MEMORANDUM STATE OF ALASKA

DEPARTMENT OF FISH AND GAME

Division of Commercial Fisheries

TO:	Lowell Fair, Regional Supervisor, Region I – CF	DATE:	5/2/2018
THROUGH:	Karla Bush, Shellfish/Groundfish Coordinator, Region I – CF	PHONE:	907-465-4259
FROM:	Andrew Olson-Groundfish Project Leader Region I – CF	SUBJECT:	2017 SSEI sablefish stock status for 2018 quota

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Overview

The Alaska Department of Fish and Game (department) evaluates stock status and establishes the Southern Southeast Inside (SSEI) annual harvest objective (AHO) using commercial fishery and longline survey catch per unit effort (CPUE) data, fishery and survey biological data (age, weight, length, and maturity), and stock status trends of sablefish populations in surrounding geographic areas. No abundance estimate is obtained for the SSEI stock.

For 2018, the SSEI AHO was raised 12% due to continued increases in the longline survey CPUE index, signs of recruitment in length and age-class distributions in the survey and fishery, introduction of escape rings for pot gear to reduce harvest of immature individuals and increasing trends in sablefish biomass from adjacent areas including the Gulf of Alaska (GOA), British Columbia, Canada (BC), and Northern Southeast Inside Subdistrict (NSEI). Sablefish in SSEI have a 30% chance of moving out of SSEI after one-year of occupancy into the GOA and BC (Hanselman et al. 2014) and therefore trends in abundance observed in adjacent areas are likely mirrored in the SSEI stock. These improvements prompted an increase of the 2018 SSEI AHO (578,774 lb) while allowing for continued recruitment and recovery of the stock (Figures 1–2). The following summarizes stock indices in SSEI and adjacent waters for recent years:

- SSEI longline survey CPUE (round lb per hook) increased 6% from 0.63 in 2016 to 0.67 in 2017 (Figure 1 and 2; Table 1);
- SSEI longline survey CPUE (round lb per hook) for fish ≥520 mm increased 4% from 0.56 in 2016 to 0.58 in 2017 (Figure 1 and 2; Table 1);
- SSEI longline fishery CPUE has been stable in last ten years with a slight increase of 4% (round lb per hook) from 0.26 in 2016 to 0.27 in 2017 (Figure 1; Table 1);
- SSEI pot fishery CPUE (round lb per pot) increased 59% from 49.2 in 2016 to 78.0 in

2017;

- SSEI fishery harvest percent of immature females increased to 67% in the longline fishery and 82% in the pot fishery from 2016 to 2017. Percent of immature males increased to 67% in the longline fishery and decreased to 49% in the pot fishery (Table 2; Figure 3);
- NSEI longline survey CPUE in round lb per hook decreased by 34.6% and in numbers per hook increased by 15% from 2016 to 2017;
- Gulf of Alaska improvements in recruitment with the 2008 year class 13% above average in size and fully mature in 2018. The 2014 year class is estimated to be very strong; however large uncertainty is associated with this estimate (Hanselman et al. 2017);
- Federal longline survey abundance index increased 14% from 2016 to 2017 and the recommended federal allowable biological catch (ABC) for 2018 is 14% higher than 2017 (Figure 4; Hanselman et al. 2017);
- The Department of Fisheries and Oceans (DFO) Canadian sablefish stock assessment showed an increase of 94% in CPUE (kg/trap) from their annual pot survey and an increase of 18% in sablefish estimated biomass from 2016 to 2017 (Brendan Connors, DFO Canada, personal communication). Regulations require two 3.5-inch escape rings on pot gear and a 55 cm minimum size limit for sablefish in all Canadian waters.

For the 2018 SSEI fishery, there are 20 Commercial Fisheries Entry Commission (CFEC) longline/pot (C61C) and three pot (C91C) permits, resulting in a 2018 Equal Quota Share (EQS) of 25,164 round lb for each permit holder. Starting with the 2017 season, holders of a C61C permit could use longline or pot gear to catch their EQS during their respective seasons. Additional new regulations were adopted at the 2018 Board of Fisheries meeting for the SSEI fisheries: 1) a concurrent longline and pot season from June 1–November 15, 2) a live market for the sale of sablefish, and 3) two 4-inch diameter escapement rings on opposing vertical walls and slopes of pots. Sablefish escape rings were implemented for pots to prevent targeting of immature fish in the live market, allow immature fish the opportunity to reproduce before being harvested, and allow for increased sustainability of the SSEI stock due to the increased potential for pot gear utilization in the fishery. Escape ring size was based on sablefish length at 50% maturity (61 cm) for both management areas (NSEI and SSEI) and sexes combined from 1988–2017. There was no change in the number of CFEC permit holders in the SSEI fisheries from 2017. For reference, historical AHOs, commercial harvests, and number of permit holders are shown in Table 3. Department longline survey removals are displayed in Table 4.

From 2016 to 2017, increases occurred in the overall SSEI longline survey (6%) and longline fishery (4%) CPUE (round pound per hook) with a large increase in the pot fishery CPUE (59%; Figure 1 and 2; Table 1). For most statistical areas in SSEI, the longline survey CPUE increased; however, in western Dixon Entrance (325401/325431) and Clarence Strait (315502) a decline occurred in CPUE for fish in round lb per hook (Figure 6). Because fishery CPUE was standardized using a generalized additive model (GAM) model, the same increasing trend occurred in all statistical areas; with only the magnitude of CPUE varying by statistical area (Figure 7). The SSEI longline survey was redesigned in 2013 to better overlap the commercial fishery distribution and available fishery habitat; prior to the redesign, Dixon Entrance survey stations were limited, but a high proportion of the commercial fishery harvest occurred in the area annually (Figures 8–10; Stahl et al. 2014). The department has utilized the redesigned survey since 2013 (Figure 9).

The department remains concerned that a large proportion of immature sablefish are harvested in the SSEI commercial fisheries before spawning. The proportion of immature sablefish harvested in both the pot and longline fisheries remains high (Table 2; Figure 3) while, sablefish caught in the Northern Southeast Inside (NSEI) fishery and survey are typically >90% mature. The probability of sablefish moving in or out of the SSEI area is high (30%) relative to NSEI (10%–14%) (Hanselman et al. 2014), so it is possible that a proportion of fish emigrate from the SSEI area into the Gulf of Alaska and British Columbia waters when they reach maturity. In recent years, the proportion of immature fish harvested in SSEI longline and pot fisheries has been exceptionally high, likely due to recruits from the 2008 year class; however, this year class is expected to be mature by 2018 (Hanselman et al. 2017). In recent years, the 2014 year class has also contributed to the high harvest of immature fish and is expected to be strong with high harvests of immature fish expected until this year class reaches maturity (Table 2; Figure 3).

Survey and Fishery CPUE Methodology

The longline survey was redesigned and expanded in Dixon Entrance and in northern Clarence Strait in 2013 (Figure 9; Stahl et al. 2014). However, five of the longline stations used in 2013 were moved in 2014, because these stations were not in sablefish habitat (based on depth or substrate) or were too close to underwater cables. Additional documentation from the 2014 survey indicated that one more station was not located in sablefish habitat; as a result, this station was moved for the 2015 survey (Stahl et al. 2014). Survey CPUE analyses are presented with the 2013 estimates excluding the five stations that were moved for the 2014 survey and with the 2014 estimates excluding the one station that was moved for the 2015 survey as these stations will not be part of the long-term data set.

Sablefish catch per hook increases with hook spacing (Sigler and Lunsford 2001); thus, fishery and survey CPUE were standardized for hook counts to account for variable hook spacing between the survey and fishery. To standardize the number of hooks to 1-m spacing, the following formula was used:

$$(1) \qquad N_{std} = N_{unstd}\, C\infty\, (1 - \exp(-kh))$$

with N = the number of hooks and h = hook spacing (Skud and Hamley 1978). To apply this equation to the directed sablefish longline fishery, NOAA Fisheries performed hook spacing experiments to obtain values for the following parameters: $C\infty$ = 2.2 and k = 0.57 (Sigler and Lunsford 2001).

To directly compare SSEI fishery and survey CPUE, the survey hook counts were standardized to 1-m hook spacing, equivalent to the protocol for the NSEI sablefish fishery (Carroll and Brylinsky 2010). Standardization of hooks for hook spacing does not change the general trends in CPUE across time; however, standardization does result in a change in the magnitude of CPUE. The survey CPUE values are reduced with standardization, which decreases the difference between the fishery and survey CPUEs.

Since 2011, the SSEI longline survey CPUE has been calculated for two different sets of data: all

fish sampled in the survey, and fish ≥520 mm (Table 1). CPUE analysis was performed for the subset of fish ≥520 mm to better compare with the SSEI longline fishery CPUE; few fish <520 mm are landed in the commercial longline fishery. CPUE analysis only included "valid" skates (contained <12 broken, bent, or snarled hooks in a 45-hook skate and did include any whale depredation).

CPUE was calculated by individual stratum using equations 2–5 with each stratum weighted by the proportion of sablefish habitat in that stratum relative to the total sablefish habitat in statistical areas surveyed in SSEI (Table 5). CPUE was calculated in fish per hook and pounds per hook, by multiplying the fish per hook for a stratum by the average weight of all fish sampled within that stratum. CPUE for fish ≥520 mm was calculated as above, with the additional step of multiplying CPUE (round pounds per hook) for each stratum by the proportion of fish ≥520 mm for that stratum prior to weighting. The overall CPUE for each year was calculated by summing the weighted CPUEs for all strata.

(2) CPUE fish/hook by stratum = number of sablefish for stratum / number of standardized hooks for stratum * proportion of total sablefish habitat in the stratum

(3) CPUE fish/hook by stratum for ≥ 520 mm fish = number of sablefish for stratum/number of standardized hooks for stratum * proportion of fish ≥ 520 mm * proportion of total sablefish habitat in the stratum

(4) CPUE lb/hook by stratum = number of sablefish for stratum / number of standardized hooks for stratum * average weight for stratum * proportion of total sablefish habitat in the stratum

(5) CPUE lb/hook by stratum = number of sablefish for stratum / number of standardized hooks for stratum * proportion of fish ≥ 520 mm * average weight for stratum * proportion of total sablefish habitat in the stratum

The SSEI commercial fishery CPUE was standardized using the following GAM:

(6) $CPUE = f_1(Year) + f_2(Gear) + f_3(Hook\ size) + f_4(Depth) + f_5(\text{Soak time}) + f_6(\text{Longitude, Latitude}) + f_7(\text{Statistical area}, bs = re) + f_8(ADFG\ number, bs = re) + \epsilon$

where *f* 's represent functions. In the model, explanatory variables were included as either fixed or random effects. ADFG number and statistical area were included as random effects (using *bs=re* statement), because these variables represent repeated measures and as random effects each vessel and subregion has its own statistical distribution. Fixed effects included in the model were year, longline gear type (conventional fixed, snap-on, automatic, or conventional gear with mixed hook spacing), hook size, soak time, set average depth, and the set start latitude and longitude. Year, gear, hook size, statistical area, and vessel were included as categorical variables. A smoother term was applied to soak time, depth, and latitude and longitude; for soak time and depth, the smoother was restricted to four knots (maximum degrees of freedom). The CPUE was normalized for the model by (Campbell et al. 1996; Campbell 2004):

(7) Normalized CPUE = ln (sablefish pounds / number of standardized hooks + mean (sablefish pounds / number of standardized hooks) * 0.10).

Additional GAM models were explored that excluded one or both of the random variables and latitude or longitude or both. The preferred model includes all the fixed and random variables and has the lowest Akaike information criterion (AIC) and explains the most variance in the data (Deviance of 43.7%). All fixed and random variables are significant and important to the model structure. Depth and CPUE have a linear relationship with CPUE increasing with depth. Soak time and CPUE have a polynomial relationship with CPUE increasing with soak time until about 10 hours and then declining. In addition, CPUE changes with both the set start latitude and longitude but more dramatically with latitude with CPUE tending to be higher in lower latitudes.

Fishery CPUE for each year was standardized using the preferred GAM model (equation 6) to the value or level of each variable that we considered the "standard". For the categorical variables, we used the survey gear standards of conventional fixed gear type and hook size of 13. For the numeric variables of depth, latitude, and longitude, the mean values from 1997 to 2017 were considered the "standard". For soak time, we used 10 hours, which is the time at which the relationship between soak time and CPUE peaks.

While all SSEI longline survey CPUE data were calculated using a random stratified estimator (weighting each stratum based on the proportion of sablefish habitat), fishery CPUE data have not been weighted by stratum at this time.

Longline and Pot Fishery CPUE Results

Longline fishery CPUE remains stable in recent years with the 2017 estimate similar to both the 5- and 10-year averages, but below the long-term average (1997 to 2017). The annual CPUE estimates have generally been lower in the last ten years (2008–2017) than in the previous six years (2002–2007; Table 1; Figure 1).

The 2017 pot fishery CPUE (round pound per pot) increased from the 2016 estimate and is greater than the five-year, 10-year, and overall averages. Pot fishery CPUE has been variable since 1997, in part, due to the limited participation in this fishery (three to five permit holders). In addition, pot fishery CPUE may have greater sensitivity to recruitment than the longline fishery, because younger and smaller fish are typically harvested in the pot fishery compared to the longline fishery (Table 2; Figures 12; 14–18).

Longline Survey CPUE Results

Longline survey CPUE (round lb per hook) has been variable since 1997 (survey data prior to 1997 are excluded since the methodology for gear soak time was not standardized; Figure 1 and 2). A large decline in survey CPUE occurred from 2006 through 2010; CPUE appeared to stabilize in 2011 and 2012 and then decline through 2015 (Figure 1 and 2). In 2016 and 2017, CPUE increased for all indices, CPUE measured in round pounds or fish per hook for all fish or fish ≥520 mm (Figure 2). The 2017 SSEI longline survey CPUE (all fish and fish ≥520 mm in round

pounds/hook) was below the long-term (1997–2017) averages (Table 1). The all fish CPUE was similar to the 10-year average, but the ≥520 mm CPUE remains below the 10-year average (Table 1). Both indices were above the 5-year average. In 2017, there was evidence of recruitment with increases in the proportions of immature fish in the pot fishery and survey (Table 2; Figure 3) and increases in small, young fish in the survey and longline fisheries (Figure 11–18).

Fishery and Survey CPUE by Geographic Area

The survey and fishery CPUE in western Dixon Entrance (325401/325431) has been high compared to most statistical areas with the survey CPUE highly variable in this area. However, after the 2013 survey redesign, the CPUE estimates for this area are less variable (Figures 6–7). The survey CPUE in western Dixon Entrance remains higher than most statistical areas but has become similar to CPUE in eastern Dixon entrance after declining since 2011 (Figure 6). As part of the 2013 SSEI survey redesign and expansion, the number of stations in Dixon Entrance increased to reflect the commercial fishery distribution and the area of sablefish habitat available in this region (Figures 8–10; Table 5). After a few years of data collection, we will be able to determine if increased sampling in this area will continue to reduce the variability of CPUE or if this variability is characteristic of fish abundance in this area. Some of the variability in CPUE for Dixon Entrance may be explained by the increased movements of fish in this area, as evidenced by the large differences in size classes by area as observed in the survey between 2010 and 2017 (Figure 19).

Differences that occurred in the geographic trends in CPUE between the survey and fishery may be related to temporal and spatial differences in the distribution and/or differences in the CPUE estimation methods. The survey CPUE increased in most of the statistical areas in Clarence Strait and eastern Dixon entrance but declined in western Dixon entrance and one statistical area in Clarence Strait (315502; Figure 6). Because fishery CPUE was standardized using a GAM model, the trends were the same for each statistical area with a slight decline; however, the fishery CPUE for each statistical area differed in magnitude. Both the fishery and survey CPUE was high in western Dixon entrance for each year compared to other areas; however, the rank of each statistical area in magnitude of CPUE was not the same for most other statistical areas for the fishery and survey. For example, the CPUE for statistical area 325533 had the highest values by year for the fishery and some of the lowest for the survey.

Some of the differences between the fishery and survey CPUE may be due to differences in the method for standardizing CPUE. For fishery CPUE we were able to standardize by depth, latitude and longitude, and by soak time. Survey soak times are less variable than fishery soak times; however, other variables used for standardization do differ by station. In the future, we will consider standardizing the survey CPUE using similar methods as fishery CPUE and include the variables of depth and latitude and longitude in the standardization. In addition, the survey CPUE is weighted by the area of habitat for each statistical due to the stratified survey design.

Differences in the survey and fishery timing may explain some of the variability in CPUE if sablefish are moving in or out of Clarence Strait and/or Dixon entrance between the survey and fishery. Spatial effects could affect CPUE if fishermen are targeting prime habitats where fish may be aggregated or if fishermen target areas with larger fish with a higher value, but possibly lower overall landed pounds. In addition, fishery CPUE may be reduced if fishermen are discarding small

sablefish but not recording them on their logbooks. In 2017, orca whales were observed depredating catch during the SSEI longline survey but not in the fishery. For the survey, once whales were observed during hauling, all skates thereafter for that set were removed from the CPUE analysis. Although fishing was excluded for the survey where orcas were observed, variability in depredation between the survey and fishery may have affected geographic trends in CPUE. In 2017 on the survey, whale depredation occurred at eight stations in lower Clarence Strait and in Dixon entrance (18, 111, 118, 121, 122, 127, 128, and 129). Prior to 2013, some of the differences in the fishery and survey CPUE may have been related to differences in the distribution of the fishery and the survey, especially in Dixon entrance where a low number of survey stations were allocated (Figure 8; Figure 10). In the last four years since the survey redesign, the CPUE appears to be more stable in Dixon entrance (Figure 7).

Biological Data

Recruitment occurred for the first time in recent years when the 2008 year class was detected in the SSEI longline survey and SSEI longline and pot fishery age and length distributions (Figures 11–18; Stahl et al. 2014). These influxes of small fish typically appear in later years in the commercial longline and pot fisheries than the survey due to discards of small fish by the commercial fleet. A smaller recruitment pulse was observed in the 2012 survey (Figures 13 and 14; Stahl et al. 2014). In 2016 and 2017, another recruitment pulse has been observed from the 2014 year class with larger proportions compared to most years of <500 mm fish in the survey and <570 mm fish in the longline and pot fisheries (Figures 11 and 12). The SSEI survey is considered to be a good indicator of future recruitment strength to populations in other areas, specifically Chatham Strait (Bracken et al. 1997), with all sablefish caught on the survey retained. Recent sablefish recruitment was also observed in the NSEI and federal sablefish longline surveys (Hanselman et al. 2017).

Historically, a greater proportion of immature fish are harvested in the SSEI commercial pot and longline fisheries than in the NSEI or federal Gulf of Alaska commercial fisheries. On average 63% of females sampled in SSEI were immature in the longline survey, 45% in the longline fishery, and 70% in the pot fishery since 2001 (averages were calculated starting at 2001, because no longline fishery biological samples were collected before this year and the majority of the harvest occurs during the longline fishery; limited pot fishery data are available prior to 2006). The percent of immature females sampled from the SSEI survey and commercial fisheries steadily increased from 2008 through 2012 with the increase continuing through 2013 for immature females sampled from the longline fishery (Table 2; Figure 3). Then a decline occurred in the proportion of immature females sampled in the survey and pot fishery from 2012 to 2015 and from 2013 to 2016 in the longline fishery (Table 2; Figure 3). In 2016 and 2017 recruitment was observed with increases in the proportion of immature females with 72% immature females in the survey, 67% in the longline fishery and 82% in the pot fishery in 2017 (Table 2). High proportions of immature male sablefish have also been sampled with, on average, greater than 55% immature males in the SSEI survey and fisheries since 2001 (Table 2; Figure 3). The harvest of immature male sablefish reached a high in 2011 with 80% immature males in the pot fishery and 66% in the longline fishery. In 2017, harvest of immature males in the pot fishery remains high at 49% and harvest in the longline fishery has surpassed the 2011 high with 67%. In the 2016 survey, a peak in the harvest of immature males occurred with 79% (Table 2; Figure 3). Differences in trends between males and females are expected; males generally mature at a younger age and size than

females. High proportions of immature fish harvested in recent years are likely due to recent recruitment to these fisheries. The survey data indicate that larger, more mature fish are found in the northern part of Clarence Strait in some years (Figure 19) and if the proportion of commercial harvest from this region has decreased, younger, immature fish caught in other areas may contribute disproportionately to the overall harvest.

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Table 1.–CPUE (round pounds per hook) for the longline survey and fishery and pot fishery (round pounds per pot) from 1997–2016. Longline fishery CPUEs are standardized.

Year	Survey CPUE all fish	Survey CPUE ≥520 mm	LL Fishery CPUE	Pot Fishery CPUE
1997	0.49	0.40	0.30	34.0
1998	0.56	0.48	0.28	45.7
1999	0.78	0.65	0.36	90.7
2000	0.74	0.69	0.32	44.8
2001	0.58	0.54	0.25	40.9
2002	0.71	0.64	0.32	49.6
2003	0.80	0.73	0.36	68.6
2004	0.83	0.78	0.30	36.4
2005	No survey	No survey	0.36	32.1
2006	0.95	0.92	0.38	36.1
2007	0.77	0.70	0.34	37.4
2008	0.81	0.80	0.28	18.3
2009	0.75	0.71	0.27	18.9
2010	0.48	0.33	0.25	26.2
2011	0.79	0.73	0.28	50.0
2012	0.76	0.71	0.23	71.4
2013	0.67[1]	0.63[1]	0.28	40.8
2014	0.61[1]	0.59[1]	0.25	42.3
2015	0.53	0.49	0.27	39.8
2016	0.63	0.56	0.26	49.2
2017	0.67	0.58	0.27	78.0
5-yr avg. (2013–2017)	**0.62**	**0.57**	**0.27**	**50.0**
10-yr avg. (2008–2017)	**0.67**	**0.61**	**0.26**	**43.5**
Overall average (1997–2017)	**0.70**	**0.63**	**0.30**	**45.3**

[1] The 2013 and 2014 survey CPUE estimates exclude the stations that were moved in the following survey year.

Table 2. Percent of immature fish in the SSEI longline survey and fisheries.

Year	Percent immature females			Percent immature males		
	Survey	LL fishery	Pot fishery	Survey	LL fishery	Pot fishery
1988	49%	No data	No data	53%	No data	No data
1989	35%	No data	No data	21%	No data	No data
1990	34%	No data	No data	30%	No data	No data
1991	58%	No data	No data	37%	No data	No data
1992	54%	No data	No data	48%	No data	No data
1993	46%	No data	No data	50%	No data	No data
1994	53%	No data	No data	40%	No data	No data
1995	61%	No data	No data	46%	No data	No data
1996	54%	No data	No data	48%	No data	No data
1997	47%	No data	No data	62%	No data	No data
1998	71%	No data	No data	61%	No data	No data
1999	88%	No data	50%	74%	No data	47%
2000	67%	No data	No data	65%	No data	No data
2001	74%	27%	No data	77%	36%	No data
2002	72%	37%	No data	72%	52%	No data
2003	50%	42%	No data	67%	60%	No data
2004	52%	42%	No data	71%	65%	No data
2005	No survey	34%	No data	No survey	46%	No data
2006	39%	26%	73%	56%	45%	42%
2007	53%	38%	68%	61%	62%	45%
2008	41%	27%	54%	51%	59%	41%
2009	50%	27%	64%	48%	41%	51%
2010	64%	43%	73%	65%	55%	51%
2011	78%	55%	88%	61%	66%	80%
2012	83%	61%	96%	76%	58%	66%
2013	76%	67%	75%	69%	67%	59%
2014	73%	58%	76%	68%	63%	65%
2015	55%	58%	45%	56%	64%	59%
2016	73%	48%	51%	79%	36%	67%
2017	72%	67%	82%	73%	67%	49%
1988–2017 avg.	**59%**	**45%**	**69%**	**58%**	**55%**	**56%**
2013–2017, 5-yr avg.	**70%**	**60%**	**66%**	**69%**	**59%**	**60%**
2008–2017, 10-yr avg.	**67%**	**51%**	**70%**	**65%**	**58%**	**59%**

Table 3. –Annual harvest objective, equal quota share, and reported harvest (round lb), along with ex-vessel value and effort for the directed commercial SSEI sablefish fishery since the equal quota share was established in 1997. In 2017, pot gear became an allowable gear type for C61C permit holders.

Year	Annual harvest objective	Total harvest	Equal share quota	Longline Fishery			Pot Fishery		
				Harvest	Ex-vessel value	No. of permits	Harvest	Ex-vessel value	No. of permits
1986	790,000			554,121	$260,436	22	*	*	2
1987	790,000			435,501	$291,785	22	*	*	1
1988	790,000			712,787	$719,914	26	*	*	1
1989	790,000			952,231	$714,173	31	*	*	1
1990	790,000			758,663	$553,823	30			0
1991	790,000			679,623	$625,253	30	*	*	1
1992	790,000			936,811	$936,811	30	*	*	1
1993	790,000			824,011	$815,770	30			0
1994	790,000			866,788	$1,066,149	30			0
1995	790,000			678,762	$1,323,585	30			0
1996	790,000			502,459	$899,401	30			0
1997	790,000	725,067	23,200	608,786	$1,345,423	30	116,281	$256,981	5
1998	632,000	578,056	20,400	496,210	$699,656	29	81,846	$113,765	4
1999	720,000	661,424	24,000	565,190	$1,006,038	26	96,234	$193,430	4
2000	696,000	590,815	24,000	494,528	$989,056	25	96,287	$187,760	4
2001	696,000	650,678	24,000	554,490	$1,064,621	25	96,188	$184,679	4
2002	696,000	650,339	24,000	554,074	$1,074,904	25	96,265	$212,746	4
2003	696,000	656,936	24,860	557,102	$1,286,906	24	99,834	$219,635	4
2004	696,000	648,845	24,860	550,472	$871,689	24	98,373	$158,986	4
2005	696,000	639,719	24,860	539,251	$1,127,483	24	100,468	$223,957	4
2006	696,000	624,832	21,750	537,812	$1,224,134	28	87,020	$210,605	4
2007	696,000	620,168	21,750	533,130	$1,306,573	28	87,038	$207,780	4
2008	696,000	618,033	21,750	531,866	$1,598,097	28	86,167	$256,300	4
2009	634,000	595,748	22,650	525,534	$1,553,838	25	70,214	$210,766	3
2010	634,000	558,633	23,400	488,449	$1,790,478	24	70,184	$258,553	3
2011	583,280	540,931	23,300	472,070	$2,309,949	22	68,861	$333,128	3
2012	583,280	521,825	25,360	445,678	$1,564,129	20	76,147	$198,906	3
2013	583,280	505,599	25,360	429,259	$1,117,189	20	76,340	$190,550	3
2014	536,618	494,830	23,331	425,465	$1,460,213	20	69,365	$230,494	3
2015	536,618	512,580	23,331	442,123	$1,492,070	20	70,457	$228,088	3
2016	482,956	475,466	20,998	412,773	$1,577,685	20	62,693	$222,437	3
2017	516,763	514,205	22,468	421,739	$1,579,931	19	92,466	$379,934	5
2018	578,774		25,164			20			3

* Indicates confidential information due to less than three permit holders participating in the fishery.

Table 4.–Department longline survey removals (round lb) from the first year of the survey (1988) to the most recent survey (2017).

Year	Longline survey removals (round lb)
1988	12,552
1989	9,946
1990	14,006
1991	19,533
1992	15,490
1993	20,586
1994	11,756
1995	8,871
1996	8,441
1997	35,494
1998	30,957
1999	34,121
2000	39,479
2001	28,965
2002	35,778
2003	40,210
2004	41,722
2005	No survey
2006	41,026
2007	37,238
2008	34,853
2009	29,532
2010	20,303
2011	34,472
2012	39,185
2013	26,208
2014	26,583
2015	20,191
2016	26,282
2017	22,913

Table 5.–The area and proportion of sablefish habitat by stratum. Sablefish habitat was delineated using the 200-fathom depth contour if depth data were available or using the SSEI sablefish longline fishery distribution. Proportion of sablefish habitat was used to weight the survey CPUE for each stratum.

Stratum	Sablefish habitat (km^2)	Sablefish habitat/total area
325533	177	0.06
325531	215	0.08
315502	484	0.18
315432	687	0.25
315431	492	0.18
325401/325431	694	0.25
Total	**2,748**	**1.00**

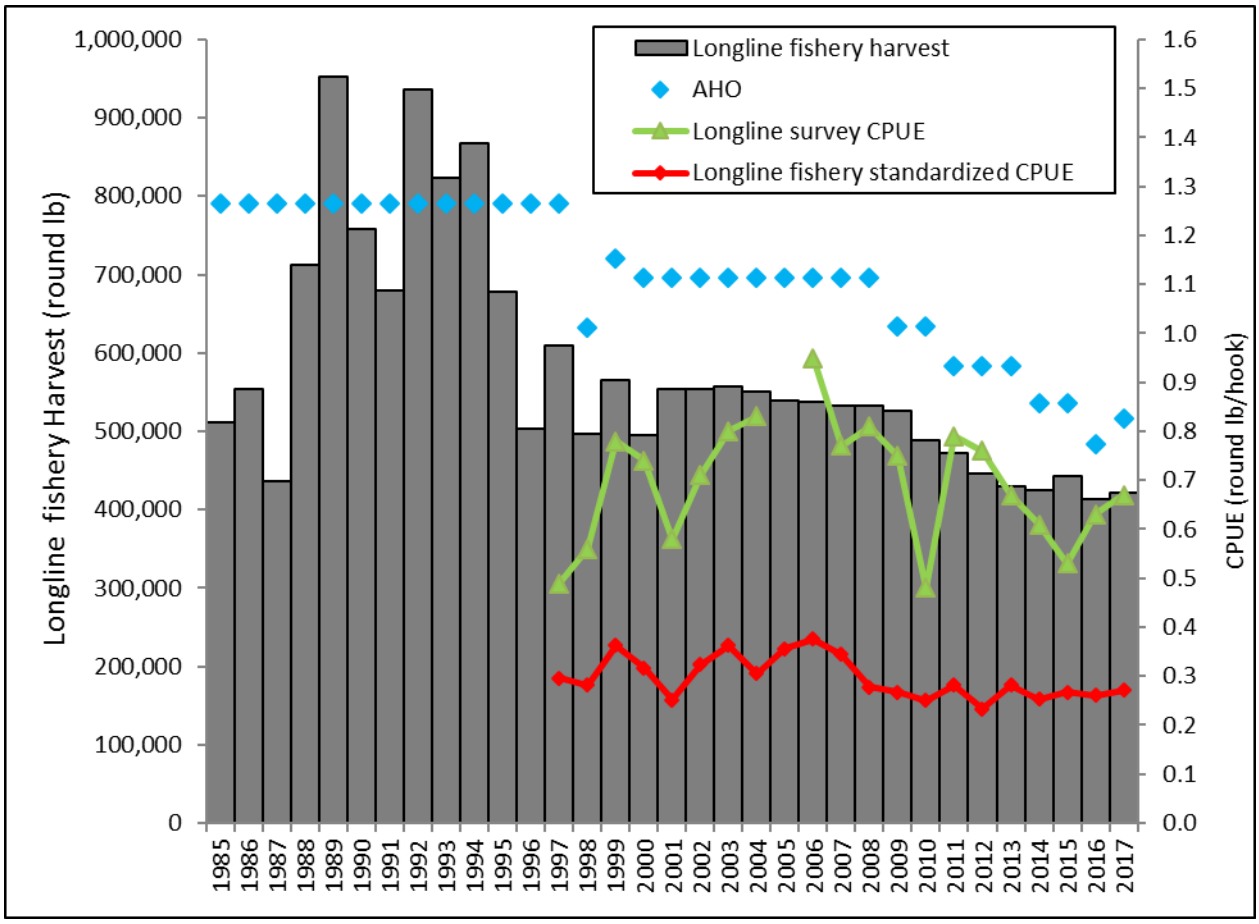


Figure 1.– SSEI longline fishery and survey CPUE and longline fishery harvest with the annual harvest objectives. Standardized fishery CPUE is shown. Survey CPUE is presented since 1997 when survey soak times were standardized. The 2013 and 2014 survey CPUE estimates exclude the stations that were moved in the following survey year. In 2017, pot gear became an allowable gear for the C61C permit; however, no harvest with pot gear is included in this graph.

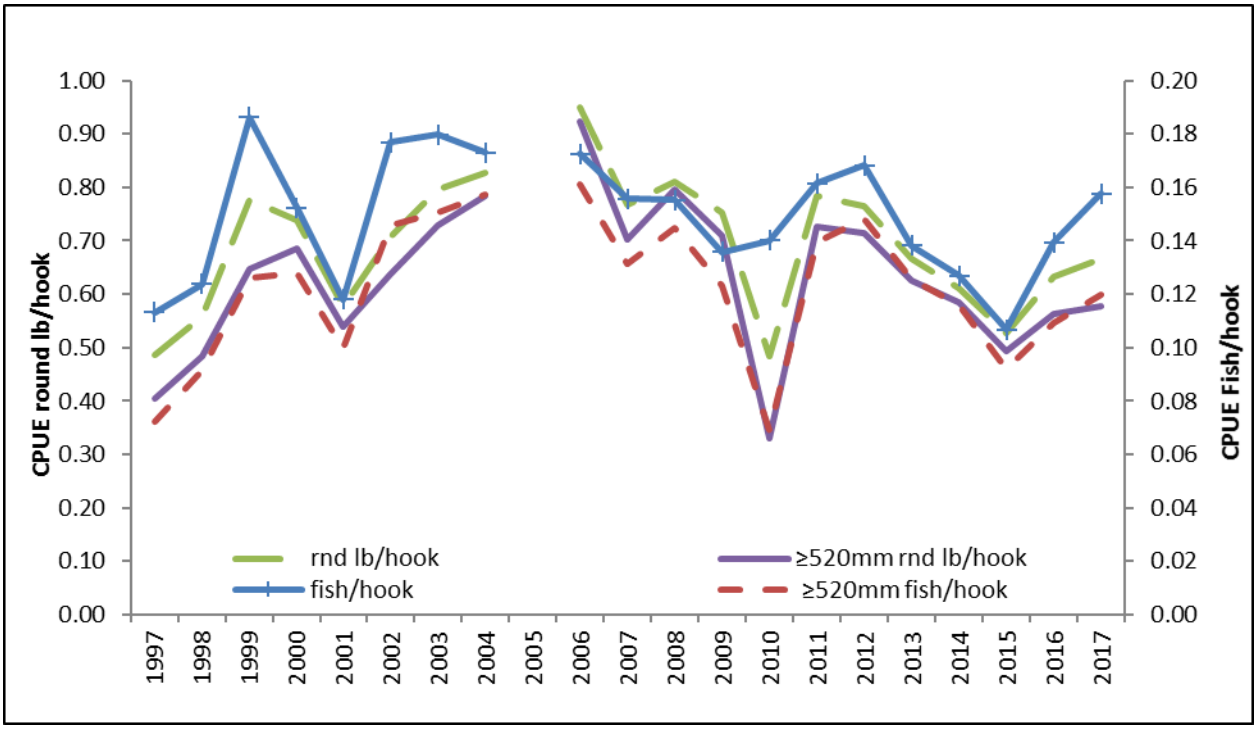
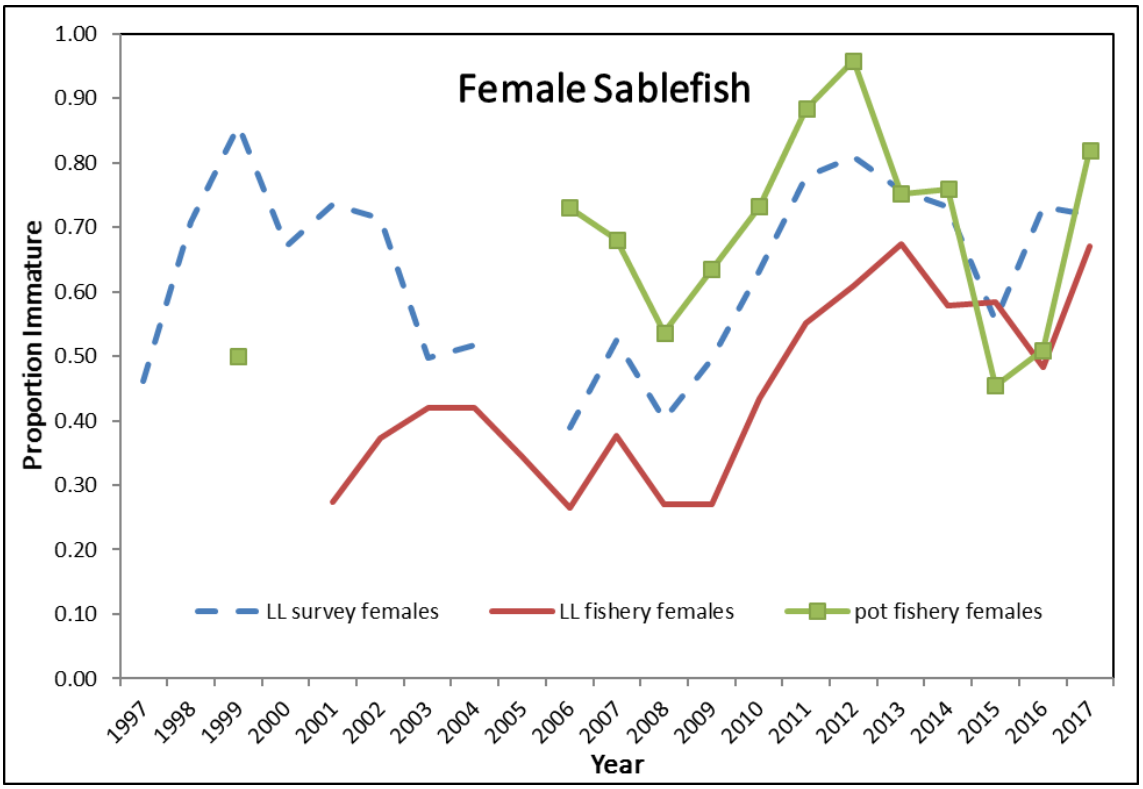


Figure 2.–SSEI Survey CPUE (round pound per hook and fish per hook) weighted by the area of sablefish habitat in each strata for all fish and fish ≥520 mm from 1997–2017. The 2013 and 2014 CPUE estimates exclude the stations that were moved in previous surveys and are not part of the long-term data set. Note that CPUE in round pounds per hook is at a different scale than CPUE in fish per hook with two different y-axes displayed.



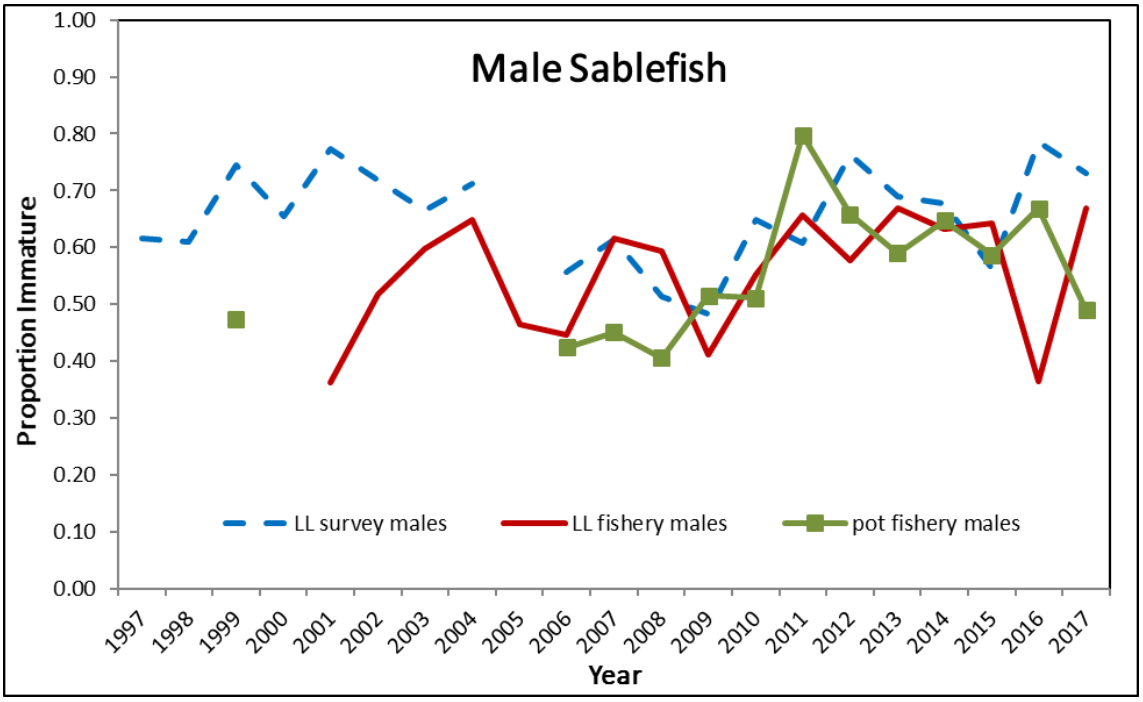


Figure 3.–Proportion of immature female and male sablefish sampled from the SSEI longline survey and the SSEI longline and pot fisheries from 1997 to 2017. Sablefish maturity data for the pot fishery are only available for 1999 and 2006–2016.

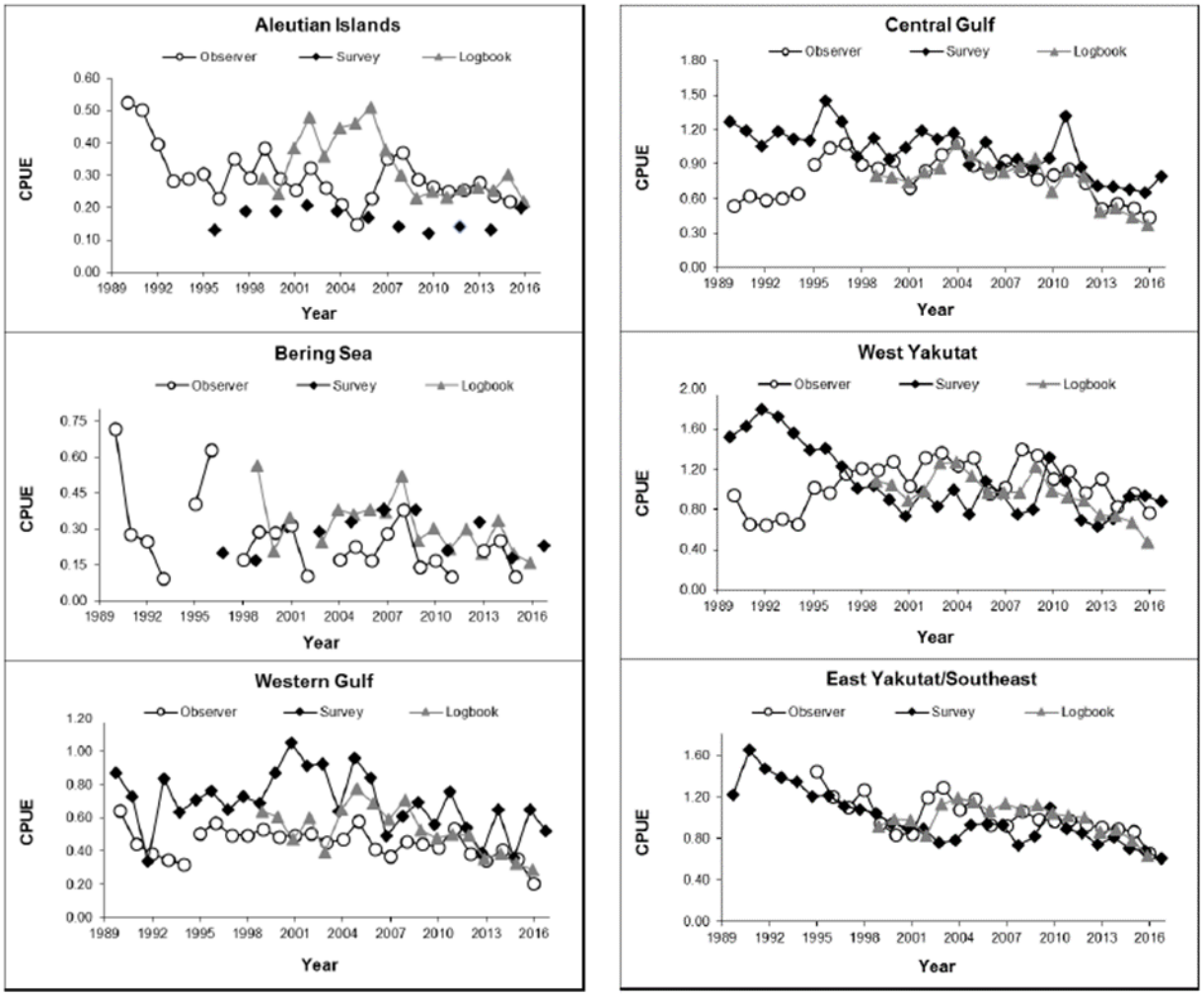


Figure 4.–Average fishery catch rate (lb/hook) by region and data source for the sablefish federal longline survey and fishery. The fishery switched from open access to individual quota management in 1995. Reprinted with permission from Hanselman et al. 2017.

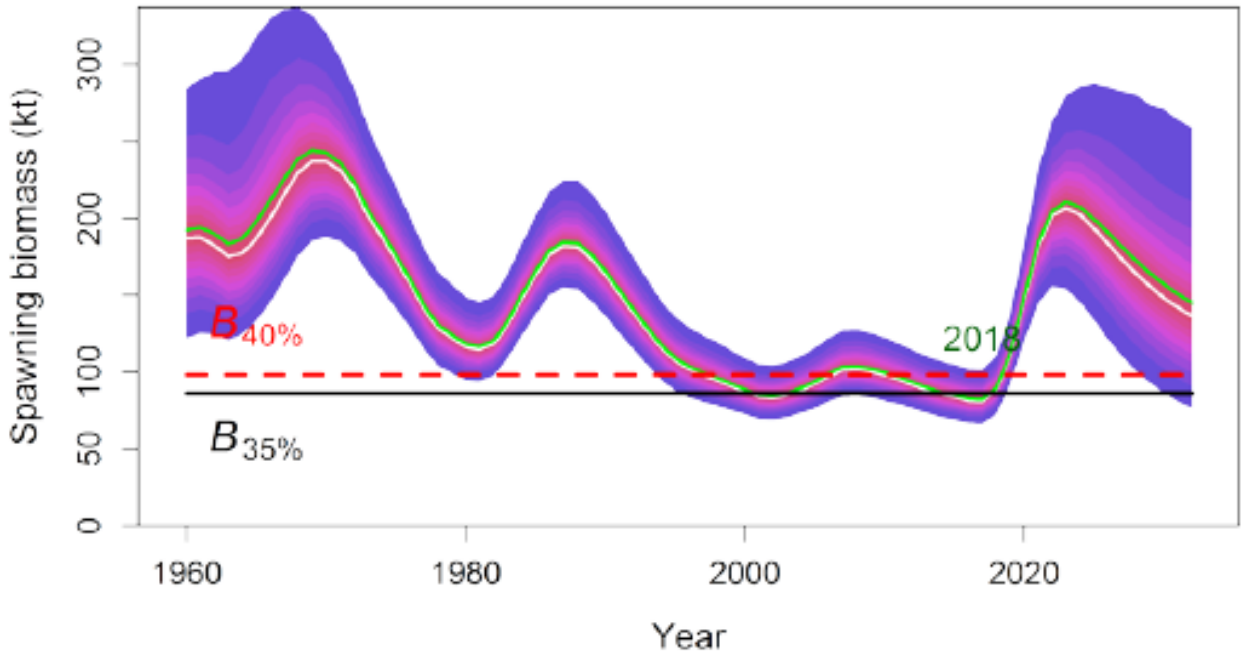


Figure 5.–Estimates of female spawning biomass (thousands of metric tons) for the Gulf of Alaska, Bering Sea, and Aleutian Islands and their uncertainty for the federal sablefish fisheries. White line is the median and green line is the mean spawning biomass. Width of shaded area is the 95% credibility interval. Reprinted with permission from Hanselman et al. 2017.

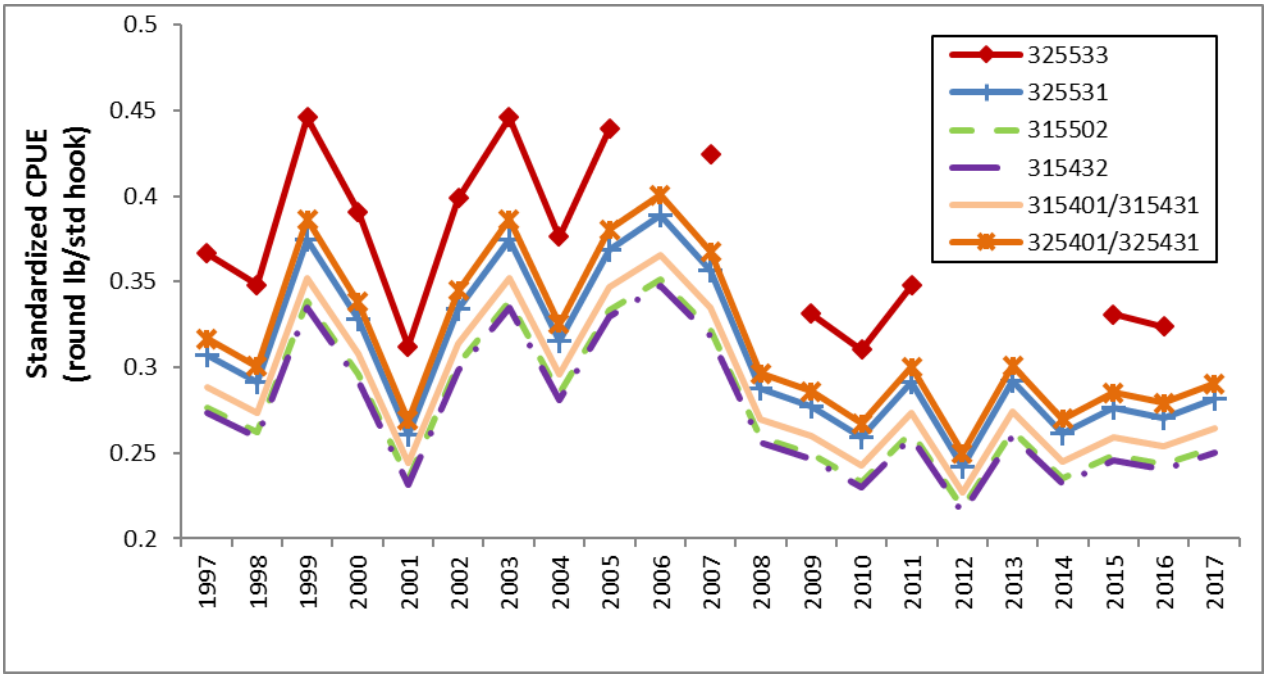


Figure 6.–SSEI longline fishery CPUE (round lb/hook) from 1997–2017. Standardized fishery CPUEs are shown by strata within SSEI management area: northern (325533 and 325531), middle (315502), and southern (315432) Clarence Strait, eastern Dixon Entrance (315401 and 315431), and western Dixon Entrance (325401 and 325431). Fishery CPUE data are not weighted by stratum. Confidential data were removed from the graph due to less than three permit holders participating within a given year and strata.

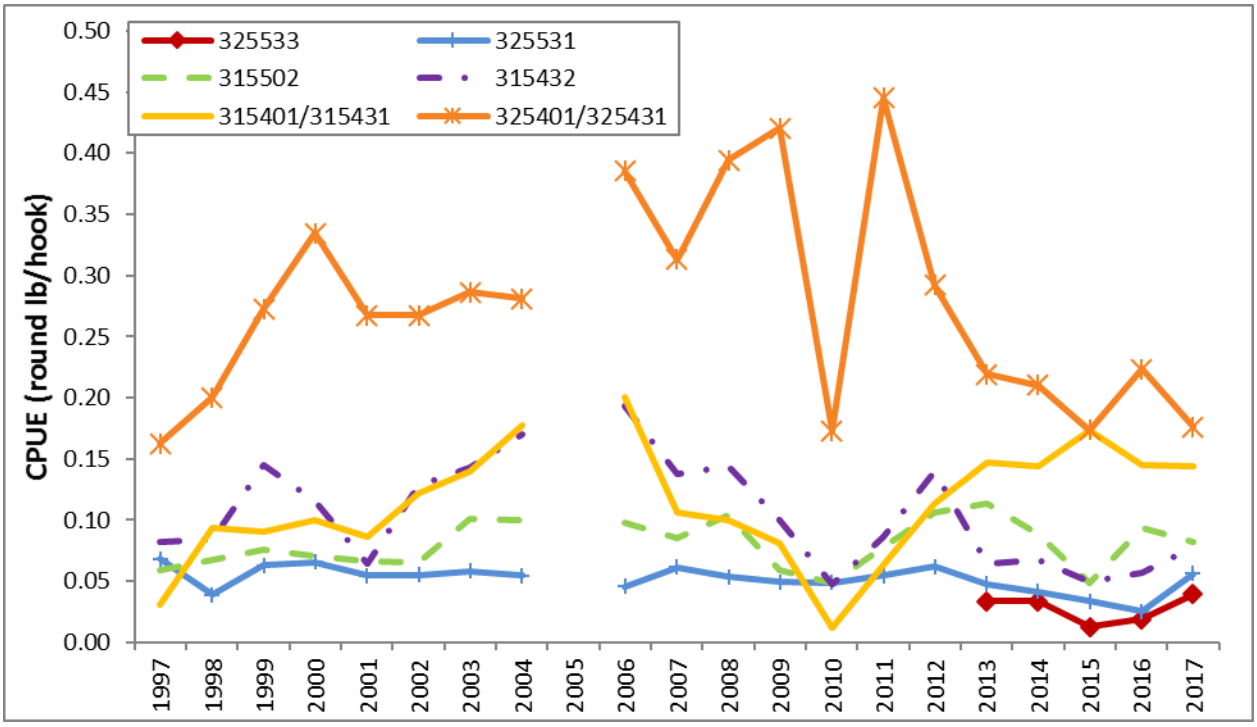


Figure 7.–SSEI survey CPUE (round lb/hook) for fish ≥ 520 mm from 1997–2017. Survey CPUEs are estimated by stratum: northern 1 (325533), northern 2 (325531), middle (315502), and southern Clarence Strait (315432) and eastern (315401 and 315431) and western Dixon Entrance (325401 and 325431). In 2013 statisitical area 325533 was added as a stratum and statistical area 315401 was removed from the eastern Dixon Entrance stratum. CPUE have been weighted by the area of sablefish habitat in each strata; these weighted CPUE estimates are used to estimate the overall CPUE by year. The 2013 and 2014 CPUE estimates exclude the stations that were moved in the following survey year.

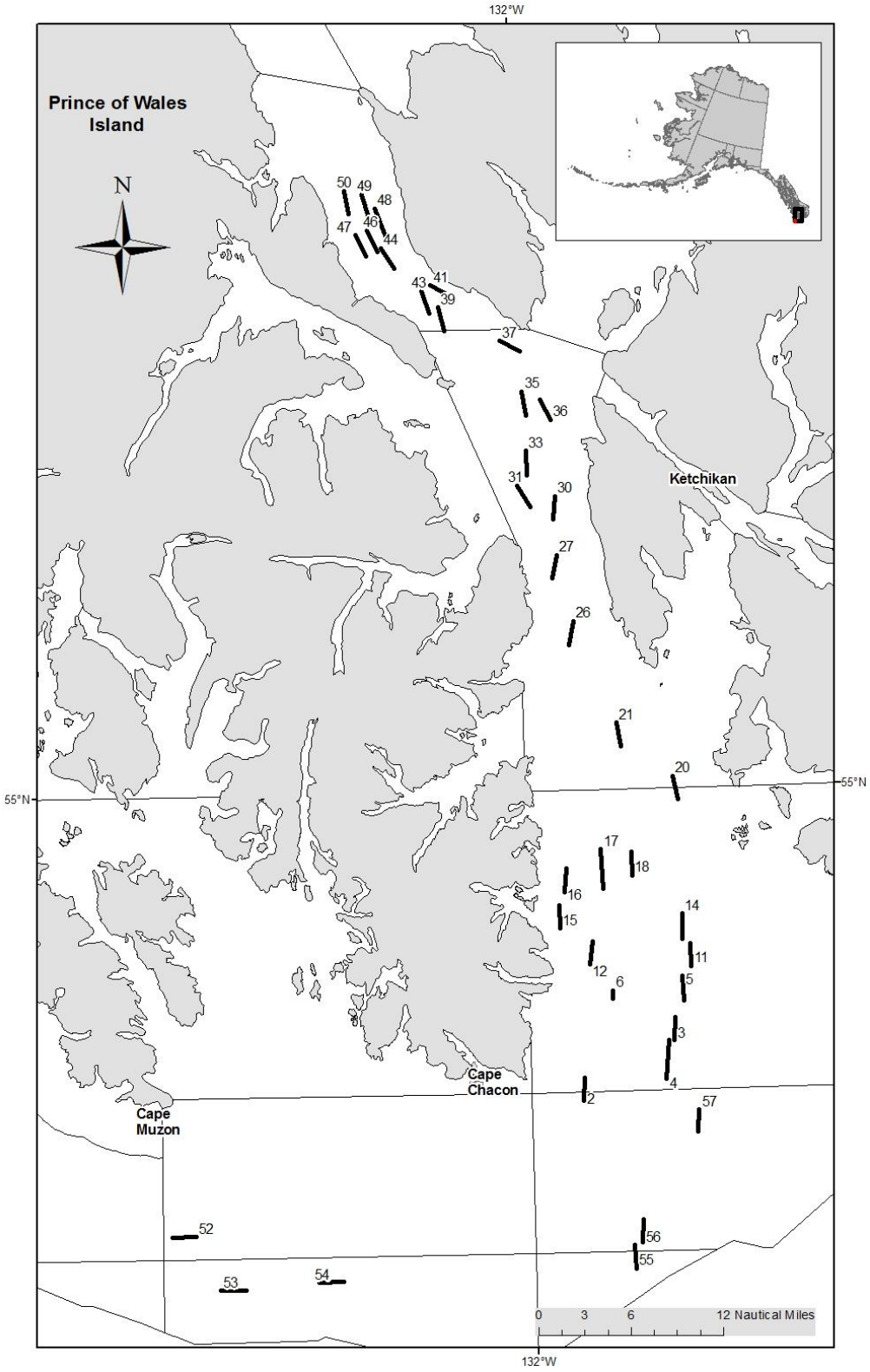


Figure 8.–SSEI longline survey stations fished prior to 2013 redesigned survey.

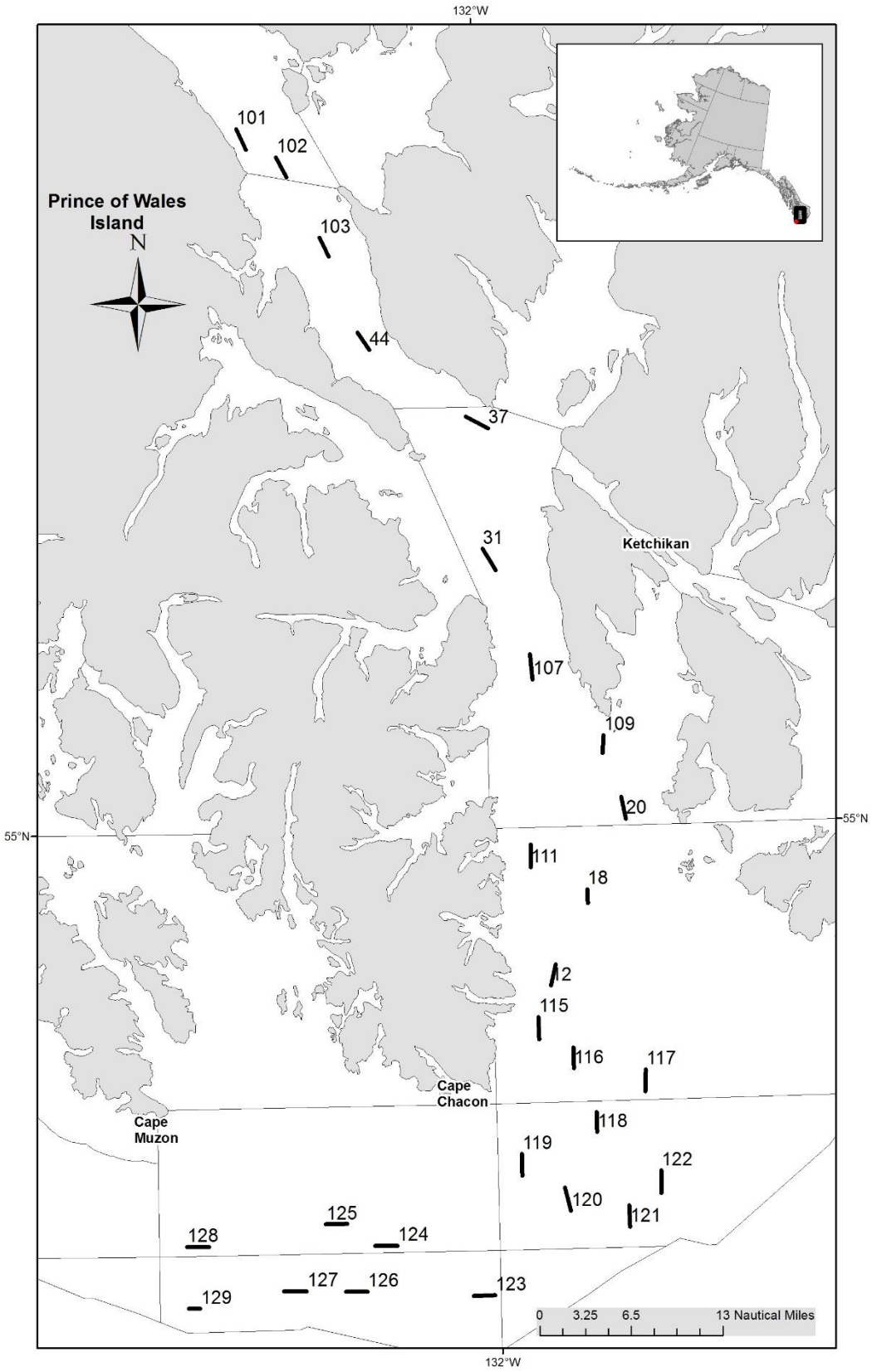


Figure 9.–SSEI Longline survey stations fished post 2013 survey redesign.

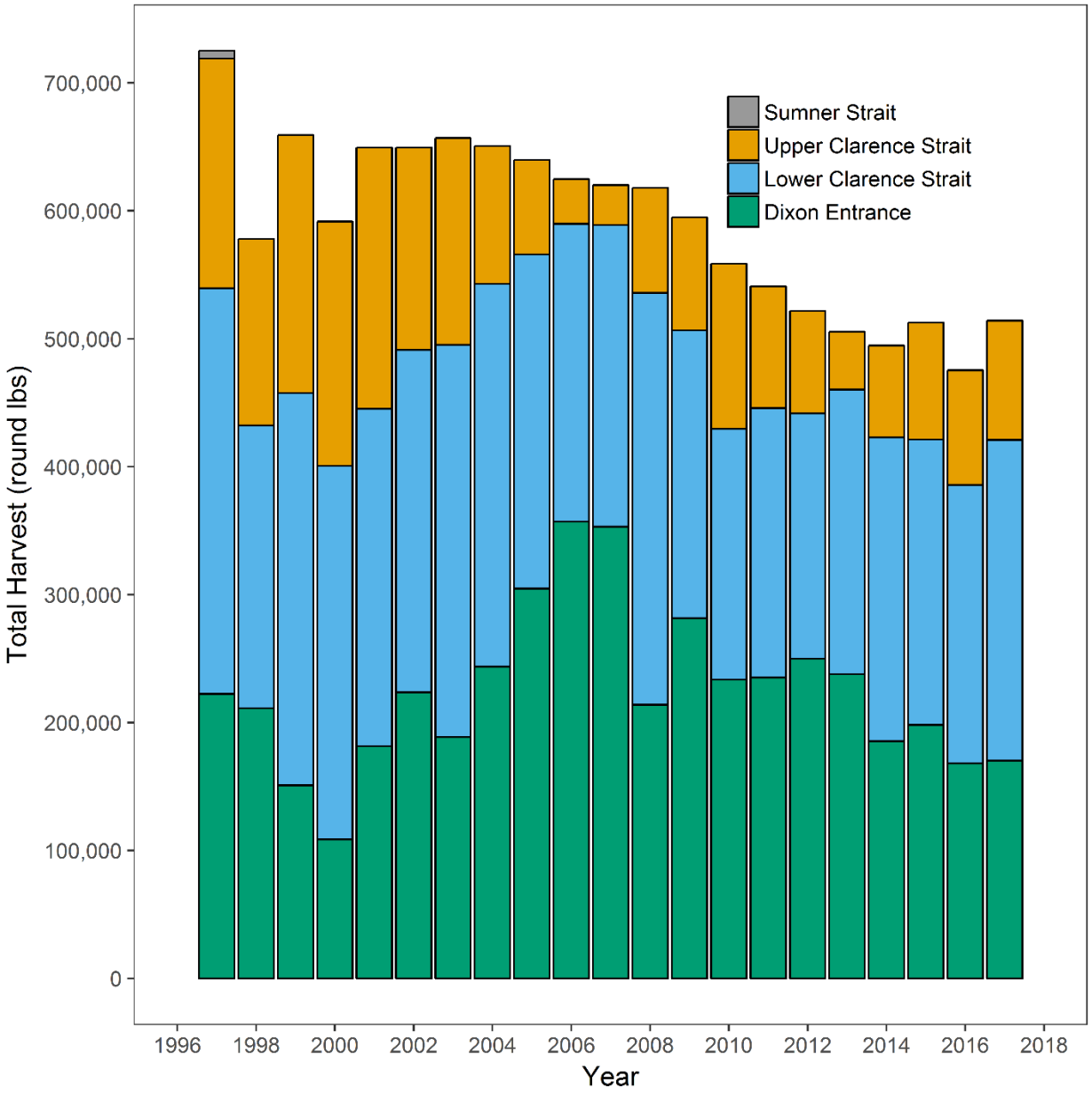


Figure 10.–Harvest distribution from 1997–2017 by area for the SSEI sablefish commercial fishery. Areas of harvest were defined by statistical areas: Sumner Strait (335601), Upper Clarence Strait (315531, 325531, 325533), Lower Clarence Strait (305501, 315432, 315501, 315502, 325433), and Dixon Entrance (315401, 315431, 325401, 325431).

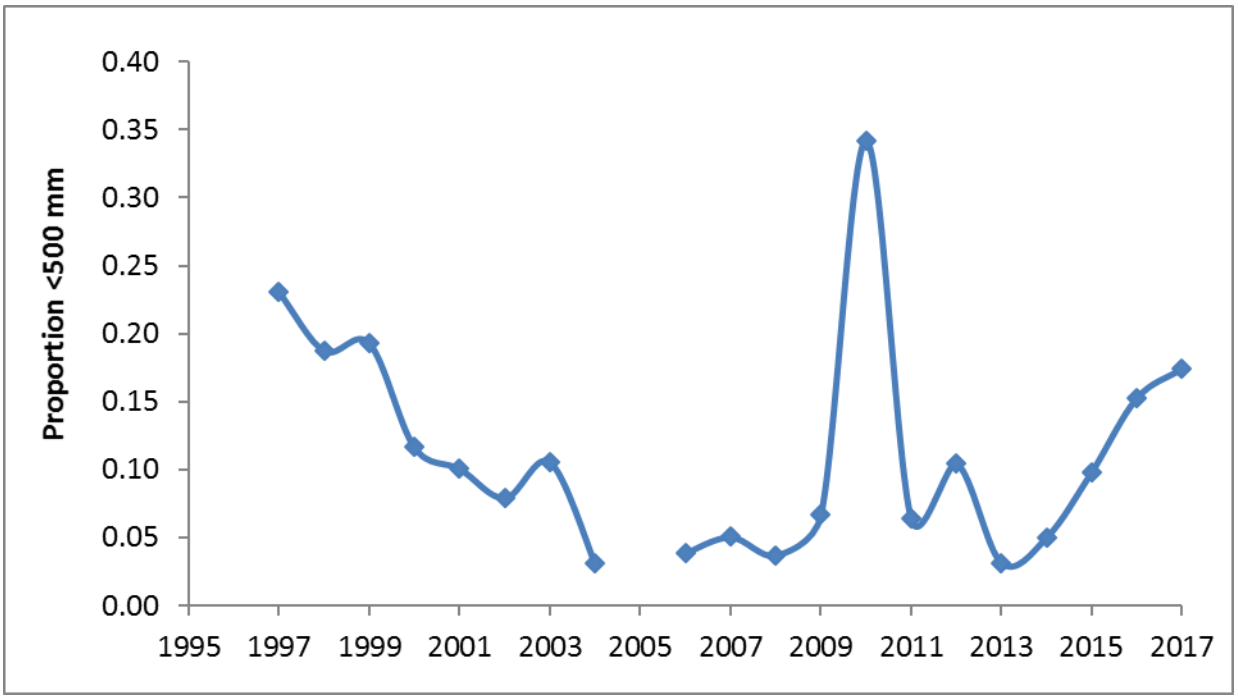


Figure 11.–Proportion of small sablefish (<500 mm) recruiting to the SSEI longline survey by year. The <500 mm size category was selected in order to best display patterns in sablefish recruitment to the survey. No survey was performed in 2005.

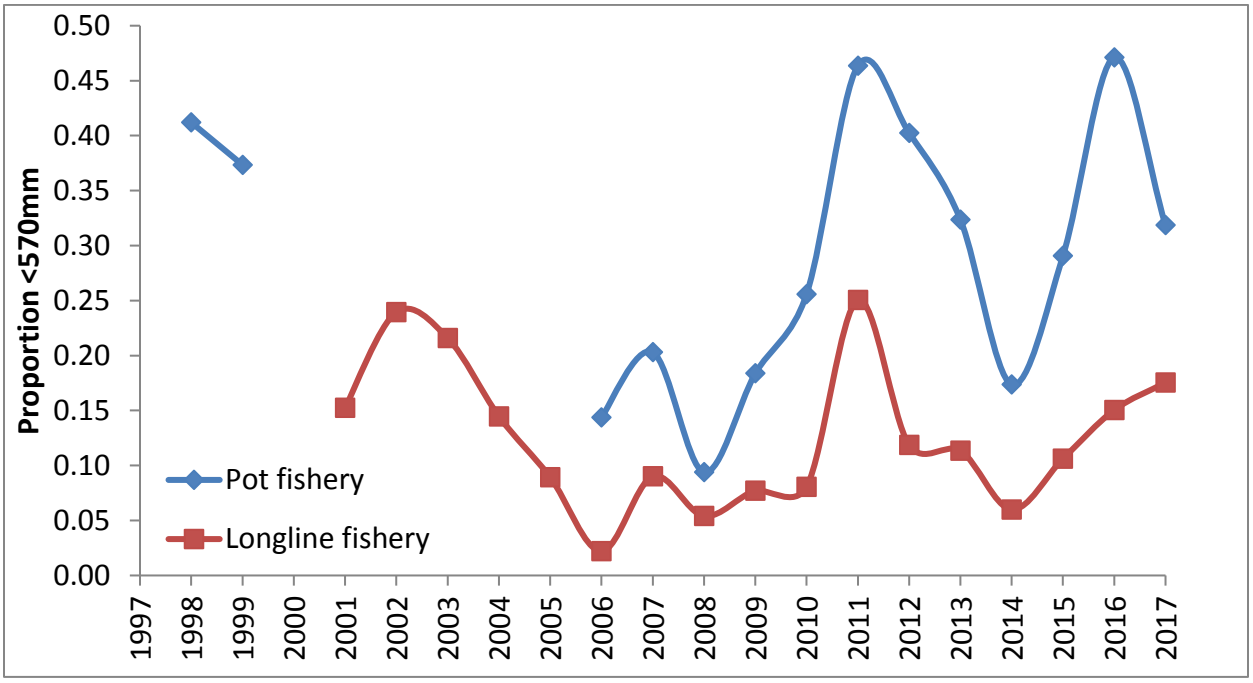


Figure 12.–Proportion of small sablefish (<570 mm) recruiting to the SSEI longline and pot fishery by year. The <570 mm size category was selected in order to best display patterns in sablefish recruitment to the fisheries. No biological data were collected for the longline fishery before 2001 or for the pot fishery from 2000 to 2005.

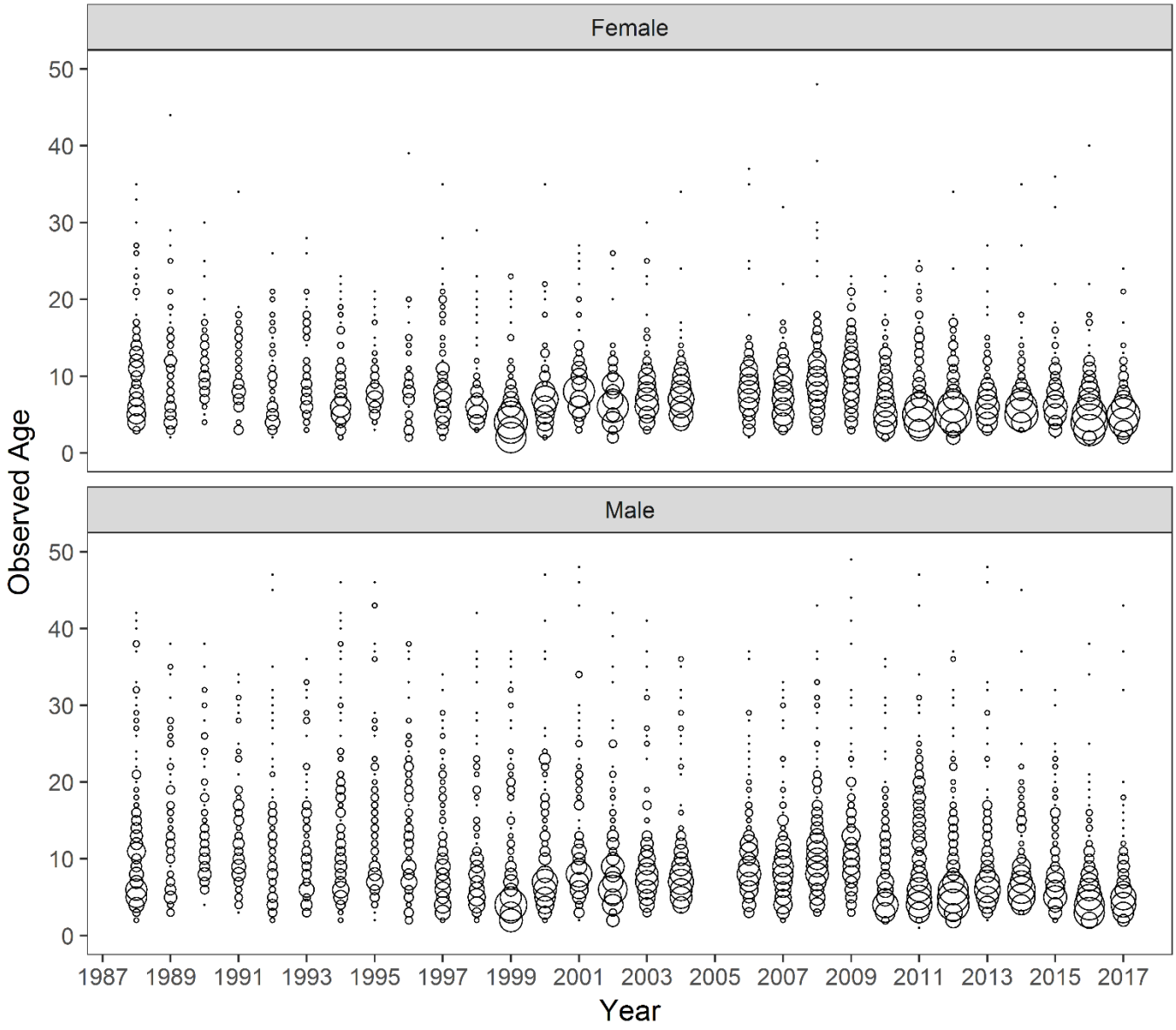


Figure 13.–SSEI longline survey proportions-at-age for female and male sablefish

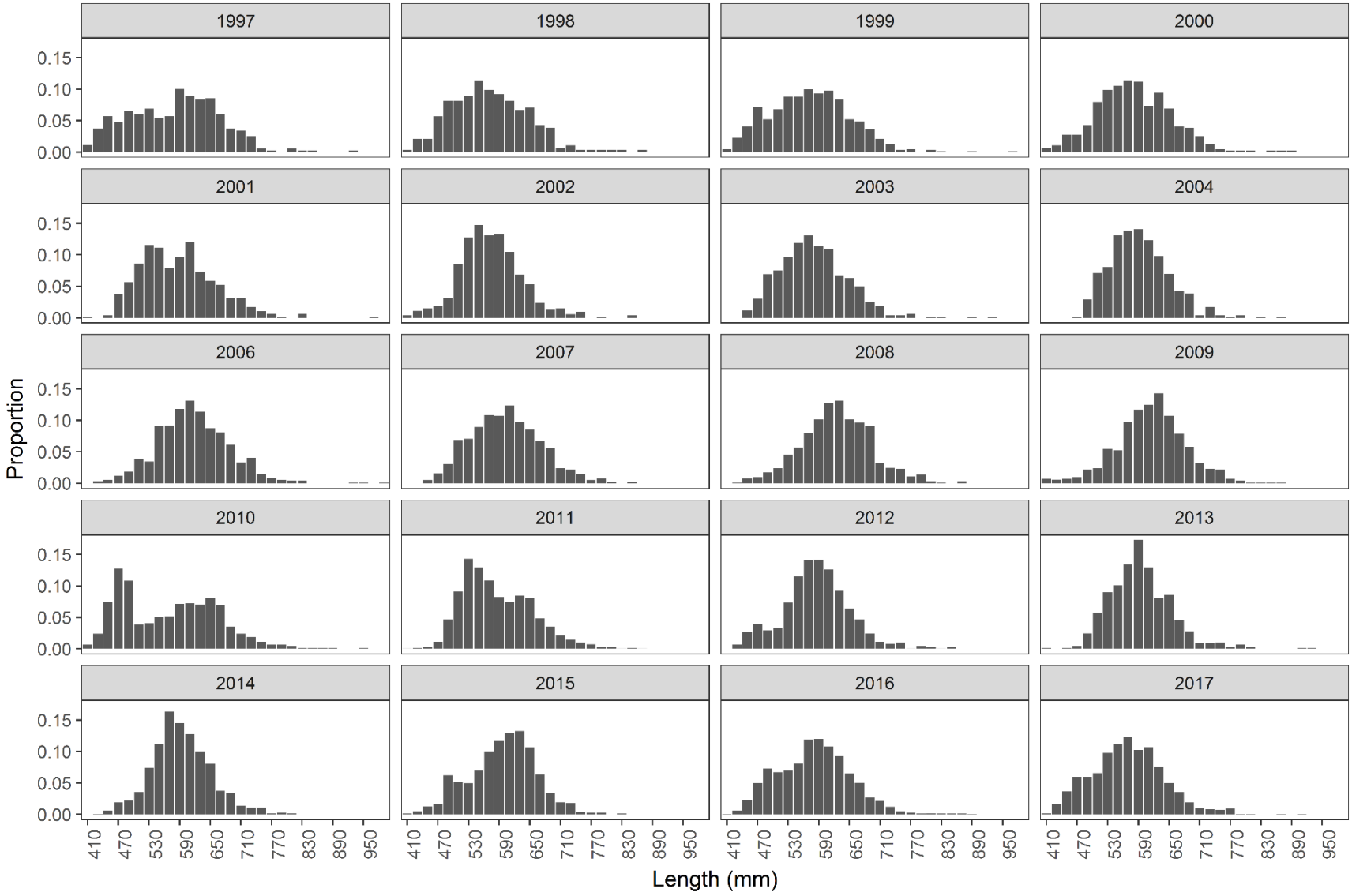


Figure 14.–SSEI longline survey sablefish length frequencies.

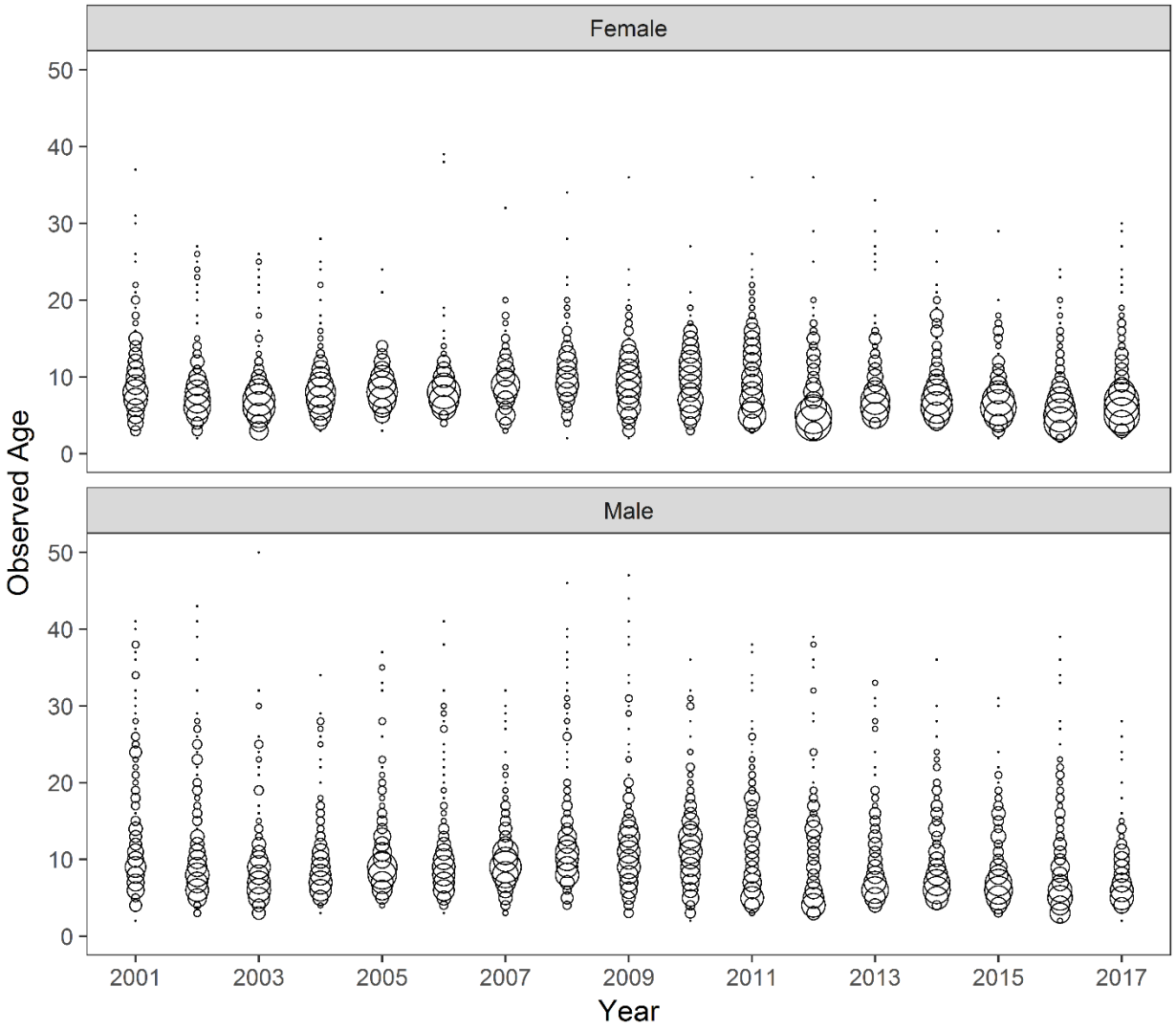


Figure 15.–SSEI longline fishery proportions-at-age for female and male sablefish.

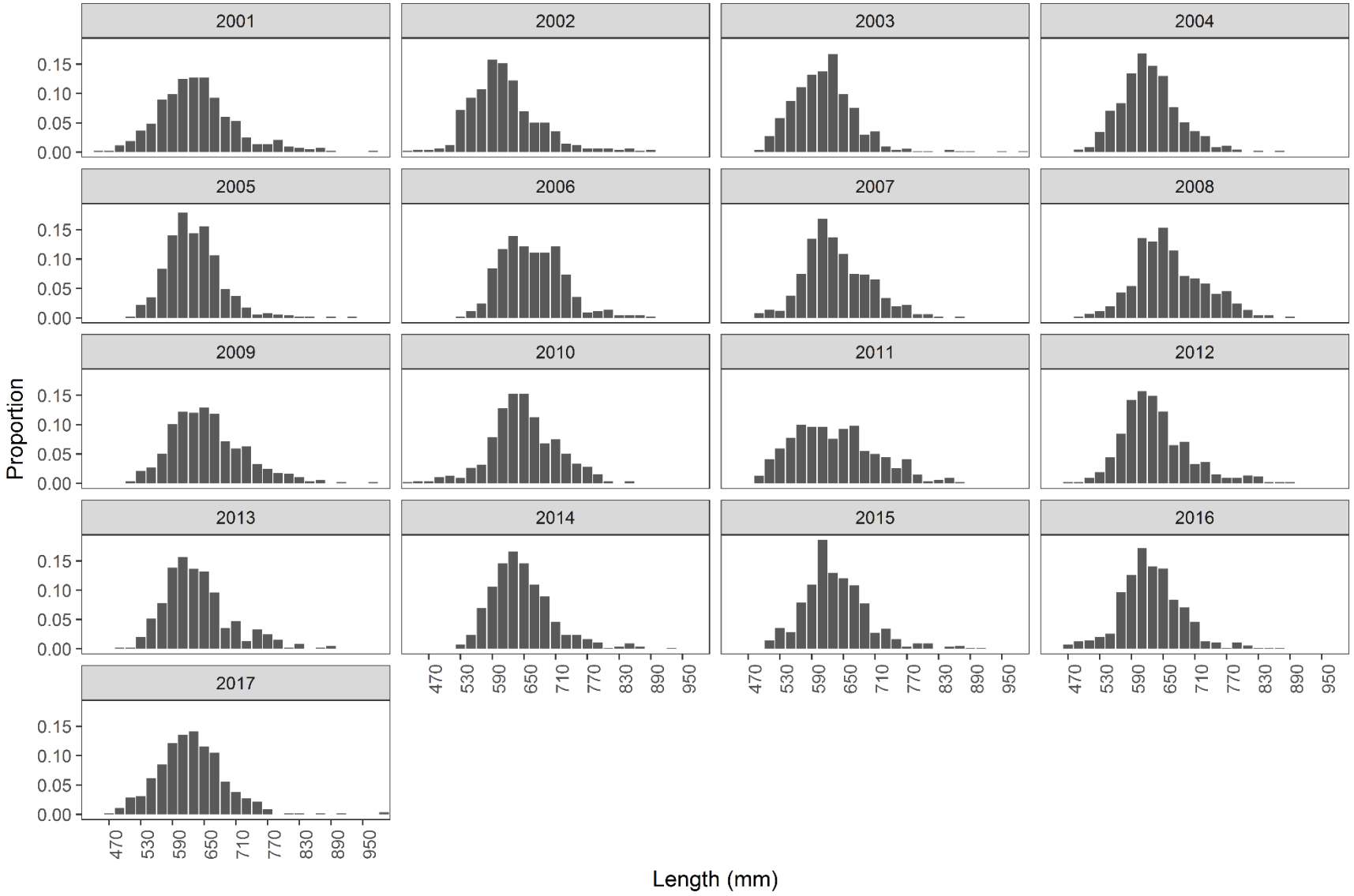


Figure 16.–SSEI longline fishery sablefish length frequencies.

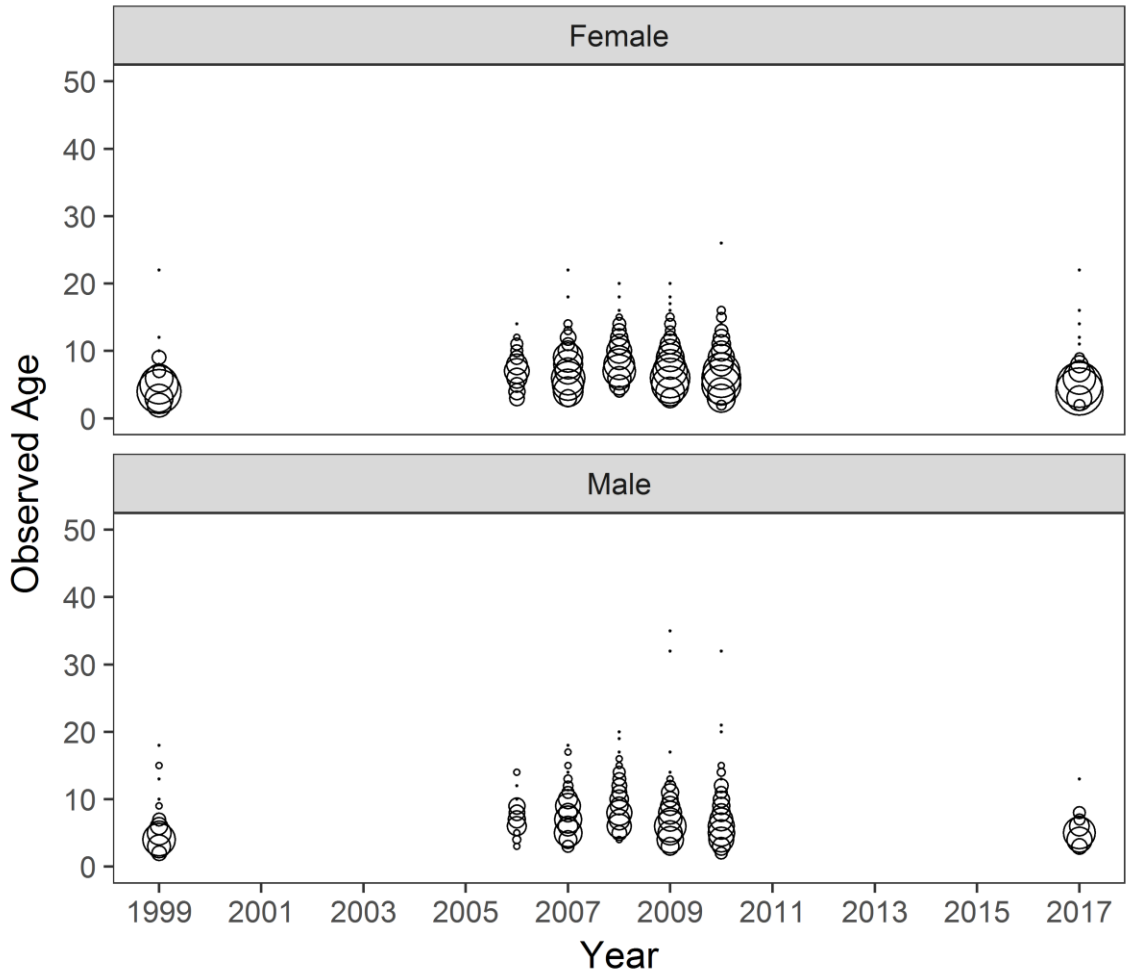


Figure 17.–SSEI pot fishery proportions-at-age for female and male sablefish.

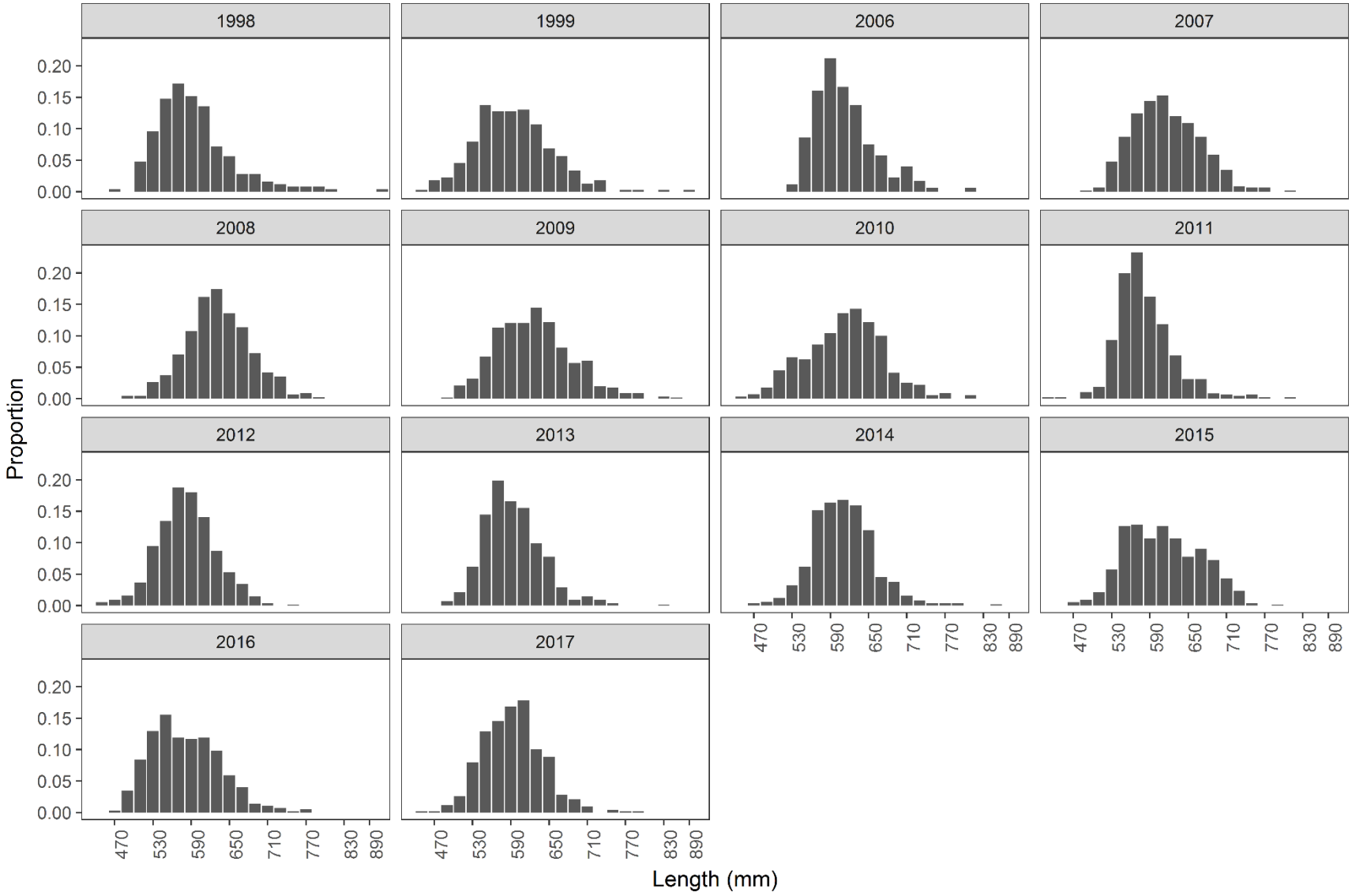


Figure 18.–SSEI pot fishery sablefish length frequencies.

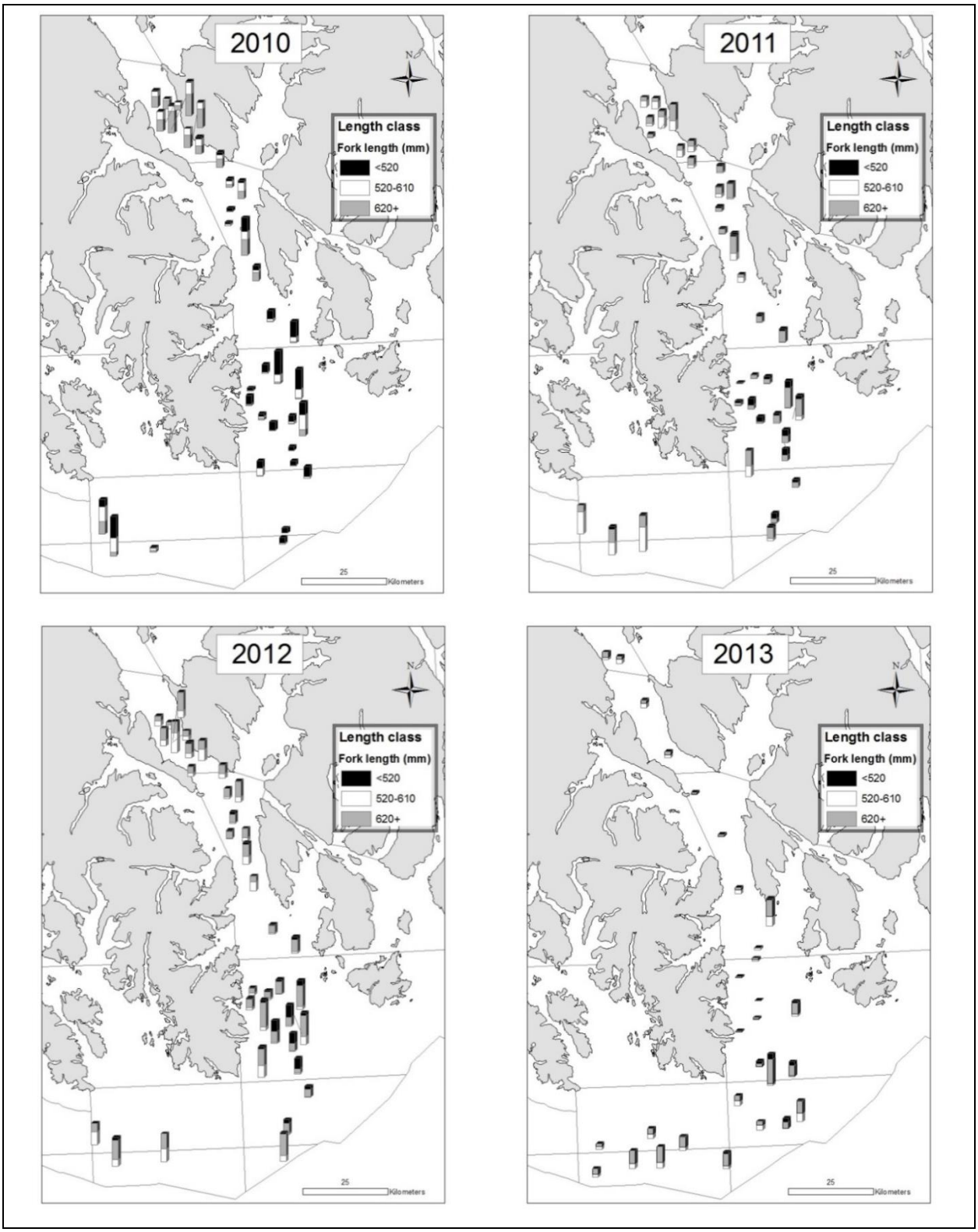


Figure 19.–SSEI longline survey catch by set and length class from 2010 to 2017. In 2013 the survey was redesigned; as a result the survey station locations are different from previous years. In 2017, sets with whale depredation were removed.

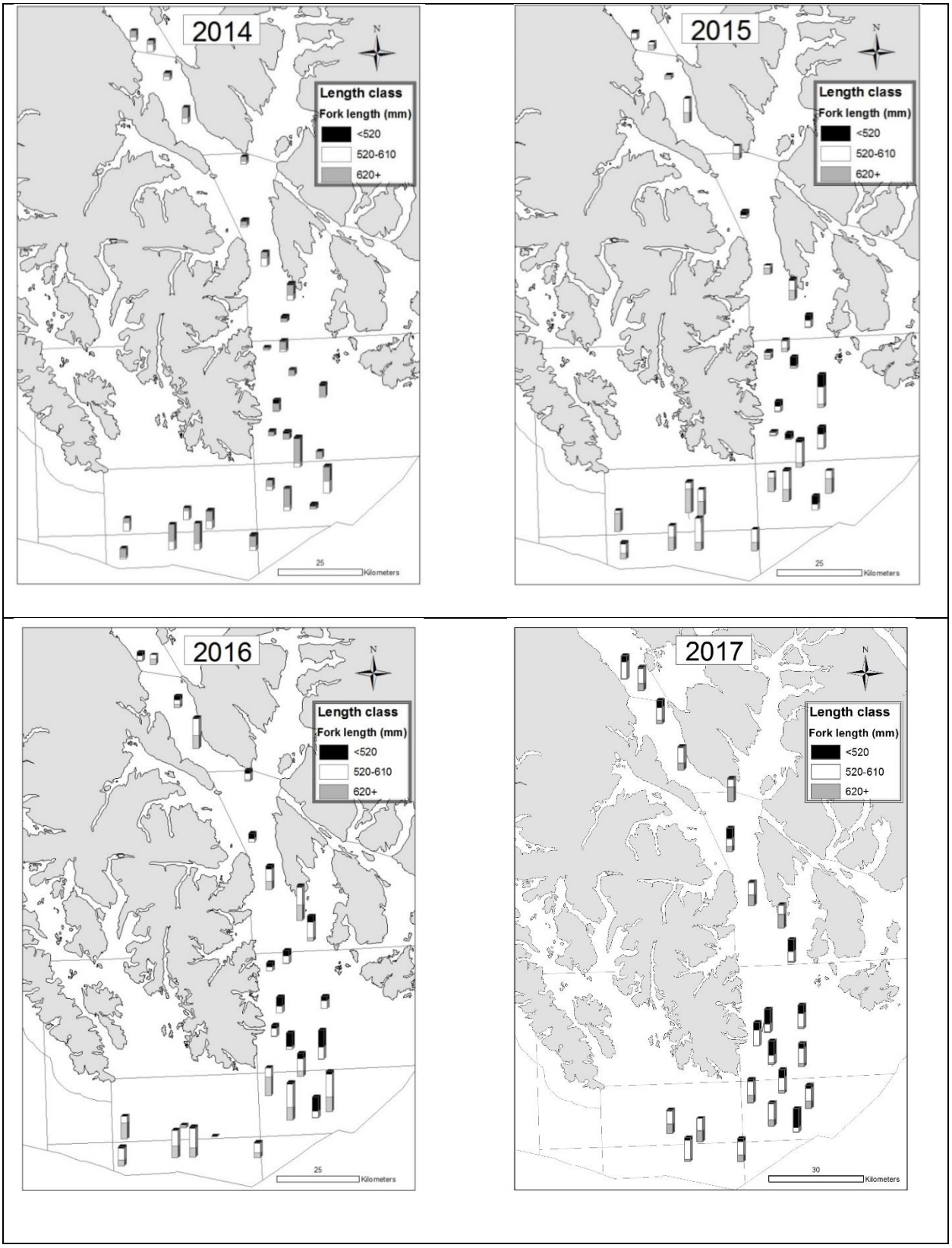


Figure 19.–Continued.