The effect of life history uncertainty on rebuilding times for the northwest Atlantic scalloped hammerhead shark (*Sphyrna lewini*)

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**Abstract**

- This study uses the open-sourced modeling software JABBA to conduct Bayesian surplus production models of northwest Atlantic scalloped hammerhead sharks (*Sphyrna lewini*)
- A sensitivity analysis was conducted by varying life history characteristics and all three life history scenarios indicate the population is recovering well within a short timeframe.

**Introduction**

- Large sharks are vulnerable to overfishing due to their large size and slow growth
- Many sharks are data limited, making it difficult to implement management plans (1)
- Northwest Atlantic *S. lewini* faced heavy fishing in the early 1980s and once again in the early 1990s
- They are protected under CITES Appendix II and the Endangered Species Act but are still caught illegally and as bycatch
- Sought after for their large fins
- This study aims to assess the population of northwest Atlantic scalloped hammerheads and perform a sensitivity analysis based on a reasonable life history range
- The stock assessment can help determine if the population is overfished and what the timeline for recovery is

**Methods**

- Catch and catch per unit effort (CPUE) data were sourced from SouthEast Data, Assessment and Review (SEDAR)
- Just Another Bayesian Biomass Assessment (JABBA) (2) was run through R (3)
- 3 life history scenarios were created by varying life history characteristics:
  - The intrinsic rate of population increase (**r**) was given a prior mean of 0.089, 0.104, and 0.121 for low, medium, and high respectively (4,5)
  - A minimum fixed observation error of 0.1 was set, an informative gamma prior of (0.001,0.001) was used and an initial biomass depletion prior of 0.9 with a CV of 0.25 was set
- Forward projections were created with fishing scenarios based on a proportion of MSY

**Results**

- Figure 2: Kobe plot for low life history scenario combined run
- Figure 3: Kobe plot for medium life history scenario combined run
- Figure 4: Kobe plot for high life history scenario combined run
- Figure 5: Biomass trajectory for low life history scenario combined run
- Figure 6: Biomass trajectory for medium life history scenario combined run
- Figure 7: Biomass trajectory for high life history scenario combined run

**Discussion**

- The high life history scenario is the most optimistic currently and in the future across all fishing levels
- The low life history scenario is more optimistic than the medium scenario in the present
- The medium life history scenario is more optimistic in the future at low levels of fishing
- There is natural variability associated with the standard deviation and this could account for differences
- All life history scenarios have a similar and positive outlook for current stock status
- The rebuilding target for most sharks is 70% probability of recovery and it is reached in all scenarios except low and medium life history runs with fishing at 100% MSY (maximum sustainable yield)
- The status quo represents current fishing and passes 70% in all three models by 2023
- While these outlooks are positive, they do not measure spawning stock fecundity and incorporating this usually results in a more pessimistic analysis
- Commercial fishing is also more common in the Pacific and threatens *S. lewini* there

**Future Studies**

- JABBA does not factor in spawning stock fecundity
- Simple Stock Synthesis is a good alternative for simple age structured modeling
- More complex age structured models would provide more accurate insight and predictions of population
- Continuing to gather catch and CPUE data is important in updating current and future predictions of biomass

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**References**

(1) Chang and Liu, 2009
(2) Winker et al., 2022
(3) R Core Team, 2022
(4) ICAT, 2012
(5) SEDAR – 77-AW04, 2022
(6) NOAA, 2023