Discussion paper regarding assessment and management of squids in the BSAI & GOA

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Overview

This discussion paper was originally prepared for the September 2014 meeting of the Joint (BSAI and GOA) Groundfish Plan Teams. Its creation was prompted by 3 main issues:

1) Long-standing concerns regarding the lack of assessment data for squids and the inadequacy of Tier 6 assessments
2) The 2013 review of non-target stocks by the Council of Independent Experts (CIE) and the CIE reviewers' comments regarding squids
3) By mid-summer 2014 the squid catch in the BSAI greatly exceeded the TAC and was on track to exceed the ABC.

In 2015, BSAI squid bycatch is again a concern. As of September 5, 2015 the total BSAI squid catch was 2,174 t. This amount greatly exceeds the TAC of 340 t, exceeds the ABC of 1,970 t, and has the potential to exceed the OFL of 2,620 t. To help AFSC and NPFMC staff better understand the issues surrounding assessment and management of squid in Alaska, the original document has been modified and updated. For brevity some details have been removed; if additional detail is needed the original discussion paper can be provided. The Plan Team and SSC comments on the original discussion paper are included here.

Brief history of squid catches, assessment and management

Recent assessments (Ormseth 2011, 2014) provide extensive detail regarding squid catch and management history and the differences between the BSAI and GOA. In the BSAI, squid catch data begin in 1977 with some large catches during the foreign and joint-venture that may indicate targeting (Table 1 and Figure 1). In the GOA, catch records begin in 1990 with little indication of directed fishing (Table 1 and Figure 1). Recent patterns of incidental catches are similar in both areas, with years of relatively low catch interspersed with much higher than average catches. In the BSAI catches were high in 2014 (1,678 t) and even higher as of September 5, 2015 (2,174 t). The 2015 catch has already exceeded the ABC of 1,970 t and has the potential to exceed the OFL of 2,620 t. The 2015 GOA catch (314 t as of 9/5/2014) is well below the TAC of 1,148 t.

Management of squid also differs between the two areas. In the BSAI, squid have been managed as a target or "in the fishery" stock since the NPFMC Tier system was adopted. Harvest recommendations are made using the original Tier 6 approach, with OFL equal to the *average* catch 1978-1995. In contrast, squid in the GOA were managed as part of the Other Species complex until 2011 when the complex was split into 4 species groups. At that time, the SSC selected a Tier 6 approach for squid that specified an OFL equal to the *maximum* catch during 1997-2007 because catch data from the earlier period were unavailable.

The abundance of squid in the BSAI and GOA is highly uncertain. Survey biomass estimates (Table 2) have acceptable CVs but undoubtedly underestimate squid populations, and temporal variability in the

survey estimates is unlikely to represent actual changes in abundance. Estimates from mass-balance ecosystem models suggest that squid biomass may be two orders of magnitude higher (880,000 t in the BSAI and 369,000 t in the GOA; Aydin et al. 2007) but there is very high uncertainty surrounding those estimates (see Plan Team comments at the end of the report). Survey biomass estimates are higher in the GOA than in the BSAI (recent averages of 7,759 t and 4,932 t, respectively), but this may be due in part to differences in survey design between the two areas. Relative to the EBS shelf and slope surveys, the GOA trawl survey has a higher density of stations in deeper waters and slope habitats where squid are more likely to be encountered.

It is difficult to envision how sufficient data could be gathered to improve the assessment without considerable expense. Squid can be detected using acoustics, and there is a biennial acoustic survey in the EBS as well as some surveying in the Aleutians. However the EBS survey ends at the shelf break, rarely surveying waters with a bottom deeper than 200 m, and squids are generally distributed beyond the shelf break and in deeper waters. An additional and perhaps greater problem is that *Berryteuthis magister* (the species that likely makes up most of the squid biomass in the BSAI and constitutes the vast majority of the incidental catch) appears to have multiple spawning cohorts within each year. As a result, even a dedicated squid survey that is conducted during only a limited part of the year is unlikely to adequately represent the entire squid population. Squid length data are collected by fishery observers and during the bottom trawl surveys, but the length-based methods that have been used for data-limited fish stocks are not appropriate for short-lived, fast-growing animals like squid. There may be some utility in analyzing patterns of fishery CPUE, and that should be explored, but that approach is unlikely to yield the management quantities required in the BSAI.

Summary of CIE reviewer's comments (the full CIE comments are available upon request)
Assessment of squid in the BSAI and GOA areas was reviewed by the CIE in May 2013. Their comments are summarized below:

1) The reviewers asserted that the management approach for squid should be consistent between the BSAI and GOA areas.
2) There was general skepticism regarding the use of catch data for setting harvest specifications for non-target stocks.
3) The reviewers gave conflicting advice regarding the appropriate catch periods for OFL estimation, but were unanimous that the BSAI period was inappropriate because it straddles the foreign and domestic fishing eras.

Response to CIE review and suggested alternatives for squid management
The CIE reviewers raised valid concerns, and many of the issues they identified have been discussed by the Plan Teams and SSC in previous years (e.g. when sharks were established as a separate stock complex in 2011). In many ways addressing the CIE's comments on squid also means addressing the general problem of data-limited stocks and Tier 6 management. There are 2 possible alternatives for proceeding with the assessment and management of squid:

1) *Maintain the status quo or a modified version of it:* Tier 6 can include myriad ways of estimating OFL, many of which have been explored in the past by the AFSC. There may also be additional data-limited methods that have not yet been explored for the NPFMC.

2) *Develop a new approach*: Since the current Tier 6 methods are problematic for squid management, an alternative would be to develop an approach that recognizes that current incidental catches are unlikely to be a conservation concern for squid stocks. This approach would directly address the issues of allowing current fishing practices to continue and prohibiting the development of a directed fishery unless sufficient data are collected to properly evaluate and monitor squid stocks.

The original discussion paper compared a number of alternatives for determining harvest specifications for squids. The alternatives were either based on historical catch (Tier 6) or used an F x B approach (modified Tier 5). Details of those alternatives are in the original report; the results are included here in Table 3. To briefly summarize those results, the alternatives produce an extremely wide range of possible OFLs, but all of the alternatives are problematic in some way.

New approaches

The validity of a new squid management approach is based on the recognition that current levels of incidental catches in the BSAI and GOA appear to be well below those that would pose a conservation concern. Current catch is likely much less than MSY. This is supported by the following observations:

- Due to their rapid growth and maturation and short lives, squid have inherently high stock productivity, and evidence from other areas (e.g. NEFMC 2010) suggests it is unlikely that a highly productive stock could be overfished in the absence of an intensive directed fishery. This is part of the rationale for the ACL exception in the Magnuson-Stevens Act for animals with a lifespan of 1 year or less.
- Although the biomass estimates from the ecosystem model are highly uncertain, and *F* x *B* approaches may be problematic for squid, it is apparent that the bottom trawl surveys substantially underestimate squid biomass. Thus even a precautionary *F* x *B* approach would specify a higher OFL than is currently used.
- The catch-based estimate using 1978-1985 data suggests that the OFL could be substantially higher than the current specification (although there is some concern with estimates based on data separated that far in time from the current day).

Because untargeted squid are unlikely to pose a conservation concern, it might be possible to depart from approaches based on estimation of OFL and instead focus on the twin objectives of 1) ensuring that specifications do not unnecessarily constrain current fisheries and 2) prohibiting the development of a directed squid fishery without sufficient information to properly manage stocks. Two potential means of achieving these goals are described briefly and were discussed at the Joint Plan Team meeting in September 2014:

1) *Move squid to the Ecosystem Component (EC) category*: Squid may meet the requirements for inclusion as EC species in the National Standard Guidelines, although this is a matter of debate (the proposed changes to EC guidelines would easily accommodate squids). This option would not provide a limit to squid catches, but it would be possible to mandate catch monitoring and periodic review and return squid to the specification process if conservation concerns developed or there was interest in a directed fishery. In addition, directed fishing could be prohibited as is the case for the forage fish group.

2) *Make harvest specifications based on total allowable catch (TAC) rather than OFL*: Under this option, ABC and TAC would be set at a level reasonably larger than the maximum value of recent catches. OFL would then be specified at a level above the ABC to account for management uncertainty (i.e. uncertainty in limiting catches to the TAC). This approach would satisfy the objectives for management while prohibiting directed fishing (unless better information becomes available) and is very unlikely to exceed a fishing mortality rate that would achieve MSY for such a highly productive, short-lived species.

Neither of these approaches addresses the potential problem of spatially-concentrated high catches of squid that can occur in the BSAI and GOA. For example, in the BSAI during 2006 and 2007, large squid catches were highly localized along the shelf break and in the vicinity of canyons (Figure 2). As with any fishing operation, there is the potential that removing a portion of the prey base (i.e., squid) in specific areas may adversely affect foraging opportunities for other species. On several occasions during the past decade the current catch limits have caused fisheries to move away such areas of high concentrations to avoid exceeding the squid TAC, and these actions may also be beneficial in that they limit the depletion of squid in localized areas. These observations are speculative because no information exists regarding the relationship between fishery removals of squid and changes in foraging opportunities for predators. Additional management measures to limit catch in particular areas (e.g. temporary spatial closures) could be used to complement any new management approach.

Plan Team comments on the original discussion paper:

Olav Ormseth presented a discussion paper covering responses to a CIE review on squid assessment and management. The CIE review suggested that the management approach should be similar in the GOA and BSAI. There also was general skepticism of the use of catch for setting harvest specifications (Tier 6 approach) and the time period for the catch time series used as a basis for the Tier 6 recommendation. There are three general possibilities for future management: status quo, identical Tier 6 approaches for GOA and BSAI, or develop a new approach. Olav presented several catch-based and fishing-mortality-times-biomass-based approaches. Olav suggested that choosing a period of potential targeting (1978-1985) and using the average would be a reasonable approach for a catch-based approach in the BSAI. Olav also described use of Baranov's catch equation as a potential alternative, because the "B" in the Tier 5 MxB limit control rule is supposed to represent the average biomass that would be experienced during the year if the stock were exploited at F=M (an assumption which is grossly violated for both BSAI and GOA squid if current biomass is used to estimate B). Based on three lines of evidence, current catch is likely less than MSY. Another approach is to move squid to the Ecosystem Component category, which would not limit squid catches but could prohibit directed fishing and require catch reporting and monitoring, and periodic review. Mary Furuness pointed out that in the BSAI, the non-specified reserve TAC provides some relief when the squid TAC is exceeded (up to the recommended value of ABC), and that any alternative that increases the BSAI squid TAC substantially is likely to be highly controversial due to the 2 million t cap. Kerim Aydin pointed out that the ecosystem model is inappropriate to use for estimating squid biomass (as contrasted with the case of BSAI octopus) for three reasons: 1) the consumption of squid is very episodic; 2) squid species identification and locations of predation indicate that there may be low overlap between the population caught by the fishery versus those caught by groundfish predators; and 3) there is high uncertainty associated with high estimated consumption by marine mammals. **The Teams recommend that consideration be given to moving squid into the**

Ecosystem Component category and, in the meantime, the Tier 6 approaches currently used in the BSAI and GOA continue.

SSC comments on the original discussion paper:

Assessments of BSAI and GOA squid were reviewed by the CIE in 2013. Squid in both the BSAI and GOA are Tier 6 assessments, with OFLs established by using a representative time period. The BSAI squid OFL is established by the average of 1978 through 1995 catch and the GOA squid OFL is based on the 1997 through 2007 maximum catch. Recent squid catch in the BSAI is above average and exceeded the BSAI TAC in 2014. The preliminary 2014 GOA squid catch is well below the TAC. The CIE made several primary observations, including: 1) that harvest approaches should be consistent between the BSAI and the GOA; 2) the BSAI time period for setting the OFL is inappropriate, given that it straddles time periods of foreign and domestic fisheries; and 3) general skepticism regarding the use of catch to establish harvest specifications. The SSC noted that squid population levels are highly variable and influenced by multiple factors, including climate and fishing pressure. This document provides responses to CIE comments and provides suggestions for alternative assessment methodologies based on these recommendations. The author provided multiple catch-based Tier 6 alternatives, including various time periods for both the BSAI and GOA, and also provided some modified Tier 5 options with various values for fishing mortality. There were also two options for estimating biomass, including the bottom trawl survey and ecosystem models. New approaches were also presented, including moving squid to be an Ecosystem Component (EC) species. In general, the SSC feels that selecting a time period appropriate for the area is a more important consideration than consistency between the BSAI and the GOA. With this in mind, the SSC is in agreement with the PT recommendations. First, that consideration is given to moving squid to an EC species. While this option should be considered, the SSC noted that keeping squid in Tier 6 would allow for limiting catches, if necessary. The second PT recommendation is that the status quo approaches for each of BSAI and GOA be brought forward in December. The status quo sets the BSAI OFL equal to the average of the catch from 1978 through 1995, and the GOA OFL equal to the maximum of the catch from 1997 through 2007. In addition, an option should be brought forward for a Tier 6 method with a time period for the BSAI that does not include years during the foreign fishing era (see CIE reviewer appendix).

Literature cited

Aydin K, S Gaichas, I Ortiz, D Kinzey, N Friday (2007) A comparison of the Bering Sea, Gulf of Alaska, and Aleutian Islands large marine ecosystems through food web modeling. NOAA Tech Memo NMFS-AFSC-178

Northeast Fisheries Science Center (2010) *Loligo pealeii* stock assessment for 2010. 51st SAW Assessment Report

Ormseth, OA (2011) Assessment of the squid stock complex in the Gulf of Alaska. In: Stock Assessment and Fishery Evaluation Report for the Groundfish Resources of the Gulf of Alaska Region. North Pacific Fishery Management Council

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Table 1. Squid catches in the BSAI and GOA, 1977-2015. The 2015 data are as of September 5, 2015.

year	BSAI total	GOA total
1977	6,734	0
1978	8,971	0
1979	6,538	0
1980	6,372	0
1981	5,945	0
1982	5,039	0
1983	3,980	0
1984	3,167	0
1985	1,620	0
1986	868	0
1987	131	0
1988	417	0
1989	306	0
1990	626	60
1991	632	117
1992	880	88
1993	683	104
1994	604	39
1995	459	25
1996	1,167	42
1997	1,474	97
1998	915	59
1999	441	41
2000	384	19
2001	1,766	91
2002	1,344	43
2003	1,282	97
2004	1,014	162
2005	1,186	636
2006	1,418	1,530
2007	1,188	416
2008	1,542	98
2009	360	345
2010	410	139
2011	336	238
2012	688	22
2013	299	319
2014	1,678	93
2015	*2,174*	*314*

Table 2. Trawl survey biomass estimates (t) for the GOA and BSAI. Estimates for the BSAI include data from the EBS shelf and slope surveys, and the Aleutian Islands survey. BSAI data are only shown for those years where all 3 surveys conducted. CV= coefficient of variation; for the BSAI the 3 survey CVs were averaged.

	GOA squid	CV	BSAI squid	average CV
1984	3,308	0.14		
1985				
1986				
1987	5,083	0.3		
1988				
1989				
1990	4,309	0.16		
1991				
1992				
1993	9,476	0.14		
1994				
1995				
1996	4,911	0.14		
1997				
1998				
1999	2,127	0.13		
2000				
2001	6,612	0.27		
2002			3,391	0.21
2003	6,322	0.18		
2004			4,898	0.44
2005	4,899	0.18		
2006				
2007	11,991	0.2		
2008				
2009	8,603	0.16		
2010			4,423	0.31
2011	4,431	0.14		
2012			5,440	0.27
2013	10,243	0.16		
2009-2013 average	7,759		4,932	

Table 3. Alternative approaches for determining squid harvest recommendations in the BSAI and GOA.

	BSAI		GOA	
current approach	OFL = 1978-1995 average		OFL = 1997-2007 maximum	
current specifications	OFL	ABC	OFL	ABC
	2,620	1,970	1,530	1,148
catch-based approaches	OFL	ABC	OFL	ABC
78-85 average	5,204	3,903	5,204	3,903
78-85 max	8,971	6,728	8,971	6,728
90-07 average	970	728	204	153
90-07 max	1,766	1,325	1,530	1,148
90-07 CI 95%UB	1,158	868	373	279
90-07 CI 99%UB	1,217	913	426	319
97-07 average	1,128	846	290	218
97-07 max	1,766	1,325	1,530	1,148
97-07 CI 95%UB	1,377	1,033	558	418
97-07 CI 99%UB	1,455	1,091	642	482
F x *B* approaches				
recent survey biomass average	4,932		7,759	
ecosystem model estimate	880,006		369,309	
	OFL	ABC	OFL	ABC
F=0.3 (survey)	1,479	1,110	2,328	1,746
decay function (survey)	2,132	1,936	3,354	3,046
F=0.3 (ecosystem model)	264,002	198,001	110,793	83,095
decay function (ecosystem model)	380,455	345,471	159,664	144,983

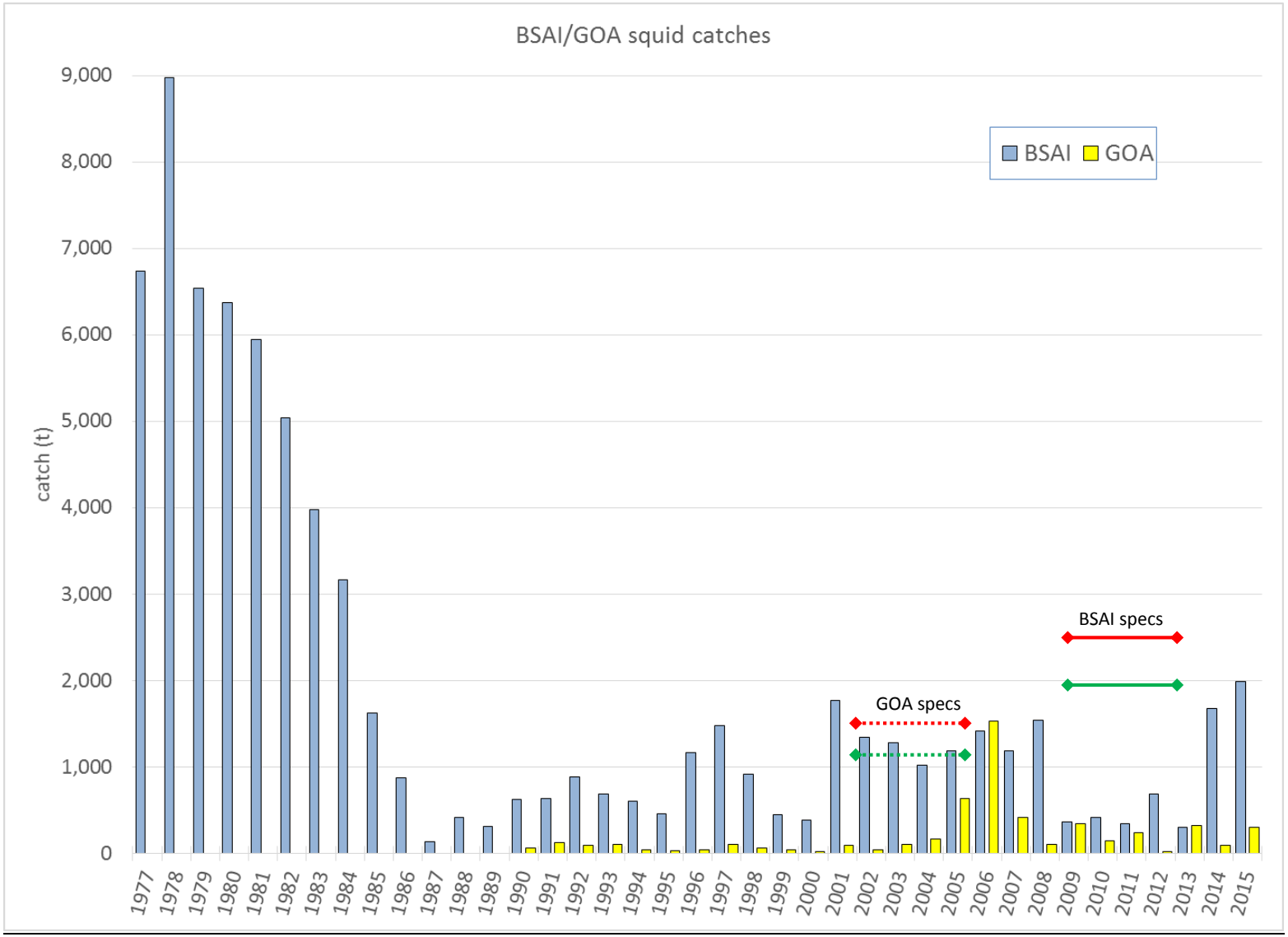
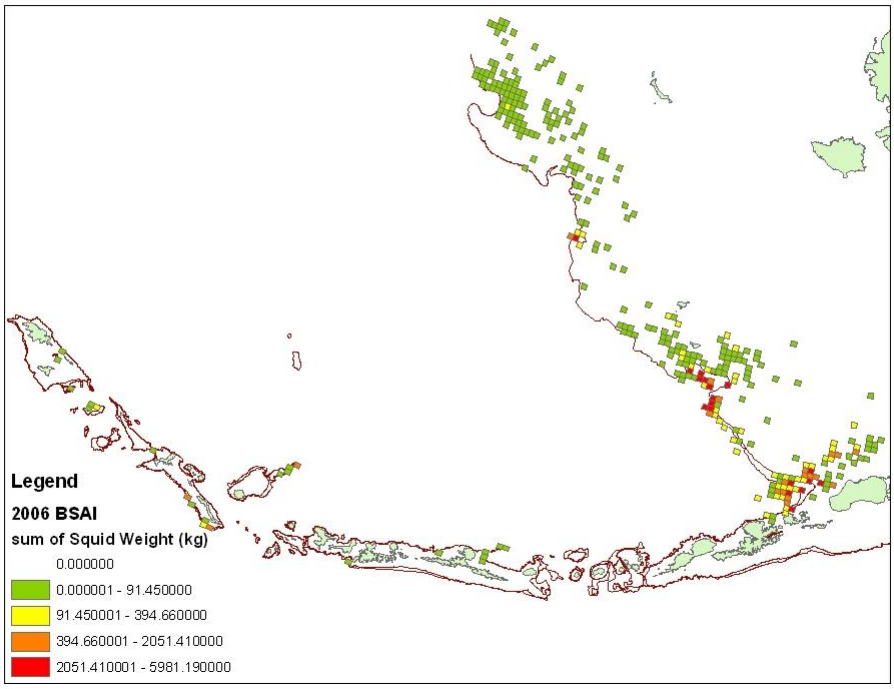


Figure 1. Catches of squids in the BSAI and GOA, 1977-2015. Red bars indicate OFL; green bars indicate ABC; solid bars indicate BSAI; dashed bars indicate GOA.

2006 BSAI



2007 BSAI

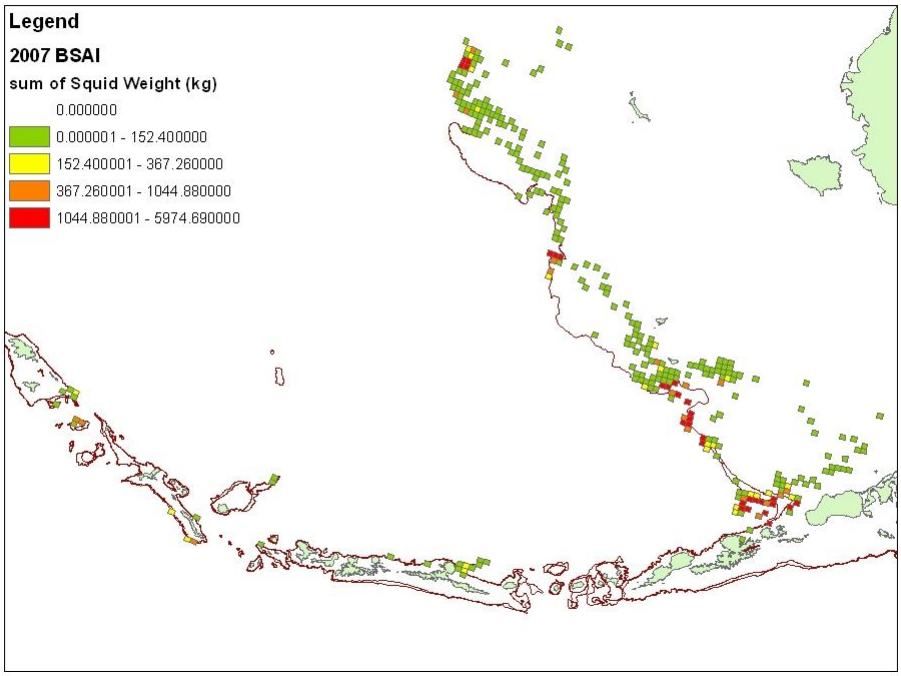


Figure 2. Distribution of annual squid catches from 2006-2007. Each 100 km^2 grid cell depicts the total observed catch in kg. For confidentiality, only grid cells containing data from three unique vessels are shown. Data are from the AFSC Fisheries Monitoring and Analysis program. Catch values delineating color legend are not consistent among years.