21. Assessment of the squid stock complex in the Gulf of Alaska

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Executive Summary

Squids in the Gulf of Alaska (GOA) are managed as a single stock complex comprising approximately 15 species. Historically squids were managed as part of the GOA "Other Species" complex, which included squids, octopuses, sharks, and sculpins. In 2011, the "Other Species" group was broken up into individual stock complexes and the squid complex received its own harvest specifications. Harvest recommendations are based on an historical catch approach setting OFL equal to maximum historical catch during 1997 – 2007. In June 2017 the North Pacific Fishery Management Council moved to reclassify squid as an "Ecosystem Component" complex, meaning that once the Fishery Management Plan has been amended to reflect this decision there will no longer be annual catch limits for squids (see https://www.npfmc.org/squid-reclassification/ for more information).

Summary of Changes in Assessment Inputs

1) Trawl survey data from 2017 have been added.
2) Catch data have been updated through October 11, 2017.

Summary of Results

1) The 2017 trawl survey biomass estimate was 2,296 t, the lowest it has been since 1999.
2) The 2017 catch data are incomplete (29 t as of October 11), but it is likely that the 2017 catch will be low compared to 2015 (411 t) and 2016 (239 t).
3) Harvest recommendations are unchanged from the status quo.

Harvest Recommendations				
	last year		**this year**	
Quantity/Status	*2016*	*2017*	**2017**	2018
Specified/recommended Tier	*6*	*6*	**6**	6
maximum catch 1997-2007	*1,516*	*1,516*	*1,516*	*1,516*
Recommended OFL	*1,516*	*1,516*	*1,516*	*1,516*
Maximum ABC	*1,137*	*1,137*	*1,137*	*1,137*
Recommended ABC	*1,137*	*1,137*	*1,137*	*1,137*
Status	*As determined last year for:*		As determined this year for:	
	2014	*2015*	2016	2017
Overfishing	*No*	*n/a*	No	n/a
(for Tier 6 stocks, data are not available to determine whether the stock is in an overfished condition)				

Responses to SSC and Plan Team comments on assessments in general

There were no relevant Plan Team or SSC comments on assessments in general.

Responses to SSC and Plan Team comments specific to this assessment

From the December 2015 SSC minutes:

The SSC did not agree with the PT's and author's recommendation for harvest specifications. While the recommended approach has a great deal of merit in its application of a more appropriate exploitation rate, bottom trawl survey biomass estimates are inherently unreliable and extremely variable for squid. As a Tier 6 species, the use of the survey biomass estimates has been consistently rejected in the past for setting harvest specifications for squid…For these reasons, the SSC recommended the status quo approach for setting 2016/2017 harvest specifications

> *Response*: This assessment aligns with the SSC's decision and includes only the status quo, Tier 6 approach.

Introduction

Description, scientific names, and general distribution

Squids are marine molluscs in the class Cephalopoda (Group Decapodiformes). They are streamlined animals with ten appendages (2 tentacles, 8 arms) extending from the head, and lateral fins extending from the rear of the mantle. Squids are active predators which swim by jet propulsion, reaching swimming speeds up to 40 km/hr, the fastest of any aquatic invertebrate. Squids also hold the record for largest size of any invertebrate (Barnes 1987). The squid assemblage in the Bering Sea/Aleutian Islands (BSAI) is better understood than in the GOA, so some of the information in this section comes from the BSAI.

In the Gulf of Alaska region there are at least 15 species of squid (Table 1). The most abundant species is *Berryteuthis magister* (magistrate armhook squid). Members of these 15 species come from six families in two orders and can be found at depths of 10 m to greater than 1500 m. All but one, *Rossia pacifica* (North Pacific bobtail squid), are pelagic but *B. magister* and *Gonatopsis borealis* (boreopacific armhook squid) are often found in close proximity to the bottom. The vertical distribution of these three species, as well as the large size of the latter two, are the probable cause of their predominance in the GOA bottom trawl survey relative to other squid species. However no squid species appear to be well-sampled by the GOA survey. Most species are associated with the slope and basin. In the GOA trawl survey the greatest squid biomass is found between 200 m and 300 m (Figure 1), and the spatial distribution is accordingly limited mainly to the continental slope, the Shelikof Sea Valley, and the various canyons that intersect the GOA shelf (Figures 2 & 3). Since most of the data come from groundfish survey bottom trawls, the information on abundance and distribution of those species associated with the bottom is much more accurate than that of the pelagic species.

Family Chiroteuthidae

This family is represented by a single species, *Chiroteuthis calyx*. *Chiroteuthis calyx* is a pelagic, typically deep water squid that is known to mate in the Aleutian Islands region. Larvae are common off the west coast of the US.

Family Cranchiidae
There are two species of this family found in the Bering Sea and Aleutian Islands, *Belonella borealis* (formerly *Taonius pavo*) and *Galiteuthis phyllura*. Mated *Galiteuthis phyllura* have been observed along the Bering Sea slope region and their larvae are common in plankton samples. Mature adults and larvae of *Belonella borealis* have not been identified in the region.

Family Gonatidae
This is the most speciose family in the region, represented by nine species: *Berryteuthis anonychus*, *Berryteuthis magister*, *Eogonatus tinro*, *Gonatus berryi*, *Gonatus madokai*, *Gonatus middendorffi*, *Gonatus onyx*, *Gonatopsis borealis*, and *Gonatopsis* sp. All are pelagic however, *B. magister*, *G. borealis*, and *Gonatopsis* sp. live very near the bottom as adults. *Gonatus onyx* is known to brood its eggs to hatching, however no evidence of that behavior exists for other members of the family. *B. magister* is known to form enormous spawning aggregations in the Bering Sea, and large schools of late juvenile stages of *B. magister* have been observed elsewhere in the North Pacific Ocean.

Family Onychoteuthidae
Two species from this family are known to occur in the GOA: *Moroteuthis robusta* and *Onychoteuthis borealijaponicus*. *Moroteuthis robusta* is the largest squid in the region, reaching mantle lengths of three feet.

Family Sepiolidae
This family is represented by a single species, *Rossia pacifica*. This small animal is found throughout the Gulf of Alaska to 1000 m. Eggs are deposited on substrate in the summer months and larva are benthic. Adults are believed to live 18 – 24 months and females may lay egg masses more than once in life time. Mature and mated females are common in the summer along the Bering Sea slope.

Management Units

Squids in the GOA are currently managed as a single stock complex that includes all known squid species in the management area. Although no directed fishery exists for squids, they are caught and retained in sufficiently large numbers for them to be considered as “in the fishery”.

Life history and stock structure

The life histories of squids in the GOA are almost entirely unknown so must be inferred from data on squid species elsewhere. Relative to most groundfish, squids are highly productive, short-lived animals. They display rapid growth, patchy distribution and highly variable recruitment (O'Dor 1998). Unlike most fish, squids may spend most of their life in a juvenile phase, maturing late in life, spawning once, and dying shortly thereafter. Whereas many groundfish populations (including skates and rockfish) maintain stable populations and genetic diversity over time with multiple year classes spawning repeatedly over a variety of annual environmental conditions, squids have no such “reserve” of biomass over time. Instead, it is hypothesized that squids maintain a “reserve” of biomass and genetic diversity in space. Many squid populations are composed of spatially segregated schools of similarly sized (and possibly related) individuals, which may migrate, forage, and spawn at different times of year over a wide geographic area (Lipinski 1998; O’Dor 1998). Most information on squids refers to *Illex* and *Loligo* species which support commercial fisheries in temperate and tropical waters. Of North Pacific squids, life history is best described for western Pacific stocks (Arkhipkin et al., 1995; Osako and Murata, 1983).

The most commercially important squid in the North Pacific Ocean is the magistrate armhook squid, *B. magister*. This species is distributed from southern Japan throughout the Bering Sea, Aleutian Islands, and Gulf of Alaska to the U.S. west coast as far south as Oregon (Roper et al. 1984). The maximum size

reported for *B. magister* is 28 cm mantle length. Prior to 2008, most of the information available regarding *B. magister* was from the western Bering Sea. A study completed in 2008 investigated life history and stock structure of this species in the EBS (Drobny 2008). In the EBS, *B. magister* appear to have an approximately 1-year life cycle. This is half the longevity of *B. magister* in the western Bering Sea (Arkhipkin et al., 1995). *B. magister* in the EBS appear to grow and mature more quickly than their conspecifics in Russian and Japanese waters. Squid growth appears to be heavily influenced by ocean temperature (Forsythe 2004), which may account for some of the regional and temporal variability.

Populations of *B. magister* and other squids are complex, being made up of multiple cohorts spawned throughout the year. *B. magister* are dispersed during summer months in the western Bering Sea, but form large, dense schools over the continental slope between September and October. Three seasonal cohorts are identified in the region: summer-hatched, fall-hatched, and winter-hatched. Growth, maturation, and mortality rates vary between seasonal cohorts, with each cohort using the same areas for different portions of the life cycle. For example, the summer-spawned cohort used the continental slope as a spawning ground only during the summer, while the fall-spawned cohort used the same area at the same time primarily as a feeding ground, and only secondarily as a spawning ground (Arkhipkin et al., 1995). In the EBS, hatch dates of *B. magister* varied by year but were generally in the first half of the year (Drobny 2008). Analysis of statolith chemistry suggested that adult squids were hatched in at least three different locations, and these locations were different from the capture locations. Juvenile and adult *B. magister* also appear to be separated vertically in the water column.

Fishery

Directed fishery

There are no directed squid fisheries in Alaskan waters at this time, although squid appear to have been occasionally targeted by foreign vessels in Alaska prior to 1990. Squid in Alaska are generally taken incidentally in target fisheries for pollock. Squids could potentially become targets of Alaskan fisheries, as there are many fisheries directed at squid species worldwide. Most of these fisheries focus on temperate squids in the genera *Illex* and *Loligo* (Agnew et al. 1998, Lipinski et al. 1998). For instance, the market squid *Loligo opalescens* supports one of the largest fisheries in the Monterey Bay area of California (Leos 1998), and has also been an important component of bycatch in other fisheries in that region (Calliet et al. 1979). There are fisheries for *B. magister* in the Western Pacific, including Russian trawl fisheries with annual catches of 30,000 - 60,000 metric tons (Arkhipkin et al. 1995), and coastal Japanese fisheries with catches of 5,000 to 9,000 t in the late 1970's-early 1980's (Roper et al. 1984; Osaka and Murata 1983). When squids are moved into the Ecosystem Components category of the Fishery Management Plan, directed fishing for squids will be prohibited.

Bycatch and discards

Squids historically represented a small proportion (~1-2%) of the Other Species catch in the GOA (Table 2). This began to change in 2003, when the proportion rose to 5%, and increased to an especially large catch in 2006 (1,516 t, 39% of the Other Species catch; Table 2), which was similar to catch levels in the BSAI during the 2000s (Ormseth and Jorgenson 2007). Since 2006 catches have been relatively low. Starting in 2011 (when the Other Species group was separated into its constituent species complexes) separate catch accounting for the GOA squid complex has been conducted by the Alaska Regional Office. The predominant species of squid in commercial catches in the GOA is believed to be *B. magister*. Retention of squids is highly variable (28%-92%; Table 2) and appears to be mainly for bait. Because squids are delicate and almost certainly killed in the process of being caught, 100% mortality of discards is assumed.

Data

Fishery

Since 2006 when an unusually high catch of squids occurred, squid catches have ranged from18 t to 412 t (Table 2). Most squid are caught incidentally in the pollock fishery (Table 3) and in the central GOA (areas 620 & 630; Table 4 & Figures 4-6). The highest fishery catch-per-unit-effort (CPUE) values occur in Shelikof Strait, west of Kodiak Island (Figures 5 & 6). This is likely due to the fact that the pollock fishery is concentrated in this area. Although catches in NMFS statistical areas 649 (Prince William Sound) and 659 (Southeast Alaska Inside waters) do not accrue to the GOA squid TAC, catch data are available for these areas and are included in this assessment. Catches in these areas are normally low relative to the other areas in the GOA, but in 2014 and 2015 high catches occurred in 649 (78 t and 109 t, respectively; Table 4 & Figure 6). In 2013 the fishery observer program was restructured. A wider range of vessels now carry observers and the observer coverage in PWS has increased. The increase in squid catches in PWS may be due to this change in observer coverage rather than to actual increase in the catch.

Squid length data are collected by fishery observers but these data are sparse. No clear size mode can be observed in the annual length compositions, with most captured squids ranging from 16 cm to 27 cm mantle length (Figure 7).

Survey

The AFSC bottom trawl surveys are directed at groundfish species, and therefore do not employ the appropriate gear or sample in the appropriate places to provide reliable biomass estimates for most squids, which are generally pelagic or, if demersal, reside off bottom. Biomass estimates for the GOA have fluctuated considerably since 1984, from 2,127 t in 1999 to 14,079 t in 2015 (Table 5). The 2017 biomass estimate (2,296 t) is the lowest since 1999 and the second-lowest value in the biomass time series. The spatial distribution of squid survey catches (Figures 2 &3) indicates that they are concentrated in waters from 200-500 m depth along the continental slope and in canyons, and that differences in abundance among years do not appear to have a spatial pattern (i.e. the spatial extent of squid distribution is not variable among years). The depth distribution of squids does appear to vary with year (Table 6 and Figure 1): The highest biomass is typically found in the 201-300 m and 301-500 m depth zones, but the relative abundance in these zones is variable. In some years (e.g. 2017), substantial biomass of squid is also found between 100 and 200 m. The survey almost certainly underestimates squid biomass. For example, a mass-balance ecosystem model of the GOA estimates the squid population at 369,309 t.

The size composition of *Berryteuthis magister*, the dominant squid in survey and fishery catches, varies among years and tends to lack a clearly defined size mode (Figure 8). Mantle length is on average less than 20 cm. This is in contrast to data from the BSAI that is consistently dominated by a single size mode at ~21 cm. In 2017, the low biomass estimate appears to be associated with a reduction in the number of larger squids in the population.

Analytic Approach

Due to the lack of reliable information regarding squid abundance and life history, annual catch limits are based on a modified Tier 6 approach where the overfishing level (OFL) is equal to the maximum historical catch during 1997 - 2007 and the allowable biological catch (ABC) is equal to 0.75 * OFL.

Results

Because they are based on historical catch, the harvest recommendations for GOA squids do not vary unless the catch data are updated. As a result the 2018-2019 are unchanged from the last full assessment:

OFL = maximum historical catch	**1,516**
ABC = 0.75 * OFL	**1,137**

Ecosystem Considerations

Previous assessments (e.g. Ormseth 2011) have included extensive information regarding ecosystem considerations for squids. A brief summary of that information is included in this report. Ecosystem information for squids is highly uncertain due to 2 factors:

1) Much of the information regarding squid predators, particularly marine mammals, is outdated.
2) The squids usually encountered in the trawl survey and commercial fisheries (most of which are *B. magister*) are much larger than those that are predated by birds and fishes. The smaller squids are likely a combination of different species and juveniles of B. magister. As a result, much of the food habits information does not apply to the portion of the squid complex dealt with in this report.

Ecosystem effects on GOA Squids *(evaluating level of concern for squid populations)*

Indicator	Observation	Interpretation	Evaluation
Prey availability or abundance trends			
Zooplankton Forage fish	Trends are not currently measured directly, only short time series of food habits data exist for potential retrospective measurement	Unknown	Unknown
Predator population trends			
Salmon	Increased populations since 1977, stable throughout the 1990s to present	Mortality higher on squids since 1977, but stable now	Probably no concern
Toothed whales	Unknown population trend	Unknown	Unknown
Sablefish	Cyclically varying population with a downward trend since 1986	Variable mortality on squids slightly decreasing over time	Probably no concern
Grenadiers	Unknown population trend	Unknown	Unknown
Changes in habitat quality			
North Pacific gyre	Physical habitat requirements for squids are unknown, but are likely linked to pelagic conditions and currents throughout the North Pacific at multiple scales.	Unknown	Unknown

Groundfish fishery effects on ecosystem via squid bycatch *(evaluating level of concern for ecosystem)*			
Indicator	Observation	Interpretation	Evaluation
Fishery contribution to bycatch			
Squid catch	Stable, generally <100 tons annually except for 2005, 2006, and 2007	Extremely small relative to predation on squids	No concern
Forage availability for salmon	Depends on magnitude of squid catch taken in salmon foraging areas	Squid catch generally low, small change to salmon foraging at current catch	Probably no concern
Forage availability for toothed whales	Depends on magnitude of squid catch taken in toothed whale foraging areas	Squid catch generally low, small change to toothed whale foraging at current catch	Probably no concern
Forage availability for sablefish	Depends on magnitude of squid catch taken in sablefish foraging areas	Squid catch generally low, small change to sablefish foraging at current catch	Probably no concern
Forage availability for grenadiers	Squid catch overlaps somewhat with grenadier foraging areas along slope	Small change in forage for grenadiers	Probably no concern
Fishery concentration in space and time	Bycatch of squid is mostly in shelf break and canyon areas, no matter what the overall distribution of the pollock fishery is	Potential impact to spatially segregated squid cohorts and squid predators	Possible concern
Fishery effects on amount of large size target fish	Effects of squid bycatch on squid size are not measured	Unknown	Unknown
Fishery contribution to discards and offal production	Squid discard an extremely small proportion of overall discard and offal in groundfish fisheries	Addition of squid to overall discard and offal is minor	No concern
Fishery effects on age-at-maturity and fecundity	Effects of squid bycatch on squid or predator life history are not measured	Unknown	Unknown

Data gaps and research priorities

Clearly, there is little information for stock assessment of the squid complex in the GOA. However, ecosystem models estimate that the proportion of squid mortality attributable to incidental catch in groundfish fisheries in the GOA region is extremely small relative to that attributable to predation mortality. Therefore, improving the information available for squid stock assessment seems a low priority as long as the catch remains at its current low level.

However, investigating any potential interactions between incidental removal of squids and foraging by sensitive species (e.g. toothed whales, albatrosses) is a higher priority for research. Limited data suggest that squids may make up 67 to 85% of the diet (by weight) for toothed whales in the GOA. Research should investigate whether the location and timing of incidental squid removals potentially overlap with foraging seasons and areas of these species, and whether the magnitude of squid catch at these key areas and times is sufficient to limit the available forage.

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Tables

Table 1. Taxonomic grouping of squid species with corresponding common name that have been found in the BSAI. It is not known whether all of these species occur in the GOA.

Class Cephalopoda; Order Oegopsida	
Family Chiroteuthidae	
Chiroteuthis calyx	
Family Cranchiidae	"glass squids"
Belonella borealis	
Galiteuthis phyllura	
Family Gonatidae	"armhook squids"
Berryteuthis anonychus	minimal armhook squid
Berryteuthis magister	magistrate armhook squid
Eogonatus tinro	
Gonatopsis borealis	boreopacific armhook squid
Gonatus berryi	Berry armhook squid
Gonatus madokai	
Gonatus middendorffi	
Gonatus onyx	clawed armhook squid
Family Onychoteuthidae	"hooked squids"
Moroteuthis robusta	robust clubhook squid
Onychoteuthis borealijaponicus	boreal clubhook squid
Class Cephalopoda; Order Sepioidea	
Rossia pacifica	North Pacific bobtail squid

Table 2. Estimated total catches of squids (all species) and estimated retention rates in Gulf of Alaska groundfish fisheries, 1990-2017 (1990 is the earliest year for which GOA squid catch data are available). This table also includes annual TACs for the Other Species (OS) complex and estimated OS catch, 1990-2010, as well as specifications for the squid complex beginning in 2011. **Squid catch reported here does not include catches in NMFS statistical areas 649 & 659, which do not count against the squid TAC. For a breakdown of squid catch by area, including 649 & 659, see Table 4.**

	squid catch	% retained	Other Species catch (t)	Other Species TAC (t)	squid TAC (t)	squid ABC (t)	squid OFL (t)	management method
1990	60	-	6,289	n/a				OS TAC
1991	117	-	5,700	n/a				OS TAC (incl. Atka)
1992	88	-	12,313	13,432				OS TAC (incl. Atka)
1993	104	-	6,867	14,602				OS TAC (incl. Atka)
1994	39	-	2,721	14,505				OS TAC
1995	25	-	3,421	13,308				OS TAC
1996	42	-	4,480	12,390				OS TAC
1997	97	-	5,439	13,470				OS TAC
1998	59	-	3,748	15,570				OS TAC
1999	41	-	3,858	14,600				OS TAC
2000	19	-	5,649	14,215				OS TAC
2001	91	-	4,804	13,619				OS TAC
2002	43	-	3,748	11,330				OS TAC
2003	77	46%	6,266	11,260				OS TAC
2004	157	69%	1,705	12,942				OS TAC (no skates)
2005	632	88%	2,513	13,871				OS TAC (no skates)
2006	1,516	84%	3,881	13,856				OS TAC (no skates)
2007	412	91%	3,035	4,500				OS TAC (no skates)
2008	84	91%	2,967	4,500				OS TAC (no skates)
2009	337	87%	3,188	4,500				OS TAC (no skates)
2010	131	91%	1,724	4,500				OS TAC (no skates)
2011	232	77%			1,148	1,148	1,530	squid complex
2012	18	28%			1,148	1,148	1,530	squid complex
2013	321	92%			1,148	1,148	1,530	squid complex
2014	94	77%			1,148	1,148	1,530	squid complex
2015	411	78%			1,148	1,148	1,530	squid complex
2016	239	59%			1,148	1,148	1,530	squid complex
*2017**	*29*	*28%*			1,137	1,137	1,516	squid complex

Data sources and notes: squid catch 1990-1996, Gaichas et al. 1999; squid catch 1997-2002, AKRO Blend; squid catch 2003-2017, AKRO CAS; Other Species catch, AKRO Blend and CAS; TAC, AKRO harvest specifications. Other Species catch from 1990-2003 does not include catch of skates in the IFQ Pacific halibut fishery, and after 2003 includes no skate catch at all.

* 2017 catch data are incomplete; retrieved October 11, 2017.

Table 3. Estimated catch (t) of all squid species in the Gulf of Alaska by target fishery, 2003-2017*. ATF = arrowtooth flounder; "shallow flatfish" and "deep flatfish" refer to the shallow and deepwater flatfish complexes, respectively. Data source: AKRO CAS.

	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017*
pollock	48	139	628	1,504	405	78	314	121	202	3	307	65	356	162	9
rockfish	9	12	2	10	3	5	14	4	12	15	10	19	24	12	20
ATF	3	1	2	1	2	0.31	7	2	17	0.33	0.21	9	25	65	0.49
Pacific cod	14	0.11	0.25	0.29	0.34	0.33	0.14	0.10	0.08	0.001	1	0.02	1	1	0.13
rex sole	2	0	0	0	0	0.08	2	3	1	0.17	1	0.19	0.41	0.23	0.003
sablefish	0.004	4	0.05	0	1	0.10	0.38	0.33	0.32	0.26	1	0.12	3	0.05	0.19
shallow flatfish	0	0.06	0	0	1	0	1	0.07	0	0	0	0	0	0	0
flathead sole	0.16	0.12	0	0.21	0	0	0.10	0.11	0.02	0	0.15	0	2	0.04	0
deep flatfish	0.13	1	0.01	0	0.01	0.01	0	0	0	0	0	0.47	0.39	0	0
IFQ halibut	0	0	0	0	0	0	0	0	0	0	0	0	0.14	0	0
other	0	0	0	0	0	0	0	0	0	0	0.10	0	0	0	0
Atka	0	0	0	0	0	0	0	0	0	0	0.10	0	0	0	0.01
total	77	157	632	1,516	412	84	337	131	232	18	321	94	411	239	29

*2017 data are incomplete; data retrieved October 11, 2017.

Table 4. Estimated catch (t) of all squid species in the Gulf of Alaska combined by NMFS statistical area, 1997-2017. Data are from AKRO CAS.

	2003	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	***2017****
610	19	15	13	12	3	4	12	3	8	5	1	5	6	11	*6*
620	43	129	607	1,485	403	77	315	121	201	6	278	69	296	119	*19*
630	13	11	11	14	5	2	10	5	18	5	40	17	107	106	*2*
640	2	2	2	5	0.408	0.273	1	2	4	2	2	2	2	3	*2*
650	0	0	0	0	1	0	0	0	0.012	0	0	0	0.005	0	*0*
GOA catch w/o inside waters	77	157	632	1,516	412	84	337	131	232	18	321	94	411	239	*29*
649	20	5	3	14	5	14	7	8	7	4	39	78	109	20	*0.124*
659	0	0.051	0	0	0.001	0	0	0	0.012	0	0	0	0	0	*0*
GOA catch w/ inside waters	97	162	636	1,530	417	98	345	139	239	22	361	172	521	260	*29*

*2017 are incomplete; retrieved October 11, 2017.

Table 5. Biomass estimates (t) of squid species from NMFS Gulf of Alaska bottom trawl surveys, 1984-2017. CV = coefficient of variation.

	Berryteuthis magister		miscellaneous squids		all squids	
	biomass	CV	biomass	CV	biomass	CV
1984	2,762	0.15	546	0.35	3,308	0.14
1987	4,506	0.34	577	0.30	5,083	0.30
1990	4,033	0.17	276	0.43	4,309	0.16
1993	8,447	0.13	1,029	0.73	9,476	0.14
1996	4,884	0.14	26	0.28	4,911	0.14
1999	1,873	0.13	254	0.46	2,127	0.13
2001	5,909	0.30	703	0.62	6,612	0.27
2003	6,251	0.18	71	0.23	6,322	0.18
2005	4,654	0.18	249	0.51	4,903	0.18
2007	11,681	0.20	359	0.49	12,040	0.20
2009	8,415	0.16	188	0.61	8,603	0.16
2011	4,040	0.13	401	0.64	4,440	0.13
2013	9,675	0.16	568	0.80	10,243	0.16
2015	13,692	0.12	387	0.65	14,079	0.12
2017	2,042	0.15	253	0.51	2,296	0.15

Table 6. Survey biomass estimates (t) and coefficients of variation (CV) by depth strata for all squids combined in the Gulf of Alaska, 1984-2017. The deepest stratum was not sampled in all years.

	1-100 m		**101-200 m**		**201-300 m**		**301-500 m**		**501-700 m**		**701-1000 m**	
	biomass	CV	biomass	CV	biomass	CV	biomass	CV	biomass	CV	biomass	CV
1984	7	0.73	65	0.33	210	0.22	2,180	0.20	381	0.29	464	0.22
1987	301	0.58	233	0.42	1,797	0.43	2,609	0.50	75	0.33	69	0.51
1990	892	0.41	1,306	0.36	966	0.34	1,145	0.18	0	-	0	-
1993	41	0.71	359	0.25	4,787	0.16	4,289	0.25	0	-	0	-
1996	278	0.65	487	0.26	2,648	0.22	1,498	0.17	0	-	0	-
1999	195	0.47	399	0.25	619	0.27	760	0.20	134	0.27	19	0.45
2001	139	0.56	867	0.41	3,016	0.30	2,591	0.58	0	-	0	-
2003	1,064	0.86	640	0.28	2,431	0.21	2,065	0.21	123	0.38	0	-
2005	213	0.44	280	0.27	3,340	0.25	855	0.14	163	0.30	53	0.60
2007	172	0.66	1,064	0.64	7,411	0.20	3,017	0.57	351	0.42	26	0.56
2009	123	0.54	1,113	0.34	5,224	0.23	1,840	0.24	228	0.34	74	0.76
2011	197	0.53	463	0.48	1,932	0.24	1,639	0.16	210	0.65	0	-
2013	376	0.56	961	0.35	4,298	0.22	4,315	0.28	293	0.36	0	-
2015	483	0.37	943	0.23	9,295	0.17	2,899	0.22	289	0.29	171	0.35
2017	147	0.57	371	0.42	740	0.27	823	0.23	215	0.32	0	-

Figures

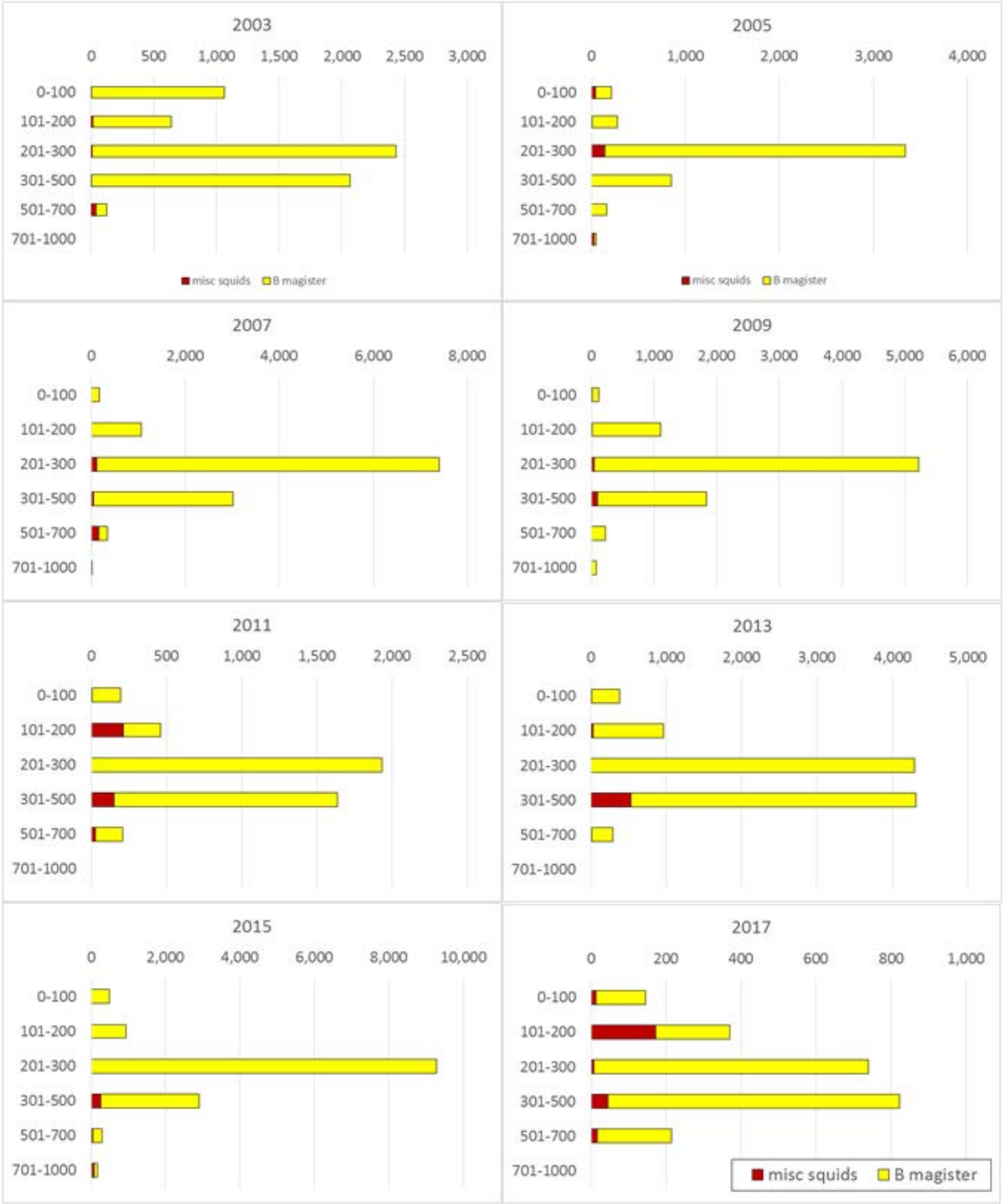

Figure 1. Distribution by depth (m) of squids captured in the NMFS Gulf of Alaska bottom trawl survey, 2003-2017.

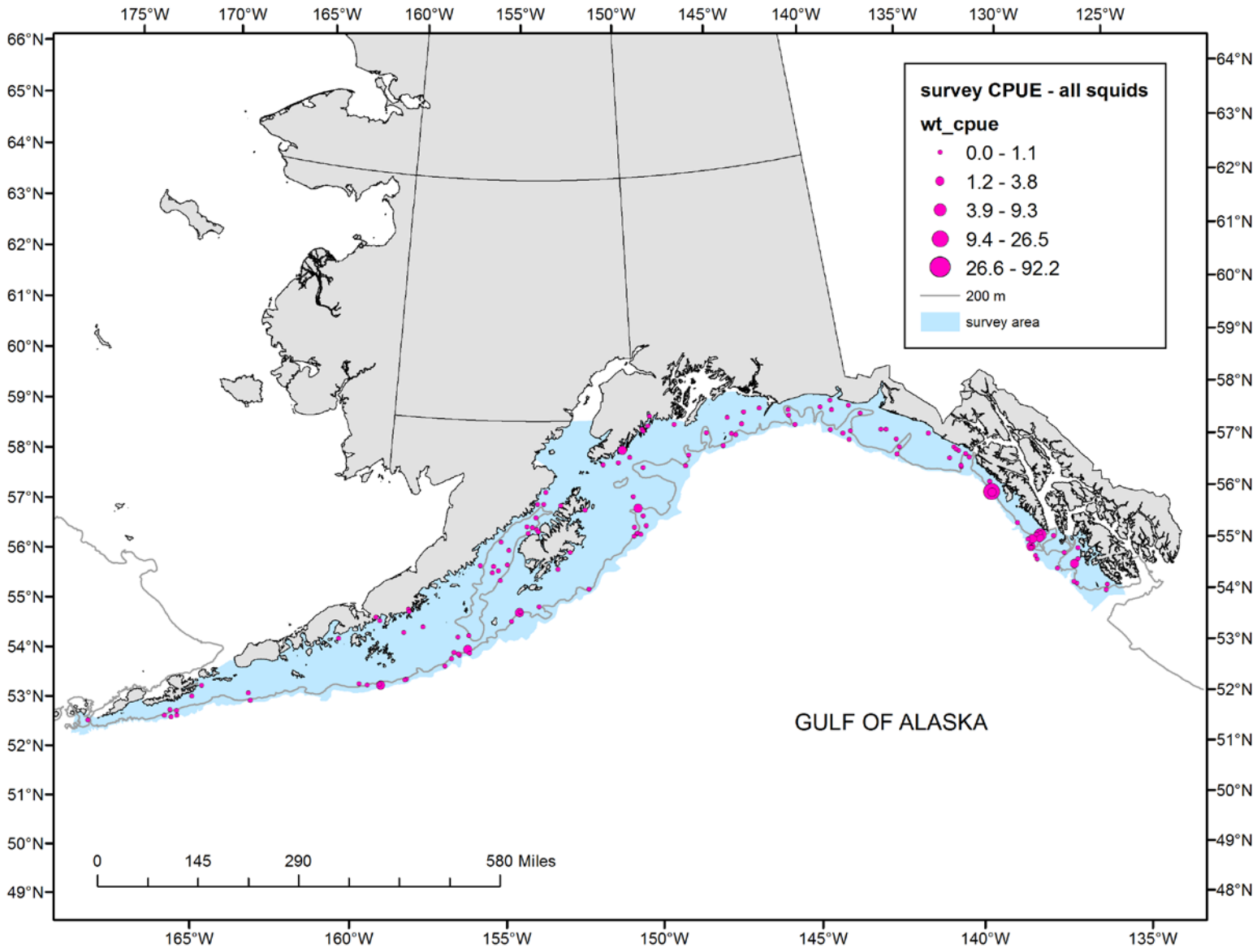

Figure 2. Catch-per-unit-effort (CPUE) of squids (all species) in the **2017** NMFS bottom trawl survey in the Gulf of Alaska.

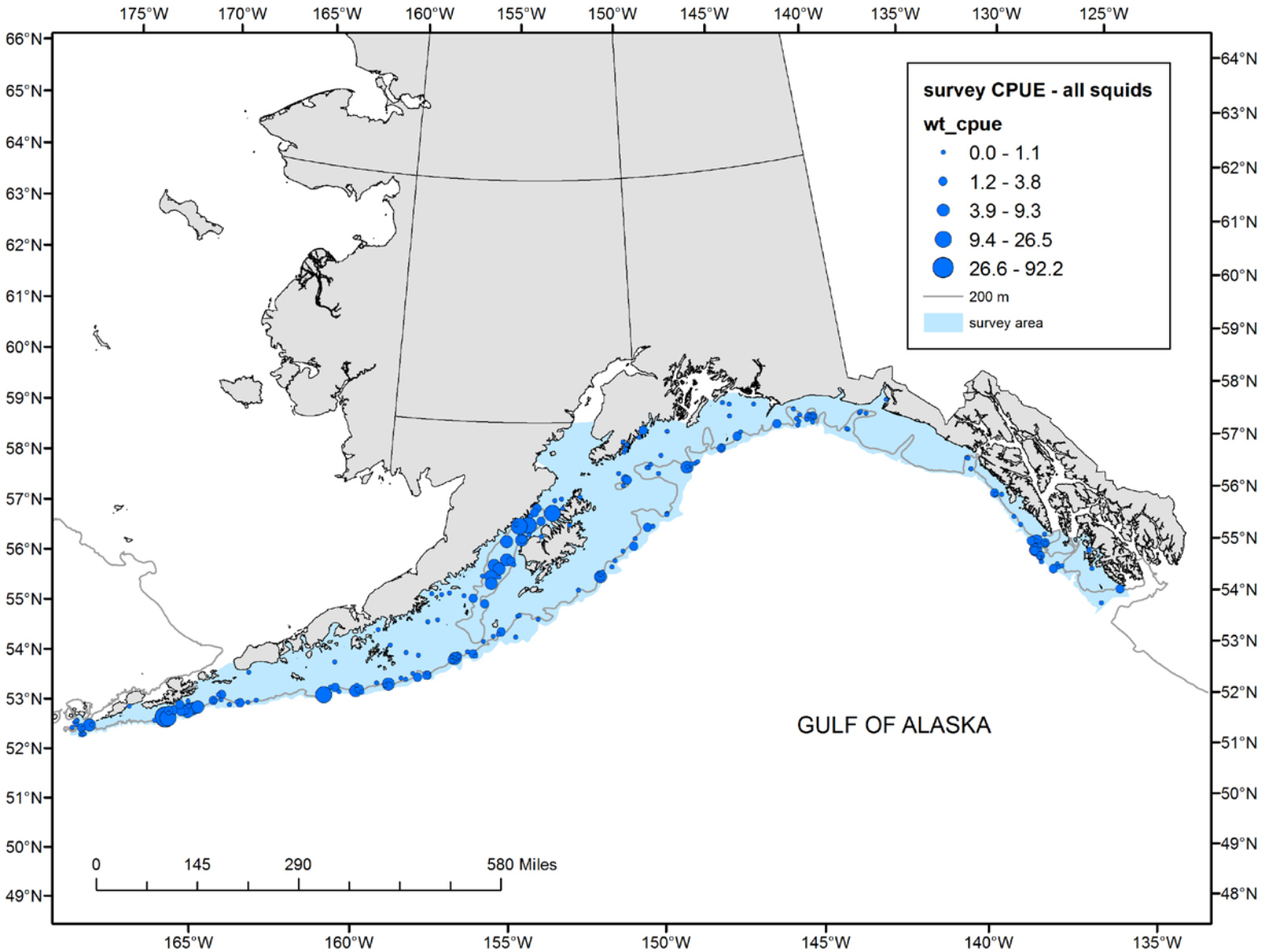

Figure 3. Catch-per-unit-effort (CPUE) of squids (all species) in the **2015** NMFS bottom trawl survey in the Gulf of Alaska.

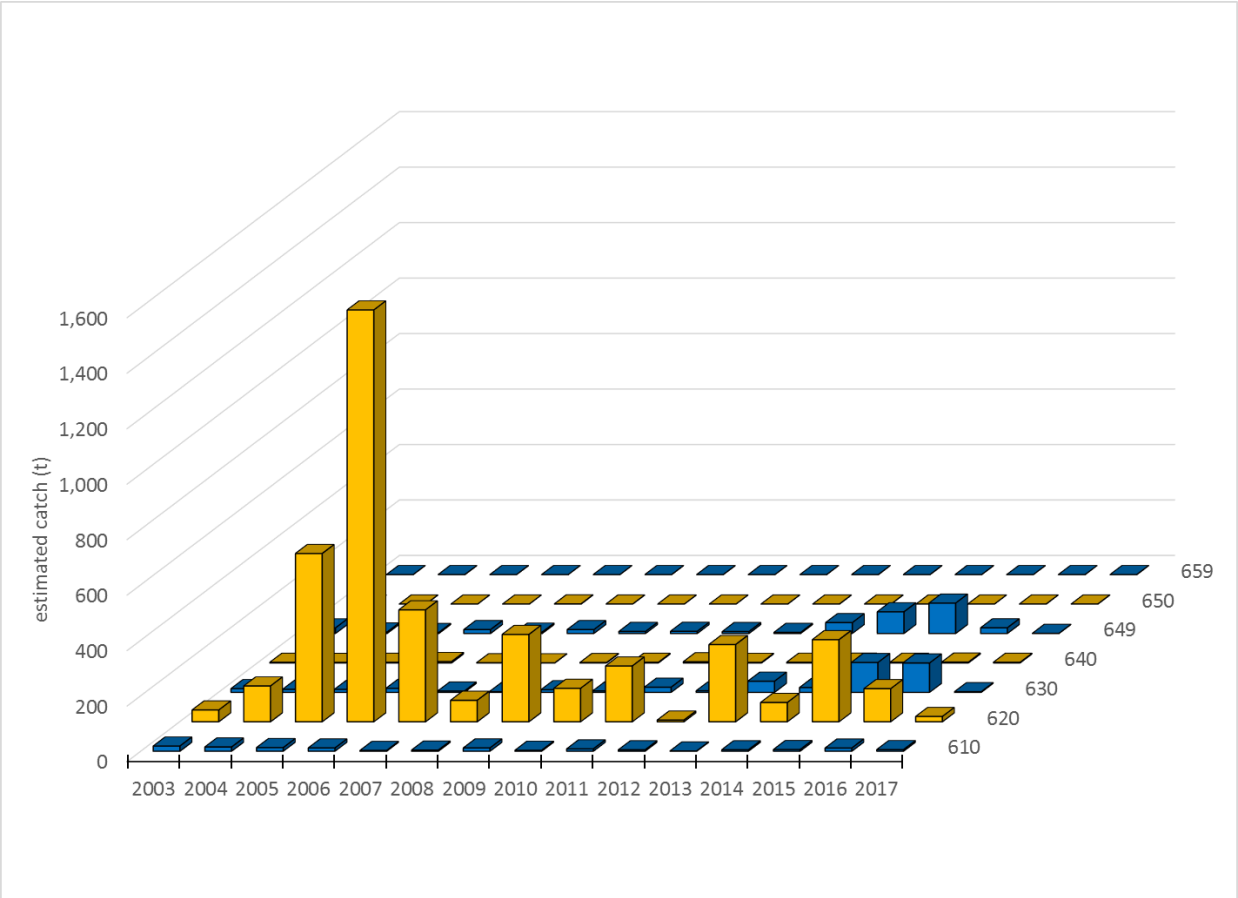

Figure 4. Estimated catch (t) of all squid species combined in the Gulf of Alaska by NMFS statistical area, 2003-2017. Data source: AKRO CAS. 2017 data are incomplete; retrieved on October 11, 2017.

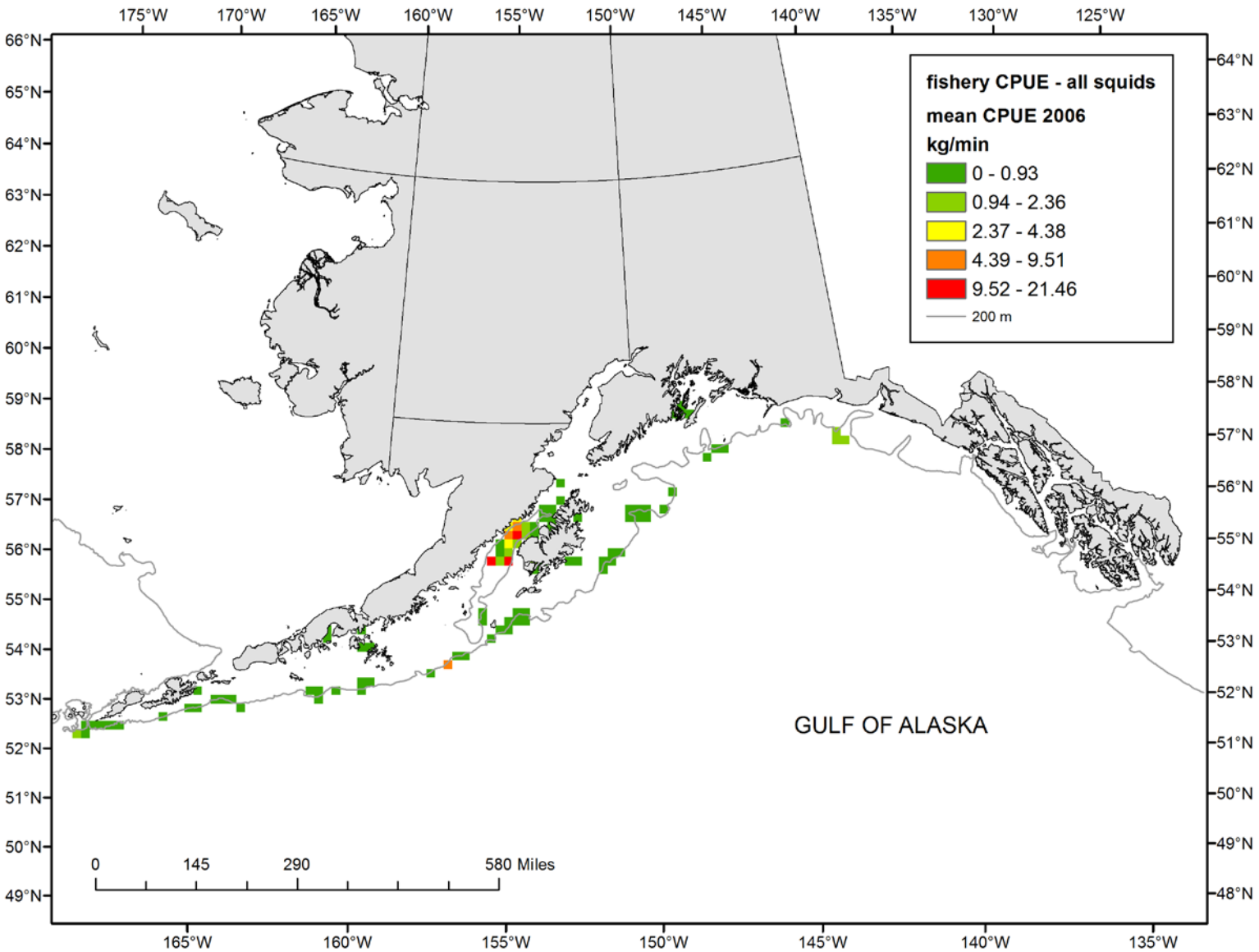

Figure 5. Catch-per-unit-effort (CPUE) of squids (all species) in observed trawl fishery hauls in the Gulf of Alaska during **2006**. Data are mean CPUE (kg/minute of tow duration) per 20 km x 20 km grid cell.

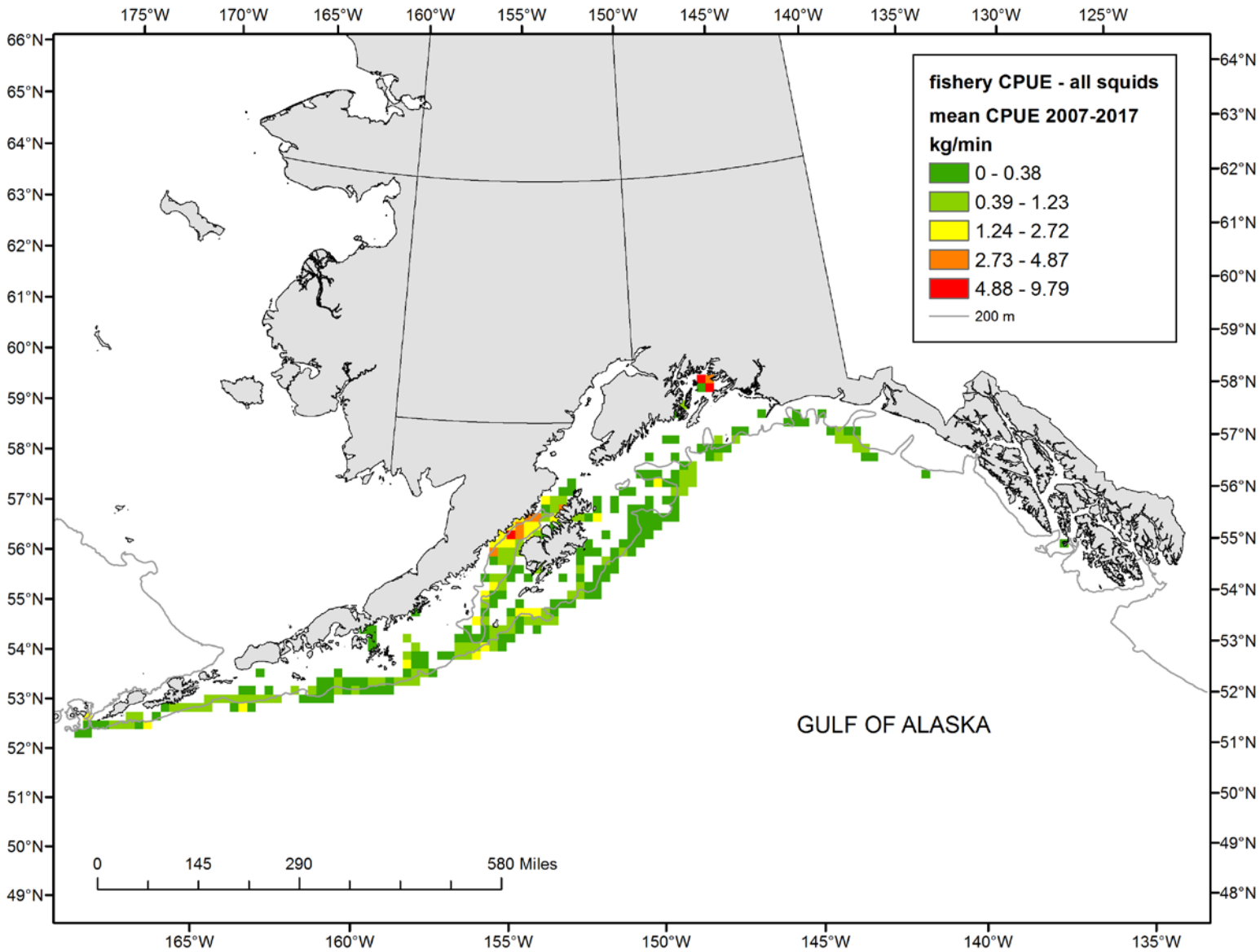

Figure 6. Catch-per-unit-effort (CPUE) of squids (all species) in observed trawl fishery hauls in the Gulf of Alaska during **2007-2017**. Data are mean CPUE (kg/minute of tow duration) per 20 km x 20 km grid cell. Does not include all data collected during 2017.

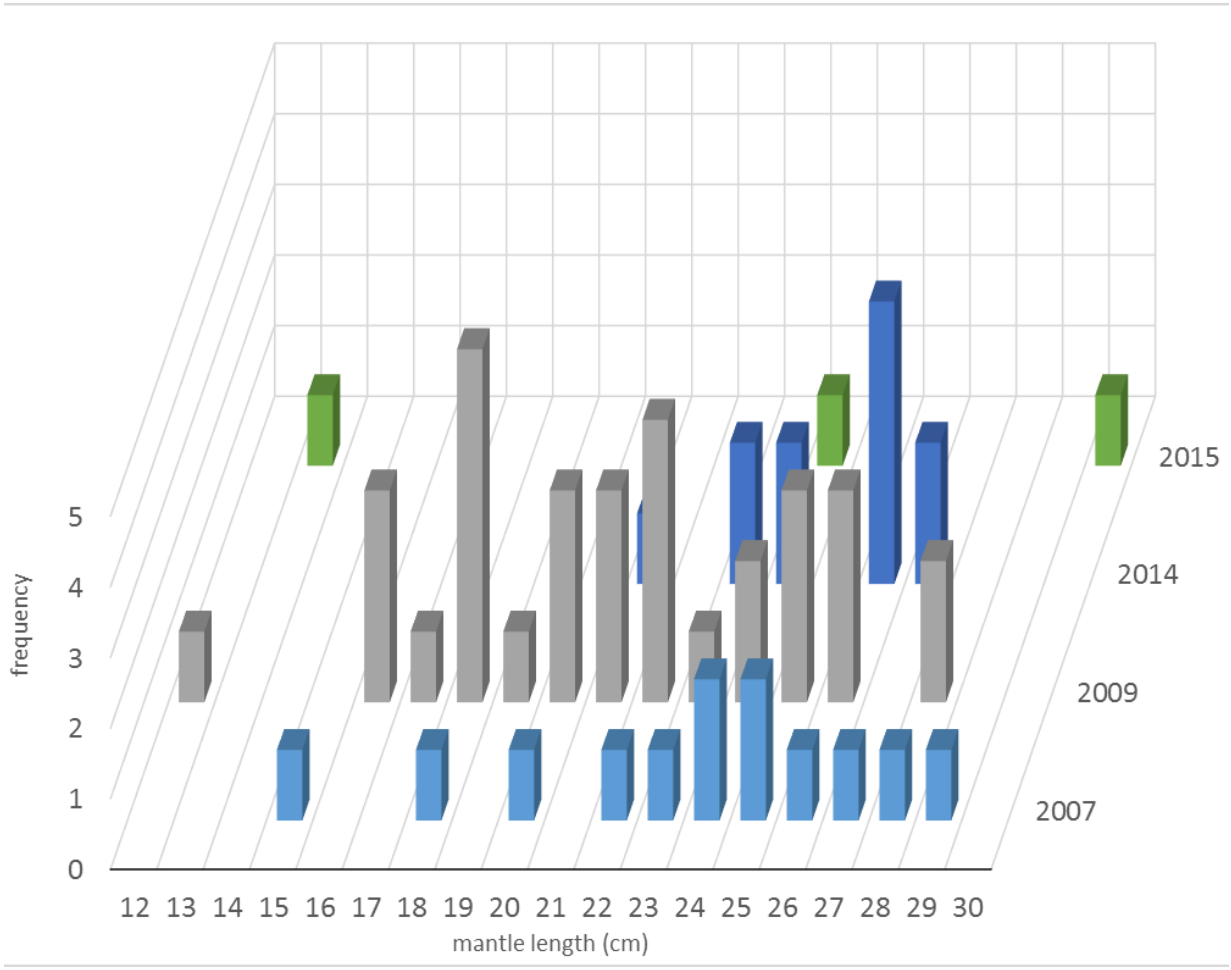

Figure 7. Size composition of squids (all species) captured in Gulf of Alaska commercial fisheries, 2007-2016 (data were not collected in all years).

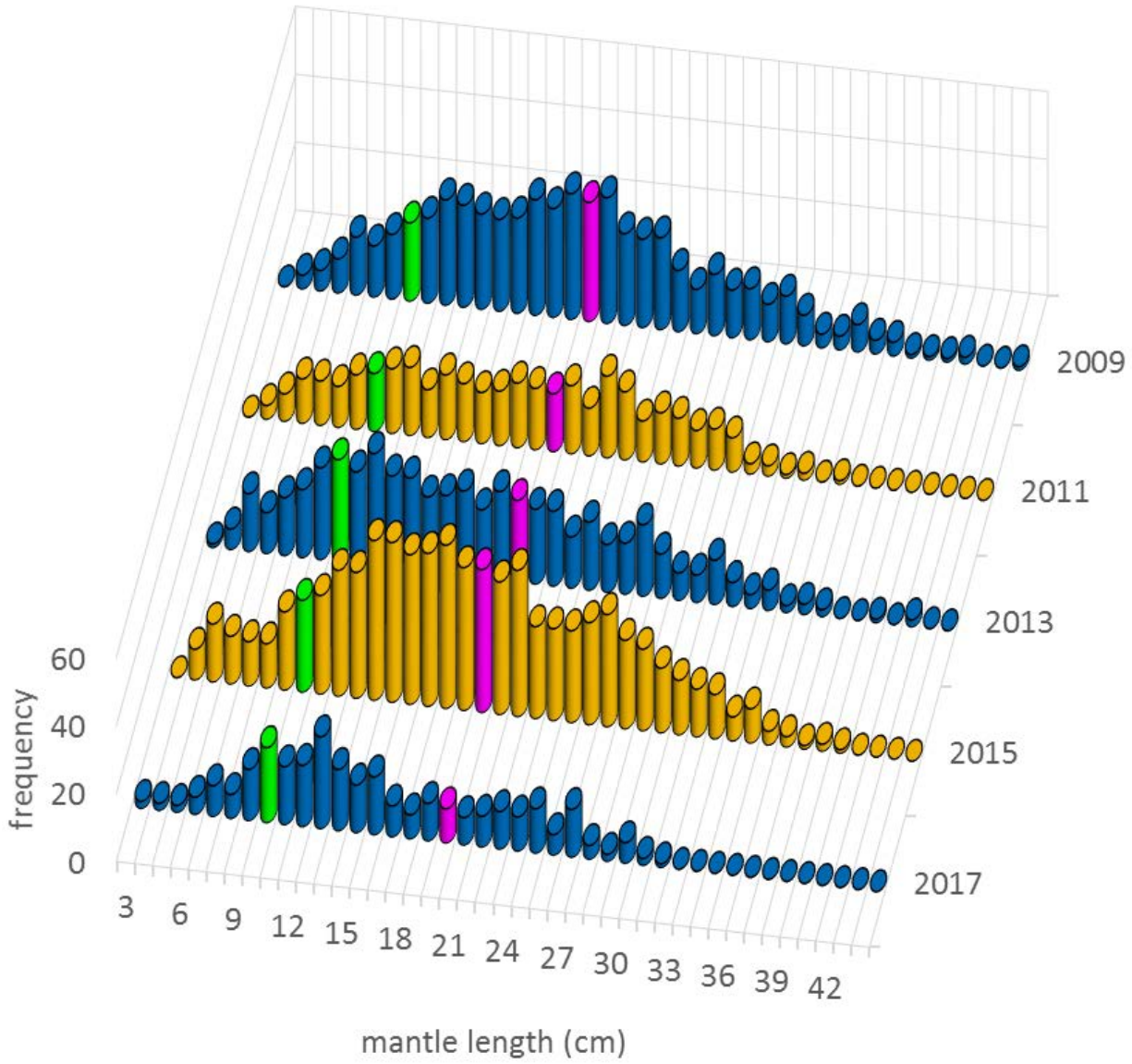

Figure 8. Size compositions of *Berryteuthis magister* in NMFS bottom trawl surveys conducted in the Gulf of Alaska, 2009-2017. Green column indicates 10 cm; fuchsia column indicates 20 cm.

Appendix: Non-commercial catch data

In order to comply with the Annual Catch Limit (ACL) requirements, non-commercial removals in the Gulf of Alaska are presented. Non-commercial removals are estimated total removals that do not occur during directed groundfish fishing activities. This includes removals incurred during research, subsistence, personal use, recreational, and exempted fishing permit activities, but does not include removals taken in fisheries other than those managed under the groundfish FMP. These estimates represent additional sources of removals to the existing Catch Accounting System estimates.

agency	ADFG			NMFS							
catch source	Large-Mesh Trawl Survey	Small-Mesh Trawl Survey	Subsistence Fishery	Annual Longline Survey	GOA Bottom Trawl Survey	Salmon EFP 13-01	Shelikof Acoustic Survey	Shelikof and Chirikof EIT	Shumigans Acoustic Survey	WGOA Acoustic Coop Survey	**total**
1988			103								**103**
1991			1,672								**1,672**
1993			41								**41**
1996			10								**10**
1997			147								**147**
1999	73										**73**
2000		0	20								**20**
2001	45										**45**
2003	16										**16**
2004		0									**0**
2005	32	37									**69**
2006		38									**38**
2007	29	15									**44**
2009	18										**18**
2010		57					13		1	0	**72**
2011	40	51			34						**125**
2012	24	39						9			**71**
2013	124	135			29	21,641					**21,929**
2014	28	46		3		716					**794**
2015	87				19						**106**
2016	31			10							**41**