Re-ageing of archived otoliths from the 1920s to the 1990s

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Background

The International Pacific Halibut Commission (IPHC) has collected otoliths for age determination since 1925. All otoliths that have been examined for age determination are kept and added to the IPHC's otolith collection, which contains samples from over 1.6 million Pacific halibut. Age determination techniques used for Pacific halibut have changed over time; prior to 1992, all otoliths were surface aged. Between 1992 and 2001, otoliths that met certain criteria were also aged by break-and-burn or break-and-bake method in addition to surface ageing. Beginning in 2002, all otoliths collected from the IPHC fishery-independent setline survey and the commercial catch have been aged by break-and-bake. Observed size-at-age (SAA) of Pacific halibut has changed over time and the reasons behind changes in Pacific halibut SAA are not well understood. Prior to this study, the potential contribution of changes in ageing methods to observed SAA was uncertain.

Microscope used by IPHC in the 1960s. New and historic surface ages were compared to see if there were differences that could be due to changes in equipment or ageing protocol.

Stored otoliths were transferred from vials to trays with individual cells.

Study goals

To provide information on the bias and imprecision of historical surface ages relative to age data from the 1990s onward, subsets of otoliths from each decade from the 1920s to the 1980s were re-aged by both the surface and break-and-bake technique, and these new ages were compared to the original surface ages. Additionally, a subset of otoliths collected in the 1990s that were previously only surface-aged were re-aged by break-and-bake. Since the 1920s, IPHC age readers have cleared Pacific halibut otoliths in glycerin solution (50% glycerin/50% water) to increase readability of the growth patterns. Otoliths are also kept in glycerin solution for long term storage. This study also provided an opportunity to observe the condition of otoliths stored for almost 90 years in glycerin solution.

Methods

Years for which otoliths had been collected and aged were identified. One or two years per decade were selected based on number of geographical regions (IPHC regulatory areas) and otoliths available. For each selected year within a decade, otoliths were retrieved from storage. Otoliths collected prior to 2002 were stored in groups of ~25 per vial. Otoliths were separated within the vial by numbered paper labels. Almost 28,000 otoliths were transferred from vials to containers that have individual cells. The transferred otoliths were further subsampled to 500 from each regulatory area for ageing. A total of 17,414 otoliths were re-aged by three experienced readers.

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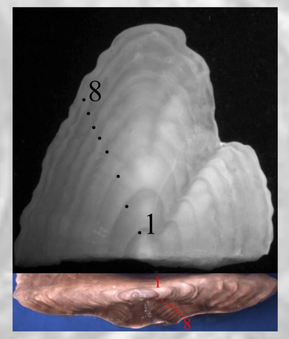
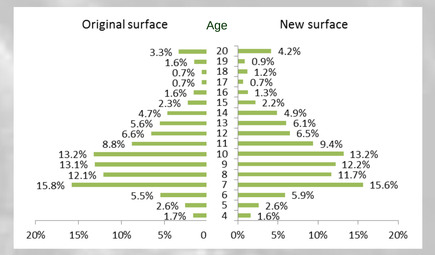
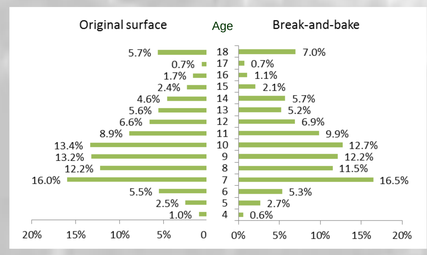
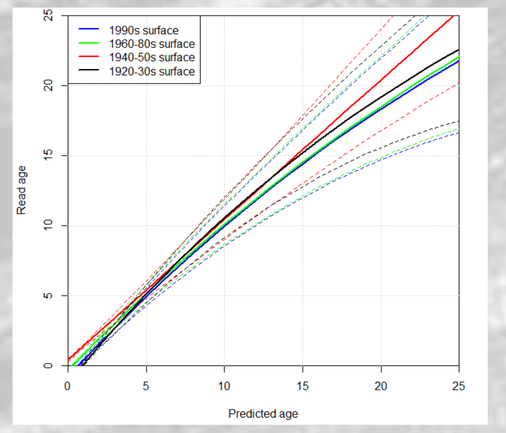


Annotated photo of surface and baked halves of an otolith collected in 1926.

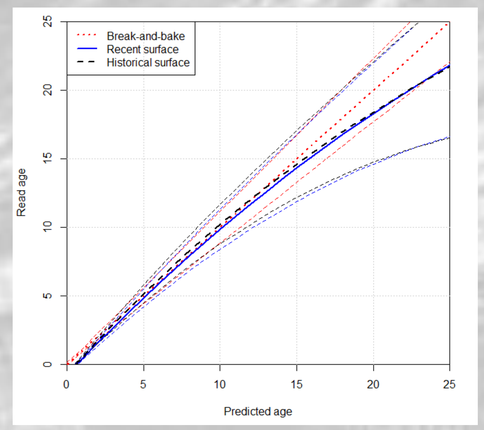




Age frequency distributions were compared for new and original surface readings and for original surface and break-and-bake readings for each decadal group. Example above is for the 1960s group.



Comparison of bias (solid lines) and imprecision (dashed lines) estimates for surface ages read during the 1990s, 1960s-1980s, 1940s-1950s, and 1920s-1930s.



Comparison of bias and imprecision for break-and-bake, recent (1998+) and pooled historical (1926-1993) surface ages.

Results

Results indicated that historical samples contained very few fish aged older than 15 years by either method. Based on simultaneous estimation of bias and imprecision for up to four unique ages per otolith, the properties of historical surface ageing methods were found to be very similar to current methods, becoming increasingly biased and imprecise beyond 15 years. This study reconciles two important questions for assessment and related analyses attempting to reconstruct the historical abundance and biological trends for Pacific halibut. These results support the conclusion that increasing trends in size-at-age observed from the 1930s through the late 1970s were not an artifact of changes in ageing methods, but represent a real biological phenomenon, for which probable mechanisms are currently being investigated. Second, there does not appear to be a need for extensive further re-ageing of historical samples. The truncated age structure of most historical samples suggests that little information will be lost if ages are aggregated beyond age 20 (as has been done in most analyses) and both the bias and imprecision of the surface method are included in any analysis.

In addition to clarifying precision of ageing methods, the re-ageing of archived otoliths also provided an excellent opportunity to observe the condition of otoliths stored in glycerin solution for up to 88 years. Most of the otoliths examined were in good condition; some samples from the 1920s and 1930s had a chalky coating that obscured surface growth patterns, but were readable when broken and baked.