Stock structure report for big and longnose skates in the Gulf of Alaska

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Big skate *Beringraja binoculata* (formerly *Raja binoculata*)

SUMMARY TABLE – BIG SKATE	
HARVEST AND TRENDS	
Factor and criterion	Justification
Fishing mortality	Fishing mortality varies by area but is very high in the CGOA ($F > F_{ABC}$).
Spatial concentration of fishery relative to abundance	The fishery is very concentrated in the CGOA, particularly around Kodiak. Fishery concentrations are somewhat similar to survey CPUE patterns.
Population trends	Trends vary by area. Big skates in the CGOA and WGOA are substantially larger than those in the EGOA and may represent the mature portion of a gulfwide population. **A biomass decline in the CGOA is a major concern.**
Barriers and phenotypic characters	
Generation time	Generation time is unknown. Female $A_{50\%}$ maturity is 5 years.
Physical limitations	No physical limitations are known.
Growth differences	Data are insufficient to address this issue.
Age/size-structure (Significantly different size/age compositions)	Length composition differs by area, with smaller and immature more common in the EGOA and larger mature skates more common in the CGOA and WGOA.
Spawning time differences	Data are insufficient to address this issue.
Maturity-at-age/length differences	Data are insufficient to address this issue.
Morphometrics	Data are insufficient to address this issue.
Meristics	Data are insufficient to address this issue.
Behavior & movement	
Spawning site fidelity	Unknown, but it is likely that big skates return to highly localized nursery areas where they deposit their eggcases.
Mark-recapture data	Extensive tagging work in BC, and limited work in Alaska, indicates limited dispersal with some large-scale movements.
Natural tags	Data are insufficient to address this issue.
Genetics	
Isolation by distance	Data are insufficient to address this issue.
Dispersal distance	Data are insufficient to address this issue.
Pairwise genetic differences	Data are insufficient to address this issue.

Harvest and trends- big skate

- *Fishing mortality*: Fishing mortality differs by area (Table B-1). In the WGOA and EGOA, F is low relative to F_{ABC}. Gulfwide, F is approximately half F_{OFL}. In the CGOA, however, fishing mortality is very high and exceeded F_{ABC} every year during 2010-2013.
- *Spatial concentration of fishery*: Big skate landings are highly concentrated in the CGOA, especially in the vicinity of Kodiak (Figures B-1 and B-2). Other areas with high big skate landings are in the Shumagin Islands and Prince William Sound. These areas also tend to have the highest CPUEs in the survey data, but the areas of concentration in the fishery do not completely match the pattern of survey CPUEs.
- *Population trends*: Population trends differ substantially among regions (Figure B-3). Biomass estimates in the EGOA are more variable than in the other areas. This is consistent with length composition data (described below and in Figure B-4) that suggest younger big skates are predominantly found in the EGOA, and then move to the CGOA and WGOA as they grow. Thus the variability in EGOA biomass may represent a recruitment signal. In contrast, biomass trends in the COGA and WGOA are less variable and may indicate a more temporally stable aggregation of older skates. There has been a steady decline in CGOA big skate biomass since 2003, which is a major concern for this stock.

Barriers and phenotypic characters- big skate

- *Generation time*: Generation time is unknown for big skates, but age at 50% maturity ($A_{50\%}$) for females is 4.8 years. Generation time is probably not excessively long for big skates.
- *Physical limitations*: There do not appear to be any physical barriers to movements of big skates.
- *Age/size structure*: Length compositions are different among the areas (Figure B-4). Big skates in the EGOA are smaller than in the other areas and are mostly immature. In contrast, skates in the CGOA and WGOA are larger and mostly mature. With some variability this pattern among areas is consistent over time (Figure B-5), with the highest mean lengths in the WGOA. These patterns suggest a gulfwide population of big skates, with large-scale ontogenetic movements. Large-scale ontogenetic migration has also been observed in Alaska skate *Bathyraja parmifera* in the eastern Bering Sea (Ormseth 2012).
- The other attributes in this section (growth differences, spawn timing, maturity differences, morphometrics, and meristics) cannot be addressed due to a lack of data.

Behavior and movement- big skate

- *Spawning site fidelity*: Fidelity to spawning sites has not been studied in big skates. In general, skates appear to deposit their embryos (protected by eggcases) in small, highly localized nursery areas (Hoff 2007). Nursery areas of other skate species in the Bering Sea have very high densities of eggcases, and skates appear to use the same areas for many years.
- *Mark-recapture data*: Extensive mark-recapture studies of big skates in British Columbia waters suggest that skates show limited dispersal from fairly small areas (King and McFarlane 2010). A small percentage (1.5%) of big skates made large-scale movements (~1,000 km). Pop-up satellite tags are currently being used to study movements of big skates in the GOA (Thomas Ferrugia, UAF, pers. comm. 2014). Preliminary results indicate that some big skates had very limited movements (~10 km) but that several moved over 100 km.
- No data were available regarding natural tags.

Genetics – big skate

- No genetics data are available for big skates.

<u>Summary and conclusions – big skate</u>

Although the data are insufficient to make any firm conclusion regarding stock structure of big skates in the GOA, the available information is consistent with a gulfwide population. Small and immature skates are mainly found in the EGOA, while the CGOA and WGOA have mostly mature skates. This pattern suggests a gulfwide population with ontogenetic movement among areas. The abundance patterns for big skates are consistent with this interpretation: higher variability in the GOA may indicate a recruitment signal, while the lower variability in the CGOA and WGOA is consistent with a group of older skates with less annual variation in abundance. In contrast, the limited movement of big skates in British Columbia waters led researchers there to conclude that separate stocks existed even across small spatial scales (King and McFarlane 2010) and that separate management was warranted.

In sum, this analysis suggests that current management practices with a gulfwide OFL is appropriate for big skates in the GOA management area. However the differences in size, and their implication for the spatial distribution of immature and mature skates, also support the use of area-specific ABCs to limit catches in each area. **The decline of big skate biomass in the CGOA, where F has exceeded F_{ABC} every year during 2010-2013, underlines this point and is of major concern.**

Table 1. Catch statistics for big skates, 2009-2013. "EGOA_1" includes only areas 640 & 650. "EGOA_2" includes areas 640 and 650 as well as areas 649 and 659 (inside waters). Colored shading indicates year/area combinations where F/F_{ABC} exceeded 1.

		2009	2010	2011	2012	2013
WGOA	catch	79	148	110	66	121
	ABC	632	598	598	469	469
	F/F_{ABC}	0.13	0.25	0.18	0.14	0.26
CGOA	catch	1,903	2,215	2,105	1,894	2,303
	ABC	2,065	2,049	2,049	1,793	1,793
	F/F_{ABC}	0.92	1.08	1.03	1.06	1.28
EGOA_1	catch	100	149	90	38	79
	ABC	633	681	681	1,505	1,505
	F/F_{ABC} _1	0.16	0.22	0.13	0.03	0.05
EGOA_2	catch	137	179	134	61	221
	ABC	633	681	681	1,505	1,505
	F/F_{ABC} _2	0.22	0.26	0.20	0.04	0.15
gulfwide	catch	2,119	2,542	2,350	2,021	2,645
	OFL	4,439	4,438	4,438	5,023	5,023
	F/F_{OFL}	0.48	0.57	0.53	0.40	0.53

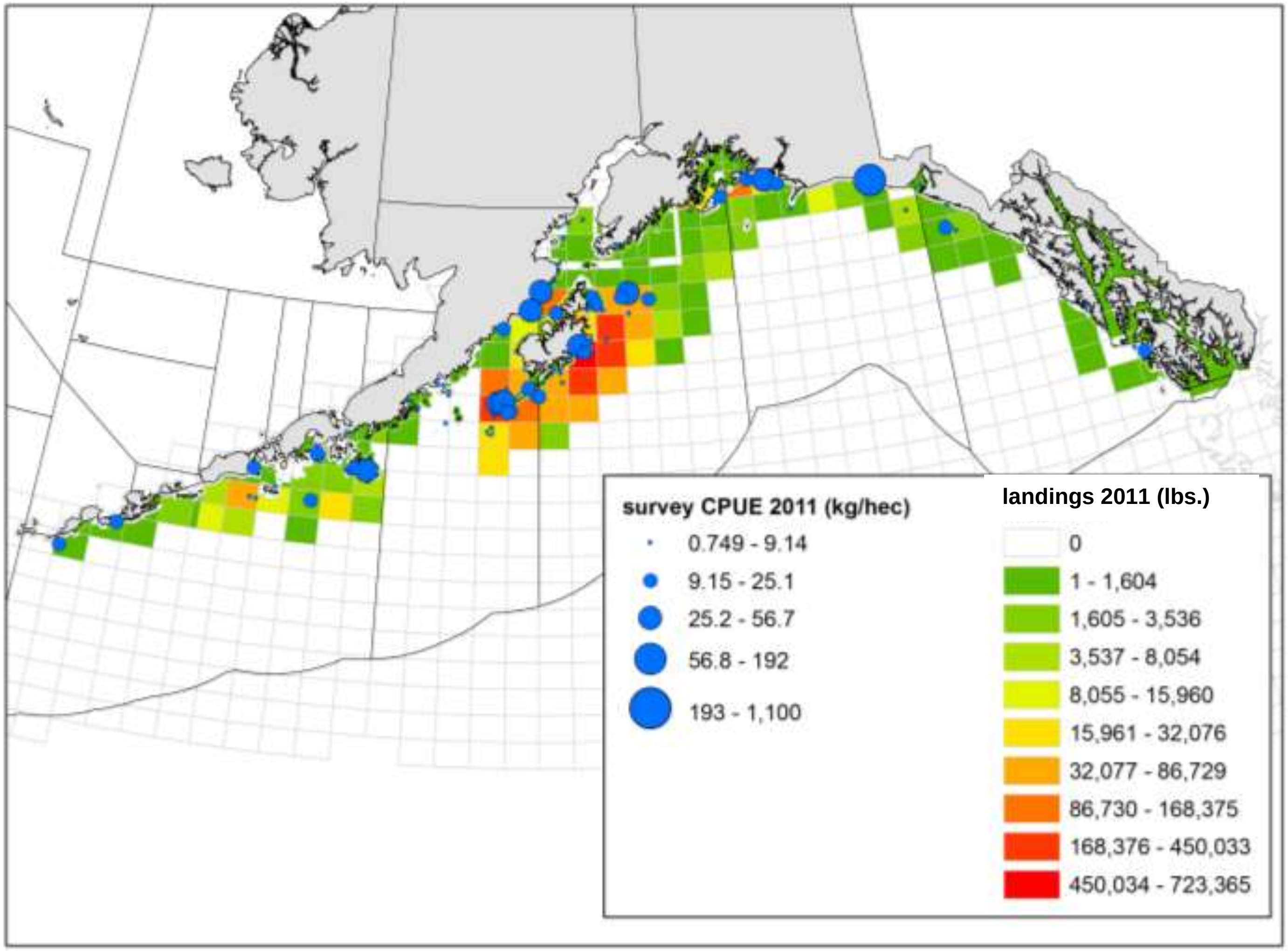

Figure B-1. Bottom trawl survey CPUEs and commercial landings of big skates in the GOA during 2011. Landings data are from ADFG fish tickets and are aggregated by ADFG statistical areas.

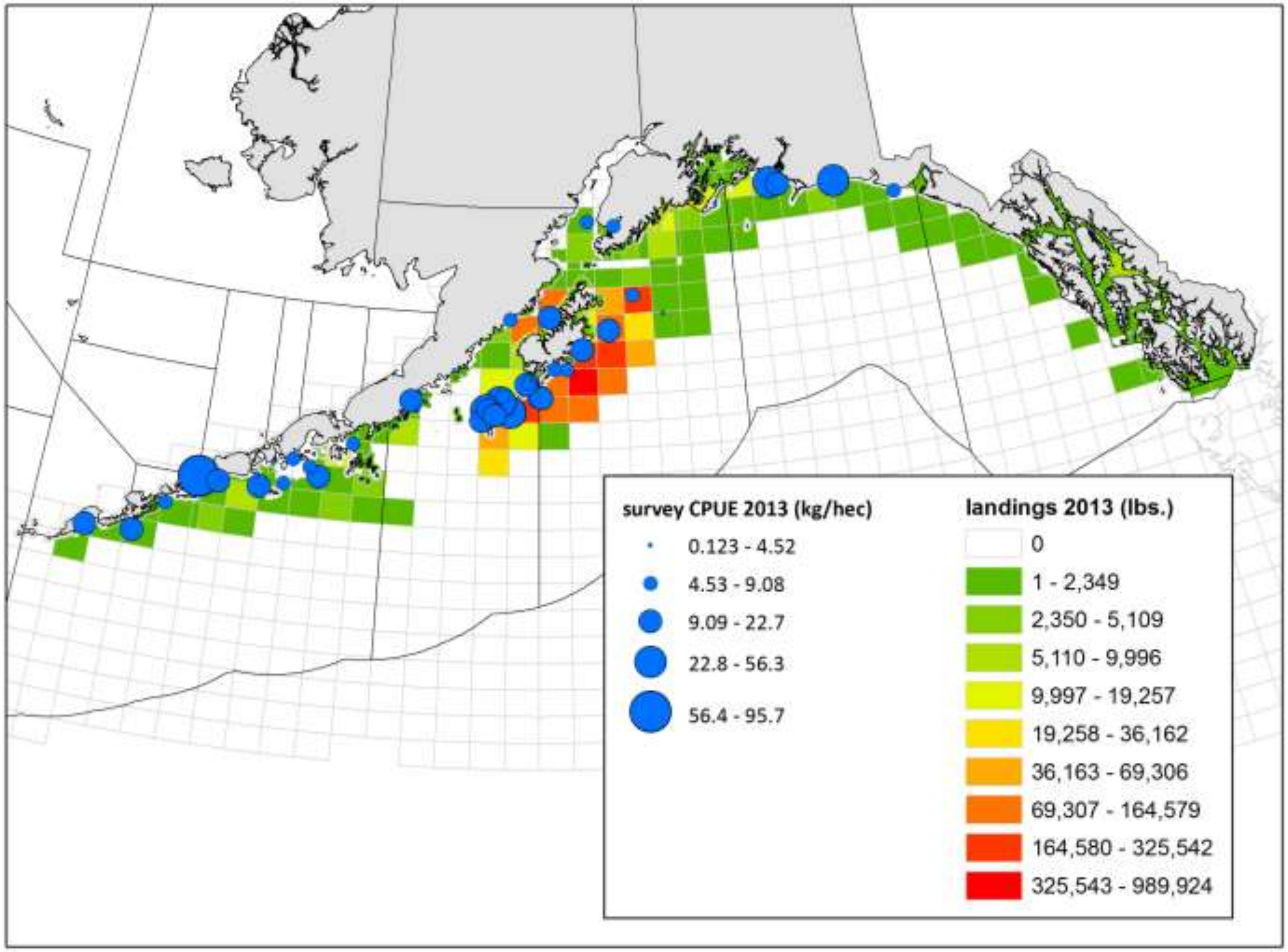

Figure B-2. Bottom trawl survey CPUEs and commercial landings of big skates in the GOA during 2013. Landings data are from ADFG fish tickets and are aggregated by ADFG statistical areas.

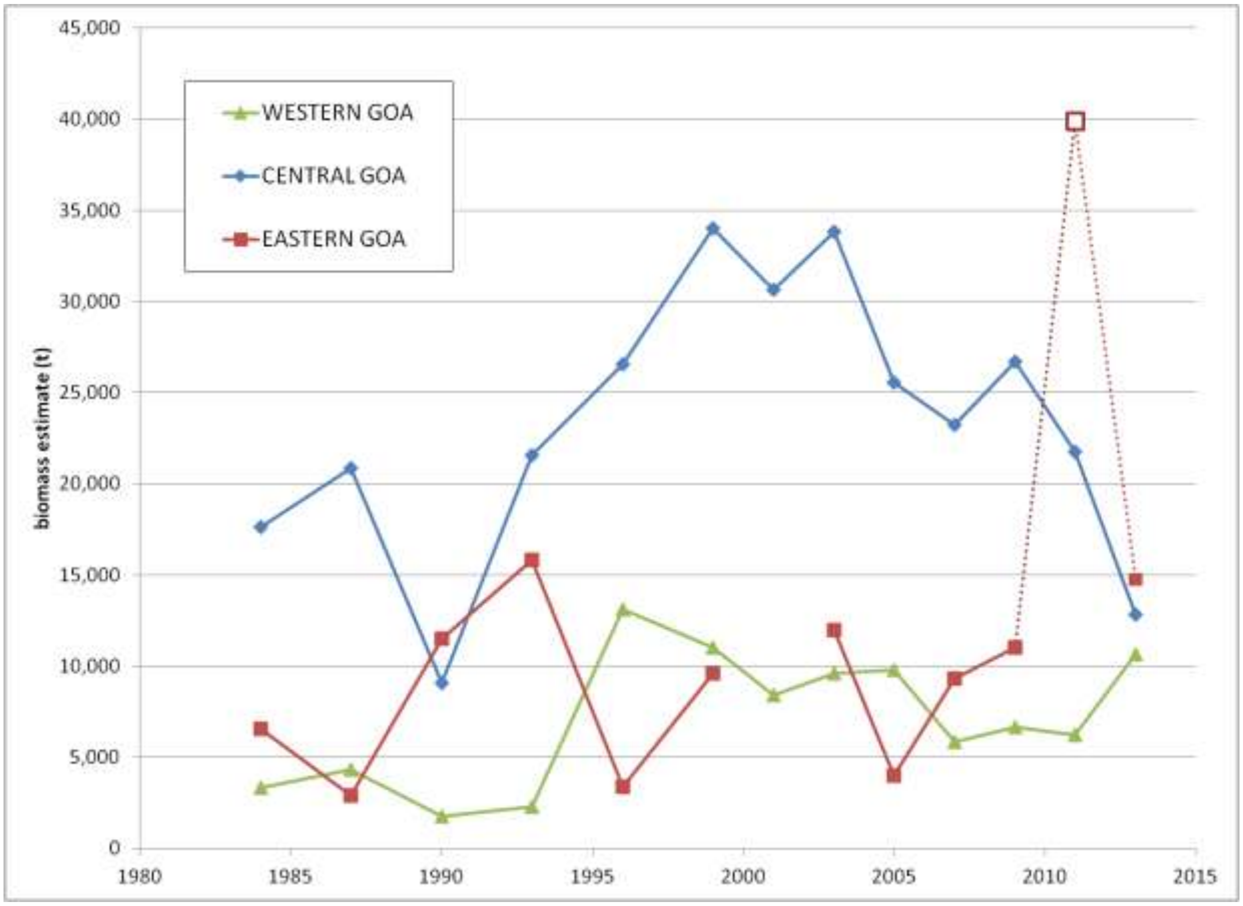

Figure B-3. Time series of survey biomass estimates for big skates in the 3 regulatory areas of the GOA, 1984-2013. Open square and dashed lines in the EGOA dataset indicate the 2011 biomass estimate that was highly influenced by a single vary large tow of big skates and had a much higher CV than the other estimates.

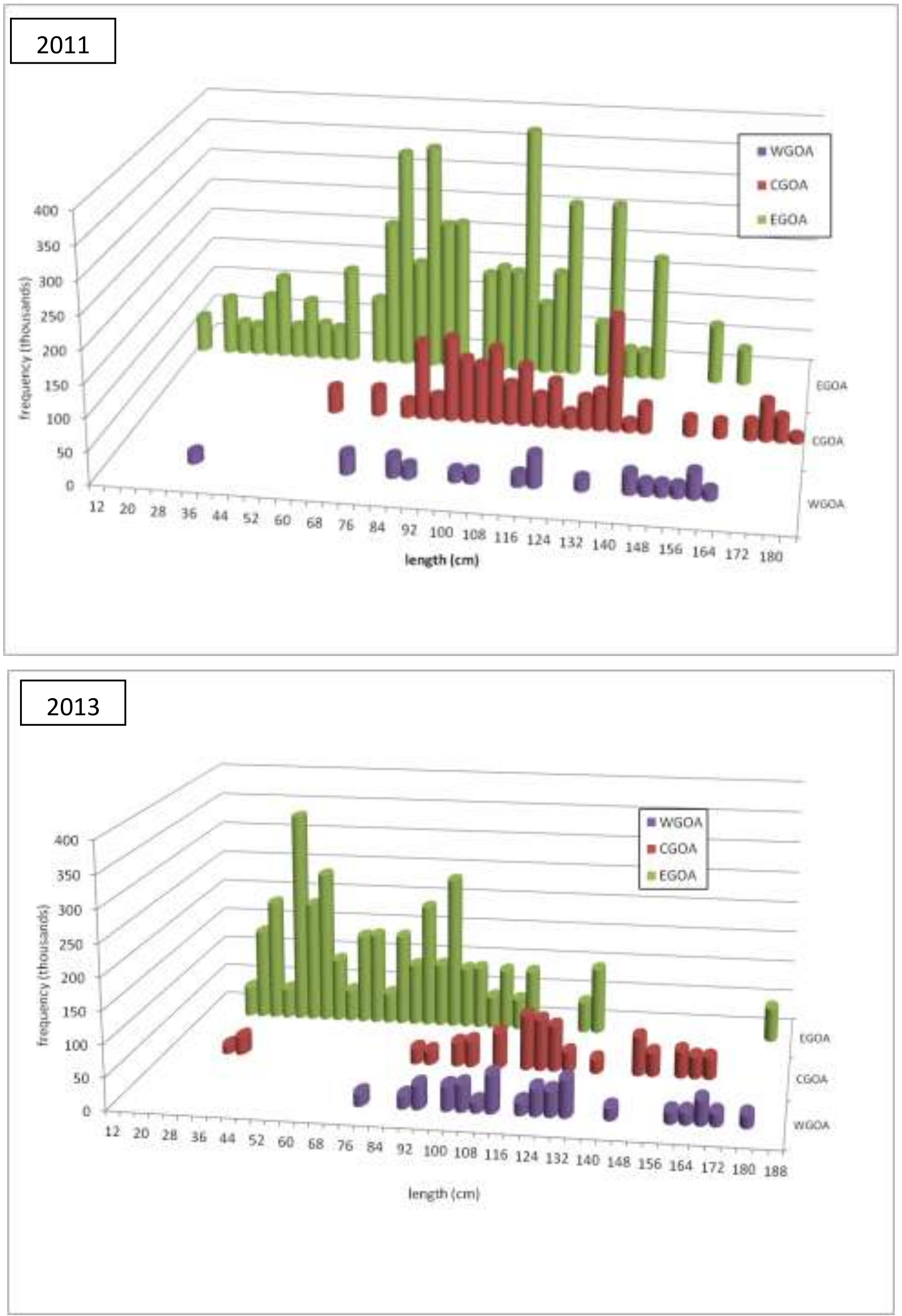

Figure B-4. Trawl survey length compositions of big skates in the GOA, by area, in 2011 (top panel) and 2013 (bottom panel).

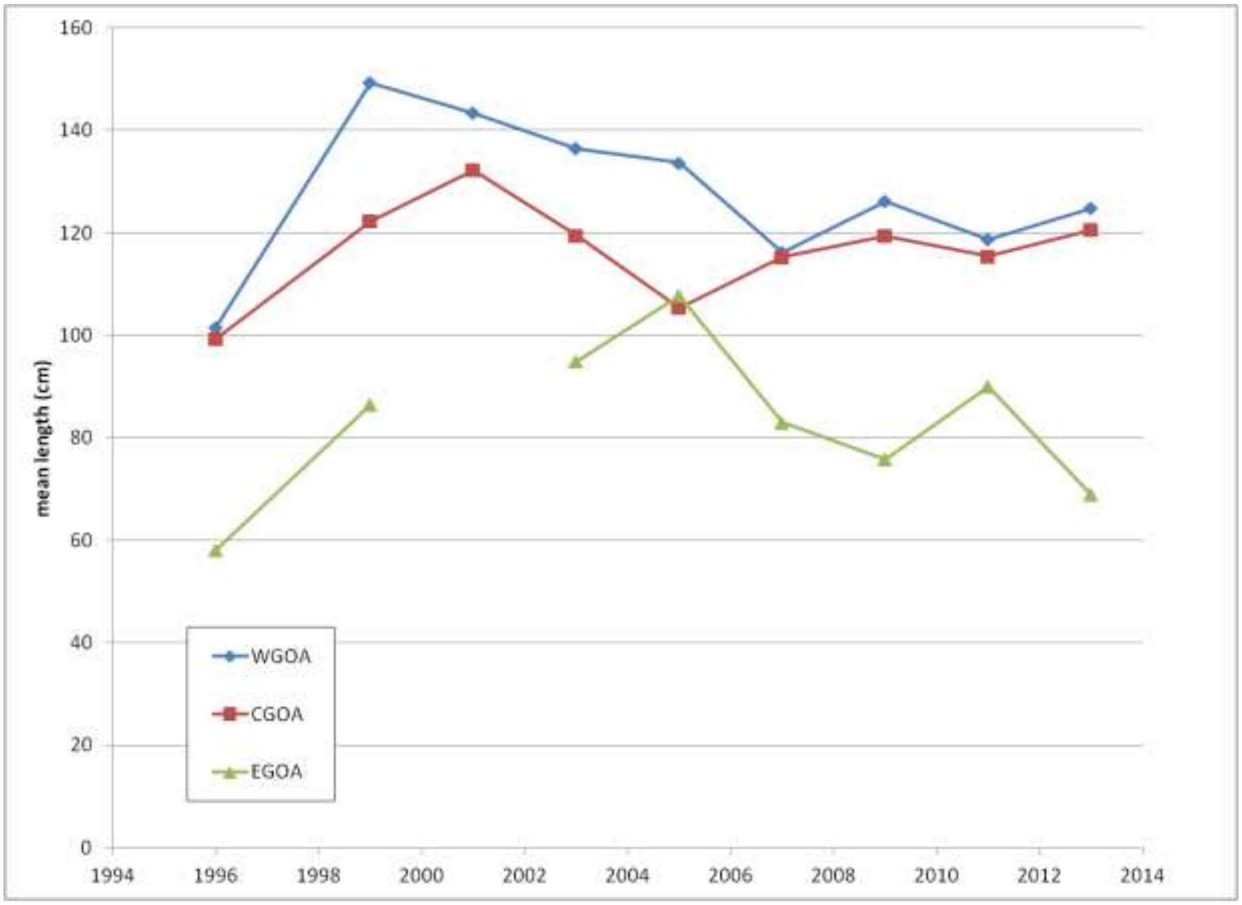

Figure B-5. Annual mean lengths of big skates in the three GOA regulatory areas, 1996-2013.

Longnose skate *Raja rhina*

SUMMARY TABLE – LONGNOSE SKATE	
HARVEST AND TRENDS	
Factor and criterion	Justification
Fishing mortality	Differs by area. $F > F_{ABC}$ in some years in the WGOA, and F may be greater than F_{ABC} in the EGOA depending on which catch data are included.
Spatial concentration of fishery relative to abundance	The fishery is highly concentrated, especially around Kodiak Island. The fishery is more concentrated than are the CPUEs in the survey.
Population trends	Population trends vary substantially among areas. Skate abundance has increased since 1990 in all areas, but the CGOA increase has been much greater than the other areas.
Barriers and phenotypic characters	
Generation time	Unknown, but female $A_{50\%}$ is 12.3 years.
Physical limitations	No physical limitations are known.
Growth differences	Data are insufficient to address this issue.
Age/size-structure	Size structure varies somewhat among the areas. Trends in mean size are fairly similar
Spawning time differences	Data are insufficient to address this issue.
Maturity-at-age/length differences	Data are insufficient to address this issue.
Morphometrics	Data are insufficient to address this issue.
Meristics	Data are insufficient to address this issue.
Behavior & movement	
Spawning site fidelity	Unknown, but it is likely that longnose skates return to highly localized nursery areas where they deposit their eggcases.
Mark-recapture data	Data are insufficient to address this issue.
Natural tags	Data are insufficient to address this issue.
Genetics	
Isolation by distance	Data are insufficient to address this issue.
Dispersal distance	Data are insufficient to address this issue.
Pairwise genetic differences	Data are insufficient to address this issue.

Harvest and trends- longnose skate

- *Fishing mortality*: Fishing mortality for longnose skates varies by area, and results vary depending on whether catch data from inside waters (areas 649 & 659) are included (Table L-1). In the CGOA, F has been approximately ½ of F_{ABC} over the last 5 years. In the WGOA, F has exceeded F_{ABC} in 3 out of the last 5 years. In the EGOA, F was relatively low during 2009-2012 but increased in 2013. When inside waters are included, F was 1.25 times F_{ABC} in 2013. These results are likely due to an increase in catch reporting rather than an increase in the actual F.
- *Spatial concentration of fishery*: The fishery is highly concentrated in several areas (Figures L-1 & L-2). The biggest area of concentration is around Kodiak Island. Landings patterns vary by year but appear to be more highly concentrated than the survey CPUE.
- *Population trends*: The abundance of longnose skates varies among the areas, as does the trend in abundance (Figure L-3). Longnose skates have increased in all areas since 1990, with most of this increase occurring before 2000. The increase has been much greater in the CGOA than in the other two areas, and the WGOA has had the lowest rate of increase.

Barriers and phenotypic characters- longnose skate

- *Generation time*: Generation time is not known for longnose skates. However $A_{50\%}$ for female and male longnose skates is 12.3 and 9 years, respectively. This suggests that generation time is relatively long for this species.
- *Physical limitations*: There are no apparent physical barriers to dispersal for this species in the GOA.
- *Age/size structure*: Length compositions vary somewhat among the areas (Figure L-4). Unlike big skates, however, these differences are minor and do not appear to represent separate segments of a gulfwide population. Mean size has varied over time in each area, and the trends in mean size are fairly similar among areas (Figure L-5).
- The other attributes in this section (growth differences, spawn timing, maturity differences, morphometrics, and meristics) cannot be addressed due to a lack of data.

Behavior and movement- longnose skate

- *Spawning site fidelity*: Fidelity to spawning sites has not been studied in longnose skates. In general, skates appear to deposit their embryos (protected by eggcases) in small, highly localized nursery areas (Hoff 2007). Nursery areas of other skate species in the Bering Sea have very high densities of eggcases, and skates appear to return to the same area for many years.
- No mark-recapture or natural-tag data exist for longnose skates.

Genetics- longnose skate

- No genetics data are available for big skates.

Summary and conclusions- longnose skate

In contrast to big skates, the data for longnose are not indicative of a gulfwide longnose skate population. Although the data are insufficient to conclude that separate longnose populations exist in the GOA, the different abundance trends and the differences in size structure are consistent with some degree of separation of stocks. Investigation of stock structure in GOA longnose skates is a priority for research.

In sum, the use of area-specific ABCs for skate management is warranted by the available data. If better evidence of discrete longnose stocks become available it may also be appropriate to define area-specific OFLs for this species. The problem of unknown stock structure is exacerbated in longnose skates due to the high concentration of fishery removals and their vulnerable life history strategy.

Table L-1. Catch statistics for longnose skates, 2009-2013. “EGOA_1” includes only areas 640 & 650. “EGOA_2” includes areas 640 and 650 as well as areas 649 and 659 (inside waters). Colored shading indicate area/year combinations where F/F_{ABC} was greater than 1.

		2009	2010	2011	2012	2013
WGOA	catch	79	106	71	37	90
	ABC	78	81	81	70	70
	F/F_{ABC}	1.02	1.31	0.88	0.52	1.28
CGOA	catch	1,096	851	892	786	1,260
	ABC	2041	2009	2009	1879	1879
	F/F_{ABC}	0.54	0.42	0.44	0.42	0.67
EGOA_1	catch	244	132	68	79	426
	ABC	768	762	762	676	676
	F/F_{ABC} _1	0.32	0.17	0.09	0.12	0.63
EGOA_2	catch	320	198	118	119	846
	ABC	768	762	762	676	676
	F/F_{ABC} _2	0.42	0.26	0.16	0.18	1.25
gulfwide	catch	1,495	1,155	1,082	941	2,195
	OFL	3,849	3,803	3,803	3,500	3,500
	F/F_{OFL}	0.39	0.30	0.28	0.27	0.63

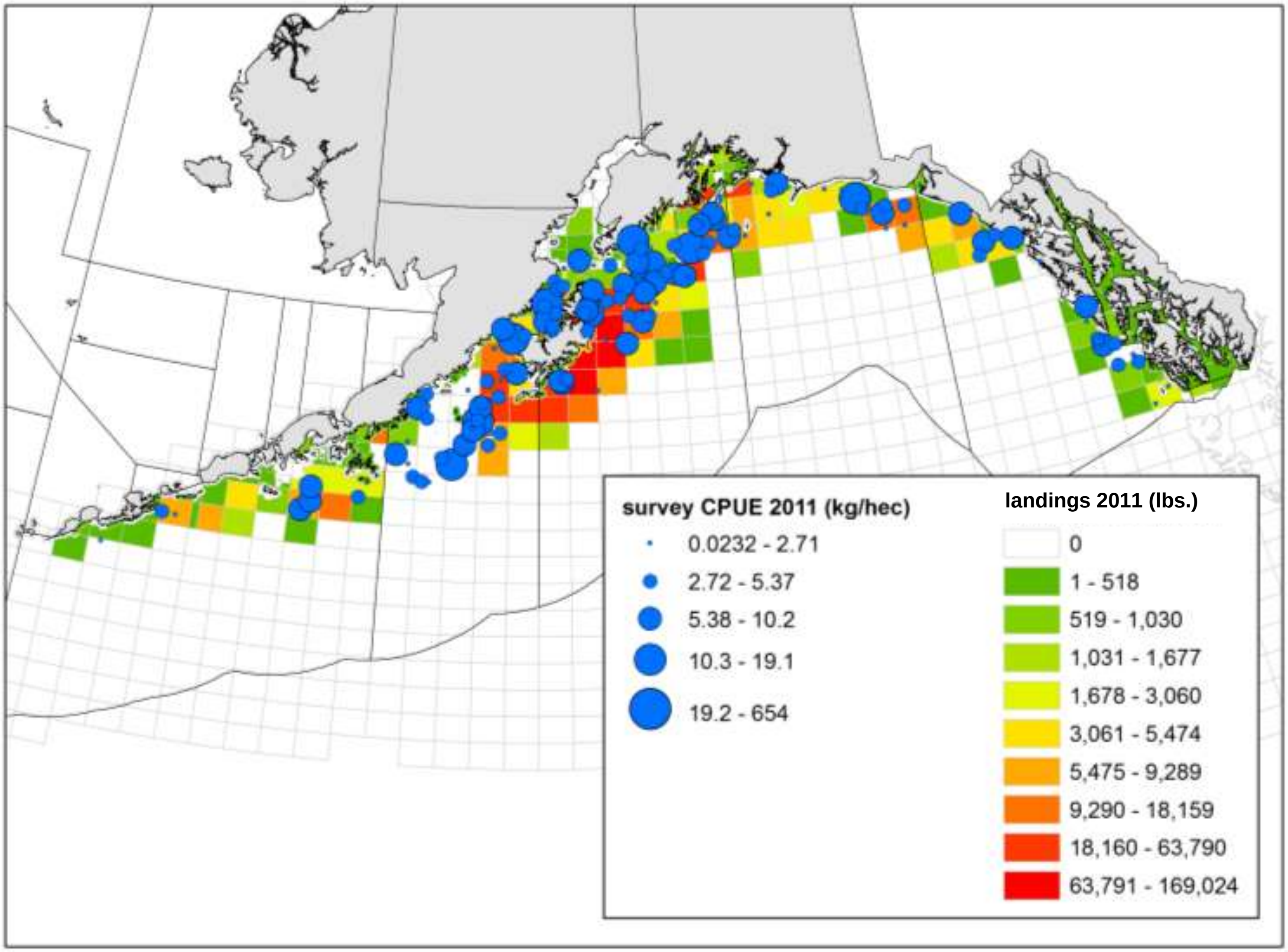

Figure L-1. Bottom trawl survey CPUEs and commercial landings of longnose skates in the GOA during 2011. Landings data are from ADFG fish tickets and are aggregated by ADFG statistical areas.

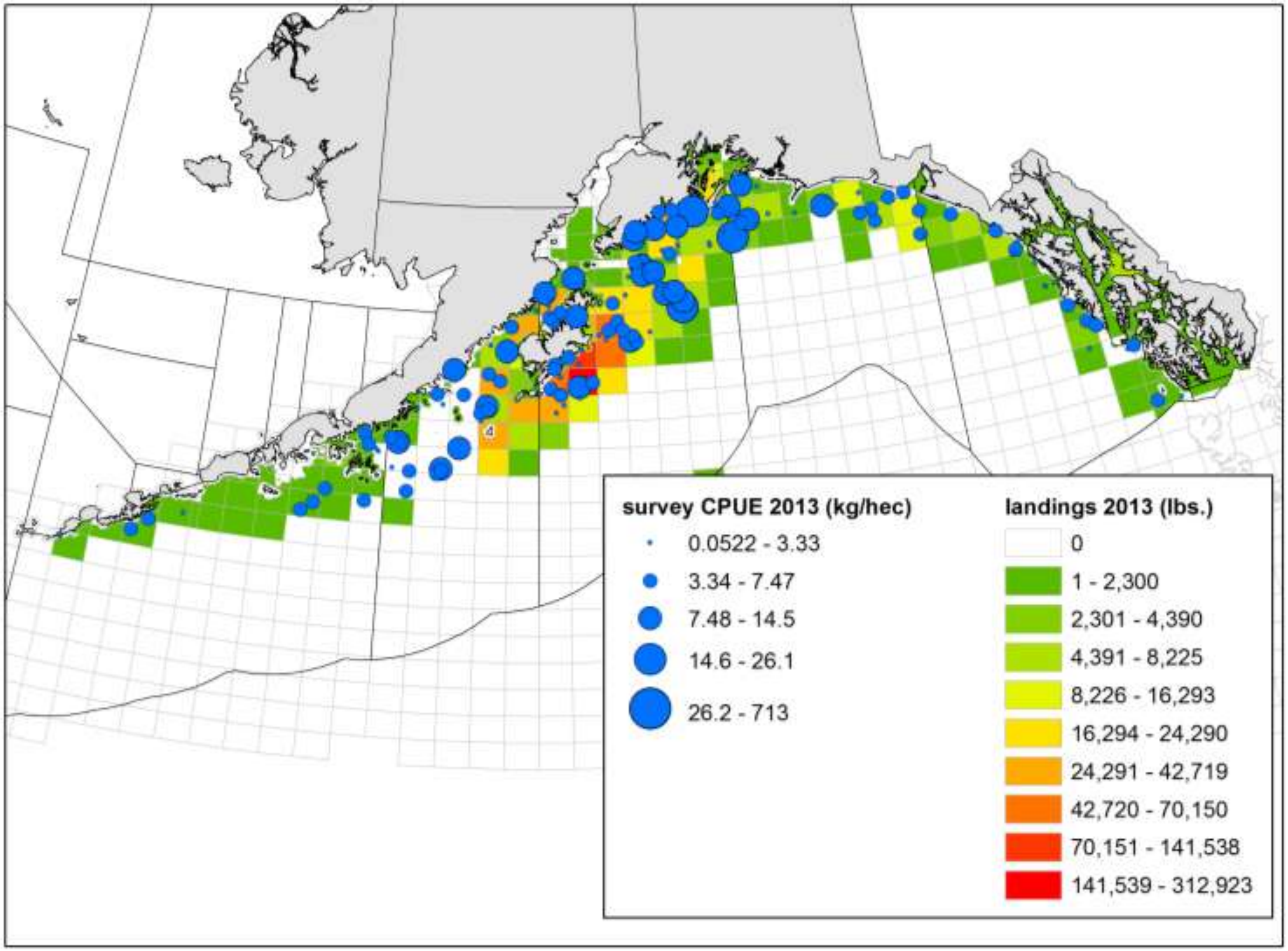

Figure L-2. Bottom trawl survey CPUEs and commercial landings of longnose skates in the GOA during 2013. Landings data are from ADFG fish tickets and are aggregated by ADFG statistical areas.

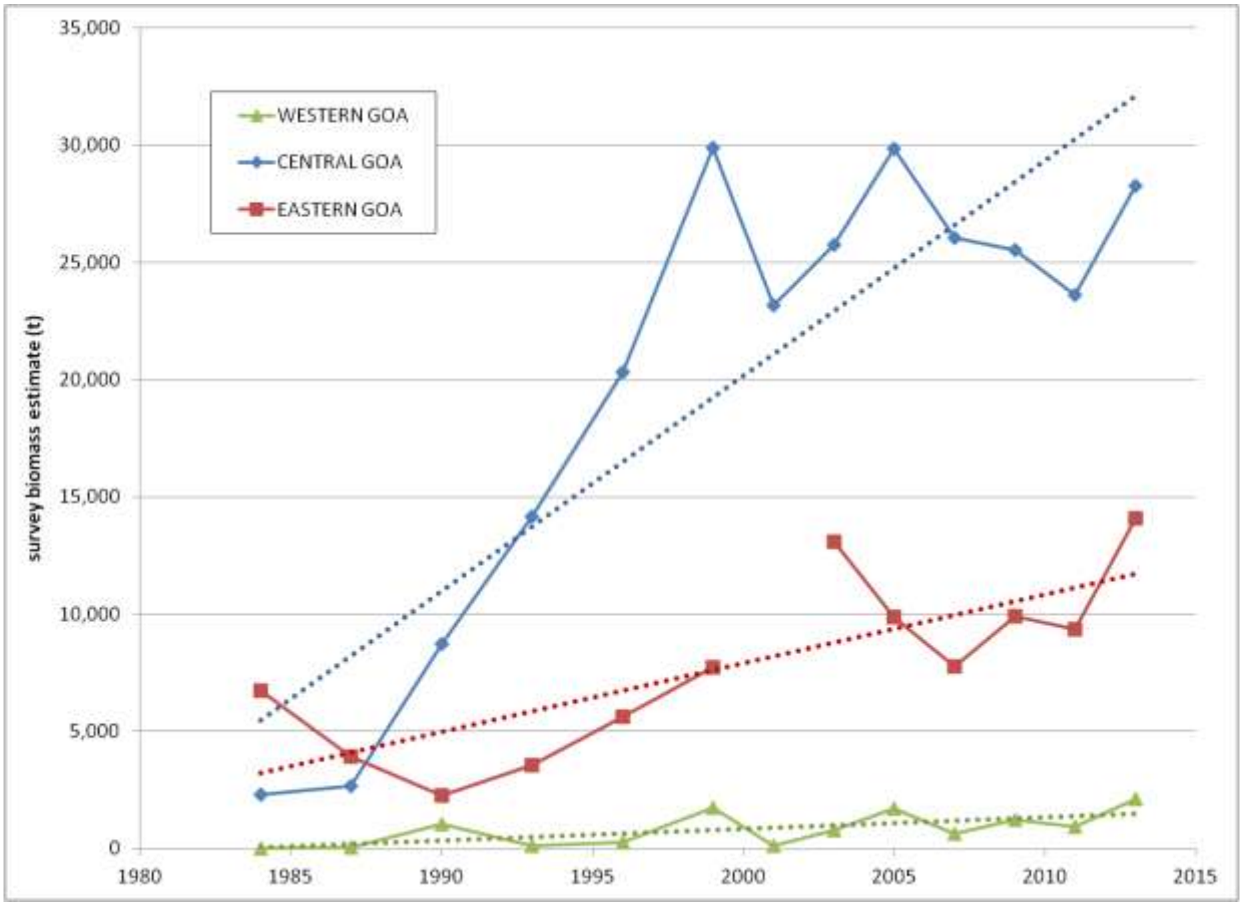

Figure L-3. Time series of survey biomass estimates for longnose skates in the 3 regulatory areas of the GOA, 1984-2013.

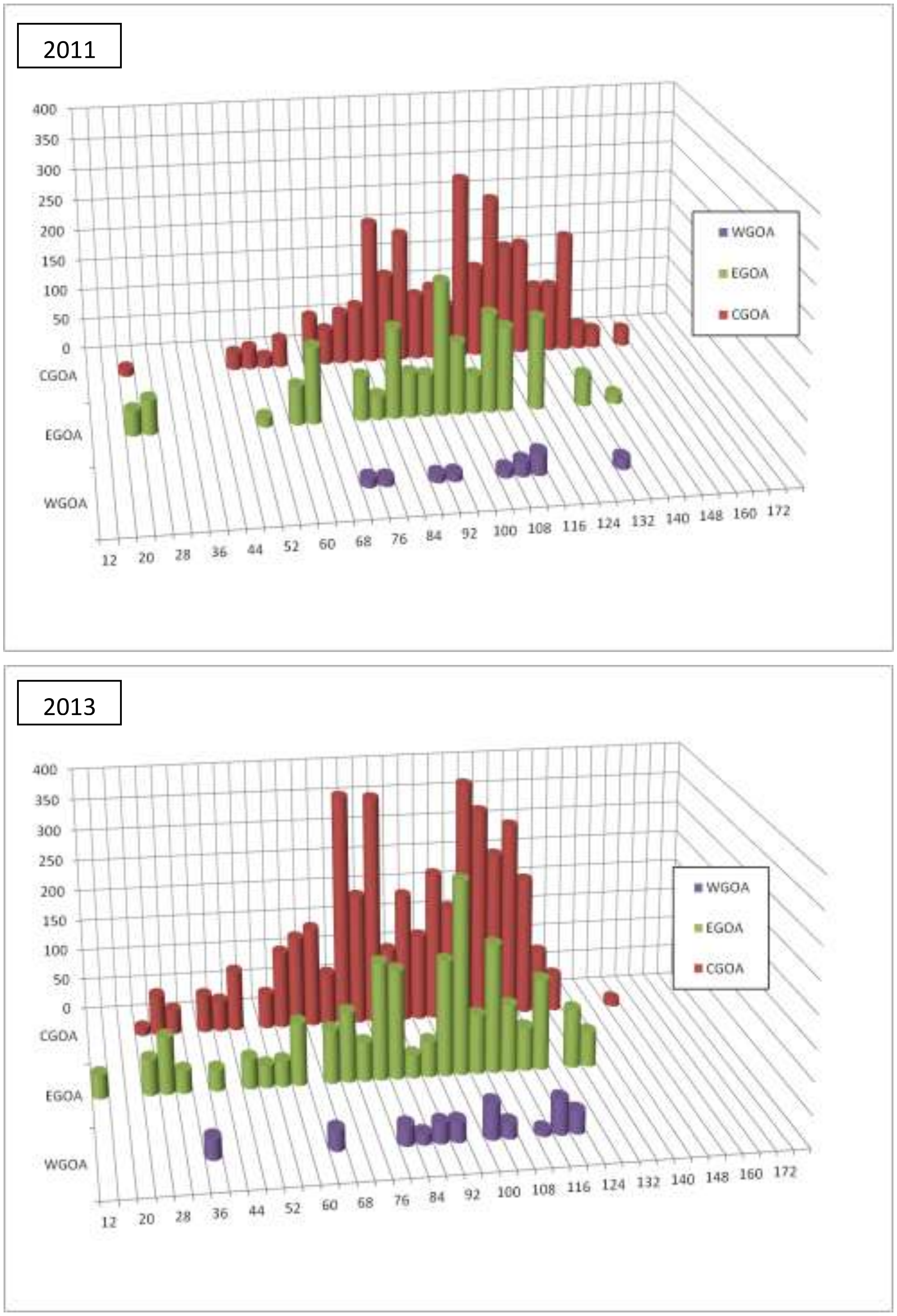

Figure L-4. Trawl survey length compositions of longnose skates in the GOA, by area, in 2011 (top panel) and 2013 (bottom panel).

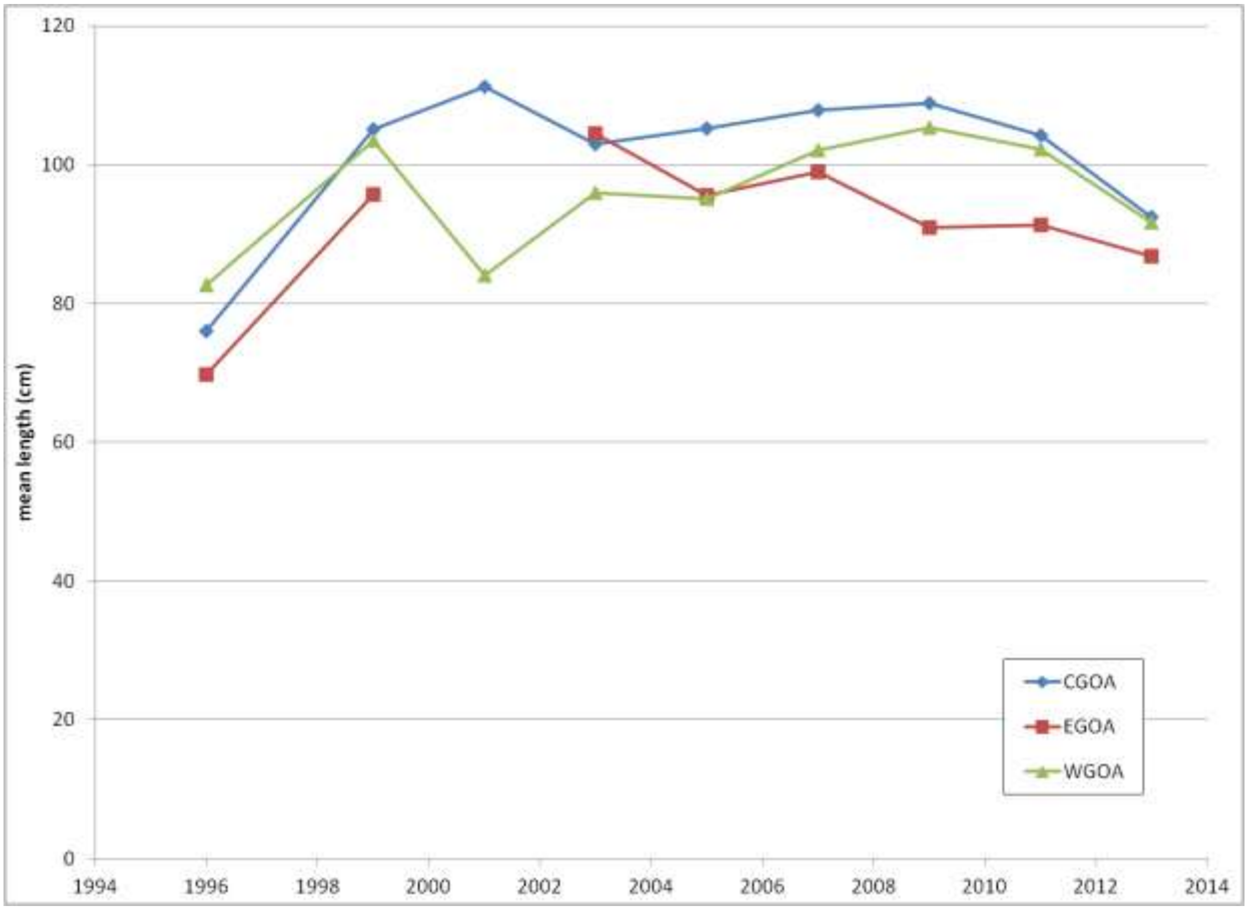

Figure L-5. Annual mean lengths of longnose skates in the three GOA regulatory areas, 1996-2013.

Literature Cited

Hoff GR (2007) Reproduction of the Alaska skate (*Bathyraja parmifera*) with regard to nursery sites, embryo development and predation. PhD dissertation, University of Washington, Seattle.

King JR and GA McFarlane (2010) Movement patterns and growth estimates of big skate (*Raja binoculata*) based on tag-recapture data. Fisheries Research 101: 50-59

Ormseth O (2012) Bering Sea and Aleutian Islands skates. IN: Stock assessment and fishery evaluation report for the groundfish resources of the Bering Sea/ Aleutian Islands regions. North Pacific Fishery Management Council, Anchorage, AK 99501