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.

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

---

**Figure ES-1.** Reconstructed historical landings (mt) for longnose skate.
Table ES-2. Recent trend in longnose skate spawning biomass and depletion.

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

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.

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

**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 SPR_{msy} 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.

<table>
<thead>
<tr>
<th>Year</th>
<th>Exploitation rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1998</td>
<td>1.66%</td>
</tr>
<tr>
<td>1999</td>
<td>2.50%</td>
</tr>
<tr>
<td>2000</td>
<td>2.90%</td>
</tr>
<tr>
<td>2001</td>
<td>1.87%</td>
</tr>
<tr>
<td>2002</td>
<td>0.68%</td>
</tr>
<tr>
<td>2003</td>
<td>1.84%</td>
</tr>
<tr>
<td>2004</td>
<td>0.81%</td>
</tr>
<tr>
<td>2005</td>
<td>1.33%</td>
</tr>
<tr>
<td>2006</td>
<td>1.60%</td>
</tr>
<tr>
<td>2007</td>
<td>1.25%</td>
</tr>
</tbody>
</table>
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

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

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

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.

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

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 $Q$.

<table>
<thead>
<tr>
<th>Forecast</th>
<th>Year</th>
<th>Low Q ($Q=0.654$)</th>
<th>Q=0.83</th>
<th>High Q ($Q=1.046$)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Total catch (mt) (landings and discard mortality)</td>
<td>SSB (mt)</td>
<td>Total catch (mt) (landings and discard mortality)</td>
</tr>
<tr>
<td>Low historical catch</td>
<td></td>
<td></td>
<td>Depletion</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>2009</td>
<td>3,428</td>
<td>11,711</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2010</td>
<td>3,269</td>
<td>11,154</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2011</td>
<td>3,128</td>
<td>10,643</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2012</td>
<td>3,006</td>
<td>10,175</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2013</td>
<td>2,902</td>
<td>9,749</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2014</td>
<td>2,816</td>
<td>9,363</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015</td>
<td>2,745</td>
<td>9,015</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2016</td>
<td>2,686</td>
<td>8,706</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2017</td>
<td>2,638</td>
<td>8,434</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2018</td>
<td>2,598</td>
<td>8,196</td>
</tr>
<tr>
<td>Average landings and discard mortality for base scenario 2004-2006</td>
<td></td>
<td>2009</td>
<td>899</td>
<td>11,711</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2010</td>
<td>899</td>
<td>11,700</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2011</td>
<td>899</td>
<td>11,691</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2012</td>
<td>899</td>
<td>11,679</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2013</td>
<td>899</td>
<td>11,665</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2014</td>
<td>899</td>
<td>11,645</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015</td>
<td>899</td>
<td>11,620</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2016</td>
<td>899</td>
<td>11,589</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2017</td>
<td>899</td>
<td>11,553</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2018</td>
<td>899</td>
<td>11,513</td>
</tr>
<tr>
<td>50% increase in average landings and discard mortality for base scenario 2004-2006</td>
<td></td>
<td>2009</td>
<td>1,349</td>
<td>11,711</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2010</td>
<td>1,349</td>
<td>11,603</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2011</td>
<td>1,349</td>
<td>11,497</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2012</td>
<td>1,349</td>
<td>11,392</td>
</tr>
<tr>
<td></td>
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<td>2013</td>
<td>1,349</td>
<td>11,286</td>
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<tr>
<td></td>
<td></td>
<td>2014</td>
<td>1,349</td>
<td>11,179</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2015</td>
<td>1,349</td>
<td>11,072</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2016</td>
<td>1,349</td>
<td>10,853</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2017</td>
<td>1,349</td>
<td>10,657</td>
</tr>
<tr>
<td></td>
<td></td>
<td>2018</td>
<td>1,349</td>
<td>10,753</td>
</tr>
</tbody>
</table>
**Table ES-8.** Summary of recent trends in longnose skate exploitation and estimated population levels.

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Landings (mt)</td>
<td>782</td>
<td>1,177</td>
<td>1,351</td>
<td>860</td>
<td>313</td>
<td>848</td>
<td>373</td>
<td>615</td>
<td>742</td>
<td>576</td>
</tr>
<tr>
<td>Estimated Discards (mt)</td>
<td>438</td>
<td>659</td>
<td>757</td>
<td>482</td>
<td>175</td>
<td>475</td>
<td>209</td>
<td>344</td>
<td>415</td>
<td>323</td>
</tr>
<tr>
<td>Estimated Total Catch (mt)</td>
<td>1,220</td>
<td>1,835</td>
<td>2,108</td>
<td>1,342</td>
<td>488</td>
<td>1,323</td>
<td>582</td>
<td>959</td>
<td>1,157</td>
<td>*899</td>
</tr>
<tr>
<td>ABC (mt)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>OY (if different from ABC) (mt)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SPR</td>
<td>74.28%</td>
<td>64.22%</td>
<td>59.83%</td>
<td>71.03%</td>
<td>87.96%</td>
<td>71.56%</td>
<td>85.99%</td>
<td>78.42%</td>
<td>74.81%</td>
<td>79.65%</td>
</tr>
<tr>
<td>Exploitation Rate (total catch/summary biomass)</td>
<td>1.66%</td>
<td>2.50%</td>
<td>2.90%</td>
<td>1.87%</td>
<td>0.68%</td>
<td>1.84%</td>
<td>0.81%</td>
<td>1.33%</td>
<td>1.60%</td>
<td>1.25%</td>
</tr>
<tr>
<td>Summary Age 2+ Biomass (B) (mt)</td>
<td>72.877</td>
<td>72.599</td>
<td>71.802</td>
<td>70.844</td>
<td>70.671</td>
<td>71.272</td>
<td>71.027</td>
<td>71.445</td>
<td>71.439</td>
<td>71.217</td>
</tr>
<tr>
<td>Uncertainty in Spawning Stock Biomass estimate</td>
<td>9,164-10,966</td>
<td>9,064-10,864</td>
<td>8,821-10,611</td>
<td>8,519-10,294</td>
<td>8,392-10,158</td>
<td>8,458-10,225</td>
<td>8,354-10,114</td>
<td>8,422-10,183</td>
<td>8,421-10,179</td>
<td>8,391-10,146</td>
</tr>
<tr>
<td>Uncertainty in Recruitment estimate</td>
<td>12,414-14,482</td>
<td>12,351-14,421</td>
<td>12,195-14,267</td>
<td>11,995-14,069</td>
<td>11,908-13,982</td>
<td>11,951-14,027</td>
<td>11,880-13,956</td>
<td>11,926-14,000</td>
<td>11,925-13,999</td>
<td>11,905-13,978</td>
</tr>
<tr>
<td>Depletion (SB/SB0)</td>
<td>71.54%</td>
<td>70.82%</td>
<td>69.06%</td>
<td>66.86%</td>
<td>65.93%</td>
<td>66.40%</td>
<td>65.64%</td>
<td>66.12%</td>
<td>66.13%</td>
<td>66.44%</td>
</tr>
<tr>
<td>Uncertainty in Depletion estimate</td>
<td>64.15%-66.11%</td>
<td>64.46%-68.41%</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

* indicates values calculated as the average for the last three years (2004-2006)
Table ES-9. Summary of longnose skate reference points.

<table>
<thead>
<tr>
<th>Reference points based on SB 40%</th>
<th>Point estimate</th>
<th>95% confidence interval</th>
</tr>
</thead>
<tbody>
<tr>
<td>Unfished Spawning Stock Biomass (SB₀) (mt)</td>
<td>14,069</td>
<td>13,042-15,096</td>
</tr>
<tr>
<td>Unfished Summary Age 2+ Biomass (B₀) (mt)</td>
<td>90,955</td>
<td></td>
</tr>
<tr>
<td>Unfished Recruitment (R₀) at age 0</td>
<td>15,454</td>
<td>14,403-16,505</td>
</tr>
<tr>
<td>MSY Proxy Spawning Stock Biomass (SB₄₀%)</td>
<td>5,627</td>
<td>5,217-6,036</td>
</tr>
<tr>
<td>SPR resulting in SB₄₅% (SPR₃₄₀%)</td>
<td>62.50%</td>
<td>62.4999%-62.500059%</td>
</tr>
<tr>
<td>Exploitation rate resulting in SB₄₀%</td>
<td>2.67%</td>
<td>N/A</td>
</tr>
<tr>
<td>Yield with SPR₃₄₅% at SB₄₀% (mt)</td>
<td>1,264</td>
<td>1,194-1,334</td>
</tr>
</tbody>
</table>

Reference points based on SPR proxy for MSY

| Spawning Stock Biomass at SPR (SB masturbating) (mt) | 1,688 | 1,565-1,812 |
| SPR₃₄₅-proxy | 45% | |
| Exploitation rate corresponding to SPR | 4.26% | N/A |
| Yield with SPR₃₄₅-proxy at SBтрат (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 |