DRAFT

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Attachment 3
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Status of the Longnose Skate (*Raja rhina*)

off the continental US Pacific Coast in 2007

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EXECUTIVE SUMMARY

Stock

Longnose skates (*Raja rhina*) are found from Navarin Canyon in the Bering Sea and Unalaska Island in Alaska to Cedros Island, Baja California in Mexico. This assessment is for the population occupying the waters off California, Oregon and Washington, bounded by Canada in the north and Mexico in the south. Within this study area, the longnose skate population is treated as one fishery stock, due to the lack of biological and genetic data supporting the presence of multiple stocks.

Catches

The longnose skate is not a commercially important target species. It is caught primarily as bycatch in trawl fisheries, where most are discarded. Although the landed catch of skates is documented through fish tickets, most records are for a combined-skate category. There are also apparent reporting inconsistencies with regard to the condition of landed skates (e.g., as whole fish or as wings). The extent to which landings in the combined-skate category were comprised by longnose skate is informed by limited periods of species-composition sampling in Oregon and Washington. Historical landed catch was reconstructed from variety of sources. Over the last 57 years, longnose skate landings ranged between 35 and 1,721 mt. Landings peaked in the mid-1990s, due to increased demand from Asian markets. Discards rates were estimated at 93% prior to 1995 and 53% after 1995, which corresponds to changes in skate markets in the mid-1990s.

Table ES-1. Recent landings (mt) for longnose skate by year and state.

Year	California	Oregon	Washington	Total (mt)
1997	779	771	171	1,721
1998	509	218	55	782
1999	518	562	97	1,177
2000	352	804	196	1,351
2001	380	410	71	860
2002	49	123	141	313
2003	74	629	145	848
2004	66	238	69	373
2005	55	508	51	615
2006	70	581	91	742

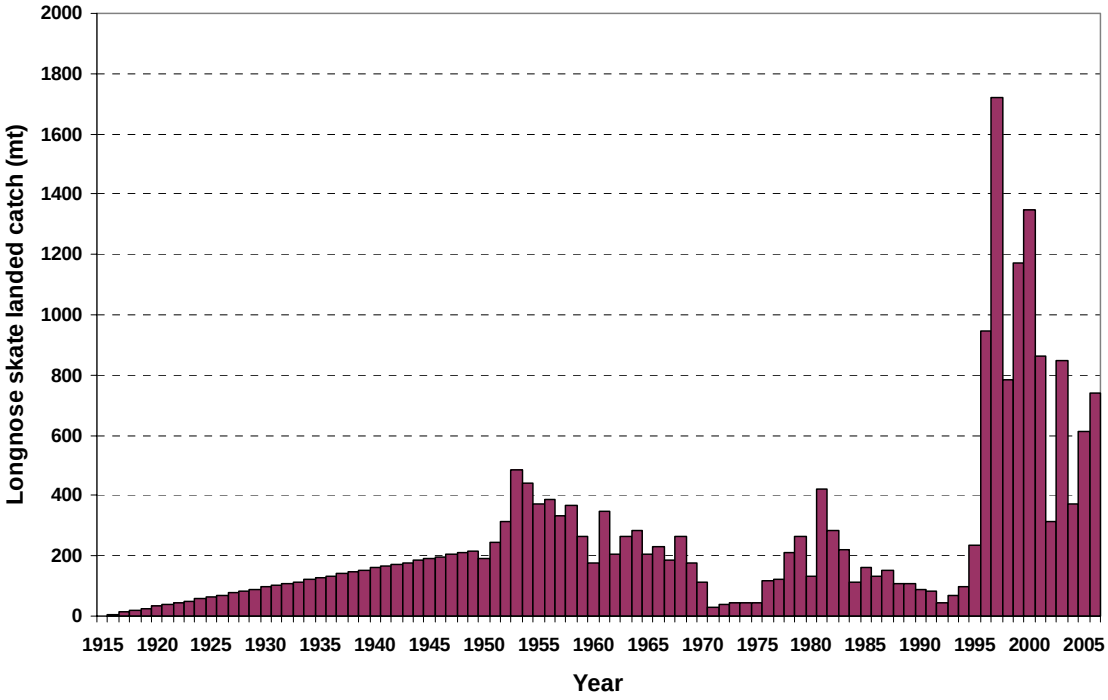

Figure ES-1. Reconstructed historical landings (mt) for longnose skate.

Data and Assessment

This is the first assessment for longnose skate on the U.S. West Coast. The Stock Synthesis 2 (version 2.00e) modeling program was used to conduct the analysis and to estimate model parameters and management quantities. Since there are no apparent differences in biological and life history parameters as well as length and age frequencies between females and males, the assessment uses a single-sex model. The model starts in 1916, assuming an unfished equilibrium state of the stock in 1915. The assessment model includes one fishery that operates within the entire area of assessment. Fishery dependent data used in the assessment include combined-skate landings (1950-2006), fishery length compositions (1995-2006) and limited age data (2003-2004). Fishery independent data include biomass estimates (1980-2006) and length compositions (1997-2006) from four NMFS surveys conducted on the continental shelf and slope, as well as age data from one of the surveys (2003). The model uses discard data from Rogers and Pikitch's study (1986-1987), the Enhanced Data Collection Project (1996-1998), and the NMFS West Coast Groundfish Observer Program (2004-2005).

Stock biomass

This assessment uses a single-sex model; therefore, spawning biomass is the sum of the mature biomasses of both sexes. Using the base model, the unexploited level of spawning stock biomass for longnose skate is estimated to be 14,069 mt. At the beginning of 2007, the spawning stock biomass is estimated to be 9,268 mt, which represents 66% of the unfished stock level.

Table ES-2. Recent trend in longnose skate spawning biomass and depletion.

Year	Estimated spawning biomass (mt)	95% Confidence interval	Estimated depletion
1996	10,622	9,712-11,532	75%
1997	10,490	9,581-11,399	75%
1998	10,065	9,164-10,966	72%
1999	9,964	9,064-10,864	71%
2000	9,716	8,821-10,611	69%
2001	9,407	8,519-10,294	67%
2002	9,275	8,392-10,158	66%
2003	9,342	8,458-10,225	66%
2004	9,234	8,354-10,114	66%
2005	9,302	8,422-10,183	66%
2006	9,300	8,421-10,179	66%
2007	9,268	8,391-10,146	66%

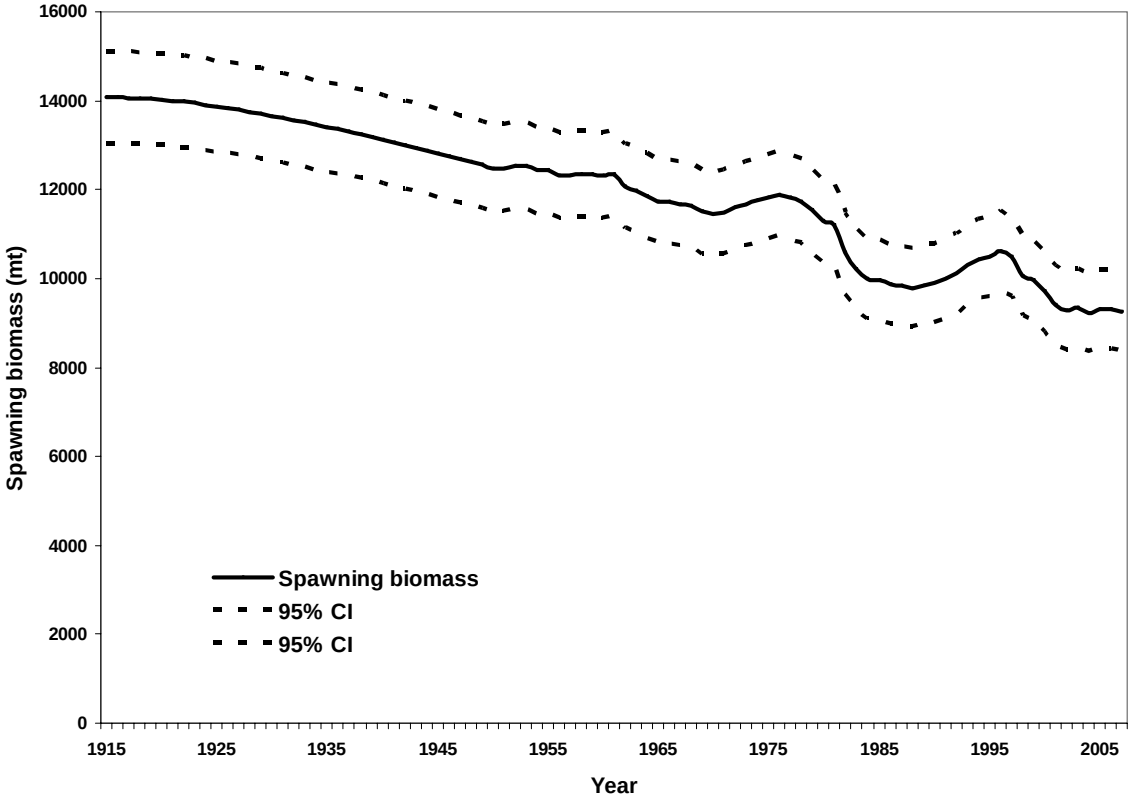

Figure ES-2. Estimated spawning biomass time-series with 95% confidence interval.

Recruitment

In the assessment, we used the Beverton-Holt model to describe the stock-recruitment relationship. Recruits were taken deterministically from the stock-recruit curve. The

level of virgin recruitment R_0 was estimated to assess the magnitude of the initial stock size. Steepness of the stock-recruitment curve was fixed at a value of 0.4, to reflect the *K*-type reproductive strategy of the longnose skate.

Table ES-3. Recent estimated trend in longnose skate recruitment.

Year	Estimated recruitment (1000s)	95% Confidence interval
1996	13,778	12,745-14,811
1997	13,701	12,667-14,735
1998	13,448	12,414-14,482
1999	13,386	12,351-14,421
2000	13,231	12,195-14,267
2001	13,032	11,995-14,069
2002	12,945	11,908-13,982
2003	12,989	11,951-14,027
2004	12,918	11,880-13,956
2005	12,963	11,926-14,000
2006	12,962	11,925-13,999
2007	12,941	11,905-13,978

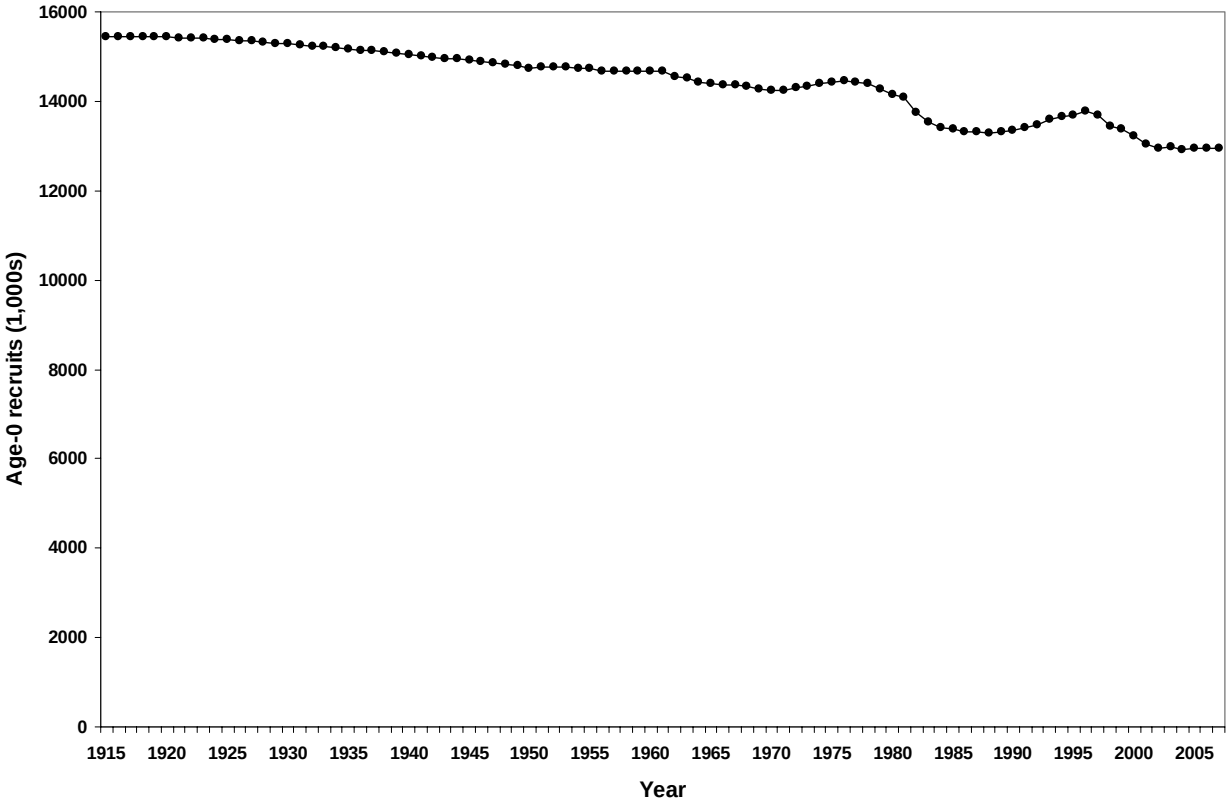

Figure ES-3. Time-series of estimated recruitment for longnose skate.

Reference Points

For the longnose skate, the management target is defined as 40% of the unfished spawning stock biomass ($SB_{40\%}$), which is estimated to be 5,627 mt (95% Confidence Interval: 5,217-6,036 mt) in the base model. The stock is declared overfished if the current spawning biomass is estimated to be below 25% of unfished level. The MSY-proxy harvest rate for longnose skate is SPR=F45%, which corresponds to an exploitation rate of 0.043. This harvest rate provides an equilibrium yield of 1,264 mt (95% Confidence Interval: 1,194-1,334 mt) at $SB_{40\%}$. The model estimate of maximum sustainable yield (MSY) is 1,268 mt (95% Confidence Interval: 1,198-1,338). The estimated spawning stock biomass at MSY is 5,253 mt (95% Confidence Interval: 4,867-5,638 mt). The exploitation rate corresponding to the estimated SPRmsy of F61% is 0.027.

Reference point results are calculated on both a per-recruit and total-recruits basis. The total-recruits results take into account the spawner-recruitment relationship with the steepness as defined in the base model (h=0.4). Because of this low steepness and other reproductive characteristics of the stock, fishing at the target SPR of 45% is expected to reduce the spawning biomass to less than 13% of the unfished level over the long term (Table ES-9). Conversely, fishing at a rate that would maintain spawning biomass near 40% of the unfished level would require a target SPR much higher than 45%. The Council's Scientific and Statistical Committee should consider the appropriateness of using the current proxy harvest rate for setting the Allowable Biological Catch for longnose skate.

Exploitation Status

The assessment shows that the stock of the longnose skate in the US West Coast is not overfished. Currently, the stock is at 66% of its unfished level. Historically, the exploitation rate for the longnose skate has been low. It reached its maximum level of 4.02 % in 1981. Currently, it is at the level of 1.25 %.

Table ES-4. Recent trend in longnose skate exploitation.

Year	Exploitation rate
1998	1.66%
1999	2.50%
2000	2.90%
2001	1.87%
2002	0.68%
2003	1.84%
2004	0.81%
2005	1.33%
2006	1.60%
2007	1.25%

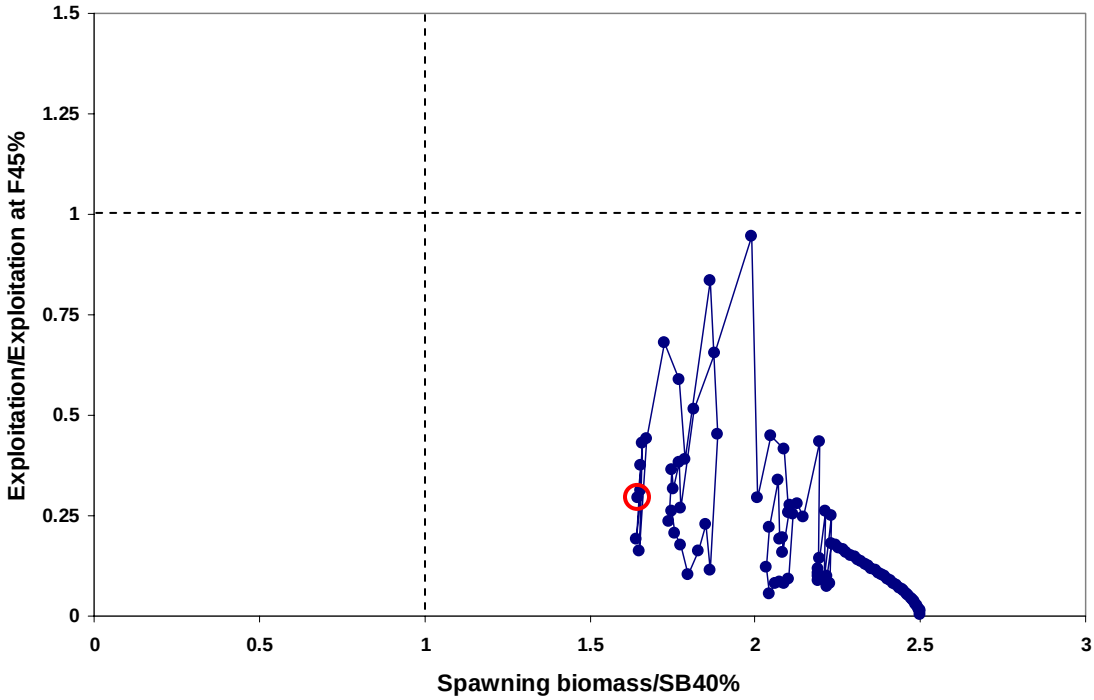

Figure ES-4. Exploitation rate and spawning biomass relative to their target values (circle indicates the point that corresponds to 2007).

Management

The longnose skate is grouped with other unrelated species ("Other Fish") for the purposes of specifying annual Allowable Biological Catches and Optimum Yields (OY). Combined landings of species within this category are typically well below the specified OY. As a result, landings of species in this category are not actively monitored throughout the year, nor have they been subject to trip-limit management. In most areas of the world, management of skates has generally been a low priority and where management and assessments are implemented, the available data are generally inadequate. The longnose skate, like other elasmobranches, presents an array of problems for fisheries management. Given the low economic value of skates, information about their fisheries and basic biology is scarce. However, skate life history characteristics make them more susceptible to overfishing than teleost fishes. Vulnerability of this group and the past history of elasmobranch fisheries collapses are general causes for concern. At the same time, the absence of a strong directed fishery for skates in this region, combined with reductions in trawl effort shoreward of 150 fm to promote rockfish stock rebuilding, reflect a different fishing environment than has characterized these other collapses.

Forecast

Projections of future catches, summary biomass, spawning biomass and stock depletion were made based on F45%, as well as the current rate of fishing mortality. The projected spawning biomasses are greater than 40% of the unfished level for both approaches. No

40:10 harvest control rule reductions were applied. Optimum yield catch values were equivalent to ABC values.

Table ES-5. 10-year forecast of longnose skate catch, summary biomass, spawning biomass and stock depletion estimated based on F45%.

Year	Total catch (mt)	Summary biomass (mt)	Spawning Biomass (mt)	Depletion
2009	3,428	71,184	9,347	66%
2010	3,269	68,833	8,847	63%
2011	3,128	66,836	8,389	60%
2012	3,006	65,135	7,970	57%
2013	2,902	63,676	7,587	54%
2014	2,816	62,403	7,241	51%
2015	2,745	61,264	6,930	49%
2016	2,686	60,211	6,654	47%
2017	2,638	59,208	6,411	46%
2018	2,598	58,226	6,201	44%

Table ES-6. 10-year forecast of longnose skate catch, summary biomass, spawning biomass and stock depletion estimated based on current rate of fishing mortality.

Year	Total catch (mt)	Summary biomass (mt)	Spawning Biomass (mt)	Depletion
2009	176	71,184	9,347	66%
2010	175	71,129	9,394	67%
2011	175	71,060	9,442	67%
2012	175	70,986	9,486	67%
2013	174	70,914	9,525	68%
2014	174	70,848	9,556	68%
2015	173	70,794	9,578	68%
2016	173	70,754	9,590	68%
2017	173	70,727	9,593	68%
2018	172	70,714	9,589	68%

Rebuilding Projection

Since the longnose skate stock is estimated to be above the overfished level, no rebuilding is required.

Unresolved Problems and Major Uncertainties

The major uncertainties for the assessment include uncertainties in the longnose skate catch history, particularly in proportion of longnose skate in combined-skate landings, discard and discard mortality rates, and Northwest Fishery Science Center (NWFSC) shelf-slope survey catchability *Q*. To address uncertainties related to longnose skate catches, alternative catch histories were developed, which reflect variations in proportion of longnose skate in combined-skate landings, as well as discard and discard mortality rates. These alternative histories include the base scenario, which was reconstructed using the best information available, along with "high" and "low" catch scenarios. To explore uncertainty regarding the estimation of the NWFSC shelf-slope survey *Q*, the base-case model (with *Q* fixed at 0.83) results were contrasted with "high" and "low" *Q* scenarios.

Alternative catch histories and *Q* values were used to define alternative states of nature and develop the decision table.

Decision Table

Three states of nature were defined based on the alternative longnose skate catch history and values of NWFSC shelf-slope survey *Q*. The base scenario uses the base catch history and base *Q* (*Q*=0.83), the "low" scenario uses the low catch history and low *Q* (*Q*=0.654), and the "high" scenario uses the high catch history and high *Q* (*Q*=1.046). Ten-year forecasts for each state of nature were calculated based on F45% for the base scenario. Ten-year forecasts were also produced with future catch fixed at the average amount (using the base catch history) for last three years (2004-2006) and at 150% of that three-year average. Under the "high" scenario, the F45% harvest rate is projected to reduce the spawning stock biomass below 40% of the unfished level within two years. In all other scenarios covered by the decision table, the spawning biomass remains above the target level throughout the 10-year projection period. The current rate of fishing mortality is significantly lower than F45% (current exploitation rate is 1.25%). Therefore, it is very unlikely that the stock, even under the "high" scenario will fall below 40% of its virgin state in the next 10 years.

Research and Data Needs

This assessment reflects a data-moderate to data-poor circumstance with respect to several influential model elements, including catch history, survey catchability, and some life history characteristics. Consequently, some critical assumptions were based on very limited supporting data and research. There are several data and research needs which, if satisfied, could improve the assessment.

Data needs:

1) Continue species-specific identification in fishery to improve the accuracy of fishery catch data;
2) Continue monitoring discard of the longnose skate;
3) Resume collecting and processing of vertebra samples for age determination to improve the accuracy of growth model parameters and size-at-age relationships.

Research needs:

1) Conduct studies to determine survival rates of discarded longnose skate, especially with trawl gear, so that total fishing mortality can be estimated more precisely;
2) Conduct studies on life history characteristics, especially those related to maturity and reproduction;
3) Conduct age-validation studies;
4) Conduct studies of longnose skate catchability by survey gear types.

Table ES-7. Decision table based on three states of nature, defined based on alternative catch histories and levels of NWFSC shelf-slope survey catchability *Q*.

		Low Q (Q=0.654) Low historical catch			Q=0.83 BASE			High Q (Q=1.046) High historical catch		
Forecast	**Year**	**Total catch (mt) (landings and discard mortality)**	**SSB (mt)**	**Depletion**	**Total catch (mt) (landings and discard mortality)**	**SSB (mt)**	**Depletion**	**Total catch (mt) (landings and discard mortality)**	**SSB (mt)**	**Depletion**
	2009	3,428	11,711	80%	3,428	9,347	66%	3,428	8,042	41%
	2010	3,269	11,154	76%	3,269	8,847	63%	3,269	7,708	39%
	2011	3,128	10,643	72%	3,128	8,389	60%	3,128	7,398	37%
	2012	3,006	10,175	69%	3,006	7,970	57%	3,006	7,111	36%
F45% for base scanario 40-10	2013	2,902	9,749	66%	2,902	7,587	54%	2,902	6,843	35%
	2014	2,816	9,363	64%	2,816	7,241	51%	2,816	6,596	33%
	2015	2,745	9,015	61%	2,745	6,930	49%	2,745	6,371	32%
	2016	2,686	8,706	59%	2,686	6,654	47%	2,686	6,169	31%
	2017	2,638	8,434	57%	2,638	6,411	46%	2,638	5,995	30%
	2018	2,598	8,196	56%	2,598	6,201	44%	2,598	5,846	30%
	2009	899	11,711	80%	899	9,347	66%	899	8,042	41%
	2010	899	11,700	80%	899	9,394	67%	899	8,249	42%
	2011	899	11,691	80%	899	9,443	67%	899	8,456	43%
Average landings and discard mortality for base scanario 2004-2006	2012	899	11,679	80%	899	9,488	67%	899	8,653	44%
	2013	899	11,665	79%	899	9,527	68%	899	8,836	45%
	2014	899	11,645	79%	899	9,559	68%	899	9,000	46%
	2015	899	11,620	79%	899	9,580	68%	899	9,141	46%
	2016	899	11,589	79%	899	9,591	68%	899	9,260	47%
	2017	899	11,553	79%	899	9,594	68%	899	9,359	47%
	2018	899	11,513	78%	899	9,588	68%	899	9,440	48%
	2009	1,349	11,711	80%	1,349	9,347	66%	1,349	8,042	41%
	2010	1,349	11,603	79%	1,349	9,297	66%	1,349	8,153	41%
50% increase in average landings and discard mortality for base scanario 2004-2006	2011	1,349	11,497	78%	1,349	9,248	66%	1,349	8,261	42%
	2012	1,349	11,392	78%	1,349	9,198	65%	1,349	8,358	42%
	2013	1,349	11,286	77%	1,349	9,143	65%	1,349	8,441	43%
	2014	1,349	11,179	76%	1,349	9,084	65%	1,349	8,506	43%
	2015	1,349	11,072	75%	1,349	9,019	64%	1,349	8,553	43%
	2016	1,349	10,964	75%	1,349	8,950	64%	1,349	8,583	43%
	2017	1,349	10,857	74%	1,349	8,878	63%	1,349	8,600	44%
	2018	1,349	10,753	73%	1,349	8,805	63%	1,349	8,606	44%

Table ES-8. Summary of recent trends in longnose skate exploitation and estimated population levels.

	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
Landings (mt)	782	1,177	1,351	860	313	848	373	615	742	*576
Estimated Discards (mt)	438	659	757	482	175	475	209	344	415	323
Estimated Total Catch (mt)	1,220	1,835	2,108	1,342	488	1,323	582	959	1,157	*899
ABC (mt)										
OY * (if different from ABC) (mt)										
SPR	74.28%	64.22%	59.83%	71.03%	87.96%	71.56%	85.99%	78.42%	74.81%	79.65%
Exploitation Rate (total catch/summary bi	1.66%	2.50%	2.90%	1.87%	0.68%	1.84%	0.81%	1.33%	1.60%	1.25%
Summary Age 2+ Biomass (B) (mt)	72,877	72,599	71,802	70,844	70,671	71,272	71,027	71,445	71,439	71,217
Spawning Stock Biomass (*SB*) (mt)	10,065	9,964	9,716	9,406	9,275	9,342	9,234	9,302	9,300	9,268
Uncertainty in Spawning Stock Biomass estimate	9,164-10,966	9,064-10,864	8,821-10,611	8,519-10,294	8,392-10,158	8,458-10,225	8,354-10,114	8,422-10,183	8,421-10,179	8,391-10,146
Recruitment at age 0	13,448	13,386	13,232	13,032	12,945	12,989	12,918	12,963	12,962	12,941
Uncertainty in Recruitment estimate	12,414-14,482	12,351-14,421	12,195-14,267	11,995-14,069	11,908-13,982	11,951-14,027	11,880-13,956	11,926-14,000	11,925-13,999	11,905-13,978
Depletion (SB/SB0)	71.54%	70.82%	69.06%	66.86%	65.93%	66.40%	65.64%	66.12%	66.13%	66.44%
Uncertainty in Depletion estimate									64.15%-68.11%	64.46%-68.41%

* indicates values calculated as the average for the last three years (2004-2006)

Table ES-9. Summary of longnose skate reference points.

	Point estimate	95% confidence interval
Unfished Spawning Stock Biomass (SB_0) (mt)	14,069	13,042-15,096
Unfished Summary Age 2+ Biomass (B_0) (mt)	90,955	
Unfished Recruitment (R_0) at age 0	15,454	14,403-16,505
Reference points based on $SB_{40\%}$		
MSY Proxy Spawning Stock Biomass ($SB_{40\%}$)	5,627	5,217-6,036
SPR resulting in $SB_{45\%}$ ($SPR_{SB40\%}$)	62.50%	62.4999%-62.500059%
Exploitation rate resulting in $SB_{40\%}$	2.67%	N/A
Yield with $SPR_{SB45\%}$ at $SB_{40\%}$ (mt)	1,264	1,194-1,334
Reference points based on SPR proxy for MSY		
Spawning Stock Biomass at SPR (SB_{SPR})(mt)	1,688	1,565-1,812
$SPR_{MSY\text{-}proxy}$	45%	
Exploitation rate corresponding to SPR	4.26%	N/A
Yield with $SPR_{MSY\text{-}proxy}$ at SB_{SPR} (mt)	787	744-831
Reference points based on estimated MSY values		
Spawning Stock Biomass at MSY (SB_{MSY}) (mt)	5,253	4,867-5,638
SPR_{MSY}	60.84%	60.80%-60.86%
Exploitation Rate corresponding to SPR_{MSY}	2.71%	N/A
MSY (mt)	1,268	1,198-1,338