



White hake (*Urophycis tenuis*) in the Gulf of Maine: Population structure insights from the 1920s

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ABSTRACT

White hake (*Urophycis tenuis*) provides an important fishery in the Gulf of Maine (GOM) that is currently depleted. Even though several year classes are present, there is little evidence of white hake reproduction occurring along the northern coastal shelf. Based on survey indices of early life history stages, researchers concluded that they reproduced at one of the two population centers located either from the Scotian Shelf area in eastern GOM or from the Georges Bank-Mid Atlantic Bight area. White hake have been absent from large areas of the GOM for more than 15 years and this suggests substantive changes may have occurred in their distribution since the 1920s. Various factors may have contributed to this observation, including the loss of spawning aggregations. This study examined the historical population structure of white hake in the Gulf during the 1920s, a period when stocks were more abundant. Their seasonal distribution, movement patterns and the behavior of individual population components were derived from relevant scientific literature and surveys of fishermen gathered during the period. The study identified several resident groups of white hake near the coastal shelf that displayed cyclic movement patterns to fishing grounds that have been abandoned for decades. The comparison of historical distribution patterns to recent white hake surveys revealed the loss of resident white hake groups from grounds bordering the northern GOM coastal shelf that apparently were undetected spawning components. Significance of the predator–prey linkage with alewives is discussed.

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1. Introduction

White hake (*Urophycis tenuis*) have been an important part of New England's Groundfish fishery for centuries. Survey data from 1955 to 1961 (Fritz, 1965) show that white hake were much more abundant than either cod or haddock in autumn and were concentrated in two general areas; one being the grounds along the northern coastal shelf from Gloucester, MA to Yarmouth, N.S., and the other being the grounds along the northern and eastern boundaries of Georges Bank (GB). However, white hake abundance in the GOM has fluctuated considerably since passage of the Magnuson Act (Magnuson-Stevenson Act, 1976). White hake landings varied from 4000 to 9600 mt/year from 1974 to 1998 (Collette and Klein-MacPhee, 2002), but by 2006 stocks in the GOM had declined to less than 2000 mt (Sosebee, 1998). These large fluctuations suggest that single species management efforts may not be the best way to achieve BMSY and have led to concerns that a better understanding of population structure and their interactions with other

species may be valuable in developing more effective management strategies.

The purpose of the study has been to determine whether white hake population structure in the GOM was previously more complex than is found today and if so, to identify any outstanding factor(s) linked to those changes. This research addressed the following specific issues: Is there historical evidence that a resident population of white hake existed in the GOM; second, if a resident population existed in the GOM, is there evidence to suggest that local spawning occurred and third, is there evidence indicating their contribution to the fishery was significant? Finally, was there evidence suggesting why coastal white hake stocks may have disappeared?

The research evaluates historical information from the 1920s and 1930s relating to the distribution and dynamics of white hake in the GOM, a period when commercial stocks were robust and their habitats were comparatively undisturbed. The primary source of fishermen's ecological knowledge (FEK) used for the study came from Rich (1929), with supplemental information from Ames (1997, 2004). The primary source of empirical data was derived from Bigelow and Schroeder (1953). The resulting combination of qualitative and empirical data from historical sources was then compared with recent quantitative scientific indices.

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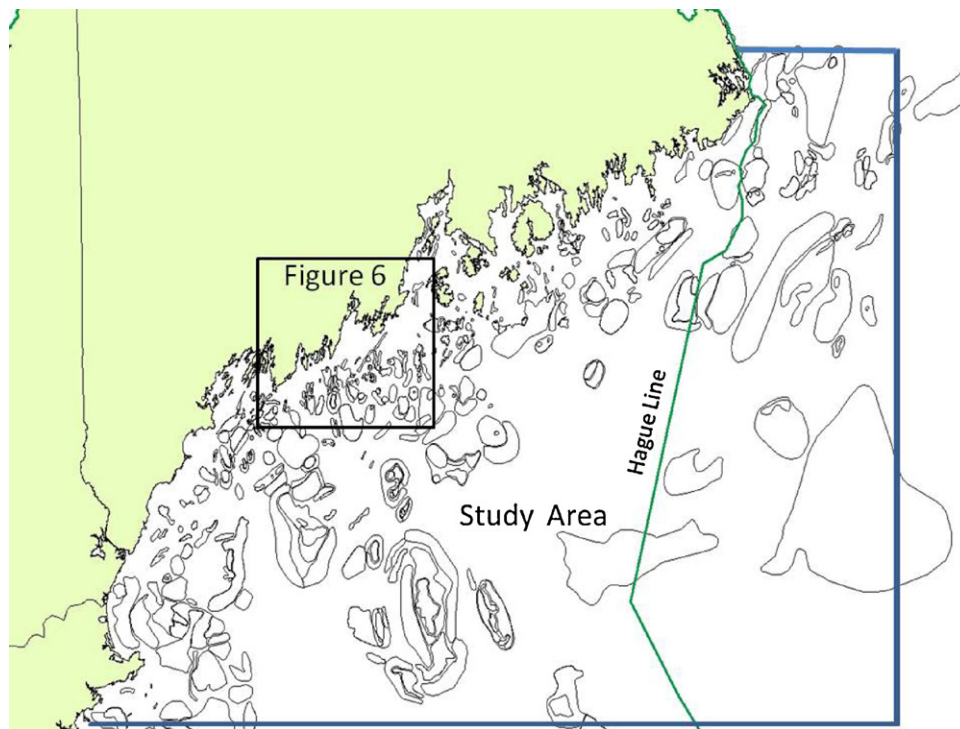


Fig. 1. The study area includes those Gulf of Maine waters and fishing grounds lying north of a line drawn from the Highlands Light on outer Cape Cod to Yarmouth, N.S.

2. Methods

The historical distribution and dynamics of white hake was evaluated in the Gulf of Maine (GOM) during the 1920s. The study area includes all the GOM lying north of a line extending east from the Highlands Light, Cape Cod ($42^{\circ}\text{N } 70^{\circ}\text{W}$) to Wrights Swell, M.A. and then to Yarmouth, N.S. ($43^{\circ}50'\text{N}, 66^{\circ}07'\text{W}$) and was similar to that used to determine the population structure of 1920s and 1930s Atlantic cod (Ames, 2004) (Fig. 1).

The following definitions were used to evaluate population structure:

- (a) A population is defined as a self-reproducing group of conspecific individuals that inhabit the same range at the same time, are affected by similar environmental factors, and are reproductively isolated from other populations.
- (b) A subpopulation is a semi-independent, self-reproducing group of individuals within a larger population that undergoes some measurable but limited exchange of individuals with other areas within the population.
- (c) A spawning component is a segment of a population that does not differ in genetics or growth, but occupies discrete spawning areas inter-annually.
- (d) A stock is an arbitrary collection of fish large enough to be essentially self-reproducing, with members of the unit exhibiting similar life history.
- (e) A group of fish is a stock component that remains in a local area throughout the year (Weis, 1951).

2.1. Sources of 1920s white hake fishing ground information.

The database relied extensively on Rich's "Fishing Grounds of the Gulf of Maine" (Rich, 1929) and was supplemented by additional inshore grounds identified by Ames (2004, 1997). Rich interviewed groups of vessel fishing captains with considerable experience on the grounds he documented. In cases of disagreement, the majority opinion about the seasonality or relative abundance of fish on

a ground was accepted. His study revisited the grounds described earlier by Goode (Goode, 1887) and included additional grounds discussed by fishermen during his interviews. All fishermen were actively employed in the fishery and most used hook-and-line methods to catch white hake on grounds that were feeding stations. Ames conducted individual interviews with retired vessel captains who described the grounds between Gloucester, MA and Cutler, Maine (2004, 1995). While all had fished commercially using hook-and-line methods, most had also used other capture methods. Supporting information came from "Fishes of the Gulf of Maine" (Bigelow and Schroeder, 1953; Collette and Klein-MacPhee, 2002).

2.2. Locating historical white hake fishing grounds.

White hake are noted for inhabiting muddy substrates in relatively deep water (80 m or deeper), though historically they were occasionally found in lesser depths (Rich, 1929). They are described as being more stationary than either cod or haddock (Goode, 1887; Bigelow and Schroeder, 1953) and display diurnal behavior, remaining on bottom in day and feeding at mid-depth in the night (Collette and Klein-MacPhee, 2002; Bigelow and Schroeder, 1953). White hake are known to prey on herring, juvenile fish, and pelagic shrimp (Collette and Klein-MacPhee, 2002). The primary fishing method used to catch white hake during the 1920s period was with baited hooks (NFC historical article, 2011); a technology that required site-specific coordinates to locate the grounds fished.

Historical fishing grounds were located by following cited historical navigation directions to a point using digitized NOAA nautical charts with 10m depth contours in a GIS system. A location from the immediate vicinity of this point was selected that was consistent with the orientation, size, shape, and substrate characteristics described by fishermen of the period. These locations were in agreement with the depth and substrates of grounds where white hake are currently found. This procedure implies a visual precision that without this clarification, would appear to overstate the information contained in the historical navigation directions.

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