Fishery Data Series No. 14-27

2013 NSEI (Northern Southeast Inside Subdistrict) Sablefish Mark-Tag Survey

by

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and

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June 2014

Alaska Department of Fish and Game **Divisions of Sport Fish and Commercial Fisheries**

Symbols and Abbreviations

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Weights and measures (metric)

centimeter	cm
deciliter	dL
gram	g
hectare	ha
kilogram	kg
kilometer	km
liter	L
meter	m
milliliter	mL
millimeter	mm

Weights and measures (English)

cubic feet per second	ft^3/s
foot	ft
gallon	gal
inch	in
mile	mi
nautical mile	nmi
ounce	oz
pound	lb
quart	qt
yard	yd

Time and temperature

day	d
degrees Celsius	°C
degrees Fahrenheit	°F
degrees kelvin	K
hour	h
minute	min
second	s

Physics and chemistry

all atomic symbols	
alternating current	AC
ampere	A
calorie	cal
direct current	DC
hertz	Hz
horsepower	hp
hydrogen ion activity (negative log of)	pH
parts per million	ppm
parts per thousand	ppt, ‰
volts	V
watts	W

General

Alaska Administrative Code	AAC
all commonly accepted abbreviations	e.g., Mr., Mrs., AM, PM, etc.
all commonly accepted professional titles	e.g., Dr., Ph.D., R.N., etc.
at	@
compass directions:	
east	E
north	N
south	S
west	W
copyright	©
corporate suffixes:	
Company	Co.
Corporation	Corp.
Incorporated	Inc.
Limited	Ltd.
District of Columbia	D.C.
et alii (and others)	et al.
et cetera (and so forth)	etc.
exempli gratia (for example)	e.g.
Federal Information Code	FIC
id est (that is)	i.e.
latitude or longitude	lat or long
monetary symbols (U.S.)	$, ¢
months (tables and figures): first three letters	Jan,...,Dec
registered trademark	®
trademark	™
United States (adjective)	U.S.
United States of America (noun)	USA
U.S.C.	United States Code
U.S. state	use two-letter abbreviations (e.g., AK, WA)

Mathematics, statistics

all standard mathematical signs, symbols and abbreviations	
alternate hypothesis	H_A
base of natural logarithm	*e*
catch per unit effort	CPUE
coefficient of variation	CV
common test statistics	(F, t, χ^2, etc.)
confidence interval	CI
correlation coefficient (multiple)	R
correlation coefficient (simple)	r
covariance	cov
degree (angular)	°
degrees of freedom	df
expected value	*E*
greater than	>
greater than or equal to	≥
harvest per unit effort	HPUE
less than	<
less than or equal to	≤
logarithm (natural)	ln
logarithm (base 10)	log
logarithm (specify base)	$\log_2$, etc.
minute (angular)	'
not significant	NS
null hypothesis	H_O
percent	%
probability	P
probability of a type I error (rejection of the null hypothesis when true)	α
probability of a type II error (acceptance of the null hypothesis when false)	β
second (angular)	"
standard deviation	SD
standard error	SE
variance	
population	Var
sample	var

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ABSTRACT

The Alaska Department of Fish and Game (ADF&G) manages the Northern Southeast Inside (NSEI) Subdistrict sablefish (*Anoplopoma fimbria*) fishery in Southeast Alaska. Mark-recapture methods have been used to estimate abundance of the stock since 1997. In 2013, longlined pot gear was used to catch sablefish in the NSEI management area, which includes the waters of Chatham Strait and Frederick Sound. Thirty-four sets (1,221 pots) were hauled, capturing 12,644 sablefish. Healthy sablefish with fork lengths between 430–1120 mm were finclipped, tagged, and released. A total of 7,960 sablefish were marked and released in statistical areas and within depth zones proportional to the average 2010–2012 commercial sablefish harvest. In addition, temperature measurements were collected to monitor the temperatures that sablefish were exposed to over during capture and handling.

Key words: Sablefish, black cod, *Anoplopoma fimbria*, Southeast Alaska, Northern Southeast Inside, NSEI, Chatham Strait, Frederick Sound, tagging, marking, mark-recapture

INTRODUCTION

Sablefish (*Anoplopoma fimbria*) are one of the most commercially valuable species in Southeast Alaska. The Northern Southeast Inside Subdistrict (NSEI) longline fishery occurs in the deep waters of Chatham Strait (between 58°19´N and 56°10´N latitude) and Frederick Sound (approximately 134°25´W, 56°51´N to 133°54´W, 57°22´N; Figure 1). During the 2013 NSEI commercial fishery, the average price paid for sablefish was $2.95 per round pound[1]; total ex-vessel value was $2.9 million. Sablefish are a long-lived species with a maximum reported age of 91 years in Southeast Alaska, although the majority of fish in the NSEI commercial harvest are under 20 years old. Careful management of the NSEI commercial fishery is necessary to ensure sustainability of this highly valued resource.

The Alaska Department of Fish and Game (ADF&G) obtains abundance estimates for sablefish in NSEI from mark-recapture methods. The marking survey has occurred since 1997 using external T-bar tags, with the exception of 2004 when Passive Integrated Transponder (PIT) tags were used. In addition, the upper or lower caudal fin has been clipped, with the exception of 1999 when only tagging was performed. From 1997 to 1999, sablefish were marked during the annual longline survey; catch per unit effort (CPUE) and biological data were also collected during this survey. Fishery recapture data indicated that fish were hook-shy (i.e., they avoided recapture by longline) due to their initial capture by longline gear for marking (Carlile et al. 2002). As a result, the mark-recapture study was not performed in 1999 but was reinstated in the following year using longlined pots to avoid hook-shyness. The longline survey occurs annually; however, only CPUE and biological data are collected. In 2011, the marking survey was cancelled due to mechanical problems with the contract vessel, and the survey was transitioned to an ADF&G vessel (R/V *Medeia)* in 2012.

ADF&G uses the abundance estimate derived from this survey and other fishery and biological data to set the annual NSEI sablefish acceptable biological catch (ABC). The survey goal is to mark sablefish among statistical areas in proportion to sablefish population abundance; commercial fishery harvest data are used to calculate marking goals based on the assumption that population abundance is proportional to commercial harvest (Dressel 2009). Prior to the 2009 survey, sablefish were marked in proportion to the depth and statistical area where fish were commercially harvested during the preceding year only. Beginning in 2009, sablefish were

[1] Metric units were not used here because the standard units recorded for processing sablefish are round pounds.

marked in proportion to the average commercial harvest and depth by statistical area for the previous 3 years to better approximate the average catch patterns of the upcoming fishery.

The sablefish mark-tag survey has occurred annually in May/June, ending approximately a month and a half before the NSEI commercial longline fishery begins (August 15). This time frame allows adequate mixing of marked and unmarked fish while minimizing fish movement in and out of NSEI before the recapture phase of the study. For mark recovery, port samplers observe the majority of NSEI commercial sablefish landings occurring in Sitka, Juneau, and Petersburg. Fish are carefully examined for tail clips, and the total number of fish with and without tail clips is used to determine abundance using a Peterson estimator. Tags are typically removed at sea by vessel crew and attached to a logbook. Tags missed by vessel crew are recovered by processor staff and given to ADF&G personnel. As an incentive for fishermen and processor staff to return tags, ADF&G offers a baseball cap or t-shirt for each tag recovered.

This report summarizes the marking and tagging activities from the 2013 NSEI sablefish mark-tag survey. The results of the 2013 mark-recapture project, including the population abundance estimate, will not be presented in this report.

OBJECTIVES

1. Capture, tag, finclip, and release at least 8,000 sablefish greater than 320 mm fork length in order to estimate population abundance based on a Petersen mark-recapture estimate.
2. Mark sablefish among statistical areas in proportion to the average of the 2010–2012 NSEI commercial harvest by statistical area.
3. Mark and tag sablefish evenly within each statistical area and by depth in proportion to the 2010–2012 NSEI commercial harvest.
4. Record temperatures to which sablefish are exposed during capture and handling.

METHODS

OPERATIONS

The survey was conducted in statistical areas where at least 2% of the average NSEI sablefish commercial fishery harvest occurred during the 2010–2012 fishing seasons (Table 1). The ADF&G research vessel, R/V *Medeia*, was used to conduct the 2013 sablefish mark-tag survey. Vessel crew and scientific staff are listed in Appendix A.

Live sablefish were captured in pots that were attached to a longline. Each longline set, or "string," consisted of 20 to 40 pots with approximately 91 m of line between each pot. On each end of the line, several buoys and 5.5 m "high flyers" were attached. High flyers are floating flagpoles designed to be visible several meters above the water line under high tide conditions when the buoys may be submerged. Pots were conical, weighed 36 kg, and had a 1.5 m bottom diameter, 1.1 m total vertical height, and 0.65 m top diameter. Each pot had two opposing tunnels for sablefish to enter.

In general, 2 pot strings were set and hauled per day. A total of 4 kg of chopped bait, consisting of 50% squid and 50% pollock, was placed in a bait bag clipped inside each pot. Soak time was adjusted dependent on the vessel operating schedule, distance between sets, weather, and the history of "sand flea" (Amphipoda: Uristidae) abundance; in locations with a history of high sand flea abundance, soak time was minimized to prevent sablefish mortalities. In addition, pots

were soaked for a minimum of 9 hours to allow sufficient time for bait scent to disperse and sablefish to travel to baited pots. Contents of each pot were released onto a sorting table. Non-sablefish catch was recorded and released overboard, and sablefish were funneled into a live well.

DATA COLLECTION

All sablefish were measured to the nearest fork length (mm). Individually numbered external T-bar tags were inserted into the flesh on the left side of the fish under the first dorsal fin if the fish was healthy and in good condition. Tagged fish were also marked with a finclip on the upper lobe of their caudal fin and sampled for length (Figure 2).

Fish were not tagged or finclipped if they were determined to have reduced survivability due to flea bites, injuries, or a lack of vigor. Fish that were ≤ 320 mm fork length were not tagged or finclipped because fish this size are typically not retained in the commercial fishery.

Captured fish that were previously tagged with an ADF&G tag and were in good health were released after recording the tag number and fork length (to the nearest centimeter). Fish that were previously tagged by an agency other than ADF&G were retained or released according to agency instructions. Fish and invertebrates incidentally captured were identified prior to release, with most fish and crabs enumerated as well. Pacific halibut (*Hippoglossus stenolepis*) were enumerated, and their condition (live vs. dead) prior to release was also recorded.

Delayed mortality or immunological suppression has been observed in experiments where capture of sablefish was simulated with gear (hook or trawl) contact and elevated air and/or water temperature exposure of 15 minutes or more (Davis et al. 2001; Davis 2005; Lupes et al. 2006). Temperature data were collected during sablefish capture and handling to determine whether any elevated temperatures or extreme temperature differences between bottom, surface, or holding tanks occurred during the survey that could contribute to sablefish mortality. Temperatures to which sablefish were exposed during capture and handling, including sea surface, ocean bottom, and holding tank temperatures, were recorded and monitored. TidbiT®[2] v2 Temp Loggers were used to record temperatures at 30-minute intervals. To collect bottom temperature measurements, a TidbiT® was attached to one pot per set string. During each pot string haul, TidbiT® loggers were used to measure the holding tank and surface temperatures. Weather conditions were also recorded during hauling and setting.

SAMPLE DESIGN

The target marking goal was initially set at 7,500 sablefish prior to the start of the 2013 survey; however, this goal was adjusted to 8,000 fish after large sablefish catches occurred at the beginning of the survey. Depths ranging from 50 to 500 fathoms[3] were considered for set placement. Obtaining the tagging goal for a particular statistical area was considered a priority over tagging and marking fish from depths where only a small proportion of the commercial harvest occurred (Table 1–4). To obtain marking goals by depth for each statistical area, bathymetric charts and depth information recorded from the vessel depth sounder from previous years' survey sets were used.

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[2] Product names used in this report are included for scientific completeness but do not constitute product endorsements.

[3] Fathoms were used in this document instead of metric units for depth because these are the units most commonly used by the commercial fleet and have therefore been the project standard.

Once the approximate tagging goal was reached for a statistical area, the next statistical area was sampled. If the tagging goal was reached in the middle of a set, sablefish catch in the remaining pots were visually estimated and the fish were released without marking, tagging, or sampling.

To distribute marked/tagged fish throughout a statistical area, no overlapping sets were performed within a statistical area, and sets were performed both over the latitudinal and longitudinal range of a statistical area.

Another consideration to set placement was the history of previous sets for an area. Numbers of sablefish captured, tagged, and marked during previous mark-tag surveys were used to determine placement of sets. Placement of survey gear was avoided in areas where problems had occurred in the past with gear damage or retrieval.

RESULTS

SCHEDULE

The 2013 NSEI mark-tag survey occurred from May 21 to June 14. The survey began in northern Chatham Strait north of the entrance to Icy Strait (Figure 1). The survey progressed south through Chatham Strait with an east-west progression into Frederick Sound. On May 31, the R/V *Medeia* arrived in Petersburg for the end of the first leg of the survey, and the vessel was docked in Petersburg from May 31 to June 2. Bait and supplies were restocked, and the ADF&G scientific staff was transferred. The R/V *Medeia* left the port of Petersburg at 3:30 p.m. on June 2 to begin the second leg of the survey. The survey continued south until June 10, reaching the southern end of Baranof Island. The survey then returned north to make several sets before arriving in Juneau on June 14. A detailed list of set locations and times can be found in Appendix B.

SET INFORMATION

A total of 1,221 pots were deployed and successfully recovered in 34 sets during the 2013 NSEI mark-tag survey. The sets were deployed in depths from 196 to 467 fathoms. Soak time averaged 19.8 hours and ranged from 9.8 to 68.6 hours, and haul time averaged 1.9 hours and ranged from 1.4 to 2.8 hours (Appendix B). Set 18 had a long soak time of 68.6 hours, because it was set prior to travel to Petersburg for the 2-day break in the survey and hauled after this break. Extreme tides pulled buoys under the surface, and on such days, buoys were easier to find during slack tides.

CATCH AND TAGGING INFORMATION

A total of 12,645 sablefish were caught during the 2013 survey; 7,960 of these fish were tagged, finclipped, and released. A total of 45 of these fish were tagged and finclipped but not measured. Twenty-five healthy fish were captured and then accidently released before they could be tagged; 2 of these fish were clipped before release. An additional 925 sablefish were captured but not marked because of sand flea damage or other injuries, such as pot abrasions or a torn mouth. In addition, an estimated 3,437 sablefish were released without marking because the marking quota was reached for a statistical area. The catch included 295 fish previously tagged by ADF&G that were re-released with their original tags. Two fish with 2012 ADF&G tags were retained because of tissue damage around the tag site. A single fish was captured with a National Marine Fisheries Service

(NMFS) tag; this fish was measured and released. The release condition of all sablefish captured during the 2013 mark-tag survey is summarized by set in Appendix E.

The number of marked fish approximated the marking goal by statistical area (Table 3). Marked fish were generally distributed throughout statistical areas and in proportion to the depths at which sablefish were caught in the commercial harvest (Table 1; Table 2; Table 4). However, this was difficult in Frederick Sound (statistical area 335701; Table 1; Table 2; Table 4), where the overall marking goal was low and only a few survey sets were scheduled. The total number of fish marked for each depth class was similar to the total marking goal for all statistical areas pooled; the difference between the number marked and the marking goal for each depth class was ≤5% (Table 2 and 4). Nearly all fish marked in Chatham Strait were captured from depths deeper than 250 fathoms, a depth range which accounted for 96% of the 2010–2012 commercial harvest for Chatham Strait.

A total of 12 species of fish and 1 species of commercially important crab were caught and identified and 13,423 individuals were enumerated during the 2013 survey (Appendix C; Appendix D). Sablefish was the dominant species caught, followed by arrowtooth flounder (*Atheresthes stomias*), Pacific halibut (*Hippoglossus stenolepis*), Dover sole (*Microstomus pacificus*), and thornyhead rockfish (*Sebastolobus alascanus*) (Appendix D). Five fish were not identifiable due to sand flea damage. A total of 284 Pacific halibut were captured; of these, 261 were released in good condition and 23 were dead (due to sand flea damage). A total of 13 golden king crab (*Lithodes aequispinus*) were captured and identified; 91 other species of macroinvertebrates were identified to the lowest possible taxonomic level but not enumerated (Appendix C).

BIOLOGICAL INFORMATION

A total of 7,915 sablefish were marked and measured, and an additional 1,290 sablefish were measured but not marked. Average length for all measured sablefish was 640 mm, and length ranged from 430 to 1,120 mm (Figure 3). The 2013 length distribution for captured sablefish appears to be normally distributed with a slight trailing tail at larger lengths (Figure 3).

In 2013, small-sized sablefish (≤650 mm) composed the majority of the catch (59%). The contribution of small-sized sablefish to the catch increased from the last 2 years (45% in 2010 and 54% in 2012). Mid- to large-sized sablefish (≥660 mm) only composed a greater proportion of the overall catch for the Frederick Sound statistical area of 335701. All other statistical areas had a higher proportion of small-sized sablefish caught with considerably larger proportions of small sablefish caught in northern (345803) and central (345703 and 345731) Chatham Strait (Table 5). Although a higher proportion of small-sized fish were caught for statistical areas in Chatham Strait, a few sets in the southern Chatham Strait statistical area of 345631 and one set in the northern Chatham Strait statistical area of 345803 had noticeably larger proportions of mid- to large-sized fish caught (Figure 4; Table 5).

TEMPERATURE DATA

Temperature data were collected during the period of sablefish capture and handling that occurred on the 2013 NSEI mark-tag survey. Bottom temperature varied less than 1°C over the entire survey, with an average bottom temperature of 5.1 °C (Figure 5). Surface temperature ranged from 5.5 °C to 9.8 °C with an average of 7.7 °C, and holding tank temperature ranged from 8.1 °C to 11.7 °C with an average temperature of 9.1 °C. Sablefish were exposed to a range

of temperatures during capture, tagging, and release. There was about 2.6°C difference between the average surface and bottom temperatures and 4.0°C difference between the average holding tank and bottom temperatures. Over the course of a day, the surface and holding tank temperatures varied up to 3.5°C and 1.8°C, respectively. Temperature of the holding tank was generally warmer than the surface temperature recorded during a day (Figure 5).

DISCUSSION

The objectives of the 2013 mark-tag survey were met with nearly 8,000 fish marked in proportion to the commercial fishery harvest by statistical area and depth. Longline gear operations were successfully deployed and retrieved by ADF&G vessel staff. The "high flyers" used in the 2013 survey increased efficiency by decreasing the time required to locate sets during extreme tides when the buoys marking pot sets may be pulled under water. Five vessel staff members, in addition to a cook, were needed to operate the vessel and perform deck operations safely. A larger crew was necessary on the R/V *Medeia* compared to previous vessels, because this vessel requires a winch operator to move pots across the deck during gear hauling and relief crew due to the physical demands of stacking and unstacking pots in the limited deck space during setting and hauling. A list of sets have been compiled for the 2010–2013 mark-tag surveys that had problems during setting or hauling and should be approached differently; some should have specific constraints for setting due to terrain, and others should be avoided altogether or during extreme weather or tides (Appendix F).

Sablefish were exposed to a wide range of temperatures as they were moved from the bottom of the ocean to the surface and into the holding tank. Sablefish generally appeared healthy and resilient to these changes in temperature exposure.

The average length of sablefish captured during the 2013 mark-tag survey was slightly less than the average lengths observed in 2010 and 2012. The average length of sablefish in 2013 continues a trend from 2010 with a near-linear decrease from 2009 (Figure 6). This is a reversal of a trend seen since the survey began using pot gear in 2000 (Stahl and Holum 2011; O'Connell and Holum 2007; Richardson 2001; Richardson 2003a; Richardson 2003b; Stahl and Holum 2008; Stahl and Holum 2009; unpublished ADF&G data[4]). A decrease in the average length of sablefish has also been observed in the NSEI longline survey and fishery since 2009 (Figure 6). It is likely that this decrease in the size of sablefish in Southeast Alaska inside waters in recent years is due to an influx of small fish to the area that may be related to one or more strong recruitment events, including fish from the 2008 year class (Hanselman et al. 2013). Because survey selectivity has been consistent over years, we conclude that the decrease in survey average length was due to one or more pulses of small fish. Before 2010, a compressed age distribution and low recruitment had been observed in Chatham Strait (Dressel 2009) and in the Gulf of Alaska (Hanselman et al. 2008) with few strong year classes apparent in the Gulf of Alaska since the 2000 year class (Hanselman et al. 2009). An influx of small fish was first observed during the Southern Southeast Inside (SSEI) longline survey in 2010 (Figure 7). Smaller average fish lengths were also observed in the 2010–2013 NSEI mark-tag surveys and the 2010–2013 SSEI commercial fishery and in the following year in the 2011 NSEI longline survey; however, this influx of fish was not as predominant in the NSEI survey or commercial fishery (Figure 8) or in the SSEI commercial fishery (Figure 7). In 2012, another influx of small

[4] Data for 2004-2006 is available through ADF&G, Division of Commercial Fisheries, Douglas.

fish was observed in the SSEI survey length distribution (Figure 7). This increase of small fish was not observed in the length distribution for the NSEI fishery or surveys or the SSEI fishery (Figure 7; Figure 8), but it may be contributing to the lower average length in the 2013 mark-tag survey (Figure 6).

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TABLES AND FIGURES

Table 1.–Average proportion of 2010–2012 NSEI sablefish harvest by statistical area and by depth class for each statistical area.

Statistical area	All depth ranges	Depth range (fathoms)								
		50–100	101–150	151–200	201–250	251–300	301–350	351–400	401–450	451–500
335701	4%	1%	2%	33%	56%	8%	0%	0%	0%	0%
345603	10%	0%	1%	1%	2%	21%	33%	42%	0%	0%
345631	39%	0%	0%	0%	1%	1%	36%	62%	0%	0%
345701	31%	0%	0%	0%	1%	5%	46%	32%	11%	5%
345731	9%	0%	0%	0%	4%	50%	29%	17%	0%	0%
345803	8%	0%	0%	0%	9%	19%	60%	12%	0%	0%

Table 2.–Marking goals by NSEI statistical area and depth based on a total goal of 8,000 marks and tags.

Statistical area	All depth ranges	Depth range (fathoms)								
		50–100	101–150	151–200	201–250	251–300	301–350	351–400	401–450	451–500
335701	280	3	6	92	157	22	0	0	0	0
345603	813	0	8	8	16	171	268	341	0	0
345631	3136	0	0	0	31	31	1129	1944	0	0
345701	2441	0	0	0	24	122	1123	781	269	122
345731	723	0	0	0	29	362	210	123	0	0
345803	607	0	0	0	55	115	364	73	0	0
All areas	8,000	3	14	100	312	823	3,094	3,263	269	122
Percent of total	100%	0%	0%	5%	4%	11%	36%	37%	4%	2%

Table 3.–Marking goals and actual number of tagged and marked sablefish released by statistical area for the NSEI mark-tag survey, 2013.

Statistical area	Average percent of 2010–2012 NSEI commercial harvest	Goal based on 8,000 marks and tags	Number marked and tagged
335701	4%	280	267
345603	10%	813	818
345631	39%	3,136	3,090
345701	31%	2,441	2,374
345731	9%	723	714
345803	8%	607	697
Total		8,000	7,960

Table 4.–Number of sablefish marked and tagged by NSEI statistical area and depth class for a total goal of 8,000 marks/tags.

	Number of fish tagged/marked by depth class (fathoms)							
Statistical area	151–200	201–250	251–300	301–350	351–400	401–450	451–500	Total
335701	20	105	142	0	0	0	0	267
345603	0	0	178	297	343	0	0	818
345631	0	0	0	1,133	1,957	0	0	3,090
345701	0	18	119	1,134	823	150	130	2,374
345731	0	0	365	218	131	0	0	714
345803	0	0	236	336	125	0	0	697
All areas	20	123	1,040	3,118	3,379	150	130	7,960
Percent of total	< 1%	2%	13%	39%	42%	2%	2%	100%

Table 5.–Proportion of sablefish captured and measured by length class in each statistical area for the NSEI mark-tag survey, 2013.

Statistical area	Number 430–650 mm	Number 660–1120 mm	Proportion 430–650 mm	Proportion 660–1120 mm
335701	128	160	0.44	0.56
345603	432	434	0.50	0.50
345631	1,787	1,633	0.52	0.48
345701	2,005	916	0.69	0.31
345731	576	256	0.69	0.31
345803	504	374	0.57	0.43
All areas	5,432	3,773	0.59	0.41

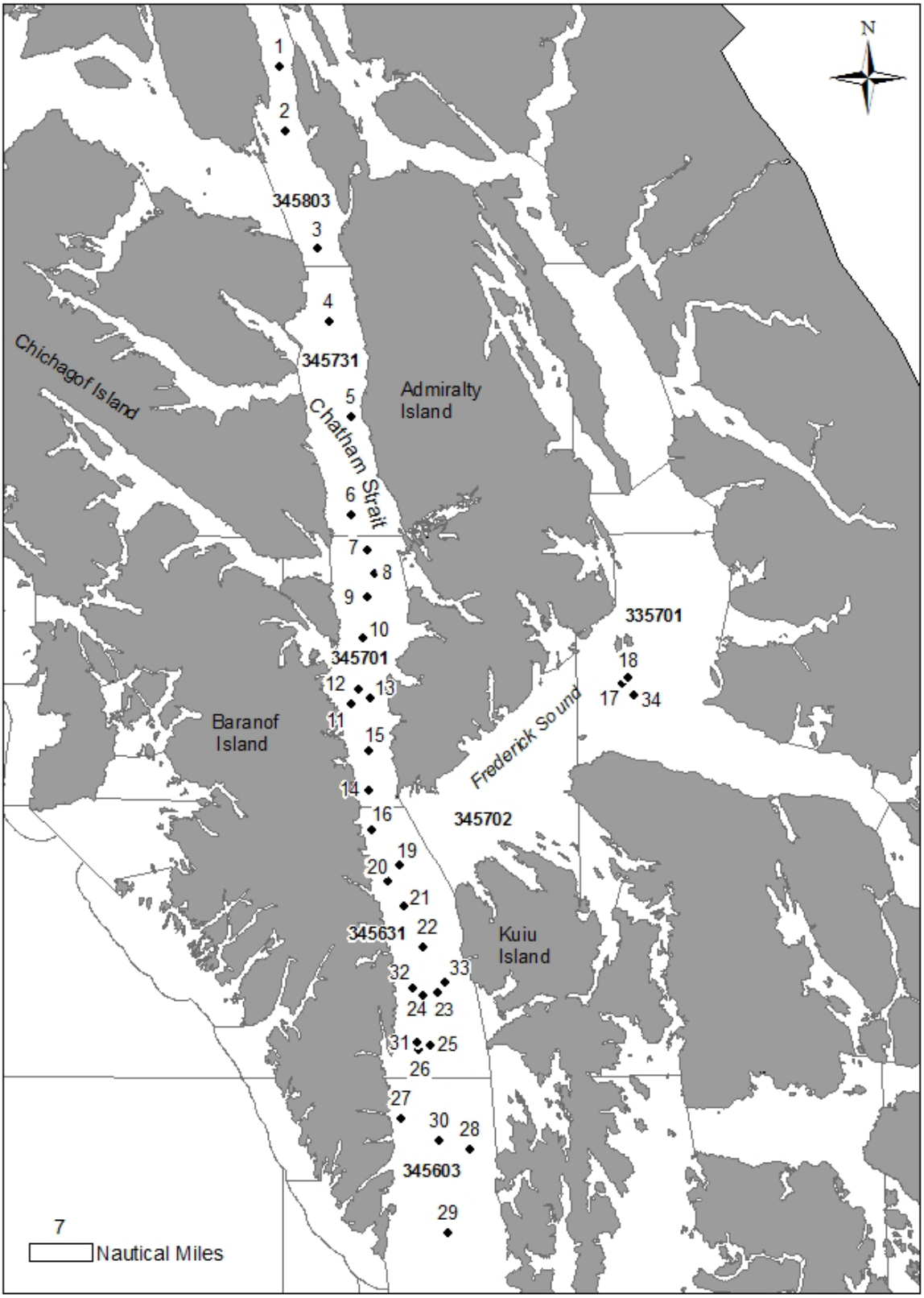

Figure 1.–Set locations for the NSEI mark-tag survey, 2013.

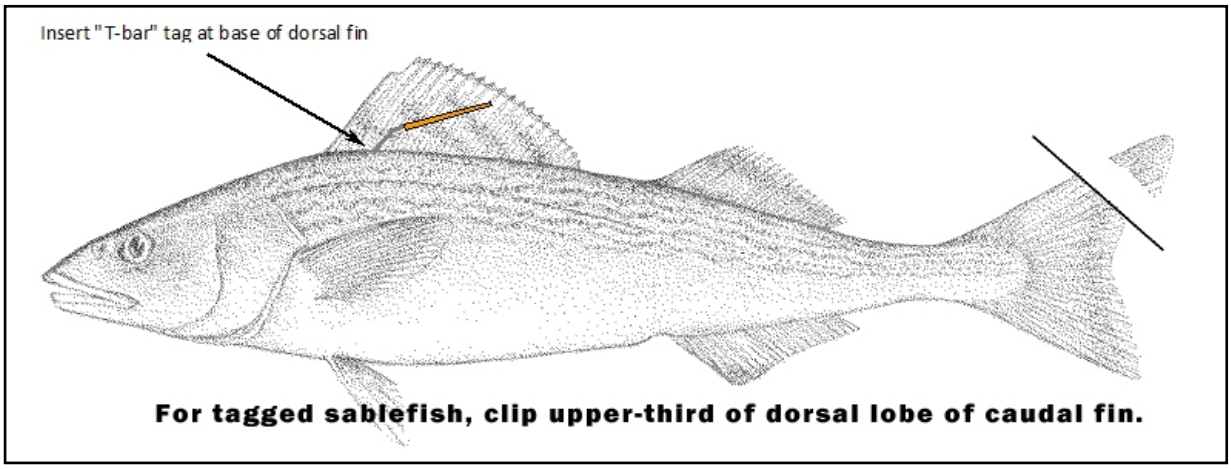

Figure 2.–Sablefish marking guidelines, NSEI mark-tag survey, 2013. Sablefish were double-marked with an upper caudal finclip and a T-bar tag.

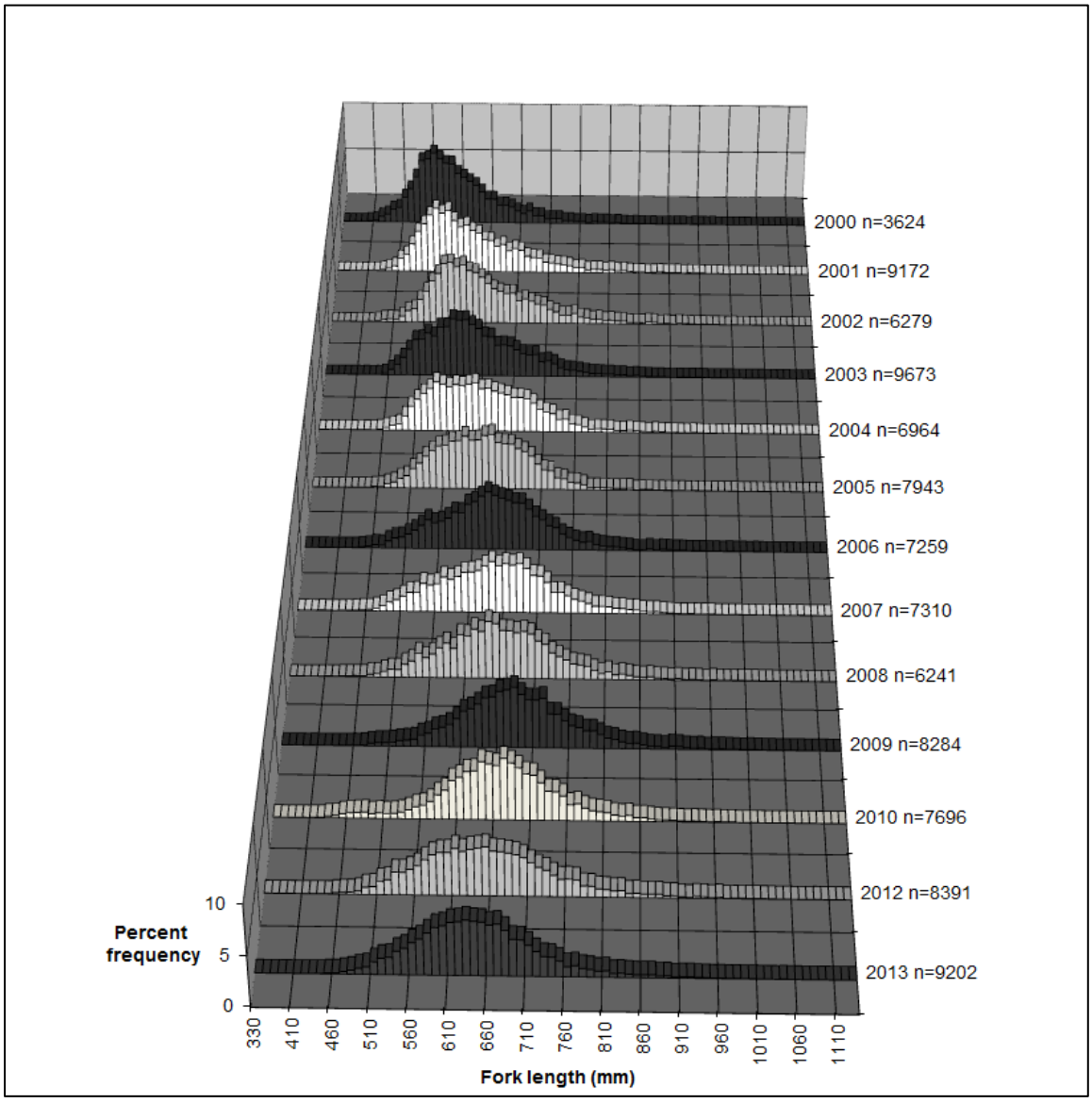

Figure 3.–Length frequency of sablefish captured and measured during the 2000 to 2013 NSEI mark-tag surveys.

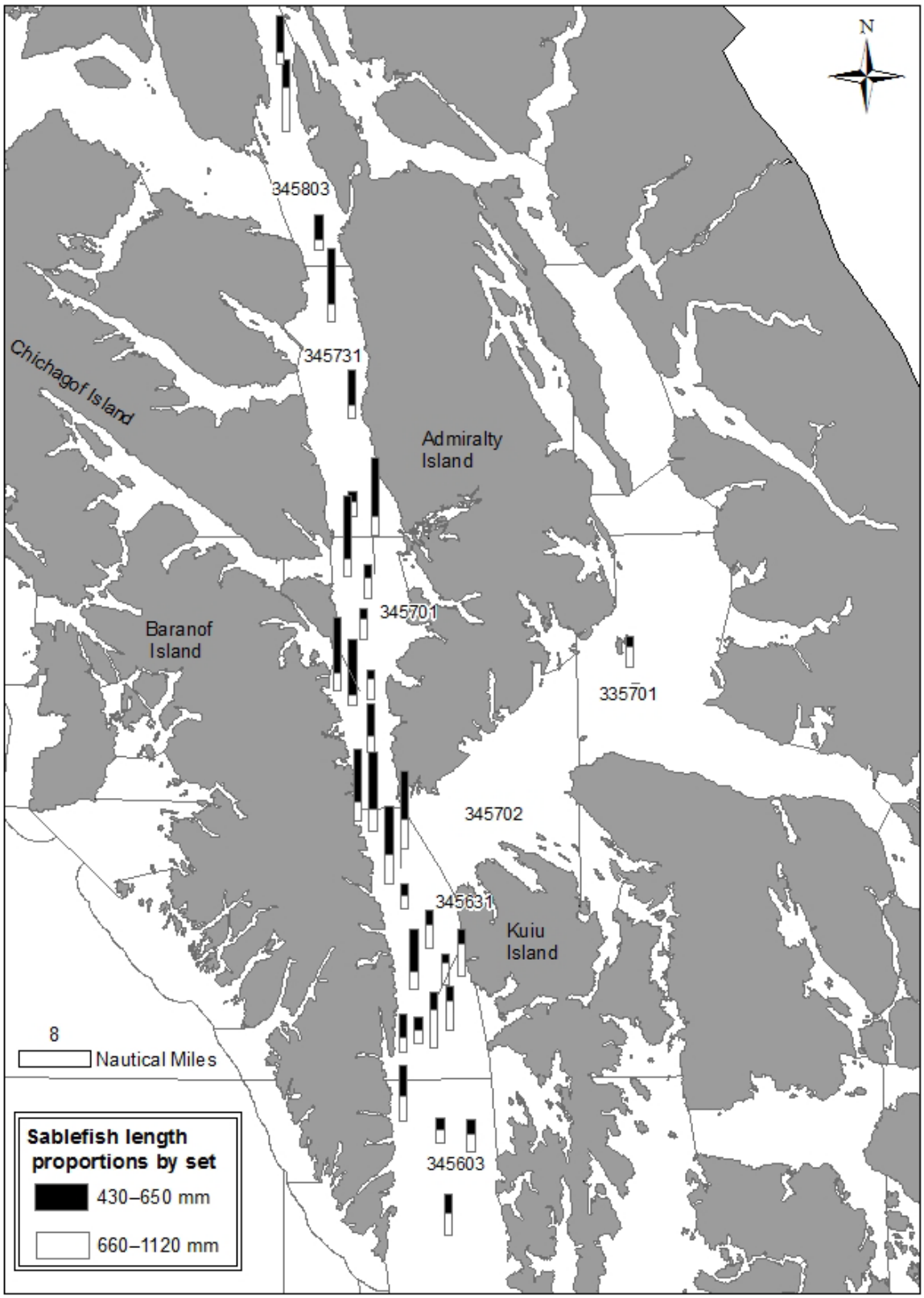

Figure 4.–Sablefish length distribution by set, NSEI mark-tag survey, 2013. Sets 17 and 18 in Frederick Sound are not visible because of low catches.

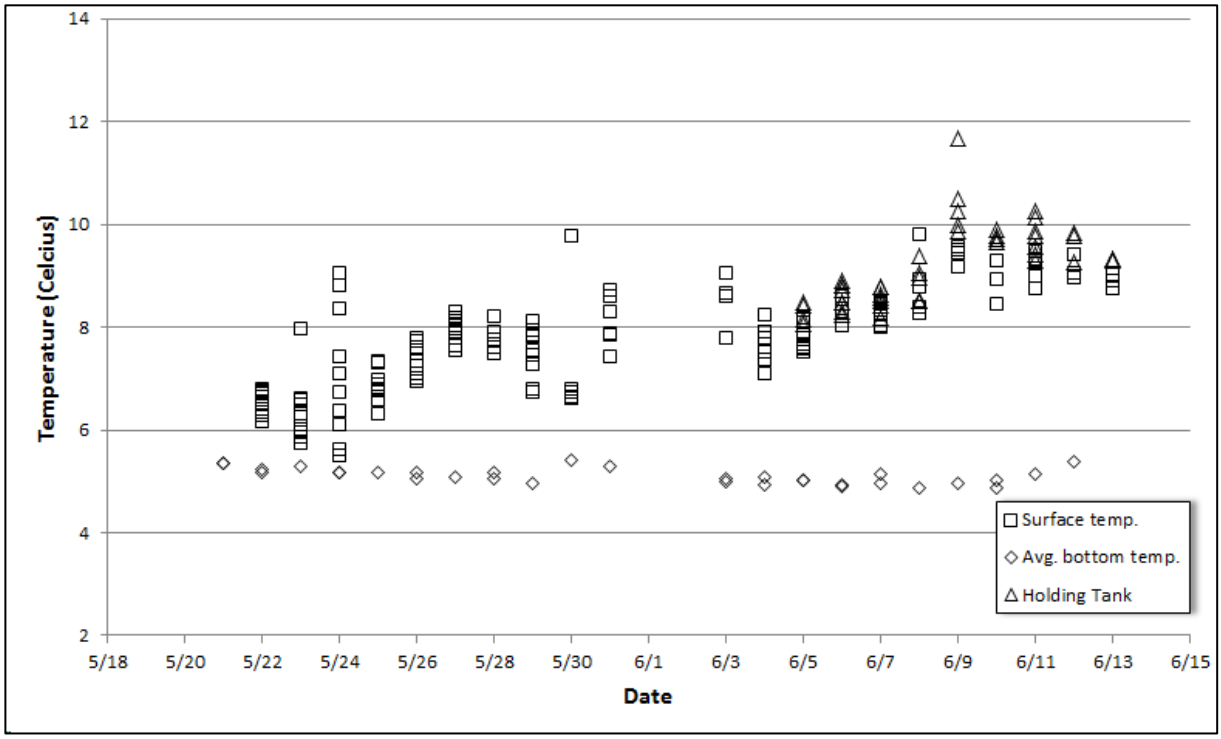

Figure 5.–Temperatures to which sablefish were exposed during capture and handling on the NSEI mark-tag survey, 2013.

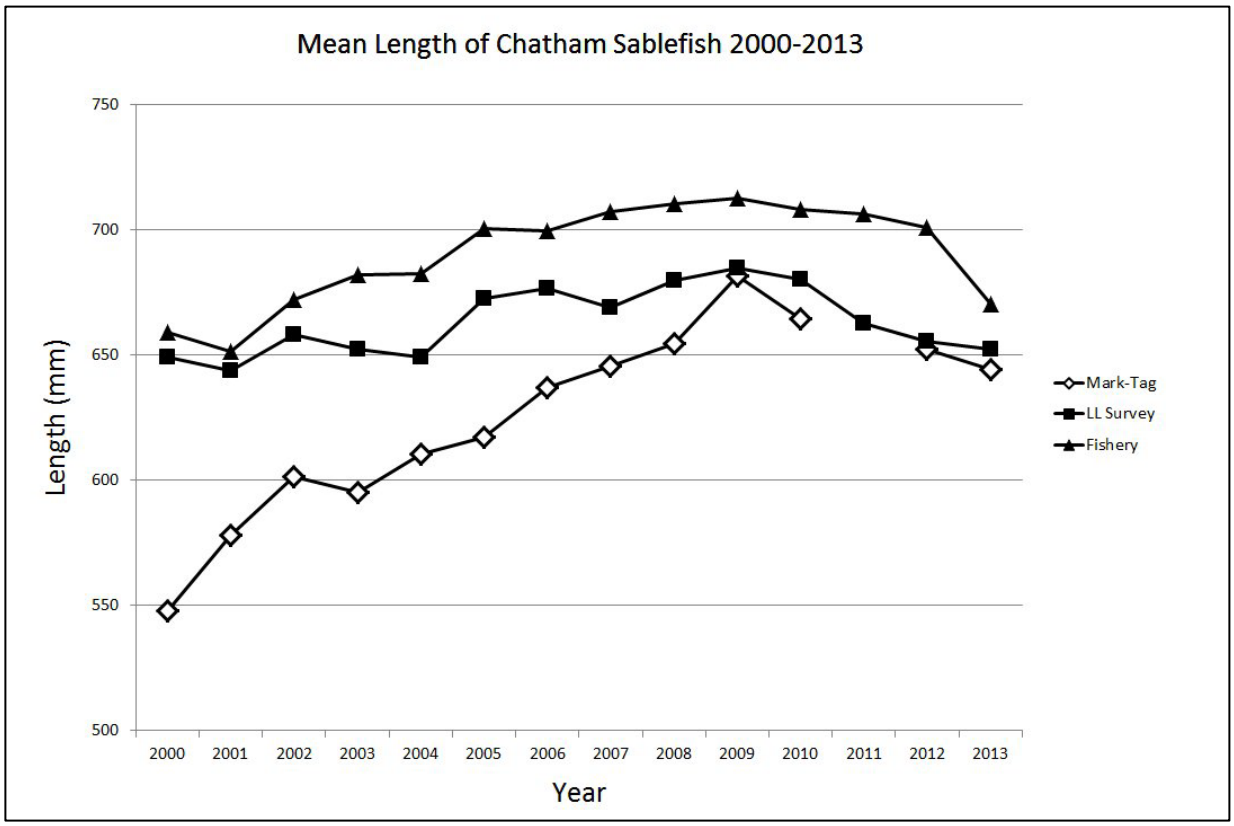

Figure 6.–Average size of sablefish sampled in NSEI Subdistrict from 2000 to 2013. No data are available for the 2011 mark-tag survey because the survey was canceled.

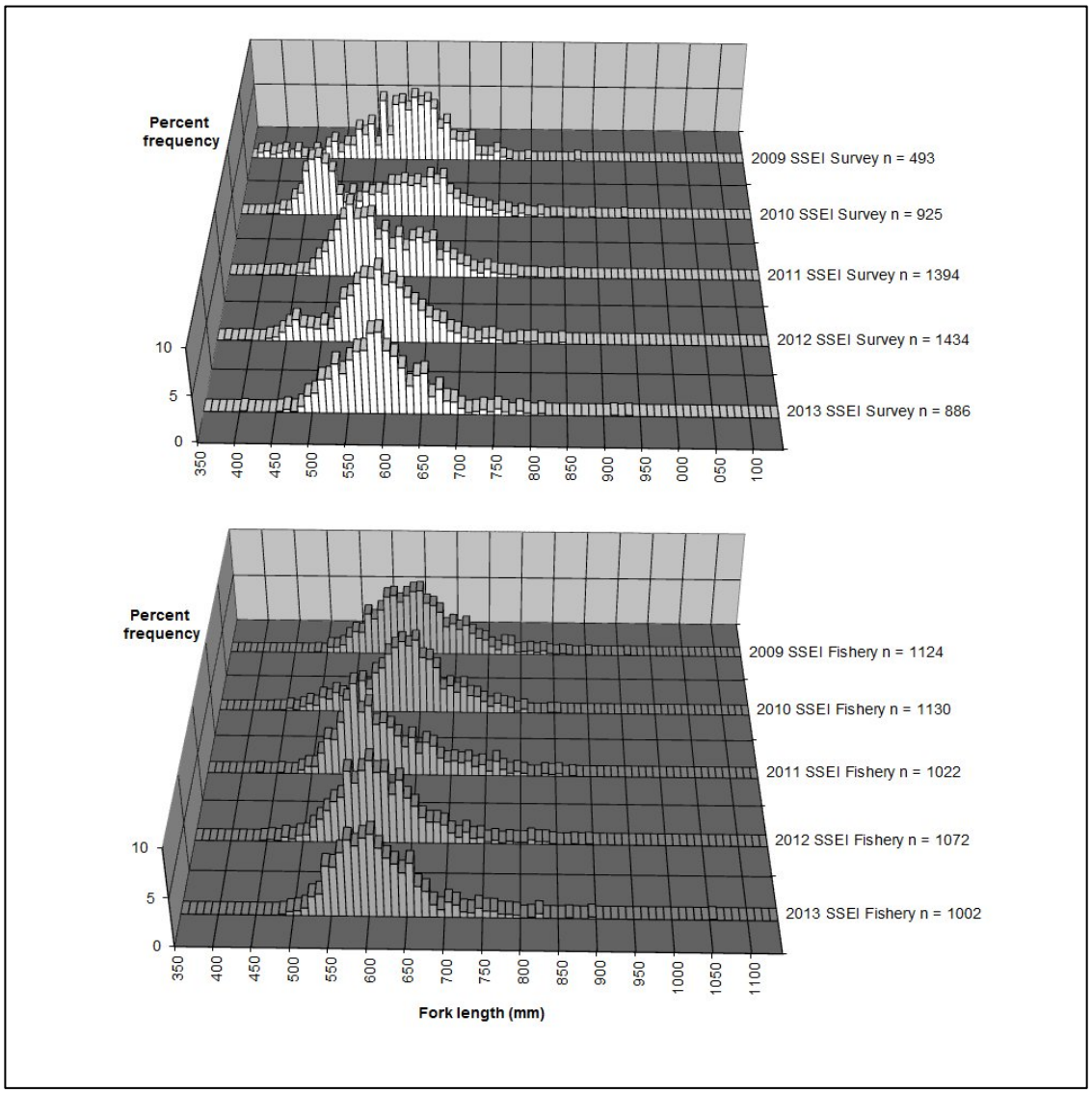

Figure 7.–Length frequency for sablefish sampled during the 2009 to 2013 SSEI longline surveys (top) and commercial fisheries (bottom).

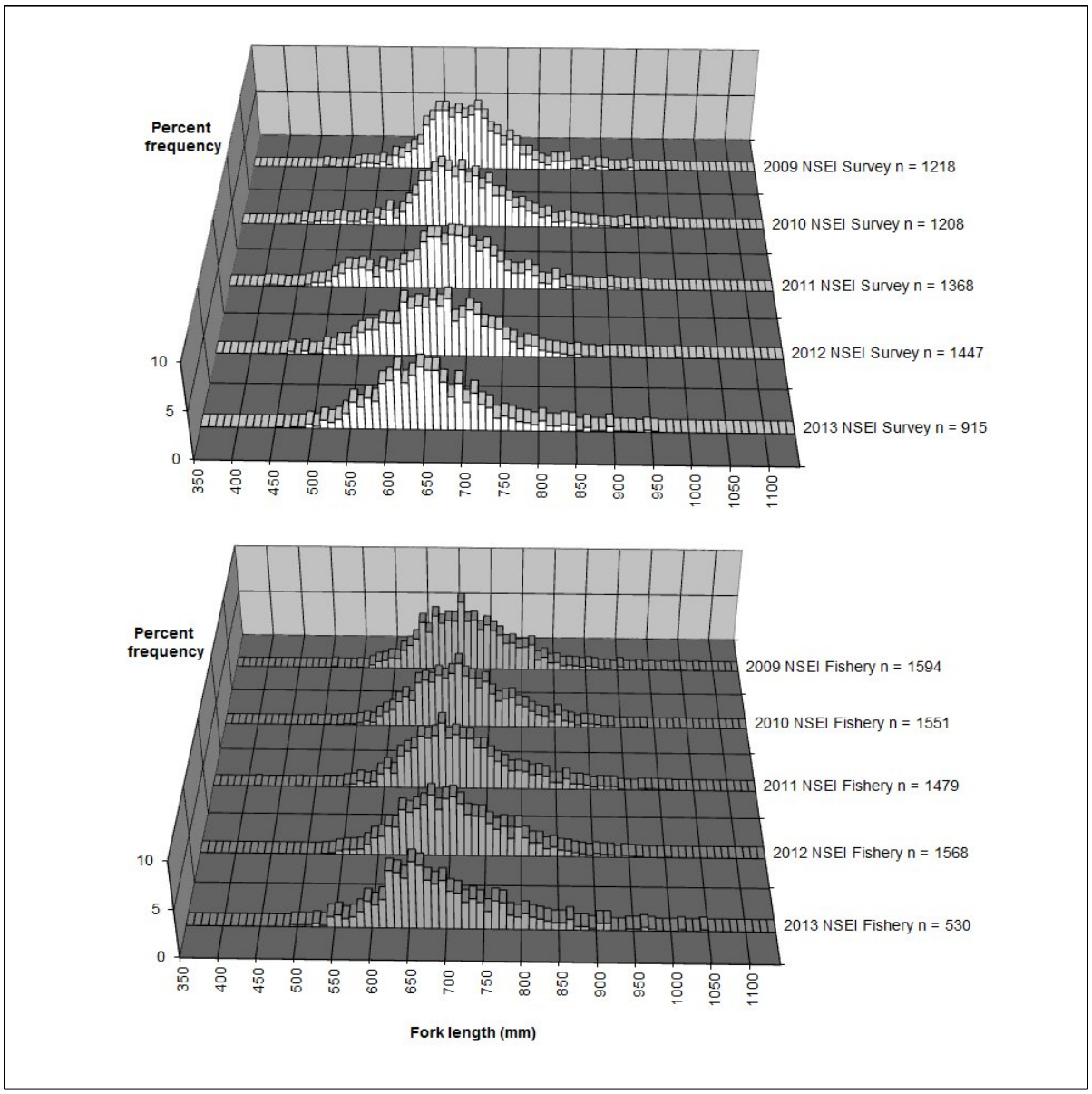

Figure 8.–Length frequency for sablefish sampled from the 2009 to 2013 NSEI longline surveys (top) and commercial fisheries (bottom).

APPENDICES

Appendix A.–The Alaska Department of Fish and Game scientific and vessel staff on the NSEI mark-tag survey, 2013 (first leg, May 21– June 1; second leg, June 4–12).

Name	Position	Leg(s)
Jim deLaBruere	Vessel (Skipper)	1 & 2
Craig Conger	Vessel	1 & 2
Cedar Stark	Vessel	1 & 2
Rick Gottwald	Vessel	1 & 2
Becky Wilson	Vessel	1 & 2
Chris Siddon	Vessel	1
Quinn Smith	Vessel	2
Kristen Green	Survey leader	1
Jennifer Stahl	Survey leader	2
Martina Kallenberger	Scientific staff	1
Aaron Baldwin	Scientific staff	1 & 2
Rhea Ehresmann	Scientific staff	2

Appendix B.–Detailed set information, including location and timing, for the NSEI mark-tag survey, 2013.

		Start				End										Depth (fathoms)			
Set	Stat area	Lat deg	Lat min	Long deg	Long min	Lat deg	Lat min	Long deg	Long min	Date Set	Time set	Soak time (h)	Haul time (h)	Haul direction	# Pots set	Start	End	Avg	Substrate
1	345803	58	22.00	135	0.70	58	19.97	134	59.89	5/21/2013	14:50	16.0	2.2	Same	34	297	275	275	Unknown
2	345803	58	14.84	134	59.47	58	12.86	134	58.67	5/21/2013	17:08	17.6	2.7	Opposite	39	332	374	354	Unknown
3	345803	58	1.82	134	52.55	57	59.83	134	52.09	5/22/2013	15:45	16.1	2.4	Opposite	39	350	321	329	Mud
4	345731	57	53.82	134	50.12	57	52.03	134	49.98	5/22/2013	17:22	18.6	2.8	Opposite	39	276	285	283	Unknown
5	345731	57	43.21	134	45.76	57	41.53	134	46.39	5/23/2013	17:00	15.2	1.6	Same	31	294	306	306	Unknown
6	345731	57	32.34	134	45.81	57	26.55	134	43.49	5/23/2013	19:04	16.8	2.2	Opposite	35	350	364	364	Mud
7	345701	57	28.47	134	42.45	57	26.61	134	43.45	5/24/2013	16:28	15.3	2.2	Same	36	299	315	316	Unknown
8	345701	57	25.91	134	41.16	57	24.18	134	41.79	5/24/2013	17:44	19.1	2.3	Same	37	293	308	303	Mud
9	345701	57	23.20	134	42.72	57	21.78	134	44.47	5/25/2013	11:41	20.2	1.7	Opposite	20	331	261	312	Mud/Hard
10	345701	57	18.76	134	43.64	57	17.09	134	43.52	5/25/2013	17:25	17.8	2.0	Opposite	20	467	464	467	Hard
11	345701	57	13.04	134	44.45	57	11.45	134	43.56	5/26/2013	16:49	14.9	2.2	Same	35	382	362	367	Mud
12	345701	57	11.40	134	45.92	57	9.49	134	45.32	5/26/2013	17:59	17.6	2.1	Opposite	27	328	338	333	Mud
13	345701	57	12.11	134	42.10	57	10.45	134	42.28	5/27/2013	17:11	14.8	1.8	Opposite	39	449	407	438	Hard
14	345701	57	1.87	134	42.38	57	3.94	134	42.74	5/28/2013	12:12	23.9	2.0	Opposite	35	350	355	358	Mud
15	345701	57	6.16	134	42.31	57	7.98	134	43.37	5/28/2013	14:01	25.2	2.2	Opposite	35	356	351	351	Mud
16	345631	56	57.45	134	41.81	56	55.66	134	41.51	5/29/2013	19:30	9.8	2.3	Opposite	37	338	336	340	Mixed
17	335701	57	13.36	133	50.62	57	14.88	133	49.00	5/30/2013	13:56	17.6	1.9	Same	37	265	201	228	Mud
18	335701	57	14.03	133	49.31	57	12.72	133	51.54	5/31/2013	11:22	68.6	2.0	Same	37	218	260	228	Mud
19	345631	56	53.46	134	36.26	56	51.92	134	35.07	6/3/2013	14:37	16.8	3.0	Same	37	365	377	371	Mud
20	345631	56	51.72	134	38.67	56	50.42	134	36.37	6/3/2013	16:22	18.9	2.2	Same	39	367	386	377	Unknown
21	345631	56	48.92	134	35.53	56	47.21	134	34.25	6/4/2013	15:52	15.4	1.7	Same	39	398	401	401	Unknown
22	345631	56	44.44	134	31.54	56	42.78	134	31.87	6/4/2013	17:05	19.3	1.6	Same	37	359	396	385	Hard
23	345631	56	39.42	134	28.90	56	41.36	134	28.12	6/5/2013	11:26	19.7	1.8	Opposite	39	349	343	345	Hard
24	345631	56	39.08	134	31.63	56	37.41	134	33.06	6/5/2013	15:18	20.4	1.4	Opposite	37	375	357	367	Hard
25	345631	56	33.55	134	30.46	56	35.50	134	29.84	6/6/2013	10:42	21.1	1.7	Opposite	39	358	356	354	Hard
26	345631	56	33.02	134	32.74	56	31.23	134	33.30	6/6/2013	14:45	22.1	1.4	Opposite	37	332	307	322	Mud

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Appendix B.–Page 2 of 2.

		Start				End										Depth (fathoms)			
Set	Stat area	Lat deg	Lat min	Long deg	Long min	Lat deg	Lat Min	Long deg	Long min	Date Set	Time set	Soak time (h)	Haul time (h)	Haul direction	# Pots Set	Start	End	Avg	Substrate
27	345603	56	25.49	134	36.15	56	27.64	134	36.03	6/7/2013	11:50	19.9	1.6	Same	39	303	321	314	Mud/Hard
28	345603	56	21.97	134	22.54	56	20.19	134	22.38	6/7/2013	17:12	17.9	1.5	Same	37	263	270	267	Hard
29	345603	56	12.84	134	27.22	56	11.24	134	27.23	6/8/2013	15:05	18.3	1.8	Same	37	381	356	369	Mud/Hard
30	345603	56	22.97	134	28.70	56	24.54	134	30.23	6/9/2013	13:22	19.9	1.7	Same	37	400	388	395	Mud/Hard
31	345631	56	33.96	134	32.94	56	35.83	134	33.06	6/10/2013	13:01	21.2	1.5	Same	37	333	349	340	Unknown
32	345631	56	39.93	134	33.78	56	41.82	134	33.84	6/10/2013	14:41	23.0	1.6	Same	39	366	378	372	Mud
33	345631	56	40.45	134	27.35	56	38.53	134	27.69	6/11/2013	17:29	17.3	1.9	Same	40	334	331	319	Hard
34	335701	57	12.05	133	48.24	57	10.26	133	48.22	6/12/2013	18:28	16.5	1.8	Opposite	39	241	196	213	Mud/Hard

Appendix C.–Species (not including sablefish) caught and identified during the NSEI mark-tag survey, 2013. Fish are listed first, and invertebrates are ordered by relative complexity.

Scientific Name	Common Name
Chordata – Chondrichthyes	**Sharks and Rays**
Somniosus pacificus	Pacific sleeper shark
Squalus suckleyi	Pacific spiny dogfish
Chordata – Osteichthyes	**Bony Fishes**
Aptocyclus ventricosus	smooth lumpsucker
Atheresthes stomias	arrowtooth flounder
Chauliodus macouni	Pacific viperfish
Hippoglossus stenolepis	Pacific halibut
Microstomus pacificus	Dover sole
Sebastes aleutianus	rougheye rockfish
Sebastes pinniger	canary rockfish
Sebastolobus alascanus	shortspine thornyhead rockfish
Stenobrachius leucopsarus	northern lampfish
Phylum Porifera – Hexactinellida	**Glass Sponges**
Heterochone calyx	glass Sponge
Phylum Cnidaria – Hexacorallia	**Anemones and Hard Corals**
Actinauge verrillii	cobblestone sea anemone
Actinistolidae unid.	purple striated anemone
Corallimorphus pilatus	club-tipped sea anemone
Crispatotrochus foxi	cup coral
Liponema brevicornis	tentacle shedding sea anemone
Phylum Cnidaria – Octocorallia	**Soft Corals**
Clavularia sp.	encrusting stolon coral
Isidella tentaculum	bamboo coral
Primnoa pacifica	red tree coral
Phylum Cnidaria – Hydroidea	**Hydroids**
Abietinaria sp.	sea fir
Garveia sp.	creeping red hydroid
Eudendrium sp.	stick hydroids
Phylum Annelida – Hirudinea	**Leeches**
Notostomum cyclostomum	striped sea leech
Phylum Annelida – Polychaeta	**Segmented Worms**
Amphicteis scaphobranchiata	shovel-gilled spaghetti worm
Galathowenia oculata	thread tubeworm
Lumbrineris sp.	marine earthworm
Maldanidae unid.	bamboo worm
Malmgreniella	deep sea scale worm
Neosabellaria cementarum	stone mason worm
Onuphidae unid.	iridescent tube worm
Spiochaetopterus costarum	three section tubeworm
Terebellidae unid.	spaghetti worm
Phylum Sipunucula	**Peanut Worms**
Golfingidae unid.	peanut worm
Phylum Nemertea	**Ribbon Worms**
Cerebratulus sp.	ribbon worm

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Scientific Name	Common Name
Phylum Mollusca – Bivalvia	**Clams, Mussels, and Scallops**
Acharax johnsoni	gutless awning clam
Conchocele bisecta	cleft clam
Macoma brota	heavy macoma
Megayoldia thraciaeformis	hatchet yoldia clam
Yoldia hyperborea	northern yoldia
Yoldia seminuda	crisscross yoldia
Phylum Mollusca – Gastropoda	**Snails and Slugs**
Arctomelon stearnsii	Arctic volute
Boreotrophon alaskanus	Alaskan trophon
Buccinum plectrum	lyre whelk
Buccinum scalariformis	silky whelk
Colus asphelus	green colus
Colus halli	Hall's colus
Colus jordani	Jordan's colus
Fusitriton oregonensis	hairy triton
Neptunea amianta	white neptune
Neptunea pribiloffensis	fat neptune
Neptunea sp.	Willett's neptune
Plicifusus griceus	grey-green colus
Phylum Bryozoa	**Moss Animals**
Alcyonidium sp.	leather bryozoan
Rhamphostomella costata	ribbed bryozoan
Phylum Brachiopoda	**Lampshells**
Frieleia halli	fragile brachiopod
Laqueus californianus	California brachiopod
Terebratulina unguicula	snake's head brachiopod
Phylum Arthropoda – Cirripedia	**Barnacles**
Chirona evermanni	giant deep-sea barnacle
Hesperibalanus hesperius hesperius	shell barnacle
Phylum Arthropoda – Peracarida	**Amphipods and Isopods**
Anonyx sp.	sand flea
Caprellidae unid.	skeleton shrimp
Erichthonius rubricoris	tubiculous amphipod
Stenothoidae unid.	amphipod
Uristidae unid.	sand flea
Rocinella angustata	Fish Louse
Synidotea sp.	sponge isopod
Phylum Arthropoda – Decapoda	**Crabs and Shrimps**
Callianopsis goniophthalma	slope ghost shrimp
Chionoecetes angulatus	angled Tanner crab
Lebbeus sp.	deep sea lebbeid
Lithodes aequispina	golden king crab
Oregonia gracilis	decorator crab

-continued-

Scientific Name	Common Name
Phylum Arthropoda – Decapoda (cont'd)	**Crabs and Shrimps**
Pagurus cornutus	hornyhand hermit crab
Pagurus ochotensis	Alaskan hermit crab
Pagurus tanneri	longhand hermit crab
Pandalus tridens	yellow-legged pandalid
Phylum Echinodermata – Crinoidea	**Feather Stars**
Florometra asperrima	northern feather star
Retiometra alascana	Alaska feather star
Phylum Echinodermata – Ophiuroidea	**Brittle Stars and Basket Stars**
Gorgonocephalus eucnemis	basket star
Ophiacantha normani	rosy brittle star
Ophiolimna bairdi	granulated brittle star
Ophiopholis japonica	Japanese daisy star
Ophiopholis longispina	long-spined brittle star
Ophioscolex corynetes	fleshy brittle star
Ophiura sp.	scaly brittle star
Ophiura sarsii	common grey brittle star
Stegophiura ponderosa	great armored brittle star
Phylum Echinodermata – Asteroidea	**Sea Stars**
Cheiraster dawsoni	fragile sea star
Crossaster borealis	deepsea sun star
Crossaster sp.	pink rose Star
Dipsacaster borealis	northern sand star
Dipsacaster eximius	extraordinary sand star
Gephyreaster swifti	gunpowder sea star
Henricia aspera	ridged blood star
Nearchaster pedicullaris	pedicellate fragile star
Pseudarchaster alascansis	Alaska scarlet star
Pseudarchaster parelli	northern scarlet star
Solaster sp.	remarkable sun star
Phylum Echinodermata – Echinoidea	**Sea Urchins and Sand Dollars**
Brisaster latifrons	heart urchin
Strongylocentrotus fragilis	fragile sea urchin
Strongylocentrotus pallidus	pale sea urchin
Phylum Echinodermata – Holothuroidea	**Sea Cucumbers**
Chiridota albatrossae	jellybean sea cucumber
Mopaldia intermedia	sea potato

Appendix D.–Fish (not including sablefish) captured by set for the NSEI mark-tag survey, 2013.

	Groundfish					Sharks		Rockfish			Other		
Set	Pacific cod	Arrow-tooth flounder	Pacific halibut	Dover sole	Unknown general groundfish	Spotted spiny dogfish	Pacific sleeper shark	Thorny-head	Rough-eye	Canary rockfish	Smooth lumpsucker	Pacific viperfish	Total
1			5	1									6
2			1										1
3			2			1							3
4			3			1							4
5			3		1				1				5
6		2	3	1				2					8
7		6	4										10
8		4	2										6
9			1										6
10		8		1									9
11		4	5	4				1					14
12		1	2	2									5
13		4	2	6	2			2					16
14		10	4	5				1					20
15		12	9	8	2		1	1				1	34
16		2	3	7									12
17	1	101	42					1		1			146
18		29	71					1	1				102
19		4	3	2				2					11
20		2	5	4									11
21		2	5	8				2					17
22		3	3	16									22
23		3	6	2									11
24			3	9				1					13
25		4	1	6				1					12
26		2	6	2				3			1		14

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	Groundfish					Sharks		Rockfish			Other		
Set	Pacific cod	Arrow-tooth flounder	Pacific halibut	Dover sole	Unknown general groundfish	Spotted spiny dogfish	Pacific sleeper shark	Thorny-head	Rough-eye	Canary rockfish	Smooth lumpsucker	Pacific viperfish	Total
27		3	5	2									10
28		9	8	2					3				22
29		19	2	3									24
30		4		7				1					12
31		5	4	9				1					19
32		5	1	5									11
33		5	9	7				1					22
34		66	61					1					128
Total	1	319	284	119	5	2	1	22	5	1	1	1	766

Appendix E.–Numbers of sablefish marked, released, retained, or discarded by set for the NSEI mark-tag survey, 2013. Lost sablefish were those that escaped overboard before measurement or tagging.

	Released				Retained		Discarded					
Set	Tagged and marked	Previously tagged by ADF&G	Previously tagged by other agency	Clipped only	Previously tagged by ADF&G	Mortality	Sand fleas	Not marketable (due to injuries)	Numbers estimated due to reaching quota	Discarded healthy due to reaching quota	Lost	Total
1	236	7					10	17	94			364
2	276	3					109	27	162			577
3	185						2	8	511	14		720
4	365	8					5	42	478		3	901
5	218	11					2	38	128			397
6	131	1					1	9	271	4		417
7	382	8						70	216		2	678
8	329	31						83	348			791
9	129	3					44	7	174	15		372
10	130	6					1	37	26			200
11	346	5					2	68	103		1	525
12	299	14					2	36	201	32	3	587
13	150	1	1				3	9				164
14	356	17						38	77	1	2	491
15	253	8					2	24				287
16	369	19		1				65	140		2	596
17	35							3				38
18	163	5					4	6			2	180
19	406	23						15	162		1	607
20	402	10					2	22	102		1	539
21	133	5						5			2	145
22	206	5						12			1	224
23	258	6						7				271
24	214	16			2			18				250
25	287	11						12				310
26	200	12						8				220

-continued-

Appendix E.–Page 2 of 2.

	Released				Retained		Discarded					
Set	Tagged and marked	Previously tagged by ADF&G	Previously tagged by other agency	Clipped only	Previously tagged by ADF&G	Mortality	Sand fleas	Not marketable (due to injuries)	Numbers estimated due to reaching quota	Discarded healthy due to reaching quota	Lost	Total
27	297	3						11	72		3	386
28	178	2						5				185
29	212	15						4				231
30	131	5						4	106			246
31	143	9						2				154
32	309	14						20				343
33	163	10						2				175
34	69	2						2				73
Total	7,960	295	1	2	2	0	189	736	3371	66	23	12,644

Appendix F.–Problem and difficult sets from the 2010, 2012, and 2013 NSEI mark-tag surveys, ordered by set number.

			Start				End				
Stat area	Year	Set #	Lat deg	Lat min	Long deg	Long min	Lat deg	Lat min	Long deg	Long min	Problem
345803	2013	3	58	1.82	134	52.55	57	59.83	134	52.09	South end of set becomes shallower; set slightly to the east
345731	2013	6	57	32.34	134	45.81	57	26.55	134	43.49	Set is near reef; follow exact track to avoid
345701	2012	7	57	29.47	134	47.10	57	27.68	134	46.74	Hard substrate and barnacles caused line break – avoid area
345701	2010	9	57	19.51	134	40.09	57	17.46	134	39.40	Line break, possibly due to hard substrate
345701	2012	9	57	23.01	134	42.63	57	21.42	134	42.77	Line caught on bottom, possibly due to hard substrate
345701	2013	9	57	23.20	134	42.72	57	21.78	134	44.47	Avoid shallow hard bottom at south end; best hauled south to north
345701	2012	11	57	13.06	134	41.44	57	11.56	134	41.34	Line caught on bottom, possibly due to hard substrate
345701	2010	14	57	2.53	134	41.76	57	0.46	134	41.62	Hard substrate – sets just north may be set
345702	2010	17	56	55.34	134	26.08	56	56.77	134	22.07	Avoid during extreme tides; high rockfish numbers
345631	2013	22	56	44.44	134	31.54	56	42.78	134	31.87	Hard bottom, derelict crab gear on bottom
345631	2013	23	56	39.42	134	28.90	56	41.36	134	28.12	Hard bottom; do not go south of set, set south to north
345631	2010	24	56	56.22	134	35.67	56	54.52	134	34.63	Hard substrate and barnacles caused line break – avoid area
345603	2012	27	56	27.08	134	36.21	56	28.95	134	35.84	North end of set hard bottom; high rockfish numbers
345603	2013	28	56	21.97	134	22.54	56	20.19	134	22.38	Hard bottom, rising at north and south ends
345603	2013	30	56	22.97	134	28.70	56	24.54	134	30.23	Relief on north end, catches better in north