Preliminary Life History Variability of Longnose Skate (Raja rhina) Across Two Large Marine Ecosystems: Gulf of Alaska and California Current System

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Abstract

The longnose skate, Raja rhina, is common in the eastern North Pacific Ocean ranging from the Bering Sea to Baja California and occurs from close inshore to a maximum of 1000 m depth. In the Gulf of Alaska (GOA), it has a maximum total length of 145 cm. A directed fishery for Raja off Kodiak Island, Alaska was initiated in 2003, ending in 2005. An experimental fishery in Prince William Sound, Alaska was reinstated in 2009. The vulnerability of elasmobranchs to over exploitation from commercial fishing, either from bycatch or a directed fishery, is well documented. This inter-agency and institutional (AFSC, NWFS, PB/SV/DV and PSC/MML) collaborative study quantitatively compares growth and age/sex at maturity of the longnose skate across two large marine ecosystems, the GOA and California Current Ecosystem (CCE), on a spatial and temporal scale. Potential environmental (e.g., bottom water temperature) and oceanographic influences on life history traits between the GOA and CCE are also examined. Vertebral (n=88) for this study were collected off the GOA, British Columbia (BC) and the U.S. west coast states between 2003 and 2009 from research surveys and via port sampling. Ages were estimated, with a maximum age of 26 years, from vertebrae prepared with the standard (unstained) thin sectioning technique in this preliminary study. A new method will be compared to validated ages from a longnose skate C14 study.

Study objective

Preliminarily estimate age, growth, and maturity parameters of longnose skates in the GOA and CCE. Generate hypothesis as to how life history parameters vary across large marine ecosystems. Provide an explanation as to what mechanisms might be responsible for the observed patterns.

Materials and methods

Specimen Collection

GOA - AFSC

n = 211 (155 males and 96 females) were collected from May 18-July 31, 2009 on the NMFS bottom trawl survey conducted by the RACE division in the GOA from 54°30’ N latitude to 47° W longitude (Fig. 1).

BC-PBS

n = 226 (101 males and 73 females) collected from May 31-June 5, 2001; June 10-28, 2002; May 22-June 7, 2003 on groundfish bottom trawl surveys and from April 27-May 24, 2004 on shrimp trawl research surveys off the west coast of Canada (Fig. 1).

WC-NWFS

n = 403 (176 males and 225 females) collected from July 10-August 15, 2003 from Goos Bay, Oregon to the US/Canada border, and from August 30-September 15, 2003 from Cape Flattery, Washington to Astoria, Oregon on the NOAA Fisheries West Coast groundfish survey. Additional skates 30°-September 15, 2003 from Cape Flattery, Washington to Astoria, Oregon = 401 (176 males and 225 females) collected from July 10-August 15, 2003. Additional skates from the GOA and CCE were collected off the GOA, GOA and BC, and the US west coast states between 2003 and 2009 from research surveys and via port sampling. Ages were estimated, with a maximum age of 26 years, from vertebrae prepared with the standard (unstained) thin sectioning technique in this preliminary study. A new method will be compared to validated ages from a longnose skate C14 study. The methods estimated ages that best fit the validated ages will be used to standardize aging criteria among agencies therefore optimizing age determination for use in stock assessment and management.

Vertebral preparation and aging precision

Vertebral sections were prepared (n=0.3 to 1.5 mm thick) on the longitudinal plane either with a low-or high-speed saw and microscope slide mounted (Fig. 1a). Growth bands from unstained vertebrae were examined under a dissecting microscope with reflected or transmitted light with the addition of mineral oil for band enhancement. Opaque and translucent band pairs were interpreted as an annulus, 1 year of growth, from the corpus calcarious and intermedialis (Fig. 1b). Two vertebral collected in the GOA were prepared with a histological staining (hematoxylin/eosin) technique (Fig. 1c) during a pilot study (Fig. 3b). Band counts were made independently by up to 3 age readers for each sample. Randomly selected specimens and age discrepancies were resolved (Table 1).

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Results

The reader-tester percent agreement from all regions ages varies from 4.0 % to 35.2 % (Table 1). The percent agreement from the pilot study tested stained specimens (n = 15) was 22.0 %. The length range for aged specimens and maximum age are similar across all regions. The ℓ∞ values for males, females and sexes combined vary considerably across all regions (Table 2). The GOA, male and female length distributions are skewed towards the greater lengths (>1000 mm TL) while compared to BC and WC. Male and female length distributions for BC and WC are similar even with the WC sample size (n=401) more than double that of GOA and BC. Overall, the male and female von Bertalanffy growth curves show a greater length-at-age for GOA while compared to BC and WC (Fig. 4). The GOA and WC male growth curves converge at an age of 19 years and length of 1200 mm (Fig. 4b). Females from the GOA and BC mature at a younger age than WC. For GOA and BC, females reach 50.6 % sexual maturity at 11 years and at 17 years for WC (Fig. 5).

Conclusions

Overall, ℓ∞ values are variable although male and female ℓ∞ are similar for BC. Maximum ages between both ecosystems (GOA and CCE) and among all three geographic regions (GOA, BC and WC) appear reasonably consistent. Length ranges from aged skates from all regions are similar even with an almost doubling of sampled skates from the WC. The average total length-at-age is highest from the GOA and lowest from BC (sexes combined). Inter-agency age interpretation may explain these age differences. Differences in maturity characteristics, maturing or fully mature, and maturity stage assignment may explain the disparity while comparing GOA and BC to WC.

Future research

Reevaluate aging criteria upon completion of initial C14 bomb derived age validation study for longnose skates. Synchronize aging criteria with inter-agency age comparison of stained and unstained vertebrae. Age current specimens to expand sample sizes for all regions and reevaluate growth parameters. Investigate regional differences in maturation and onset of maturity. Explore environmental (e.g., bottom water temperature), demographic, effects and potential influences on life history traits across the GOA, and CCE ecosystems, including the “current” between the Alaska and California Current.

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The recommendations and general content presented in this paper do not necessarily represent the views or official positions of the Department of Commerce, the National Oceanic and Atmospheric Administration, or the National Marine Fisheries Service.