Age reading of herring at the Swedish Museum of Natural History – otoliths or scales?

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Content

Introduction

The age of all herring used for the Marine Monitoring Programme for Contaminants in Marine Biota are determined in order to be able to normalize fish to a certain age (although age-normalization is currently not included in the contaminant time trend analysis). Historically, scales are used for age reading, which has the advantage that the fish does not need to be opened or thawed in order to do an age determination and specimen selection for the programme. However, other labs have for the last decades started using otoliths for age determination instead. This method is thought to be more accurate. Otoliths can either be read direct under a microscope or they can be sliced and stained before reading. Using otoliths has furthermore been suggested to be faster than for scales.

The aim for the project was therefore to 1) test if we could find an effective and fast method for removing otoliths from herring, 2) evaluate if reading otoliths would save time compared to reading scales and 3) to compare the result from the two methods (age from otolith and scale) to see if there was a bias in the "scale age". Our focus was for this report on reading the otoliths directly under a microscope.

An earlier study conducted at the museum also evaluated the use of scales versus otoliths for age determination. In this study the otoliths were sliced and stained, which means that the two studies are not one to one comparable. The focus on the previous study was also limited to our 3rd aim and did not evaluate the time or otolith removal components.

Method

The method for removing otoliths from frozen fish that had not previously been opened was to expose the otolith by making a cut behind the neck of the herring, at the height of the gills and gently wiggle the head loose (**Figure 1**).

Figure 1. Exposing the otoliths by cutting the head of the fish.

Results and discussion

1. Otolith extraction methods

The method for exposing the otoliths in the frozen fish did not work well. The thought was that the head would loosen but the liver stay whole and not be exposed. However, this was in many cases not successful and the liver would fall apart. This can result in bias in the liver weight as well as contaminant exposure of the liver.

Another method used for contaminant monitoring of herring at the Finnish Environmental Institute that could be tried in the future might overcome the problem of exposure to the liver. Here, the removal of otoliths from the head of a herring is done by opening the head from the front with small scissors, starting in front of the eyes, and opening the top of the head like a car's engine hood. Then by removing the brain the otoliths are exposed for picking up with tweezers. It could be tested if this method works on frozen fish.

2. Time component

The lab did not find that the extraction and determination of age using otoliths had a major time saving component. The age was read directly for otoliths under microscope with no slicing and staining of the otoliths. Even so, the task of reading the otoliths were more time consuming than reading the scales. In addition, for the northern station in the Bothnian Bay and Sea slicing and staining would be necessary, which will take even longer than the direct reading for the southern stations. The lab therefore concluded that it was unlikely that the method of reading otoliths would be faster even if they got more practice in the method.

3. Age comparison

Figure 2 and Table 1 describe the difference between the three methods/labs. In Kattegat at the Swedish west coast scales overestimate the average otolith age by 1 year, at Abbekås in the Baltic Proper the method differences are less than two months and at Ålandshavet the age is underestimated but only by less than half a year.

There is a trend within these three stations that suggest that the difference between the age classification determined by scales at NRM and otoliths at SLU that follow the salinity. A systematic bias following the change in salinity could influence the contaminant evaluation for contaminants that bioaccumulate suggesting a lower concentration level at Fladen and a higher concentration level at Ålandshavet at a certain age than the actual level at that age. However, we have too few stations to confirm this trend. In addition the earlier report by Dahlgren et al. (2011), which included 22 stations, did not show such a trend over the salinity gradient of these stations.

Table 1. Average age for the three methods/labs and stations.

	SLU otoliths	NRM scales	NRM otoliths	SLU otoliths	NRM scales	NRM otoliths
	All age classes			Age class 3-5 as determined by NRM scale method		
Fladen	3.3±2.1	4.2±2.0	3.7±2.2	2.7±1.3	3.7±0.9	2.8±0.8
Abbekås	4.3±2.2	4.5±1.9	4.7±1.3	3.4±0.8	3.5±0.7	4.2±1.0
Ålandshav	5.8±3.6	4.8±1.6	4.1±2.3	4.6±2.0	4.2±0.4	3.3±0.9

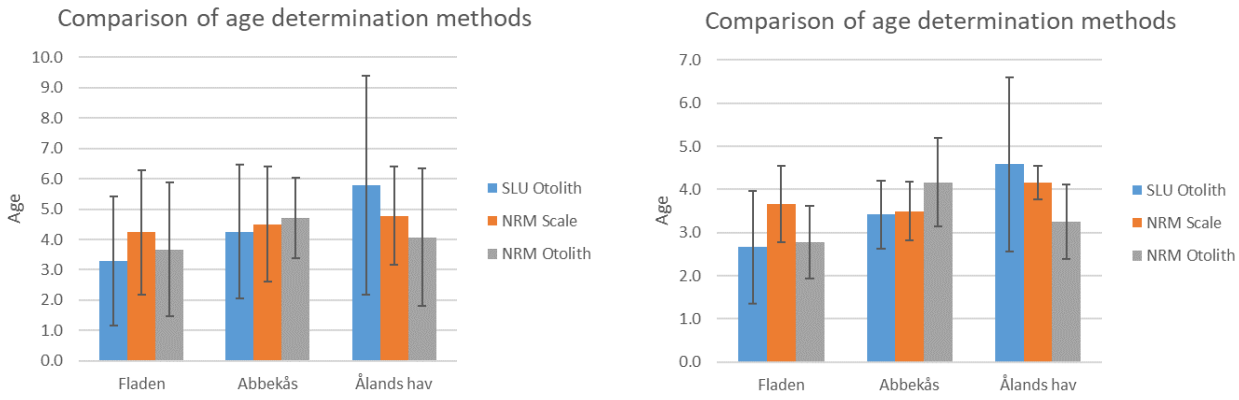

Figure 2. Comparison of the two methods and three labs with averages for each station. A) for all herring and B) for herring with a "scale age" determined to be 3-5.

In Table 2 we compare our result with result from the Dahlgren et al. (2011) study, where the age of 504 herring were determined. We see a slightly lower accuracy in our study but still almost 80% of the fish we would normally include in our survey is only one year from the age determined by otoliths. In our study we did not color and slice otoliths, which were done in the Dahlgren study and which could explain the higher

accuracy. On the other hand we do not compare the methods for the Bothnian Bay and Sea where age determination is not possible without that additional step to the method when reading the otoliths.

Our result in general indicate that fish determined within the age range favored by the marine programme are in most cases determined within ±1 year for the single fish and ≤1 year when looking at station averages. Thus, the bias of using scales (if otoliths are indeed giving more true age determinations) can likely be considered relatively small compared to other uncertainties. Furthermore, since there is currently no age correction in the programme the age component can be seen as less important.

Table 2. Comparison of results from our study and the Dahlgren et al (2011) study showing the percentage overlap between age determined by otoliths at SLU and age determined by scales at NRM.

	N	Same year	NRM + one year	NRM – one year	NRM ± one year
Our study all	48	35%	29%	4%	69%
Our study (4-5 years)	36	39%	33%	6%	78%
Dahlgren et al. 2011	504	41%	30%	13%	84%

Conclusion

The main conclusion for the lab was that there were pros and cons to both methods of age determination. However, the main reasons for switching method – more accurate age determination and time savings – did not improve to an extent that suggest a switch would make sense at present. In addition, using the method of cutting the head of the frozen herring in order to extract the otoliths turned out not to be viable and had the risk of contamination of the liver. In theory, other methods (one presented above) could possibly prove to solve this problem and should be explored in the future.

For the time being, we are therefore continuing with the use of scales for age determination in herring within the Swedish Monitoring Programme for Contaminants in Marine Biota.

References

Dahlgren, H, S. Danielsson, N. Gustavsson. Utvärdering av metodik för åldersbestämning av sill och strömming, Swedish Museum of Natural History, Rapport nr 11:2011