18. Assessment of the Skates Stock Complex in the Gulf of Alaska

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Executive Summary

Directed fishing of skates is currently prohibited in the Gulf of Alaska (GOA). However, incidental catches of skates in other fisheries are sufficiently high enough that skates are considered to be "in the fishery" and require harvest specifications. The GOA skate complex is managed as three separate units: big skate (*Beringraja binoculata*), longnose skate (*Raja rhina*) and other skates. Big and Longnose skates have GOA-wide overfishing limits (OFLs) while the Acceptable Biological Catches (ABCs) are region specific (western [WGOA], central [CGOA], and eastern [EGOA]). Remaining skate species are managed as an "other skates" group, with GOA-wide harvest specifications. All GOA skates are managed under Tier 5, where OFL and ABC are based on survey biomass estimates and natural mortality rate (*M*).

Summary of Changes in Assessment Inputs

Changes in the input data:

1. Updated catch estimates from 2022 and 2023 (2023 catch data as of October 16, 2023)

2. Biomass estimates from the 2023 GOA bottom trawl survey.

Changes in the assessment methodology:
No changes were made to the assessment methodology.

Summary of Results

For 2024, the recommended maximum allowable ABC from the Tier 5 specifications for Big skate is 745 t in WGOA, 1,749 t in CGOA and 341 t in EGOA. The specifications for Longnose skate is 104 t in WGOA, 1,894 t in CGOA and 538 t in EGOA. The specifications for Other skates is 665 t. Reference values for all skates are summarized in the following tables, with the recommended ABC and OFL values for 2024 in bold. In the tables below W, C, and E indicate the Western, Central, and Eastern GOA regulatory regions respectively.

Big skate (*Beringraja binoculata*)					
Quantity		As estimated or *specified last* year for: 2023	2024	As estimated or *recommended this* year for: **2024**	2025
M (natural mortality rate)		0.1	0.1	0.1	0.1
Tier		5	5	5	5
Biomass (t)	W	7,882	7,882	9,934	9,934
	C	19,756	19,756	23,326	23,326
	E	10,581	10,581	4,545	4,545
	GOA Wide	38,220	38,220	37,804	37,804
F_{OFL}		0.100	0.100	0.100	0.100
$maxF_{ABC}$		0.075	0.075	0.075	0.075
F_{ABC}		0.075	0.075	0.075	0.075
OFL (t)	GOA Wide	3,822	3,822	**3,780**	3,780
*max*ABC (t)	W	591	591	745	745
	C	1,482	1,482	1,749	1,749
	E	794	794	341	341
ABC (t)	W	591	591	**745**	745
	C	1,482	1,482	**1,749**	1,749
	E	794	794	**341**	341
Status		As determined *last* year for: 2021	2022	As determined *this* year for: 2022	2023
Overfishing?		No	n/a	No	n/a

Longnose skate (*Raja rhina*)					
Quantity		As estimated or *specified last* year for: 2023	2024	As estimated or *recommended this* year for: **2024**	2025
M (natural mortality rate)		0.1	0.1	0.1	0.1
Tier		5	5	5	5
Biomass (t)	W	2,013	2,013	1,384	1,384
	C	27,258	27,258	25,249	25,249
	E	6,890	6,890	7,172	7,172
	GOA Wide	36,162	36,162	33,804	33,804
F_{OFL}		0.100	0.100	0.100	0.100
$maxF_{ABC}$		0.075	0.075	0.075	0.075
F_{ABC}		0.075	0.075	0.075	0.075
OFL (t)	GOA Wide	3,616	3,616	**3,380**	3,380

Longnose skate (*Raja rhina*)					
		As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
Quantity		2023	2024	**2024**	2025
*max*ABC (t)	W	151	151	104	104
	C	2,044	2,044	1,894	1,894
	E	517	517	538	538
ABC (t)	W	151	151	**104**	104
	C	2,044	2,044	**1,894**	1,894
	E	517	517	**538**	538
		As determined *last* year for:		As determined *this* year for:	
Status		2021	2022	2022	2023
Overfishing?		No	n/a	No	n/a

Other skates (*Bathyraja*)				
	As estimated or *specified last* year for:		As estimated or *recommended this* year for:	
Quantity	2023	2024	**2024**	2025
M (natural mortality rate)	0.1	0.1	0.1	0.1
Tier	5	5	5	5
Biomass (t)	13,114	13,114	8,869	8,869
F_{OFL}	0.100	0.100	0.100	0.100
$maxF_{ABC}$	0.075	0.075	0.075	0.075
F_{ABC}	0.075	0.075	0.075	0.075
OFL (t)	1,311	1,311	**887**	887
*max*ABC (t)	984	984	665	665
ABC (t)	984	984	**665**	665
	As determined *last* year for:		As determined *this* year for:	
Status	2021	2022	2022	2023
Overfishing?	No	n/a	No	n/a

None of the three assessment groups experienced overfishing in 2022. This statement was determined by comparing the catch in 2022 to the associated OFL. For Big skate, the catch and OFL were 1,031 t and 3,822 t. For Longnose skate, the catch and OFL were 998 t and 3,616 t and for Other skates, the catch and OFL were 981 t and 1,311 t.

As of October 16, 2023, none of the assessments groups are experiencing overfishing; Big skate catch and OFL are 792 t and 3,822 t, Longnose skate catch and OFL are 1,055 t and 3,616 t and Other skate catch and OFL are 316 t and 1,311 t. As for 2023 ABCs, Big and Other skates have catches below their regional

ABCs (Tables 18-1 and -2). Longnose skate has catches below their regional ABCs except for EGOA where the catch is larger than teh regional ABC (607 t catch and 517 t ABC) (Table 18-3).

Responses to SSC and Plan Team Comments on Assessments in General

There were no comments related to this assessment from the SSC or Plan Team.

Responses to SSC and Plan Team Comments Specific to this Assessment

There were no comments on this assessment from the SSC or Plan Team.

Introduction

The full introduction can be found in the 2021 GOA skate assessment (Ormseth 2021). What follows is an abbreviation of the 2021 introduction.

Description, scientific names, and general distribution

Skates (family *Rajidae*) are flat-bodied cartilaginous fishes related to sharks. At least 15 species of skates in four genera (*Raja*, *Beringraja*, *Bathyraja*, and *Amblyraja*) are commonly found in shallow inshore waters to very deep benthic habitats in Alaskan waters (Eschmeyer *et al.* 1983; Stevenson *et al.* 2007). In the GOA, the most common skate species are the Longnose skate (*Raja rhina*) and the Big skate (*Beringraja binoculata*). The range of the Big skate extends from the Bering Sea to southern Baja California in depths ranging from 2 to 800 m. The Longnose skate has a similar range, from the southeastern Bering Sea to Baja California in 9 to 1,069 m depths (Love *et al.* 2005). While these two species have wide depth ranges, they are generally found in shallow waters in the GOA. The remaining 13 species, all from the family *Bathyraja*, are treated as one group called "Other skates" in this assessment since they are markedly less common. Within this group, the three most common species are the Aleutian skate (*B. aleutica*), the Alaska skate (*B. parmifera*), and the Bering skate (*B. interrupta*). The Aleutian skate ranges throughout the north Pacific from northern Japan to northern California and has been found in waters 16 to 1,602 m deep. The Alaska skate is restricted to higher latitudes from the Sea of Okhotsk to the eastern Gulf of Alaska in depths from 17-392 m (Stevenson *et al.* 2007). The range of the Bering skate is difficult to determine at this time as it may actually be a complex of species, with each individual species occupying a different part of its general range from the western Bering Sea to southern California (Love *et al.* 2005; Stevenson *et al.* 2007).

The species within the skate assessment occupy different habitats and regions within the GOA groundfish Fishery Management Plan. This assessment distinguishs habitat primarily by depth for GOA skates. The highest biomass of skates is found in the shallowest continental shelf waters of less than 100-m depth and is normally dominated by Big skates, while Longnose skates are the most abundant species in the 101-200 m depth zone. Skates in the *Bathyraja* genus are dominant in the deeper waters extending from 200 to 1000 m or more in depth. These depth distributions are reflected in the spatial distribution of GOA skates. Big skates are located inshore and are most abundant in the central and western GOA. Longnose skates are located further offshore and are relatively less abundant in the western GOA.

Life history and stock structure

Skate life cycles are similar to sharks, with relatively low fecundity, slow growth to large body sizes, and dependence of population stability on high survival rates of a few well-developed offspring (Moyle and Cech 1996). Sharks and skates in general have been classified as "equilibrium" life history strategists, with very low intrinsic rates of population increase implying that sustainable harvest is possible only at very low to moderate fishing mortality rates (King and McFarlane 2003). Within this general equilibrium

life history strategy, there can still be considerable variability between skate species in terms of life history parameters (Walker and Hislop 1998).

While smaller-sized skate species have been observed to be somewhat more productive, large skate species with late maturation (11+ years) are most vulnerable to heavy fishing pressure (Walker and Hislop 1998; Frisk *et al.* 2001, 2002). Several studies have explored the effects of fishing on a variety of skate species to determine which life-history traits and stages are the most important for management. Age and size at maturity and adult size/longevity appear to be more important predictors of resilience to fishing pressure than fecundity or egg survival. Skate species with the largest adult body sizes (and the empirically related large size/age at maturity, Frisk *et al.* (2001)) were least resilient to high fishing mortality rates. This is most often attributed to the long juvenile stage during which relatively large yet immature skates are exposed to fishing mortality. After an extensive review of population information for many elasmobranch species, Frisk *et al.* (2001) recommended that precautionary management be implemented especially for the conservation of large species.

Fishery

A full description of the fishery history can be found in the 2021 GOA skate assessment (Ormseth 2021). What follows are any recent significant changes to the fishery or management measures.

Directed fishery, bycatch, and discards in federal waters

There has been no directed fishery for skates since 2005. There are incidental catches of skate in other fisheries such as arrowtooth flounder and Pacific Cod. In January 2016, the Alaska Regional Office indefinitely reduced the maximum retainable amount of all skates from 20% to 5%.

Management units

Since 2005, Big skates and Longnose skates have had separate ABCs and TACs for WGOA, CGOA and EGOA to address concerns about disproportionate harvest of skates. Other skates continue to be managed as a Gulf-wide species complex because they are not generally retained and are difficult to distinguish at the species level. See Tables 18-1, -2 and -3 and Figures 18-1 and -2 for a time series of the total catch, TAC, ABC and OFL for the three assessment groups.

Data

Fishery

Catch

See Tables 18-1, -2 and -3 and Figures 18-1 and -2 for a time series of the total catch for the three assessment groups from 2005 to 2023. The 2023 catch data are incomplete. They were last updated on October 16, 2023.

Age and Size Composition

Fishery observers have been collecting length composition data since 2009. However, they are not used to determine stock status for any of the three assessment groups.

Survey

There are several potential indices of skate abundance in the Gulf of Alaska, including longline and trawl surveys. For this assessment, only the AFSC bottom trawl surveys 1984-2023 is used when determining harvest recommendations and biomass estimates since it has the most comprehensive spatial coverage of the available surveys. Information on the other potential indices can be found in the 2021 GOA skate assessment (Ormseth 2021).

AFSC bottom trawl survey biomass estimates

The AFSC bottom trawl survey was a triennial survey until 2003 when it became biannual. Biomass estimates from the survey for all three assessments groups can be found in Table 18-4. The survey biomass estimates for Big and Longnose skates has been pretty stable for the past five years with little evidence of the population increasing or decreasing (Figure 18-3). The 2023 survey biomass estimate for Big skate estimate increased by 15% while the Longnose survey biomass estimate decreased by 9% when compared to the previous (2021) survey biomass estimate. Both are well within the 2021 survey biomass estimated confidence intervals. As for Other skates, their survey biomass estimates declining from 2013 to 2019. It has remained around the same low level ever since. The 2023 survey biomass estimate (8,617 t) is the lowest value since 1993 (Figure 18-3).

The GOA regional survey biomass estimates for Big skate are in Table 18-5. These survey estimates have larger coefficient of variance (CV) when compared to the GOA-wide estimates. Big skate are most abundant in CGOA. The survey biomass estimates in CGOA and WGOA appears relatively stable though there is a lot of variability. The EGOA survey biomass estimates have been declining since 2019 with the lowest survey biomass estimate (3,258 t) occurring in 2023 (Figure 18-4). It is difficult to determine the severity of this decline given the large CVs.

The GOA regional survey biomass estimates for Longnose skate are in Table 18-6. These survey estimates also have larger CVs when compared to the GOA-wide estimates. Longnose skate are the most abundant in CGOA. The survey biomass estimates in all three areas appear to be relatively stable thought there is a lot of variability (Figure 18-5).

Analytical approach

All three GOA skates assessment groups are Tier 5 stocks that require an estimated biomass time series. A random effects (RE) model within the REMA model R package (Sullivan *et al.* 2022) was used to produce biomass estimates suitable for harvest recommendations. The REMA model is a generalized random effects model for fitting biomass estimates with the option of including multiple survey strata. For each assessment group (Big, Longnose, and Other), a GOA-wide RE model was used to determine the recommended OFL and GOA-wide ABC. For Big and Longnose skates, a regional-specific (Western, Central and Eastern) REMA model was run to determine the proportion of the GOA-wide biomass within each region. The biomass in each region was determined by multiplying the proportion, determined by the region specific REMA model, by the GOA-wide biomass, determined by GOA-wide RE model. The confidence intervals for the region specific biomass was determined by assuming the standard error of the log of the proportion by region multiplied by the GOA-wide biomass was equivalent to the standard error of the log of the region specific biomass determined by the region specific REMA model.

Parameter Estimates

Natural Mortality (M)

An M value of 0.1 was used for all three GOA skate assessment groups.

Results

For all three assessment groups, the GOA-wide projected biomass for 2024 was lower than the projected biomass for 2023 from last years assessment. For Big and Longnose skates, the decrease was small (38,220 t to 37,804 t, a 1.09% decline for Big skate and 36,162 t to 33,804 t, a 6.52% decline for Longnose skate). The decline in Other skates was the largest (13,114 t to 8,869 t, a 32.37% decline for Other skates). Other skates had a large decline from 2013 to 2019 and have remained low ever since. It is difficult to say whether Other skates biomass is still declining however the 2023 estimate (8,869 t) is the lowest since 1995.

The region specific biomass estimates for Big and Longnose skates can be used to determine whether changes to the population biomass are GOA-wide or region specific. For Big skate, the WGOA and CGOA projected biomass for 2024 was higher than the their projected biomass for 2023 from last years assessment (7,882 t to 9,934 t, a 26.03% increase for WGOA and 19,756 t to 23,326 t, a 18.07% increase for CGOA). The only area that had a decrease was EGOA (10,581 t to 4,545 t, a 57.05% decline). EGOA has the smallest estimated biomass out of all three areas and is at its lowest estimated value since 1990. The exploitation rate (catch/biomass) for EGOA has been relatively high for the past four years when compared to the entire exploitation rate time series except for 2006 (Figure 18-6). However, the total catch of Big skate in EGOA has remained below the TAC since at least 2005 (Figure 18-2).

As for the Longnose skate region specific biomass estimates, they all declined except for EGOA (2,013 t to 1,384 t, a 31.25% decrease for WGOA, 27,258 t to 25,249 t, a 7.37% decrease for CGOA and 6,890 t to 7,172 t, a 4.09% increase for EGOA). The largest decline occurred in WGOA which had the smallest estimated biomass. It is difficult to determine if this decrease is a sign of a declining population in WGOA or if this is just variability in the survey biomass estimates, which has wide confidence intervals, or natural annual variability (Figure 18-5). It is also important to point out that, as of October 16, 2023, the catch in EGOA is above the ABC (Figure 18-2). This is the first time this has happened since at least 2005. However, the catch in EGOA has been close to the ABC for the past two years. Also, for the past two years the exploitation rate in EGOA has been high when compared to the entire exploitation rate time series. The highest exploitation rate occurred in 2023 (Figure 18-6).

Exploitation Rates

The GOA-wide exploitation rates have alot of inter-annual variability (Figure 18-7). Other skates tend to have the highest exploitation rates with considerable inter-annual variability (values ranging from 0.094 - 0.035 since 2016). Big and Longnose skates have had low exploitation rates with values below 0.04 since 2017. The area specific exploitation rates for Big skate show a declining trend for CGOA and WGOA while EGOA has been increasing since 2019. In 2023, all three areas have exploitation rates below 0.03, as of October 16, 2023 (Figure 18-6). As for Longnose skate area specific exploitation rates, CGOA has been declining since 2013 with a 2023 value of 0.015, EGOA has been increasing since 2018 with a 2023 value of 0.085 and WGOA has alot of interannual variability with a 2023 value of 0.042. All the 2023 Longnose skate area specific exploitation rate values are as of October 16, 2023 (Figure 18-6).

Harvest Recommendations

Amendment 56 Reference Points

All three skate assessment groups are a Tier 5 stock. Therefore harvest recommendations are based on an estimated biomass time series (B_{est}). The harvest recommendations are calculating as follows; $F_{OFL} = M$, $OFL = F_{OFL} * B_{est}$ and $ABC_{max} = 0.75 * OFL$ where ABC_{max} is the maximum permissible ABC.

Specification of OFL and Maximum Permissible ABC
Big skate

The REMA model biomass estimate of Big skate for 2024 is 37,804 t, therefore the OFL = 3,780 t and ABC_{max} = 2,835 t. The regional biomass estimates are 9,934 t (26.3%) for the WGOA; 23,326 t (61.7%) for the CGOA; and 4,545 t (12%) for the EGOA. The resulting region-specific ABCs are 745 t for the WGOA; 1,749 t for the CGOA; and 341 t for the EGOA.

Longnose skate

The REMA model biomass estimate of Longnose skate for 2024 is 33,804 t, therefore the OFL = 3,380 t and ABC_{max} = 2,536 t. The regional biomass estimates are 1,384 t (4.1%) for the WGOA; 25,249 t (74.7%) for the CGOA; and 7,172 t (21.2%) for the EGOA. The resulting region-specific ABCs are 104 t for the WGOA; 1,894 t for the CGOA; and 538 t for the EGOA.

Other skates

The REMA model estimate of Other skate biomass for 2024 is 8,869 t, therefore the OFL = 887 t and ABC_{max} = 665 t. The Other skate ABC is not apportioned among regions.

Status Determination

None of the three assessment groups experienced overfishing in 2022. This statement was determined by comparing the catch in 2022 to the associated OFL. For Big skate, the catch and OFL were 1,031 t and 3,822 t. For Longnose skate, the catch and OFL were 998 t and 3,616 t and for Other skates, the catch and OFL were 981 t and 1,311 t.

Risk Table and ABC recommendation

The following template is used to complete the risk table:

	Assessment-related considerations	***Population dynamics considerations***	***Environmental/ecosystem considerations***	***Fishery Performance***
Level 1: No Conern	Typical to moderately increased uncertainty/minor unresolved issues in assessment.	Stock trends are typical for the stock; recent recruitment is within normal range.	No apparent environmental/ecosystem concerns	No apparent fishery/resource-use performance and/or behavior concerns
Level 2: Major Concern	Major problems with the stock assessment; very poor fits to data; high level of uncertainty; strong retrospective bias.	Stock trends are highly unusual; very rapid changes in stock abundance, or highly atypical recruitment patterns.	Multiple indicators showing consistent adverse signals a) across the same trophic level as the stock, and/or b) up or down trophic levels (i.e., predators and prey of the stock)	Multiple indicators showing consistent adverse signals a) across different sectors, and/or b) different gear types
Level 3: Extreme concern	Severe problems with the stock assessment; severe retrospective bias. Assessment considered unreliable.	Stock trends are unprecedented; More rapid changes in stock abundance than have ever been seen previously, or a very long stretch of poor recruitment compared to previous patterns.	Extreme anomalies in multiple ecosystem indicators that are highly likely to impact the stock; Potential for cascading effects on other ecosystem components	Extreme anomalies in multiple performance indicators that are highly likely to impact the stock

Evaluation of risk for GOA skates (all species) in 2023

Assessment-related considerations
Skates in the GOA are managed under Tier 5 and are thus by definition data-limited. Skate biomass is reliably estimated by the bottom trawl survey and the REMA model performs well for all stocks and stock/region combinations. There are no considerations that would warrant reducing the ABC below maximum permissible. Rated Level 1, No Concern.

Population dynamics considerations
The GOA-wide biomass of Big and Longnose skates have been relatively stable since 2005. There is a little concern about the low biomass estimates in EGOA for Big skate and the high catch in EGOA for Longnose skate. However, the biomass estimates in EGOA for Big skate have historically been low and the biomass estimates for Longnose skate in EGOA appear unaffected by the increase in catch. The biomass for Other skates is approximately the same as in 1996, so the low biomass is not unprecedented, and it appears to have been at the level for the past five years. As a result of these observations there are no undue concerns regarding dynamics. Rated Level 1, No Concern.

Environmental/Ecosystem considerations
The most recent data available suggest an ecosystem risk Level 1 – No Concern: "No apparent environmental/ecosystem concerns" given moderate environmental conditions, limited and mixed information on the abundance of prey, predators, and competitors, and a lack of a mechanistic understanding for the direct and indirect effects of environmental change on the survival and productivity of skates. The Skate complex is dominated in biomass by the Big skate (*Beringraja binoculata*) and Longnose skate (*Raja rhina*), and also includes the Aleutian skate (*Bathyraja aleutica*), the Bering skate (*B. interrupta*), and the Alaska skate (*B. parmifera*). This summary of environmental considerations for the Skate complex is based on Big skate, a representative of the dominant species retained catch by biomass and minor species of skates (the Aleutian skate, Bering skate and Alaska skate).

Environment: While optimal temperatures for skate life stages (all demersal) are not known, it is reasonable to expect that the 2023 average ocean temperatures at depth on the shelf edge and shelf were adequate for skates (AFSC longline survey: Siwicke (2023), AFSC bottom trawl survey, O'Leary (2023)). Big skate are primarily found in western and central GOA, at depths of 2-800m, but primarily in nearshore waters at depths less than 100m. Skates spawn and eggs develop on the upper slope and outer shelf, and after hatching distribute across the shelf as juveniles and adults. Growth and development times for skate embryos are directly related to temperature and nursery sites occur within a narrow, undefined range of temperature on the shelf edge (Hoff 2008). Bottom temperatures on the shelf edge were average in 2023 but have been above average since 2019, with unknown potential impacts on skate embryos. Winds and surface currents can increase transport of eggs and larvae from offshore to nearshore nursery areas, and eddy activity can retain larvae nearshore (Bailey *et al.* 2008). The winter of 2022/2023 had variable eddy kinetic energy across the GOA, with above average eddy kinetic energy in the Haida and Seward locations and below average in the Sitka and Kodiak eddy locations, producing approximately average potential transport of larvae onto the shelf habitat (Cheng 2023).

Prey: The status of skate prey was unknown with signs of decrease, although considered adequate given their generalist feeding habits. Small skates typically consume small crustaceans and polychaetes, while larger skates consume shrimp, crab, and fishes (Orlov 1998, 2003; Yang 2007; Kemper *et al.* 2017). There were signs of decreased abundance in invertebrate prey (Tanner crab, shrimp, motile epifauna), although Tanner crab remains relatively high (ADF&G trawl survey: Worton (2023), AFSC bottom trawl survey: Whitehouse (2023)). Polychaetes and infauna are not well monitored.

Predators & Competitors: There is no cause to suspect increased predation or competitive pressure on the Skate complex. Primary predators of skates include Pacific cod and P. halibut, for larval skates,

marine mammals (including sperm whales, sea lions) and dogfish, for adult skates. P. cod and P. halibut populations remain at relatively low abundance (Hulson *et al.* 2023). Populations of Steller sea lions (5%-45% frequency of occurrence of skates in diet, Trites *et al.* (2007)) have stabilized (eastern GOA) or remain greatly reduced (western GOA). Sperm whale populations (28% diet is skate, Wild *et al.* (2020)) are not well known but not expected to have changed. Competitors with overlapping habitat and diets, may include deepwater flatfish (Dover sole) and rex sole.

Fishery performance
As a nontarget stock, catches of skates in the GOA are influenced by their abundance and by the behavior of target fisheries. Recent changes in maximum retention amounts appear to have reduced targeting and retention of skates. Rated Level 1, No Concern.

Summary of risk evaluation: Proper evaluation of risk is difficult for a data-limited stock. However, the available data suggest no concerns that rise above Level 1. No reduction to maximum ABC is recommended.

Summary and ABC recommendation

Assessment-related considerations	*Population dynamics considerations*	*Environmental/ecosystem considerations*	*Fishery Performance*
Level 1: No Concern	Level 1: No Concern	Level 1: No Concern	Level 1: No Concern

Ecosystem Considerations

A full description of the ecosystem considerations can be found in the 2021 GOA skate assessment (Ormseth 2021). There is also a thorough ecological description in the **Risk Table and ABC recommendation** segment under the **Results** section.

Data Gaps and Research Priorities

A full description of the data gaps and research priorities can be found in the 2021 GOA skate assessment (Ormseth 2021). What follows is an abbreviation from the 2021 GOA skate assessment.

It appears that a larger proportion of skate mortality in the GOA comes from fishing mortality rather than predation. Therefore, the highest priority research should continue to focus on direct fishing effects. It is also important to continue research on the productive capacity of skate populations, including information on age, growth, maturity, fecundity, and habitat associations.

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Tables

Table 18-1. Harvest specifications and catch (t) for Big skates in GOA, 2005-2023 (the current management regime for GOA skates was initiated in 2005). The ABC and catch are divided into three GOA regulatory regions; Western (W), Central (C), Eastern (E)). R is the percent of Total Catch retained.

	Catch					OFL	ABC				TAC			
Year	**W**	**C**	**E**	**Total**	**R**	**Total**	**W**	**C**	**E**	**Total**	**W**	**C**	**E**	**Total**
2005	26	811	65	903	72%	5,332	727	2,463	809	3,999	727	2,463	809	3,999
2006	72	1,272	344	1,688	54%	4,726	695	2,250	599	3,544	695	2,250	599	3,544
2007	69	1,518	8	1,594	49%	4,726	695	2,250	599	3,544	695	2,250	599	3,544
2008	132	1,241	45	1,418	70%	4,398	632	2,065	633	3,330	632	2,065	633	3,330
2009	79	1,903	100	2,082	70%	4,398	632	2,065	633	3,330	632	2,065	633	3,330
2010	148	2,236	149	2,533	71%	4,438	598	2,049	681	3,328	598	2,049	681	3,328
2011	110	2,109	90	2,309	80%	4,438	598	2,049	681	3,328	598	2,049	681	3,328
2012	66	1,902	38	2,005	94%	5,023	469	1,793	1,505	3,767	469	1,793	1,505	3,767
2013	121	2,321	91	2,533	62%	5,023	469	1,793	1,505	3,767	469	1,793	1,505	3,767
2014	159	1,396	99	1,654	26%	5,016	589	1,532	1,641	3,762	589	1,532	1,641	3,762
2015	236	1,211	56	1,503	16%	5,016	731	1,257	1,267	3,255	731	1,257	1,267	3,255
2016	167	1,854	50	2,071	33%	5,086	908	1,850	1,056	3,814	908	1,850	1,056	3,814
2017	194	1,453	84	1,730	32%	5,086	908	1,850	1,056	3,814	908	1,850	1,056	3,814
2018	303	929	78	1,310	39%	3,797	504	1,774	570	2,848	504	1,774	570	2,848
2019	132	1,117	102	1,351	48%	3,797	504	1,774	570	2,848	504	1,774	570	2,848
2020	31	811	180	1,023	54%	4,278	758	1,560	890	3,208	758	1,560	890	3,208
2021	126	429	189	744	16%	4,278	758	1,560	890	3,208	758	1,560	890	3,208
2022	164	766	100	1,031	15%	3,822	591	1,482	794	2,867	591	1,482	794	2,867
2023	47	629	116	792	21%	3,822	591	1,482	794	2,867	591	1,482	794	2,867

Table 18-2. Harvest specifications and catch (t) for Other skates in GOA, 2005-2023 (the current management regime for GOA skates was initiated in 2005). Retained is the percent of Catch retained.

Year	Catch	Retained	OFL	ABC	TAC
2005	711	16%	1,769	1,327	1,327
2006	1,393	19%	2,156	1,617	1,617
2007	1,257	20%	2,156	1,617	1,617
2008	1,374	15%	2,806	2,104	2,104
2009	1,548	13%	2,806	2,104	2,104
2010	1,496	15%	2,791	2,093	2,093
2011	1,388	16%	2,791	2,093	2,093
2012	1,207	13%	2,706	2,030	2,030
2013	1,903	2%	2,706	2,030	2,030
2014	1,896	6%	2,652	1,989	1,989
2015	1,775	6%	2,652	2,235	2,235
2016	1,637	6%	2,558	1,919	1,919
2017	1,665	7%	2,558	1,919	1,919
2018	746	6%	1,845	1,384	1,384
2019	897	8%	1,845	1,384	1,384
2020	487	1%	1,166	875	875
2021	733	4%	1,166	875	875
2022	981	10%	1,311	984	984
2023	316	7%	1,311	984	984

Table 18-3. Harvest specifications and catch (t) for Longnose skates in GOA, 2005-2023 (the current management regime for GOA skates was initiated in 2005). The ABC and catch are divided into three GOA regulatory regions; Western (W), Central (C), Eastern (E)). R is the percent of Total Catch retained.

	Catch					OFL	ABC				TAC			
Year	**W**	**C**	**E**	**Total**	**R**	**Total**	**W**	**C**	**E**	**Total**	**W**	**C**	**E**	**Total**
2005	37	993	162	1,192	70%	3,757	66	1,972	780	2,818	66	1,972	780	2,818
2006	57	682	219	957	32%	3,860	65	1,969	861	2,895	65	1,969	861	2,895
2007	76	978	342	1,396	29%	3,860	65	1,969	861	2,895	65	1,969	861	2,895
2008	34	965	113	1,112	59%	3,849	78	2,041	768	2,887	78	2,041	768	2,887
2009	79	1,096	244	1,419	45%	3,849	78	2,041	768	2,887	78	2,041	768	2,887
2010	106	868	131	1,106	63%	3,803	81	2,009	762	2,852	81	2,009	762	2,852
2011	70	898	74	1,042	60%	3,803	81	2,009	762	2,852	81	2,009	762	2,852
2012	39	802	93	934	70%	3,500	70	1,879	676	2,625	70	1,879	676	2,625
2013	86	1,267	443	1,797	37%	3,500	70	1,879	676	2,625	70	1,879	676	2,625
2014	59	1,159	336	1,554	55%	3,835	107	1,935	834	2,876	107	1,935	834	2,876
2015	137	1,173	349	1,660	53%	3,835	152	2,090	976	3,218	152	2,090	976	3,218
2016	155	889	348	1,391	33%	4,274	61	2,513	632	3,206	61	2,513	632	3,206
2017	189	766	316	1,271	26%	4,274	61	2,513	632	3,206	61	2,513	632	3,206
2018	57	593	233	882	33%	4,763	149	2,804	619	3,572	149	2,804	619	3,572
2019	60	630	315	1,005	29%	4,763	149	2,804	619	3,572	149	2,804	619	3,572
2020	21	363	265	648	30%	3,449	158	1,875	554	2,587	158	1,875	554	2,587
2021	40	522	470	1,032	9%	3,449	158	1,875	554	2,587	158	1,875	554	2,587
2022	68	517	413	998	8%	3,616	151	2,044	517	2,712	151	2,044	517	2,712
2023	59	389	607	1,055	5%	3,616	151	2,044	517	2,712	151	2,044	517	2,712

Table 18-4. Gulf-wide biomass estimates (t) and coefficients of variation (CV) for the three assessment groups in the Gulf of Alaska from 1990-2023. Observed are from the AFSC bottom trawl survey and the Predicted are from the random effects model fitted to the survey time series (REMA model). L95% and U95% are the bounds of the 95% confidence interval for the predicted index.

	Big Skate					Longnose Skate					Other Skate				
	Observed		Predicted			Observed		Predicted			Observed		Predicted		
Year	Index	CV	Index	L95%	U95%	Index	CV	Index	L95%	U95%	Index	CV	Index	L95%	U95%
1990	22,316	0.25	34,823	22,261	54,475	11,995	0.22	15,200	10,747	21,498	13,921	0.25	11,378	7,108	18,212
1991			36,123	24,674	52,884			16,267	11,724	22,572			7,052	3,483	14,279
1992			37,471	27,321	51,392			17,409	13,083	23,167			4,371	2,052	9,311
1993	39,733	0.18	38,869	30,197	50,033	17,803	0.12	18,632	15,135	22,937	1,449	0.32	2,709	1,392	5,273
1994			40,180	31,758	50,836			20,812	16,165	26,794			4,089	1,914	8,737
1995			41,536	33,395	51,661			23,246	18,064	29,916			6,171	3,114	12,229
1996	43,064	0.18	42,937	35,108	52,510	26,226	0.14	25,966	21,126	31,915	9,746	0.19	9,313	6,611	13,119
1997			44,363	35,708	55,117			28,786	22,296	37,165			11,718	6,132	22,391
1998			45,838	36,328	57,836			31,912	24,609	41,382			14,743	7,856	27,670
1999	54,650	0.15	47,361	36,969	60,674	39,333	0.14	35,378	28,332	44,176	18,879	0.12	18,550	14,885	23,118
2000			47,333	36,716	61,021			36,309	27,783	47,452			19,349	10,000	37,440
2001			47,306	36,762	60,874			37,266	28,350	48,985			20,183	9,521	42,788
2002			47,279	37,114	60,228			38,247	30,015	48,736			21,053	10,885	40,720
2003	55,397	0.16	47,251	37,823	59,030	39,603	0.09	39,254	33,672	45,762	21,738	0.12	21,960	17,661	27,305
2004			45,832	37,679	55,750			39,689	32,527	48,428			25,537	14,850	43,915
2005	39,320	0.16	44,456	37,138	53,215	41,370	0.08	40,129	34,943	46,084	29,998	0.11	29,697	24,072	36,637
2006			44,157	36,496	53,426			38,075	31,157	46,529			30,815	17,950	52,901
2007	39,630	0.19	43,860	36,353	52,918	34,470	0.11	36,126	30,673	42,550	32,274	0.11	31,975	26,162	39,081
2008			44,165	36,459	53,499			36,309	29,623	44,505			29,548	17,185	50,805
2009	44,349	0.16	44,471	36,906	53,587	36,652	0.09	36,493	31,526	42,242	27,399	0.12	27,304	21,805	34,191
2010			44,804	36,371	55,193			36,399	29,632	44,710			24,397	14,199	41,922
2011	67,883	0.37	45,139	36,091	56,456	33,911	0.11	36,304	30,583	43,096	21,364	0.10	21,800	17,949	26,478
2012			44,748	35,816	55,907			39,036	31,670	48,114			25,573	14,901	43,890
2013	38,234	0.26	44,360	35,870	54,860	44,484	0.11	41,972	35,583	49,508	30,705	0.11	29,999	24,179	37,219
2014			44,493	35,678	55,486			41,939	34,161	51,488			27,394	15,942	47,071
2015	58,047	0.17	44,625	35,721	55,748	41,926	0.09	41,906	36,074	48,681	25,186	0.11	25,015	20,404	30,668
2016			42,752	35,170	51,969			41,840	33,615	52,077			21,044	12,213	36,258
2017	33,610	0.17	40,958	33,975	49,375	49,501	0.17	41,773	33,845	51,559	17,820	0.13	17,703	13,923	22,507
2018			40,551	33,420	49,205			38,194	30,623	47,638			14,088	8,114	24,462
2019	43,482	0.16	40,149	33,307	48,397	32,279	0.11	34,922	29,507	41,330	10,736	0.15	11,212	8,565	14,677
2020			39,144	31,619	48,460			35,254	28,598	43,457			11,909	6,789	20,890
2021	31,856	0.21	38,165	30,141	48,324	36,606	0.11	35,588	30,195	41,945	13,330	0.18	12,649	9,214	17,365
2022			37,984	29,547	48,830			34,685	28,027	42,925			10,592	6,021	18,631
2023	36,594	0.19	37,804	29,169	48,996	33,129	0.10	33,804	28,225	40,486	8,617	0.15	8,869	6,658	11,813
2024			37,804	28,177	50,721			33,804	25,207	45,333			8,869	4,029	19,520
2025			37,804	27,319	52,315			33,804	23,262	49,124			8,869	3,017	26,069

Table 18-5. Big skates biomass estimates (t) and coefficients of variation (CV) for three regions of the Gulf of Alaska from 1990-2023. Observed are from the AFSC bottom trawl survey and the Predicted are the proprotion from the GOA-wide predicted biomass produced from the random effects model fitted to the survey time series (REMA model). L95% and U95% are the bounds of the 95% confidence interval for the predicted index.

	Western					Central					Eastern				
	Observed		Predicted			Observed		Predicted			Observed		Predicted		
Year	Index	CV	Index	L95%	U95%	Index	CV	Index	L95%	U95%	Index	CV	Index	L95%	U95%
1990	1,744	0.47	2,644	1,258	5,555	9,071	0.35	18,770	10,310	34,171	11,501	0.39	13,409	6,963	25,824
1991			2,871	1,364	6,046			20,032	12,134	33,070			13,220	6,021	29,025
1992			3,113	1,566	6,190			21,346	14,312	31,837			13,012	6,000	28,220
1993	2,312	0.33	3,370	1,940	5,854	21,586	0.19	22,711	16,981	30,374	15,836	0.37	12,788	6,950	23,532
1994			4,838	2,614	8,954			25,492	18,605	34,929			9,850	4,723	20,544
1995			6,685	3,555	12,573			27,546	20,191	37,581			7,304	3,547	15,043
1996	13,130	0.42	8,930	4,882	16,333	26,544	0.19	28,772	21,822	37,934	3,391	0.30	5,235	2,982	9,192
1997			9,255	4,837	17,708			29,016	20,992	40,107			6,092	2,950	12,582
1998			9,570	5,214	17,566			29,195	20,817	40,944			7,073	3,435	14,566
1999	11,038	0.27	9,870	6,255	15,576	34,007	0.20	29,300	21,181	40,531	9,606	0.34	8,191	4,718	14,221
2000			9,708	5,328	17,690			29,229	20,356	41,969			8,397	3,864	18,246
2001			9,547	5,040	18,086			29,153	20,105	42,272			8,606	3,707	19,977
2002			9,387	5,184	17,000			29,072	20,362	41,509			8,819	4,000	19,441
2003	9,602	0.29	9,229	5,945	14,326	33,814	0.22	28,987	21,225	39,588	11,980	0.38	9,036	5,004	16,316
2004			9,382	5,542	15,883			28,911	21,311	39,220			7,540	3,848	14,775
2005	9,792	0.33	9,493	6,012	14,991	25,544	0.21	28,700	21,979	37,477	3,984	0.36	6,262	3,487	11,248
2006			8,569	4,931	14,889			27,886	20,746	37,484			7,703	3,968	14,954
2007	5,872	0.44	7,657	4,530	12,943	24,420	0.27	26,824	20,231	35,566	9,337	0.33	9,380	5,666	15,528
2008			7,465	4,225	13,189			26,028	19,381	34,955			10,672	5,618	20,272
2009	6,652	0.37	7,245	4,439	11,824	26,691	0.22	25,140	19,285	32,771	11,007	0.32	12,087	7,352	19,872
2010			7,125	4,141	12,259			23,051	17,471	30,413			14,628	7,069	30,271
2011	6,251	0.30	6,900	4,396	10,828	21,761	0.17	20,809	16,281	26,598	39,870	0.61	17,430	7,967	38,133
2012			8,173	4,768	14,009			20,354	14,982	27,652			16,221	7,251	36,289
2013	10,669	0.42	9,611	5,841	15,813	12,810	0.21	19,764	14,123	27,657	14,754	0.56	14,986	7,471	30,061
2014			10,057	5,907	17,124			21,416	16,197	28,317			13,019	6,068	27,932
2015	13,449	0.25	10,427	6,900	15,758	32,038	0.19	22,992	17,280	30,593	12,560	0.56	11,206	5,697	22,040
2016			9,050	5,489	14,919			23,490	17,487	31,555			10,212	4,861	21,455
2017	5,068	0.30	7,815	4,931	12,387	22,878	0.21	23,881	18,288	31,184	5,664	0.49	9,261	4,835	17,738
2018			8,512	5,062	14,314			22,050	16,395	29,655			9,989	5,124	19,474
2019	12,179	0.32	9,213	5,848	14,514	18,371	0.25	20,230	15,077	27,145	12,931	0.28	10,706	6,631	17,283
2020			8,920	5,233	15,202			21,000	15,220	28,976			9,225	4,710	18,065
2021	6,525	0.33	8,587	5,327	13,841	16,835	0.28	21,675	15,820	29,696	8,495	0.51	7,903	4,245	14,713
2022			9,302	5,094	16,984			22,646	16,367	31,335			6,036	2,972	12,260
2023	10,669	0.46	9,934	5,276	18,706	22,667	0.20	23,326	17,081	31,852	3,258	0.34	4,545	2,439	8,468
2024			9,934	4,329	22,798			23,326	15,590	34,899			4,545	1,758	11,753
2025			9,934	3,692	26,729			23,326	14,476	37,585			4,545	1,382	14,952

Table 18-6. Longnose skates biomass estimates (t) and coefficients of variation (CV) for three regions of the Gulf of Alaska from 1990-2023. Observed are from the AFSC bottom trawl survey and the Predicted are the proprotion from the GOA-wide predicted biomass produced from the random effects model fitted to the survey time series (REMA model). L95% and U95% are the bounds of the 95% confidence interval for the predicted index.

	Western					Central					Eastern				
	Observed		Predicted			Observed		Predicted			Observed		Predicted		
Year	Index	CV	Index	L95%	U95%	Index	CV	Index	L95%	U95%	Index	CV	Index	L95%	U95%
1990	1,045	0.71	502	210	1,197	8,708	0.29	12,056	7,998	18,172	2,242	0.26	2,642	1,717	4,066
1991			456	185	1,123			12,878	8,881	18,676			2,933	1,893	4,545
1992			413	153	1,116			13,743	9,986	18,913			3,253	2,179	4,856
1993	105	0.72	374	121	1,159	14,158	0.15	14,653	11,472	18,715	3,539	0.19	3,604	2,662	4,881
1994			413	143	1,195			16,241	12,407	21,262			4,157	2,872	6,017
1995			456	172	1,209			17,998	13,793	23,484			4,793	3,329	6,900
1996	278	0.64	503	212	1,194	20,328	0.17	19,939	15,782	25,191	5,620	0.18	5,525	4,163	7,332
1997			619	293	1,305			21,916	16,710	28,744			6,252	4,356	8,972
1998			761	381	1,517			24,080	18,226	31,813			7,072	4,932	10,141
1999	1,747	0.52	935	459	1,905	29,872	0.18	26,447	20,427	34,239	7,714	0.17	7,996	6,046	10,576
2000			950	460	1,959			26,563	20,020	35,245			8,797	6,039	12,813
2001			963	476	1,948			26,640	20,127	35,262			9,662	6,466	14,438
2002			975	510	1,865			26,676	20,769	34,262			10,596	7,311	15,357
2003	782	0.45	986	571	1,703	25,741	0.12	26,667	22,296	31,895	13,080	0.15	11,602	8,894	15,134
2004			1,089	614	1,931			27,747	22,593	34,077			10,853	7,870	14,966
2005	1,719	0.36	1,201	697	2,071	29,853	0.09	28,801	24,654	33,645	9,797	0.18	10,127	7,746	13,239
2006			1,084	626	1,878			27,488	22,436	33,678			9,503	6,779	13,322
2007	628	0.47	978	547	1,747	26,083	0.12	26,232	22,062	31,191	7,759	0.24	8,916	6,530	12,174
2008			1,040	564	1,916			25,989	21,159	31,921			9,281	6,609	13,034
2009	1,214	0.64	1,104	619	1,970	25,534	0.10	25,733	21,906	30,228	9,904	0.19	9,656	7,350	12,685
2010			1,140	632	2,059			25,528	20,616	31,609			9,730	7,018	13,492
2011	940	0.43	1,178	694	1,998	23,609	0.14	25,322	20,790	30,843	9,362	0.19	9,805	7,472	12,867
2012			1,352	796	2,295			27,047	21,664	33,768			10,637	7,673	14,744
2013	2,127	0.33	1,552	954	2,524	28,274	0.14	28,884	23,904	34,901	14,083	0.17	11,537	8,717	15,269
2014			1,436	851	2,425			30,609	24,742	37,867			9,894	7,106	13,775
2015	708	0.43	1,319	742	2,345	34,243	0.10	32,172	27,077	38,226	6,975	0.22	8,415	6,236	11,356
2016			1,549	921	2,606			32,000	25,418	40,287			8,290	5,873	11,701
2017	2,133	0.31	1,818	1,143	2,893	39,219	0.20	31,797	25,276	40,000	8,150	0.22	8,158	6,052	10,998
2018			1,846	1,072	3,181			28,614	22,734	36,016			7,734	5,526	10,824
2019	2,221	0.38	1,873	1,115	3,148	22,709	0.13	25,725	21,135	31,312	7,350	0.18	7,324	5,568	9,634
2020			1,816	1,049	3,144			26,251	21,111	32,643			7,186	5,083	10,160
2021	2,037	0.34	1,761	1,084	2,859	28,070	0.12	26,779	22,367	32,060	6,500	0.26	7,049	5,080	9,781
2022			1,562	878	2,777			26,011	20,832	32,477			7,112	4,921	10,279
2023	1,025	0.42	1,384	720	2,660	24,734	0.13	25,249	20,558	31,009	7,371	0.21	7,172	5,124	10,038
2024			1,384	613	3,127			25,249	18,660	34,164			7,172	4,434	11,598
2025			1,384	535	3,578			25,249	17,352	36,738			7,172	3,972	12,949

Figures

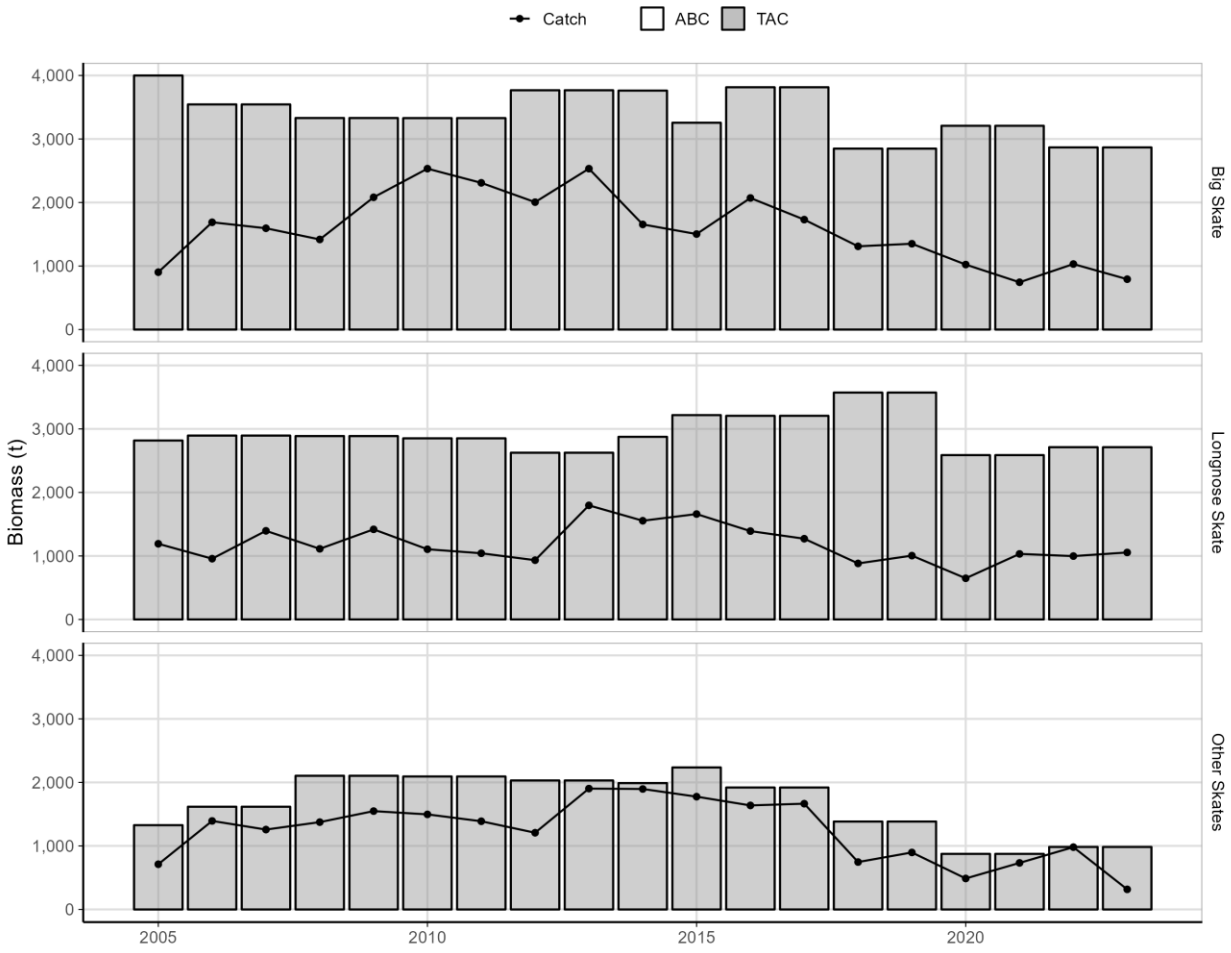

Figure 18-1. Catch, ABC and TAC for Big, Longnose and Other skates from 2005-2023. If the ABC is not visible, it means the TAC equals the ABC for that year.

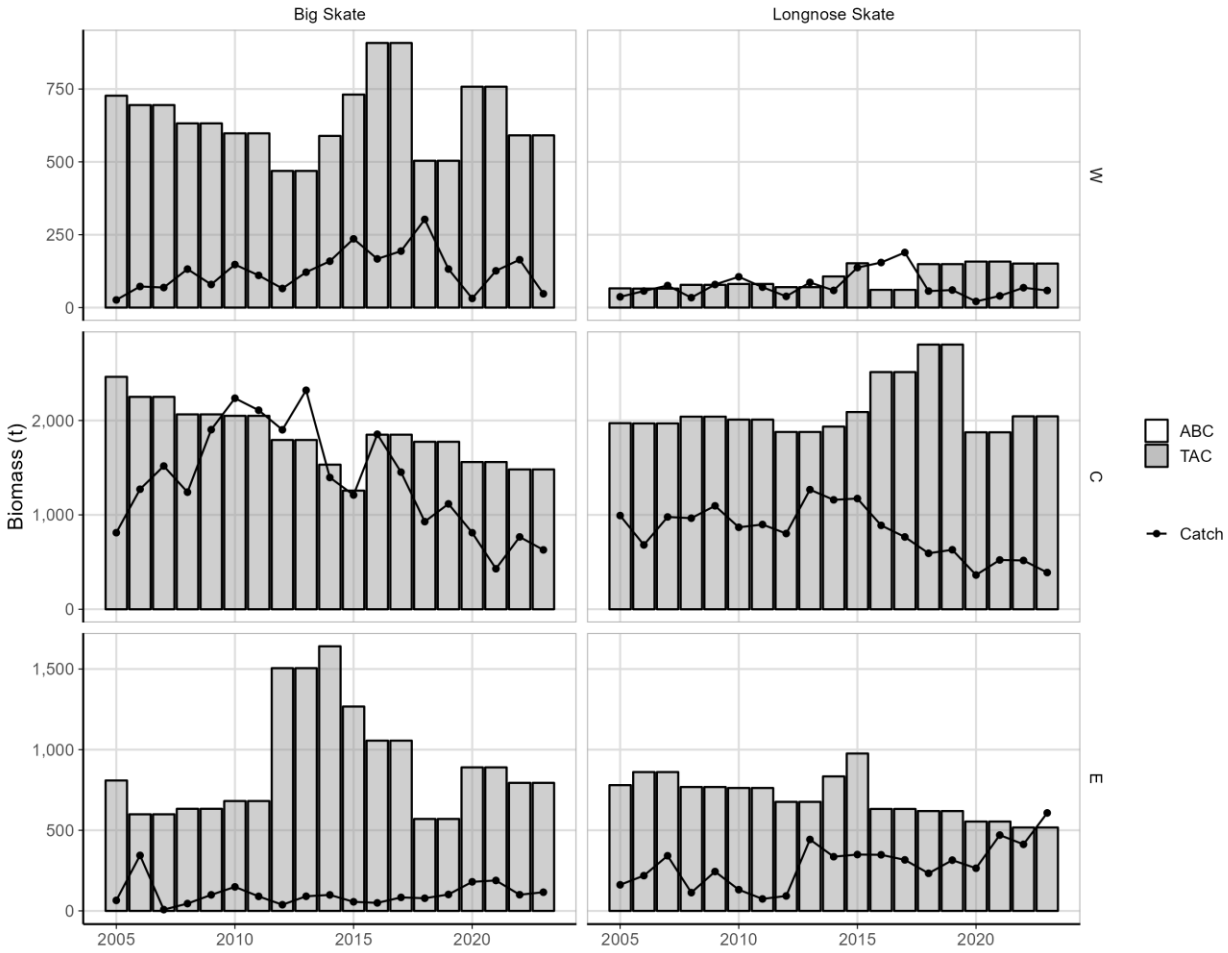

Figure 18-2. Catch, ABC and TAC in the three Gulf of Alaska regions (Western [W], Central [C], and Eastern [E]) for Big and Longnose skates from 2005-2023. If the ABC is not visible, it means the TAC equals the ABC for that year.

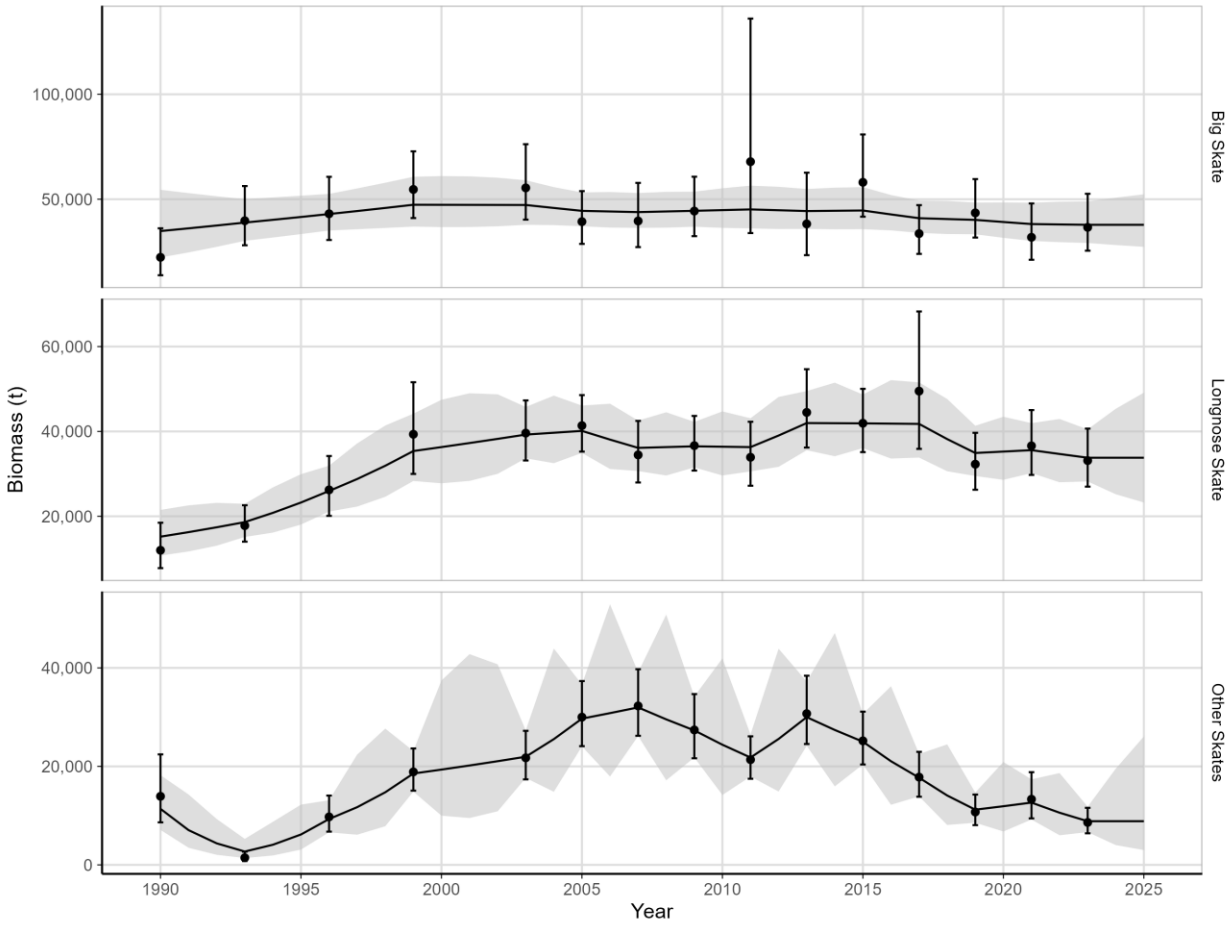

Figure 18-3. Biomass estimates (t) for Big skates (top), Longnose skates (middle), and Other skates (bottom) in the Gulf of Alaska between 1990-2025, from the AFSC bottom trawl survey (dots) and the random-effects model (RE) (black line). The grey shaded region is 95% confidence interval (in log-space) from the REMA model while the error bars are the 95% confidence interval (in log-space) from the survey. Note that vertical scales differ between the plots.

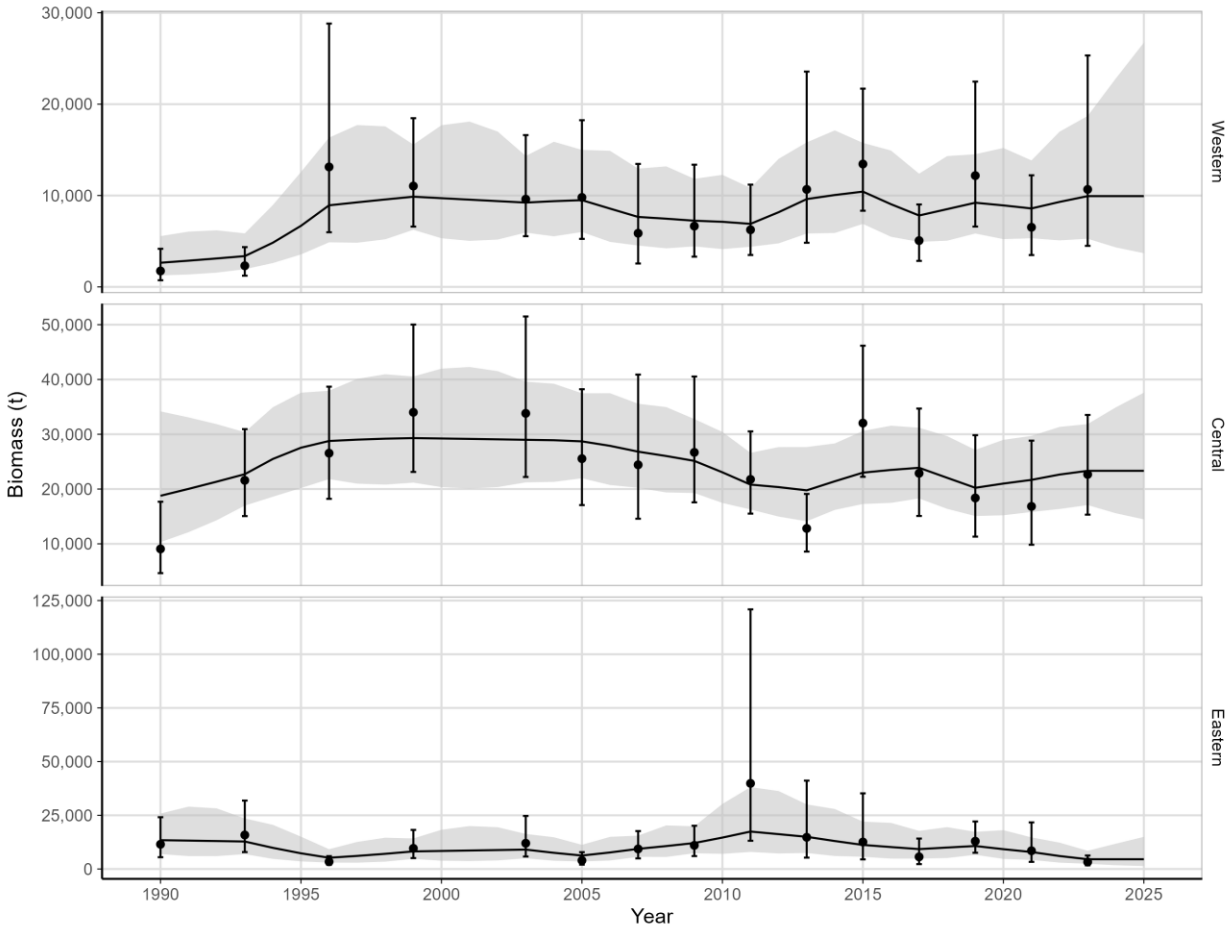

Figure 18-4. Biomass estimates (t) for Big skate in the three Gulf of Alaska regions from the AFSC bottom trawl survey (dots) and the proprotion in each area from the GOA-wide predicted Big skate biomass produced from the random effects model fitted to the survey time series (REMA model) (black line) from 1990-2025. The grey shaded region is 95% confidence interval (in log-space) calculated using values from REMA while the error bars are the 95% confidence interval (in log-space) from the survey. Note that vertical scales differ between the plots.

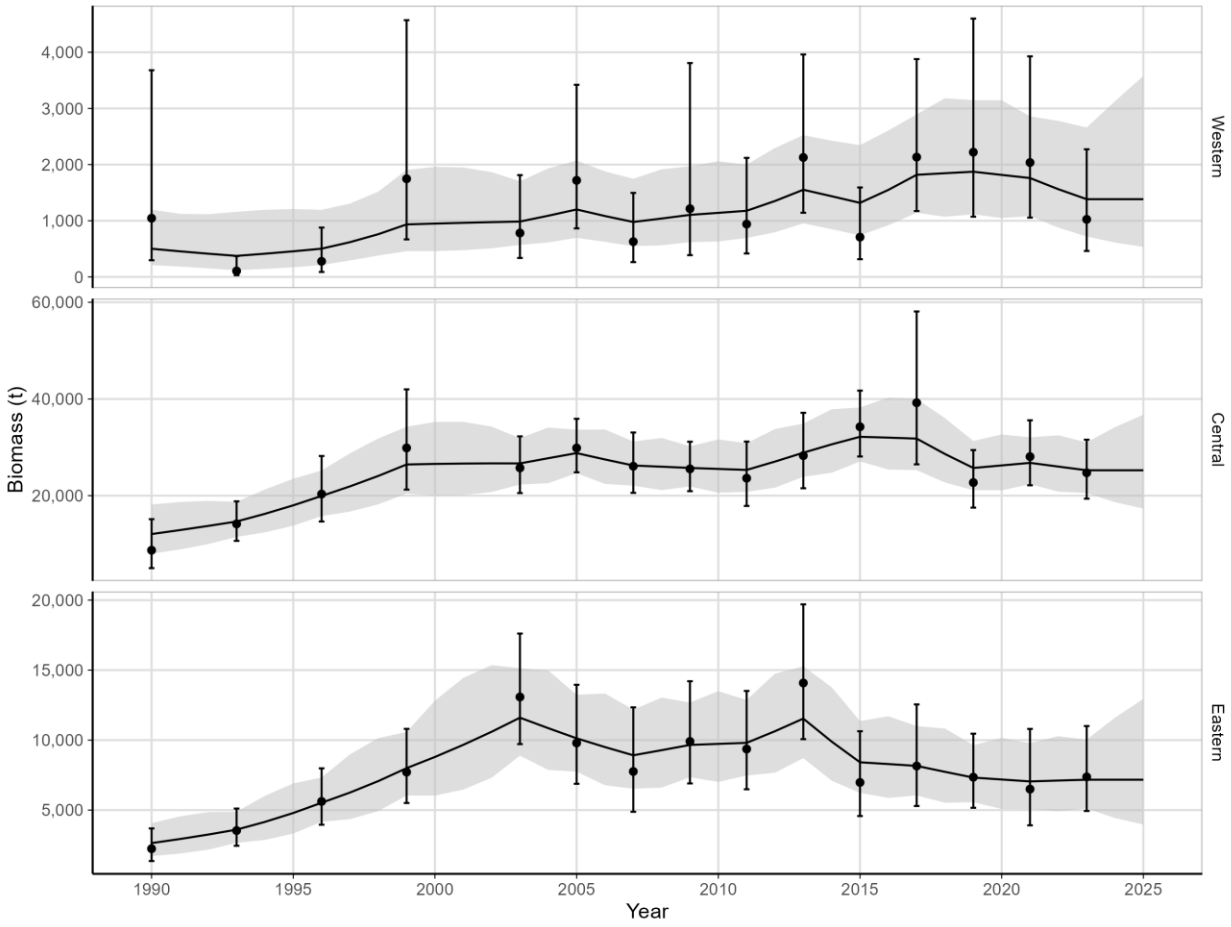

Figure 18-5. Biomass estimates (t) for Longnose skates in the three Gulf of Alaska regions from the AFSC bottom trawl survey (dots) and the proprotion in each area from the GOA-wide predicted Longnose skate biomass produced from the random effects model fitted to the survey time series (REMA model) (black line) from 1990-2025. The grey shaded region is 95% confidence interval (in log-space) calculated using values from REMA while the error bars are the 95% confidence interval (in log-space) from the survey. Note that vertical scales differ between the plots.

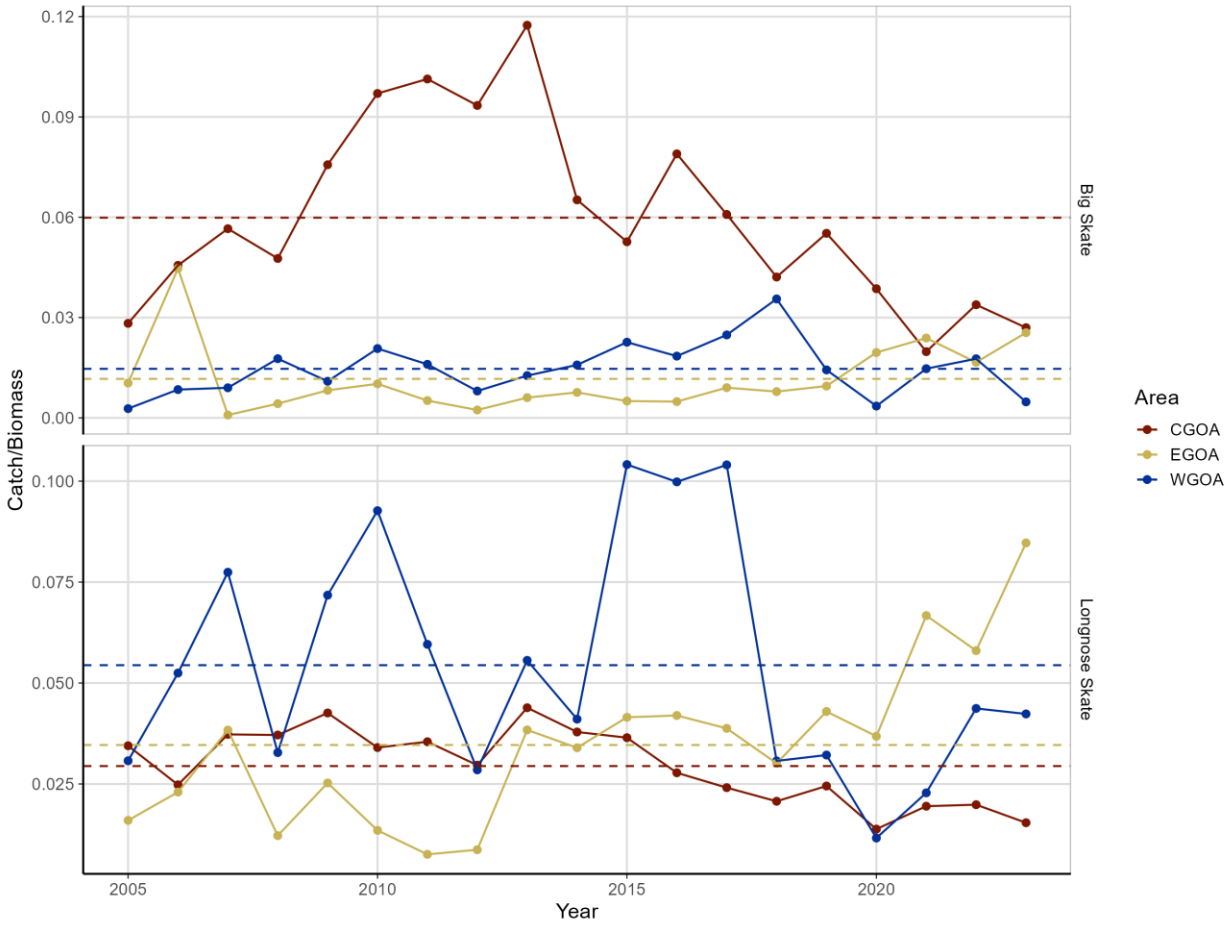

Figure 18-6. Exploitation rate in the three Gulf of Alaska regions (Western [WGOA], Central [CGOA], and Eastern [EGOA]) for Big and Longnose skates from 2005-2023. The dashed lines are the mean exploitation rates for the associated color.

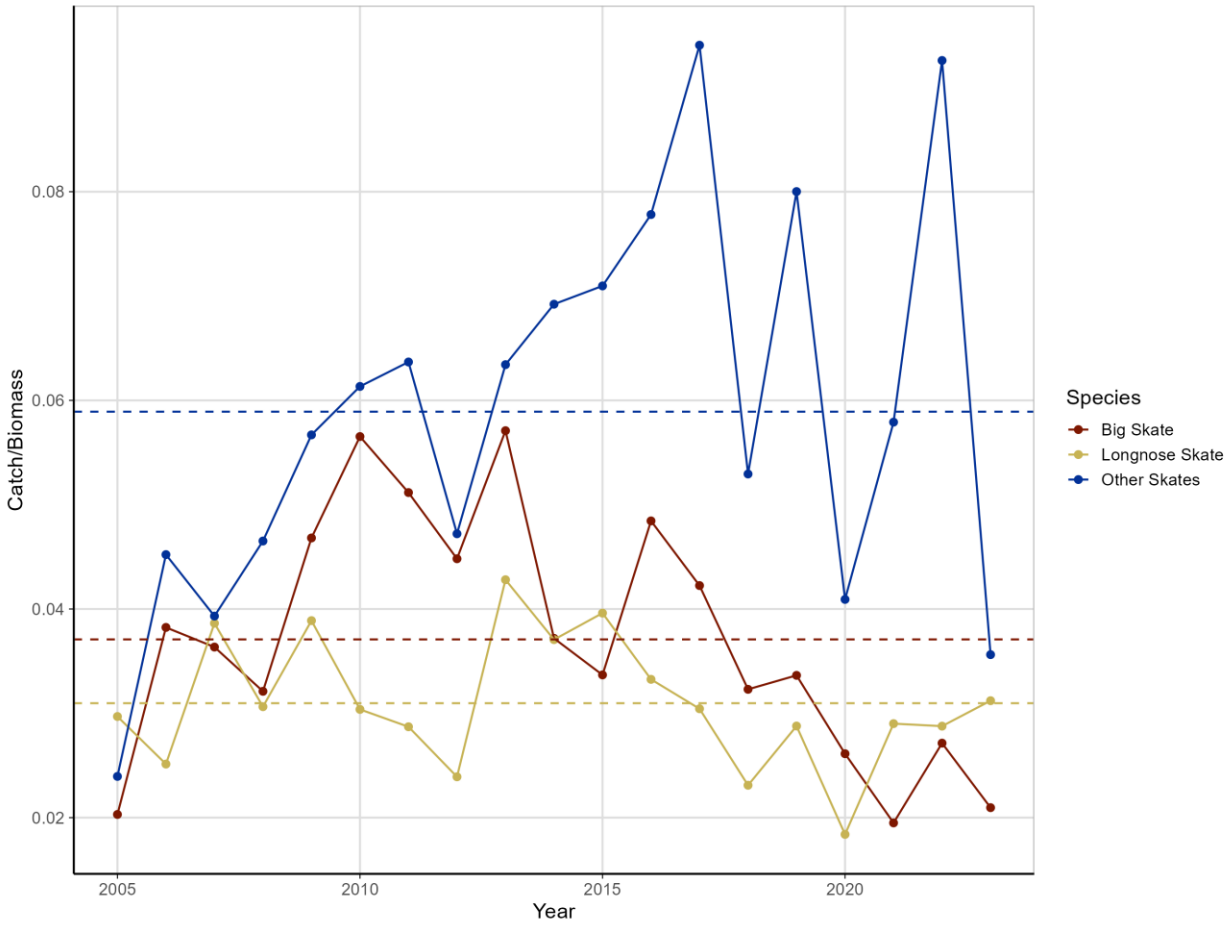

Figure 18-7. Gulf of Alaska wide exploitation rate for all three assessment groups (Big skate, Longose skate and Other skates) from 2005-2023. The dashed lines are the mean exploitation rates for the associated color.