

Precipitous Declines in Northwest Atlantic Dusky Sharks

Author list

Dusky sharks, *Carcharhinus obscurus*, are highly vulnerable to overfishing because they are slow to mature (19-21 years) and have low reproductive output (8-10 pups every 2-3 years)¹. We show that in the Northwest Atlantic, dusky sharks have declined to under 1% of their abundance since the 1960s and declines may have increased since the implementation of management measures. For this species to survive in the Northwest Atlantic, there will need to be a great reduction of fishing effort in multiple fishery sectors internationally.

We estimated trends in relative abundance of dusky sharks from multiple data sources in the Northwest Atlantic using generalized linear models, which are robust to a wide range of model assumptions (for methods, see supplementary information). We found consistent, and dramatic, declines in all data sources examined (Fig. 1). There was no statistical difference in estimates from bottom trawl surveys as compared to longline surveys. The meta-analytic estimate of decline rate was 12.2% per year (95% CI: 8.4 to 15.9%) which corresponds to an absolute decline of 99.1% (95% CI: 95.8 to 99.8%) since 1970. This decline is also reflected in the change in the average mass of individuals, which has declined to 40% since 1972 in the UNC-IMS surveys.

In 1993, the U.S. implemented their Atlantic sharks fishery management plan which includes time-area closures and prohibits the retention of bycaught dusky sharks⁴. Using

Comment [TDS1]: Are landings still allowed?

piece-wise generalized linear models we estimated the relative change in decline since 1993 (see supplementary information). Our estimates suggest that declines in dusky sharks may have been greater since 1993, -0.14: 95% CI -0.29 to 0.01 (for details, see supplementary information).

Comment [TDS2]: This is not significant

Bycatch and targeted catch of Northwest Atlantic dusky sharks occurs in multiple fishery sectors in the both U.S. and Mexican waters^{2,5-6}. Current management efforts, such as prohibiting the retention of dusky sharks, are likely not effective conservation measures since dusky sharks suffer high mortality (33% released dead in bottom longlining⁷). Since the current management plans came into force, dusky sharks have declined by an additional XX%. Given their high mortality when captured, fishing effort will need to be greatly reduced across a multiple fishery sectors in both the U.S. and Mexican waters to ensure the survival of Northwest Atlantic dusky sharks. The reduction in fishing mortality needed for the species survival is between 70 to 80% of the present mortality (Myers and Worm 2005),

Comment [R3]: can we cut this?

The loss of these large predatory sharks from the Northwest Atlantic will not only lead to a further erosion of large predator diversity⁸ but may also lead to trophic cascades with unknown consequences⁹. Currently, Northwest Atlantic dusky sharks are listed as vulnerable by the World Conservation Union (IUCN)¹⁰ and, in the U.S., they are listed by the National Marine Fisheries Service (NMFS) as a “Species of Special Concern” but receive no protection under the U.S. Endangered Species Act¹¹. Given the estimated

Comment [R4]: We could get rid of this as well.

Comment [R5]: We could get rid of this ref. I think.

declines, the long generation time¹, and the apparent lack of effectiveness of management

Comment [R6]: could we cut this?

measures, immediate action is needed throughout the populations range.

References

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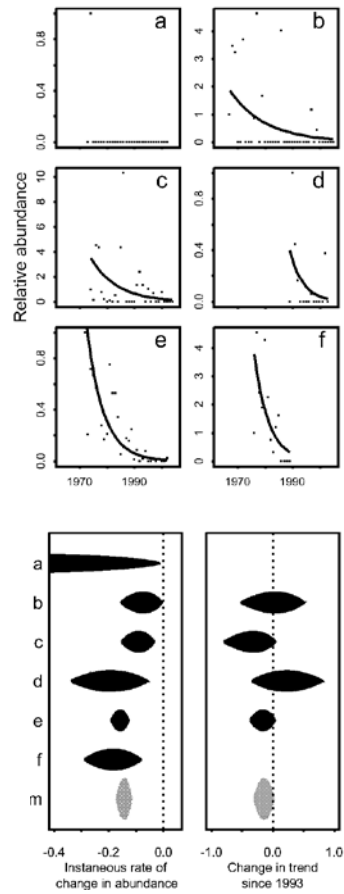


Figure 1. Trends in relative abundance (top), likelihood profiles of the year rate of change during the whole time period (bottom left) and the change since 1993 (bottom left) for Northwest Atlantic dusky sharks for (a.) Northern Gulf of Mexico bottom shrimp trawl survey, (b.) NMFS offshore bottom trawl survey, c. NMFS inshore bottom trawl survey, d. southeast U.S. SEAMAP bottom shrimp trawl survey, e. North Carolina

Institute of Marine Sciences longline survey, f. Crooke commercial longline data. The likelihood profiles are displayed as raindrop plots, in which the height is proportional to the loglikelihood within the 95% confidence regions (Barrowman and Myers 2003). Also shown are the profile likelihoods for the meta-analytic means.

Comment [R7]: perhaps cite this only in supplement