Difficulty of Age Determination Between Pacific Hake *(Merluccius productus)*, Pacific Ocean Perch *(Sebastes alutus)*, and Sablefish *(Anoplopoma fimbria)*.

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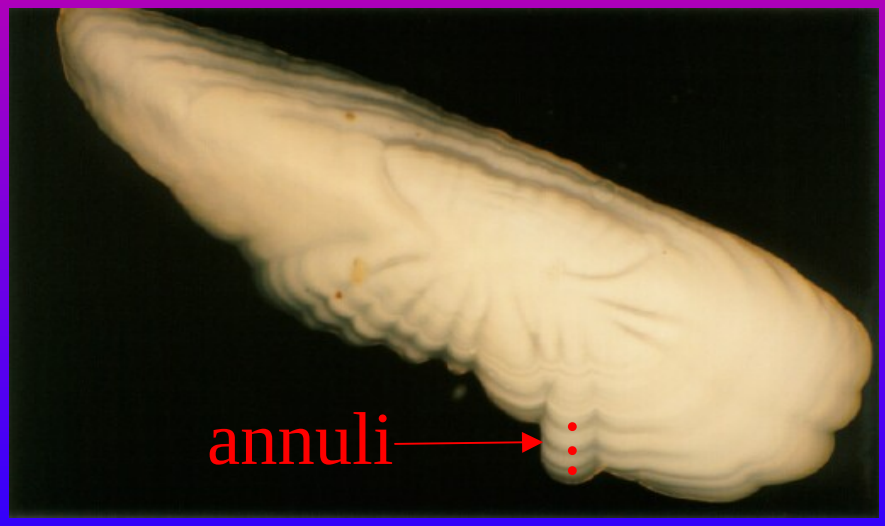
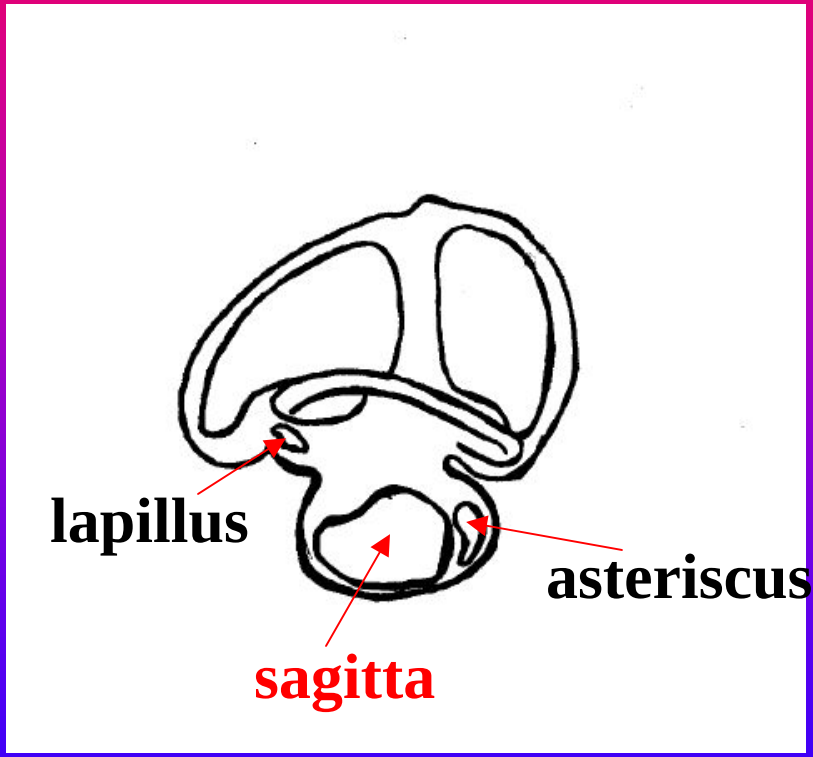
The most widely used method of estimating fish age is through the analysis of otoliths

- **The otolith is a calcareous concretion in the inner ear.**
- **Daily and annually concentric rings are formed in the otolith.**

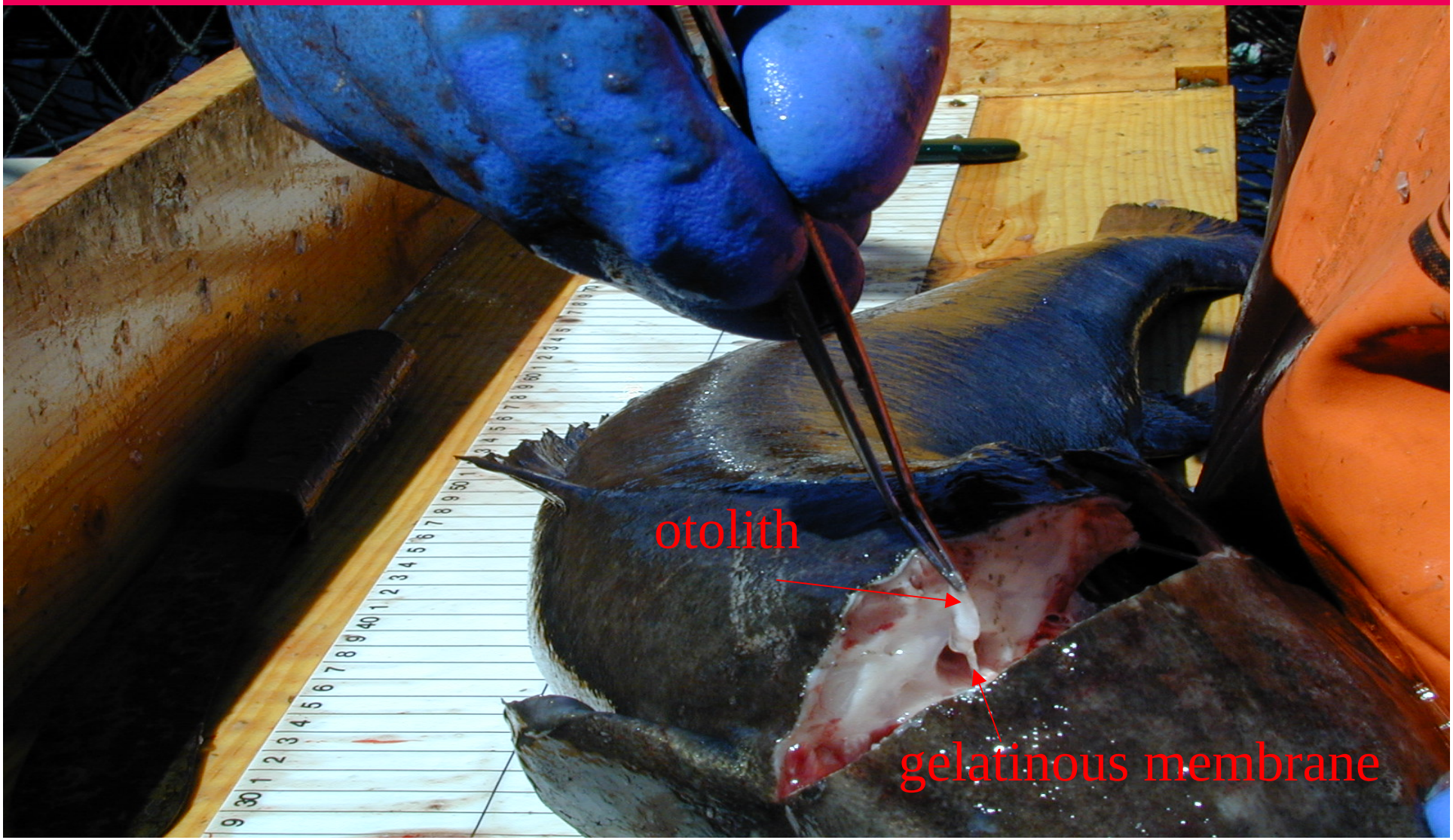


Otoliths are located in the semicircular ear canal

Suspended in a gelatinous membrane are two sets of otoliths, the lapillus, the asteriscus, and the sagitta.



A sagitta otolith being extracted from a sablefish

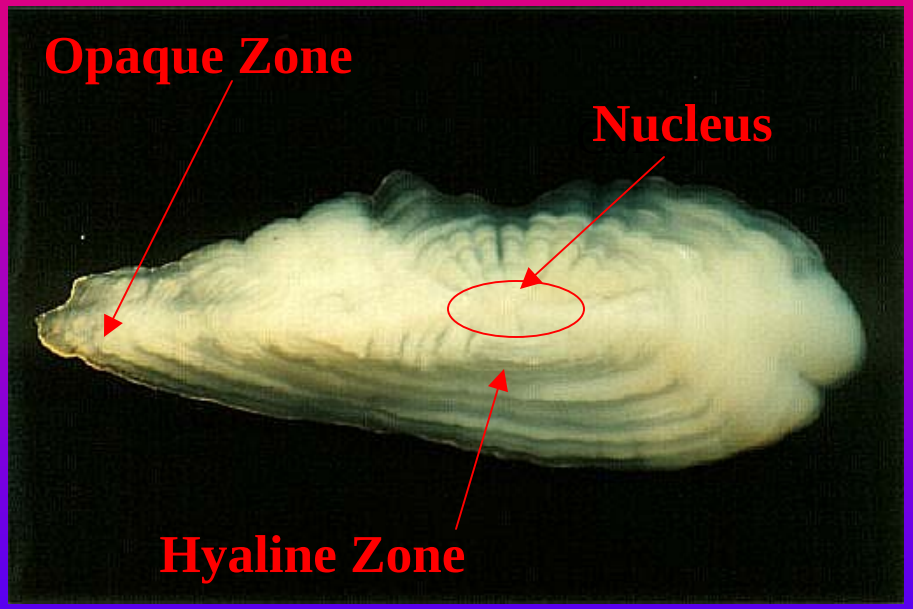


Otolith extraction takes place either at sea or at port docks

Surface ageing can be used to help determine ages of young fish

- **Surface ageing is a central support in determining the age of young fish.**
- **Surface ageing can result in underestimating the age of the fish.**

sablefish otolith



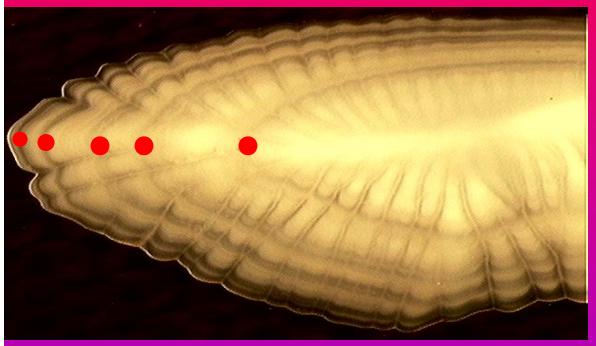
The burnt cross-section is the preferred way of determining ages

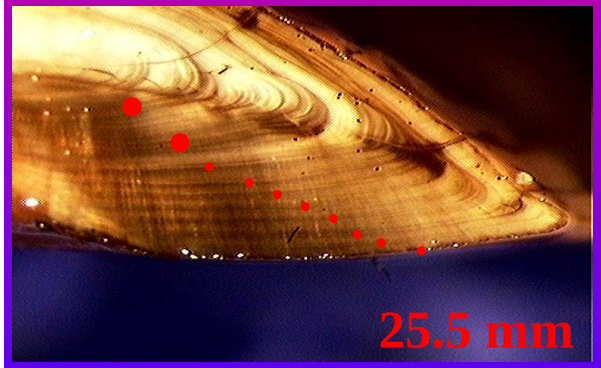
- **Age determination in mature fish were obtained by using a burnt cross section of a sagitta otolith.**
- **Growth zones appear as opaque (light) or translucent (dark) zones.**

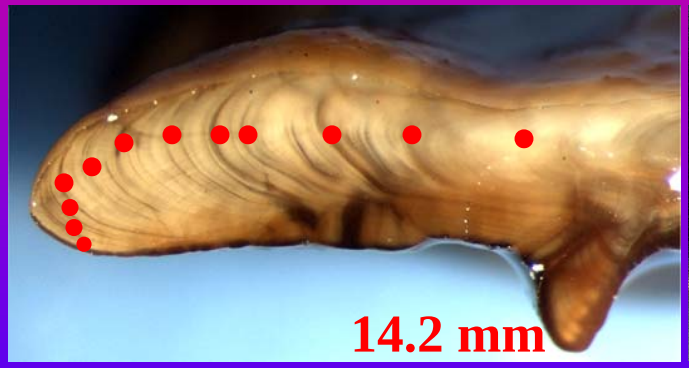
Three different life histories, three different otoliths

- **Pacific hake are a short-lived species and less difficult to age.**
- **Pacific ocean perch (POP), are long-lived, increasing the level of difficulty.**
- **Sablefish are long-lived and more difficult to age.**

Otoliths vary in readability, size and shape







Pacific hake

Pacific ocean perch

sablefish

Periodic "double-reads" were conducted to quantify ageing uncertainty

- **To assess our ability to reproduce an age estimate, a 20% sub-sample of the otoliths were re-read.**
- **The double-reads are evaluated with statistical methods.**
- **The double-read is how we maintain quality control.**

Validating ages with side-by-side analysis

- **To validate ages amongst readers side-by-side analyses were conducted.**
- **This validation method is a critical key to improving our reading proficiency.**

Percent agreement and coefficient of variation were used to compare the difficulty between species with differing life histories.

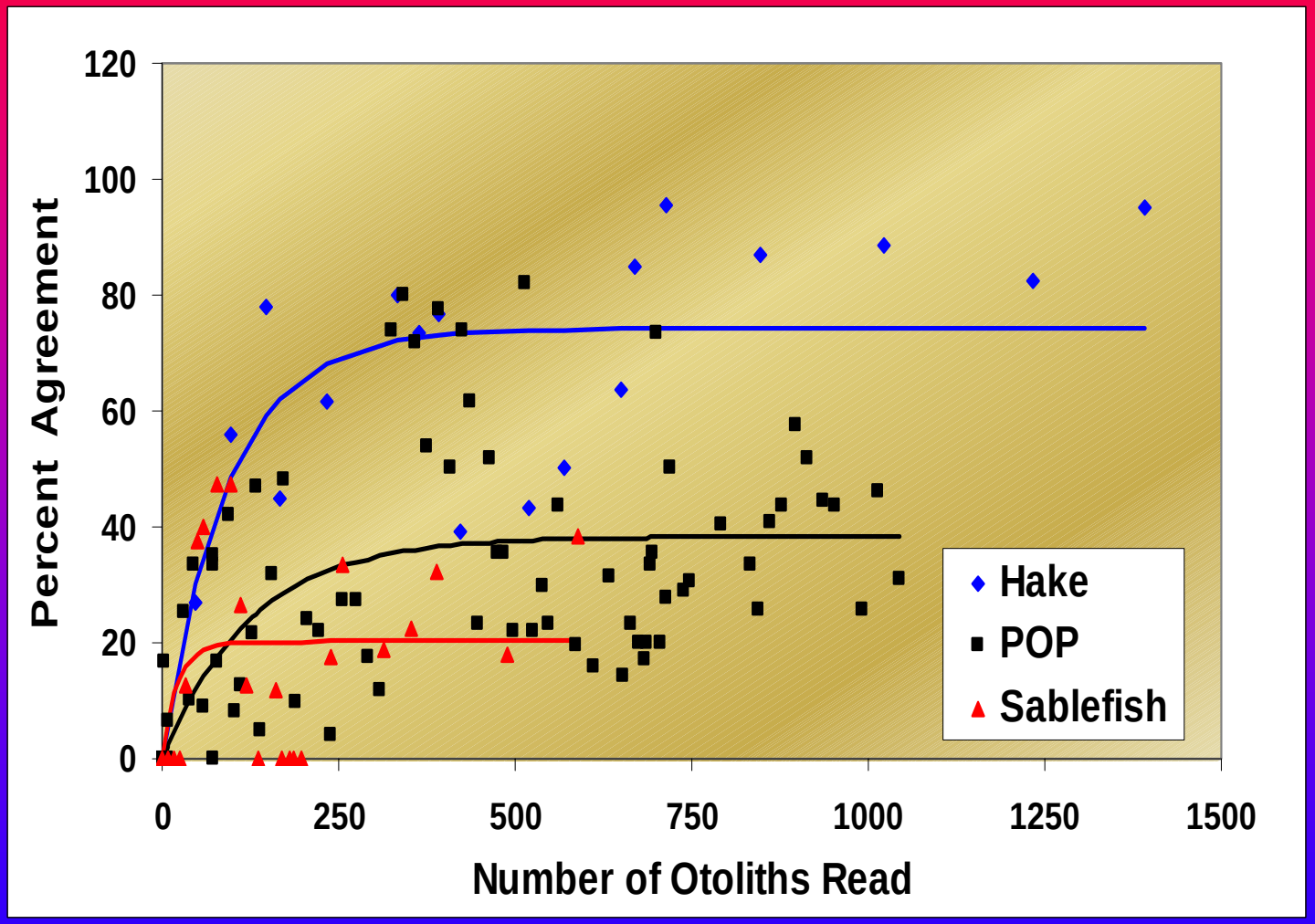
- ***n* = sample size (number of specimens aged)**
- ***Mean (□) = (tester + reader) / 2***
- ***Percent agreement* = (number of specimens agreed upon / *n*) x 100**
- ***Standard deviation (SD)* = ♦ [(tester – □)^2 + (reader – □)^2]**
- ***Coefficient of variation (CV)* = (SD / □) x 100**

Equations from (Kimura and Lyons 1991)

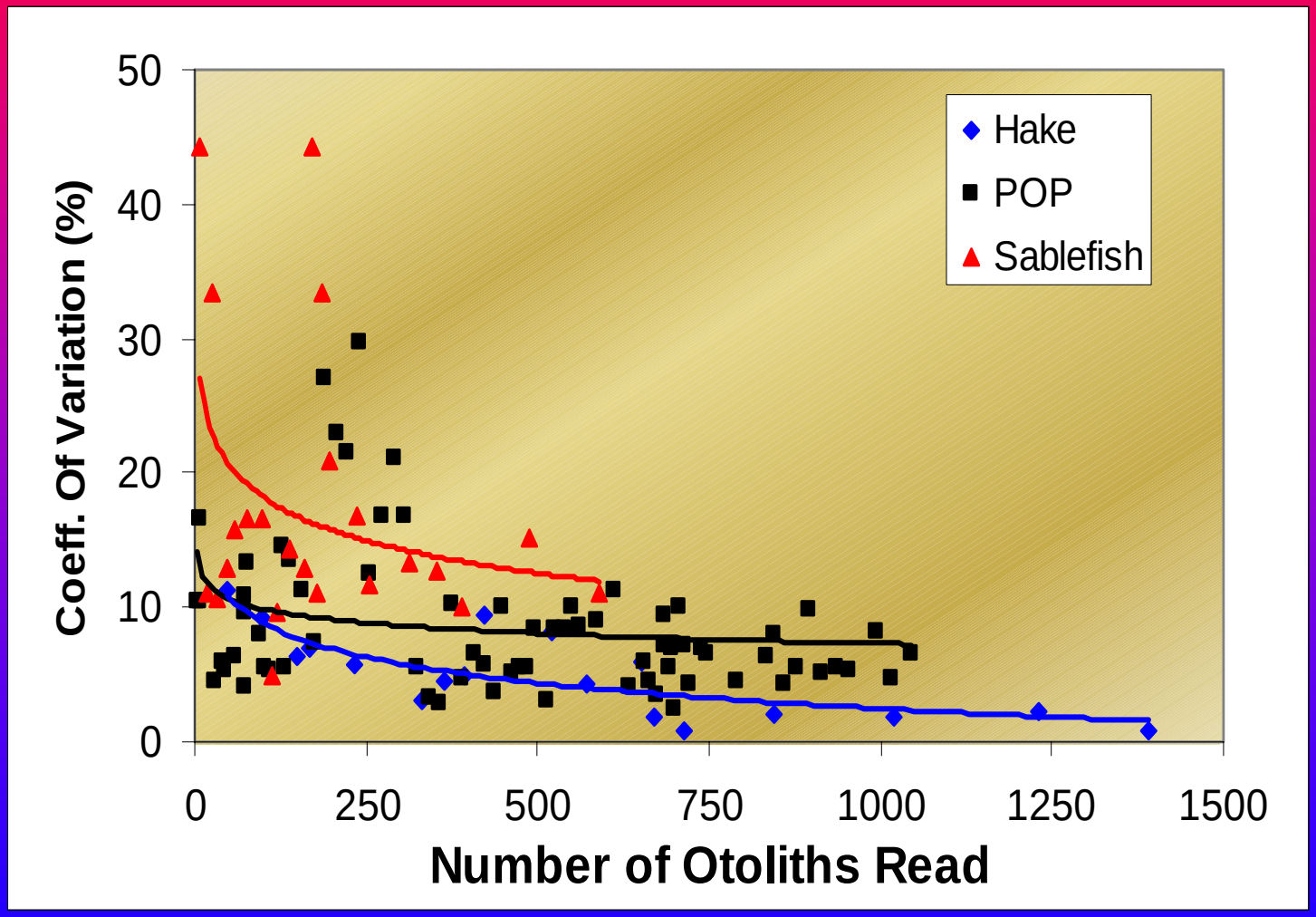
Percent agreement was highest in short-lived species and lowest in long-lived species

	Mean Age	Percent Agreement	CV	Pos. Bias	Neg. Bias	Total #
Hake	4.31	86.87	2.00	5.84	7.29	1386
POP	15.90	36.35	6.40	30.23	33.42	1161
Sable-fish	12.92	49.66	7.32	29.43	20.92	435

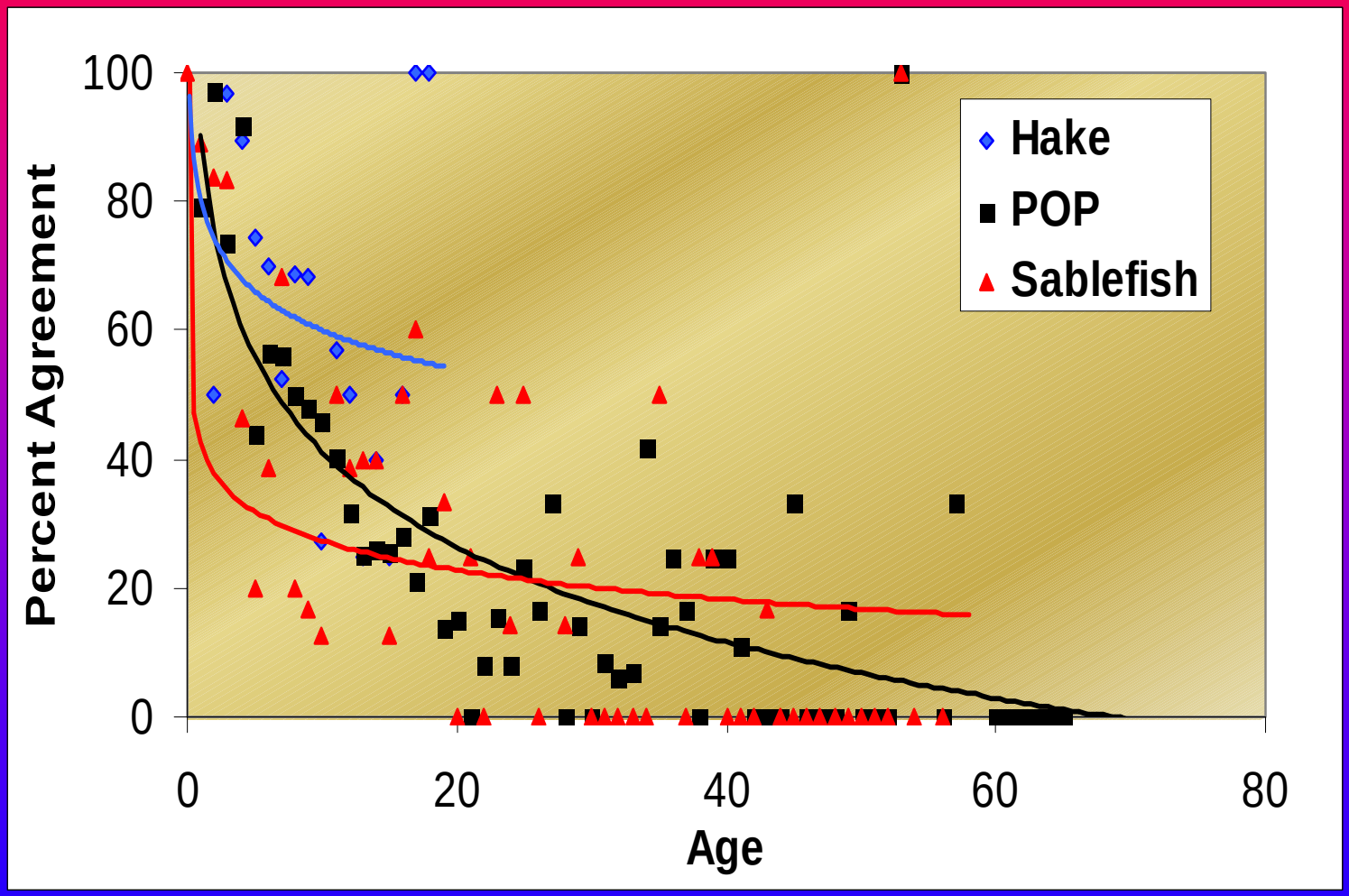
Hake, the short-lived species, required the fewest number of otoliths to learn



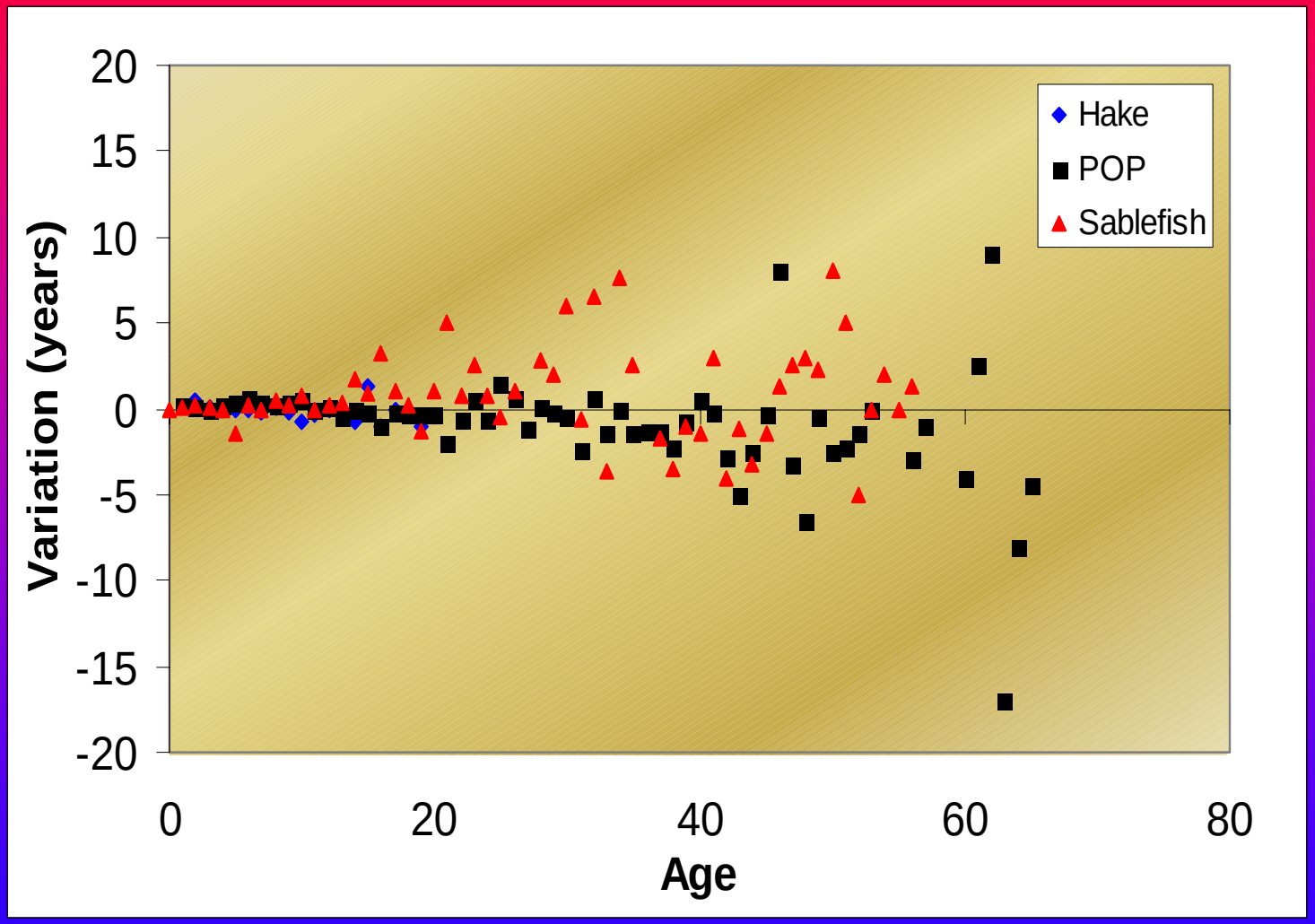
Sablefish, the long-lived species, required the most otoliths to learn



Once learned, percent agreement continues to decrease with age



Variation in the estimated age increases with age



Conclusions

- **Otolith morphology and structure varied markedly between fish species with different life histories.**
- **Difficulty in otolith age determination varied from species to species.**
- **Long-lived fish required more training to read.**
- **Percent agreement decreased with fish age, while variation increased with fish age.**

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