Use of bomb radiocarbon to validate age in the North Atlantic population of *Polyprion americanus*, including re-calculation of natural mortality estimates from life history parameters

**Introduction**

Wreckfish, *Polyprion americanus*, is a commercially important, long-lived demersal fish, occurring throughout the Atlantic. Wreckfish can be found in the eastern Atlantic from Norway to South Africa, including the Mediterranean, Canary Islands, Azores, Bermuda, and Madeira. Along the western North Atlantic they can be found from Grand Banks, Newfoundland to La Plata River, Argentina (Ball 2001 and Sedberry 1999). Adult wreckfish can be found at depths of 40-800 m, however, most occur in waters deeper than 300 m, with a maximum reported depth of 1000 m (Sedberry 1999). At these depths, adult wreckfish concentrate around steep, rocky bottoms and deep coral reefs, but can be found in lower concentrations along flat hard bottom (Sedberry 1999). Despite the wide geographic range, recent DNA evidence distinguishes a North Atlantic and South Atlantic population (Ball 2000). This study will focus on the North Atlantic population of *P. americanus*.

Commercial fishing for wreckfish takes place throughout its North Atlantic range, with the exception of Bermuda. The western North Atlantic fishery is considered a success story of fisheries management; however, important life history information is still lacking. For instance, much is unknown about the early life history of juvenile North Atlantic wreckfish and although age estimates have been published, no age validation study has been performed. The latter may result in inaccurate estimates of various age related biological parameters. The current study will use bomb radiocarbon analysis to validate current age estimates for this reported long-lived species. Once the ages have been validated, we will estimate natural mortality rates for possible use in stock assessments and calculations of annual catch limits. In addition, growth rate back-calculations will be used to characterize early life history traits. Finally, accurate growth curves will be formulated based on the new age information.

**Why Age Validation?**

- Otoliths of long-lived fishes are notoriously difficult to read with increasing age, because increment patterns become more compact and harder to differentiate.
- There is a large age gap between the reported max ages of the North Atlantic (39 years) and South Atlantic population (76 years). In addition, *P. oxyrinchus* a congeneric species, is found to reach ages approaching 60 years.
- The North Atlantic population is admittedly thought to have been under-aged.
- Accurate age estimates allow for calculation of growth rates, age at maturity, age at recruitment, as well as natural mortality. Furthermore, these biological parameters can be analyzed for changes over the years in order to determine the health of a fishery.

**Methods**

- Samples used in this study have been previously collected from commercial catches by federal and state port samplers for the years of 1989-present.

**Bomb radiocarbon analysis**

- During the 1950s to 1960s, radiocarbon surface 14C activity doubled in the world’s oceans, due to extensive nuclear arms testing (Broecker 1985), ultimately creating a chronometer.
- The core of an otolith, representing the first year of life, can be analyzed for 14C levels. These calculations help make up for the lack of smaller specimens and allow for better estimations of von Bertalanffy growth model parameters, back calculations will be performed using the biological intercept algorithm:

\[
L_t = L_\infty \left(1 - e^{-K(t-t_0)}\right)
\]

Where,
- \(L_t\) is the size of a fish at a certain age
- \(t_0\) is otolith size at a certain age
- \(L_\infty\) and \(O_\infty\) are the size of the fish and otolith at the biological intercept
- \(K\) and \(c\) are the size of the fish and otolith at capture

**Natural mortality**

- Natural mortality rates will be estimated using the same methodologies as those employed by the South Atlantic Fishery Management Council.

\[
\log_{10} L_\infty = 0.0066 \times 3.799 + 0.8543 \log_{10} L_0 + 0.4634 c_{\text{ intercept}}
\]

Where,
- \(L_t\) and \(K\) are estimates from the von Bertalanffy growth model
- \(T\) is the average temperature of the Blake Plateau

**Implications**

Due to under aging, natural mortality rates and life history traits used in previous stock assessments may have been incorrect. This project proposes to validate ages and aging techniques, allowing for accurate estimation of life history traits. This information can then be used by managers to properly manage the species, as well as maximizing a healthy economic return from the fishery.