious		Line wrapped around fluke
LL0173-11	1997	Aug-97	M	Hawaii	81.4	24	PC		Injured	Serious		Hooked in mouth / hook ingested
LL0201-20	1998	Apr-98	M	Hawaii	72.6	27	PC		Injured	Serious		Hooked in mouth / hook ingested
LL0392-03	2000	Jan-01	T	Non-EEZ	78.8	218	PC		Injured	Serious		Hooked in mouth
LL0418-05	2001	Feb-01	T	Other US	81.3	91	PC		Injured		*Serious*	*7/7 PC serious*
LL0446-01	2001	May-01	T	Non-EEZ	76.5		PC		Injured		*Serious*	*7/7 PC serious*
LL0656-17	2002	Feb-02	T	Other US	82.8	95	PC		Injured		*Serious*	*Hooked; 7/7 PC serious*
LL0663-10	2002	Feb-02	T	Non-EEZ	81.0	218	PC		Injured	Serious		Hooked in mouth
LL0695-11	2002	Mar-02	T	Other US	82.9		PC		Injured	Serious		Hooked in mouth
LL0808-03	2002	Jul-02	T	Non-EEZ	81.1	150	PC		Injured	Serious		Hooked in mouth
LL0850-02	2002	Sep-02	T	Non-EEZ	76.9	275	PC		Injured	Serious		Hook ingested
EX0745		Apr-02	E	OUTSIDE			PM		Injured			Experimental set; Not prorated
LL0257-08	1999	May-99	M	Hawaii	74.3	25	PM		Injured	Not Serious		Entangled, apparently got free
LL0559-05	2001	Oct-01	T	Other US	85.6	42	SA		**Dead**			**Line wrapped around beak**
LL0164-25	1997	Apr-97	M	Non-EEZ	71.9	18	SL		Injured	Not Serious		Hooked in fluke
LL0348-08	2000	Nov-00	T	Hawaii	77.0	35	SL		Injured		*Not Serious*	*1/1 other SL not serious*
LL0063-11	1995	Mar-95	M	Non-EEZ	65.5	30	TT		Injured	Serious		Hooked in mouth
LL0240-06	1999	Jan-99	M	Non-EEZ	64.8	40	TT		Injured	Serious		Hook ingested
LL0126-03	1996	May-96	M	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	M	Non-EEZ	66.5	29	UC	PC,GG,GM	Injured	Serious		Hooked in mouth
LL0323-13	2000	Oct-00	T	Non-EEZ	82.4	100	UC	PC,GG,TT	Injured		*Serious*	*Hooked; 14/14 PC,GG,TT serious*
LL0387-16	2000	Jan-01	T	Hawaii	78.3	146	UC	PC,GM	Injured		*Serious*	*Hooked; 9/10 other PC,GM serious*
LL0558-06	2001	Oct-01	T	Non-EEZ	83.8	218	UC	PC,GM	Injured		*Serious*	*9/10 other PC,GM serious*
LL0792-08	2002	Jun-02	T	Other US	84.3	364	UC	UC	Injured	Not Serious		Hooked; swam away with no gear attached
LL0804-04	2002	Jul-02	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	M	Non-EEZ	73.1	30	UW	ZU	Injured	Not Serious		Hooked in fluke
LL0191-03	1998	Jan-98	M	Non-EEZ	64.0	25	UW	GG,TT	Injured		*Serious*	*7/7 GG,TT serious*
LL0228-10	1998	Nov-98	M	Hawaii	76.5	50	UW	ZU	Injured		*Not Serious*	*1/1 probable ZU not serious*
LL0239-11	1999	Jan-99	M	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	S	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.

Year	% Sets obs	Non-serious Injury			Mortality and Serious Injury											
		All areas combined			Hawaiian EEZ			Other U.S. 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.

Year	% Sets obs	Non-serious Injury			Mortality and Serious Injury											
		All areas combined			Hawaiian EEZ			Other U.S. 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**

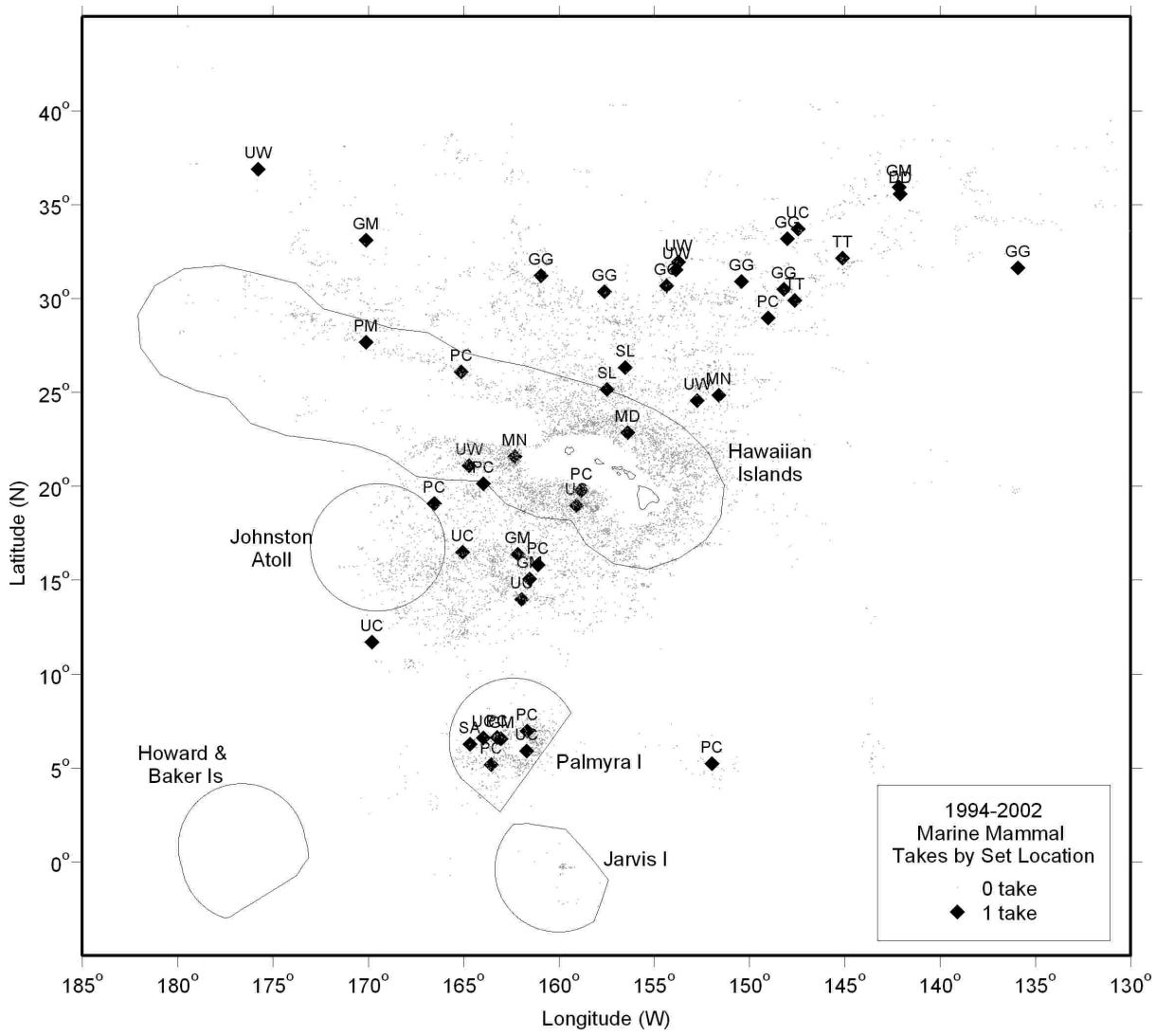

Figure 1. Locations of observed sets (small dots) and cetacean takes (black diamonds) in the Hawaii-based longline fishery, 1994-2002. Species codes above diamonds are defined in the text (Results). Lines represent U.S. waters surrounding the Hawaiian Islands and other central Pacific territories within the range of the fishery.