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Saltwater Sleuths: NOAA Researchers Seek Clues in Unusual Places to Help Determine the Ages of Fish and Shellfish Populations

Fish Scales, Mollusk Shells Play a Role in Fishery Management

Fishery biologist Sandy Sutherland looks through the lens of the microscope at tiny sections of fish earbones, known as otoliths, each showing annual bands of growth. She carefully counts the bands to determine the age of the fish, then moves on to the next sample. Known as an age reader, Sutherland is one of a small team at NOAA's Northeast Fisheries Science Center (NEFSC) whose aging work is critical to stock assessments needed to manage the nation's fishery resources in the Northwest Atlantic Ocean.

Year after year, Sutherland and colleagues age tens of thousands of samples. They come from many sources: shell samples from surfclams, otoliths from several dozen fish species, vertebra from monkfish, and scales from summer, winter, and yellowtail flounder.

"Age reading requires a lot of patience," says Jay Burnett, a fishery biologist who joined NEFSC in 1982 in the stock assessment group and now heads the Fishery Biology Program within the NEFSC's Fisheries and Ecosystems Monitoring and Analysis Division. "This has been a very busy year. In 2008 we will read more than 100,000 samples."

The aging team works in the "Cottage", a Cape Cod-style house along the Woods Hole waterfront which once served as home to the laboratory's directors. Boxes full of samples arrive at the Cottage each week. About 60 percent of the samples are from commercial fish that are landed in ports from Virginia to Maine. About 30 percent are from the Center's own research surveys, and about 10 percent come from the Northeast Fishery Observer Program, which places samplers directly on commercial fishing vessels. A fraction of the samples come from recreational fishing and the NOAA Fisheries Cooperative Research Program.

"Some fisheries are very seasonal, so samples vary," Burnett says. "Commercial samples will come from fish that have a market value and are caught in certain areas where fishermen know they will find them. Survey samples come from sampling in many areas. Observer program samples come from a variety of targeted commercial species and bycatch, or unwanted species that are not landed."

Burnett says the samples from the different groups provide a range of sizes and ages, and include species that are both commercially fished and those which are not, making it a good representation of what occurs in nature. Age estimates are based on visible growth increments that are deposited annually, much like tree rings.

Otoliths are the most common hard part used for aging species and are read whole, baked and broken, or sectioned. Wherever possible, fish scales are impressed in laminated plastic for aging, which is very cost-effective because there is little processing necessary to collect and process scales. Some species, however, require special attention: baked vertebrae are used to age monkfish, and thin sections of chondrophores, a cavity at the hinge of bivalve mollusks, are used to age surfclams.

The majority of requests for age data come from stock assessment teams, and others from state fisheries agencies and other nations. Given the demand for age data, the NEFSC laboratory in Woods Hole, Mass. analyzes more samples than any other NOAA Fisheries laboratory or state fisheries program in the Northeast U.S., partly because many agencies don't have enough qualified readers or have abandoned their aging programs.

Burnett emphasizes that quality control and quality assurance measures are critical to the group's success. When counting annual rings, "you have to validate that one year is really one year, and that everyone is reading the samples in the same way so there is a high degree of accuracy in the data you provide."

To maintain the quality of the data and a high level of precision or repeatability in age reading, the program has assembled a reference collection of known age samples. Annual exchanges for quality control and precision for cod and haddock age reading are conducted with Canadian colleagues. Readers are also checked against others in the group. Other quality control measures are used to evaluate accuracy and precision, while validation of aging methods includes recapturing tagged fish and measuring naturally occurring isotopes or bomb radiocarbon in longer-lived fishes.

Age reading has an official name – sclerochronology, defined as the study of periodic increments in skeletal organisms like shells, scales, otoliths and vertebra. While it is not as well known to the public as dendochronology, the study of tree rings used to determine age and environmental changes, sclerochronology has become an increasingly important tool in the marine sciences.

Sclerochronology can reconstruct the life history and environmental conditions preserved in fossil skeletons, such as the daily banding in coral reef skeletons and the annual growth rings in mollusk shells. Growth patterns can reflect monthly, fortnightly (every two weeks), tidal and even daily increments of time. The first known reliable age estimate of a fish occurred in 1759, but it was not until the end of the 19th century that the art of age estimation was rediscovered.

Burnett says the aging program began at the NEFSC in the 1940s with haddock and yellowtail flounder scales but really picked up steam in the 1960s. Today the group is among the most active in the nation, providing age data for stock assessments not just for the NEFSC but also for the Commonwealth of Massachusetts and several other states as well as for Canada's Department of Fisheries and Oceans, since some stocks straddle political boundaries. Other U.S. environmental agencies, such as the EPA, and academic scientists seek the expertise of this group as well, or seek access to several decades worth of archived samples.

The responsibilities for age samples and data, and the declining number of organizations who have age readers, keep the group busy. Each winter, samples from cod, haddock and yellowtail flounder on Georges Bank are analyzed for the Transboundary Resource Assessment

Committee, or TRAC, which provides assessments necessary to manage the shared resources of the U.S. and Canada in the Gulf of Maine-Georges Bank region.

Between 12,000 and 15,000 samples will be analyzed for the annual summer flounder assessment. Twice a year, several thousand samples are analyzed for stock assessment review committees, known as SARCs, which focus on specific species.

The 2008 Groundfish Assessment Review Meeting (GARM), a series of four meetings culminating in August at NEFSC headquarters in Woods Hole, will review the status of 19 managed groundfish stocks; 13 will require age data. Burnett says his group will analyze about 100,000 samples by June 1 for the GARM, significantly more than the 72,500 age samples analyzed for the last GARM in 2005, which also covered 19 managed stocks.

Ninety-five percent of the group's work is done for stock assessments, the remainder for research. Production aging, as the stock assessment work is called, uses an established methodology and applies it to thousands of samples. It is a skill which takes time to acquire. Burnett has been aging samples for 22 years, Sutherland for 4 years. Other team members have between four months and 27 years of experience aging samples. Given the demand by the 2008 GARM for production aging, research aging has not been a major focus this past year but this is something the group plans to return to soon.

"You can't estimate fishing mortality and be able to say anything reliable about stock status unless you know the demographics of the various populations," Burnett says of the importance of age data. "It is like the local school department needing to know the ages of students to plan for the future. It is the basis of everything."

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Related links:

NEFSC Fishery Biology Program: http://www.nefsc.noaa.gov/femad/pbio/fbi/fbi.html
Status of Fishery Resources off the Northeastern United States: http://www.nefsc.noaa.gov/sos/
2005 GARM Report: http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0513/