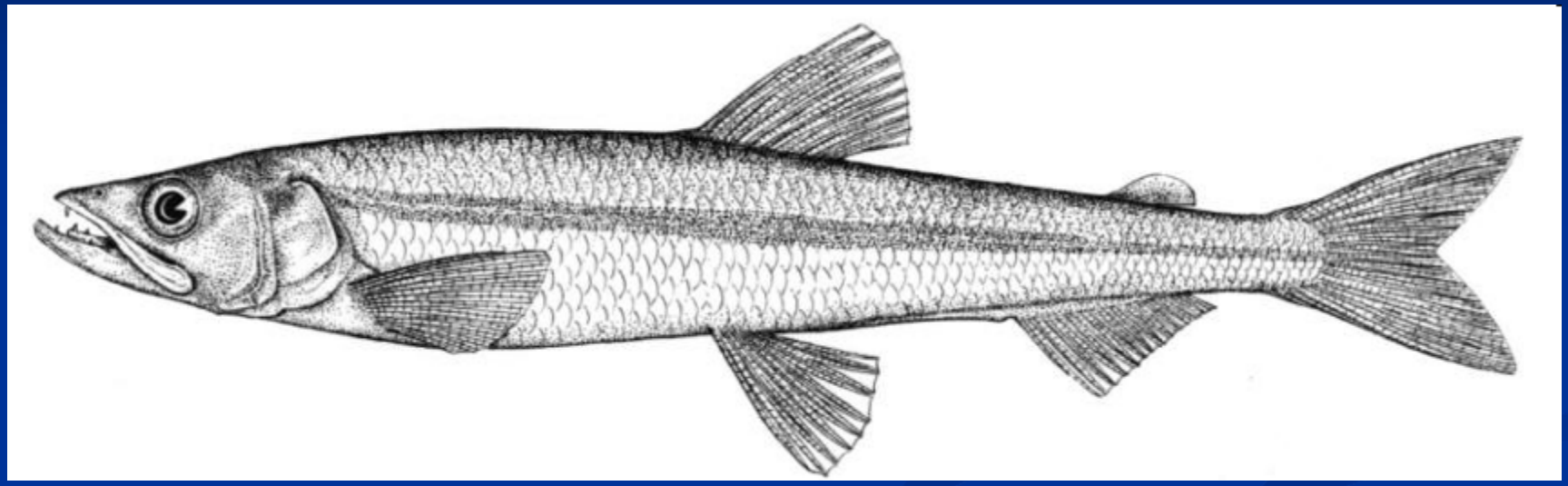
Improving methods to accurately age rainbow smelt (*Osmerus mordax)*



Scott Elzey, Massachusetts Division of Marine Fisheries
Claire Enterline, Maine Department of Marine Resources
Jessica Fischer, New Hampshire Department of Fish and Game

American Fisheries Society 2010 Meeting, Pittsburgh, PA

Anadromous Rainbow Smelt

Can live up to 6 years and 10”, but more typically 2-3 years and 6”

Eat plankton, small shrimp and fish

Spring
- Spawn at head of tide

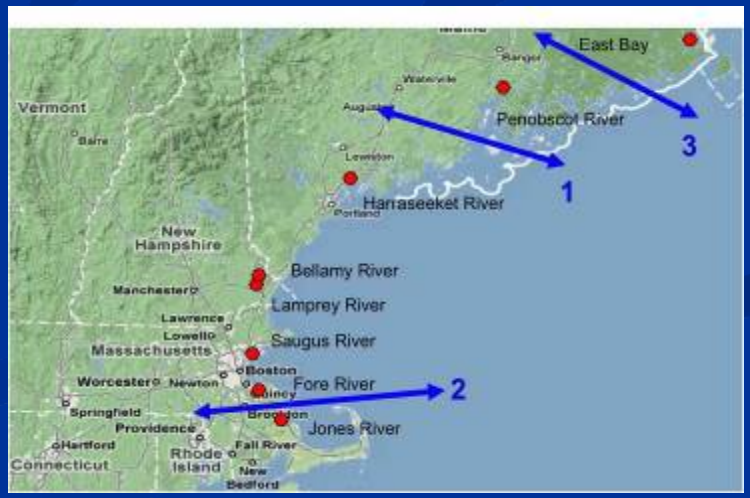
Summer
- Young of the year in estuaries, adults in coastal waters

Fall
- Open bays, moving towards shore

Winter
- Sheltered bays, large tidal rivers

May spawn in different streams each year within the same river system

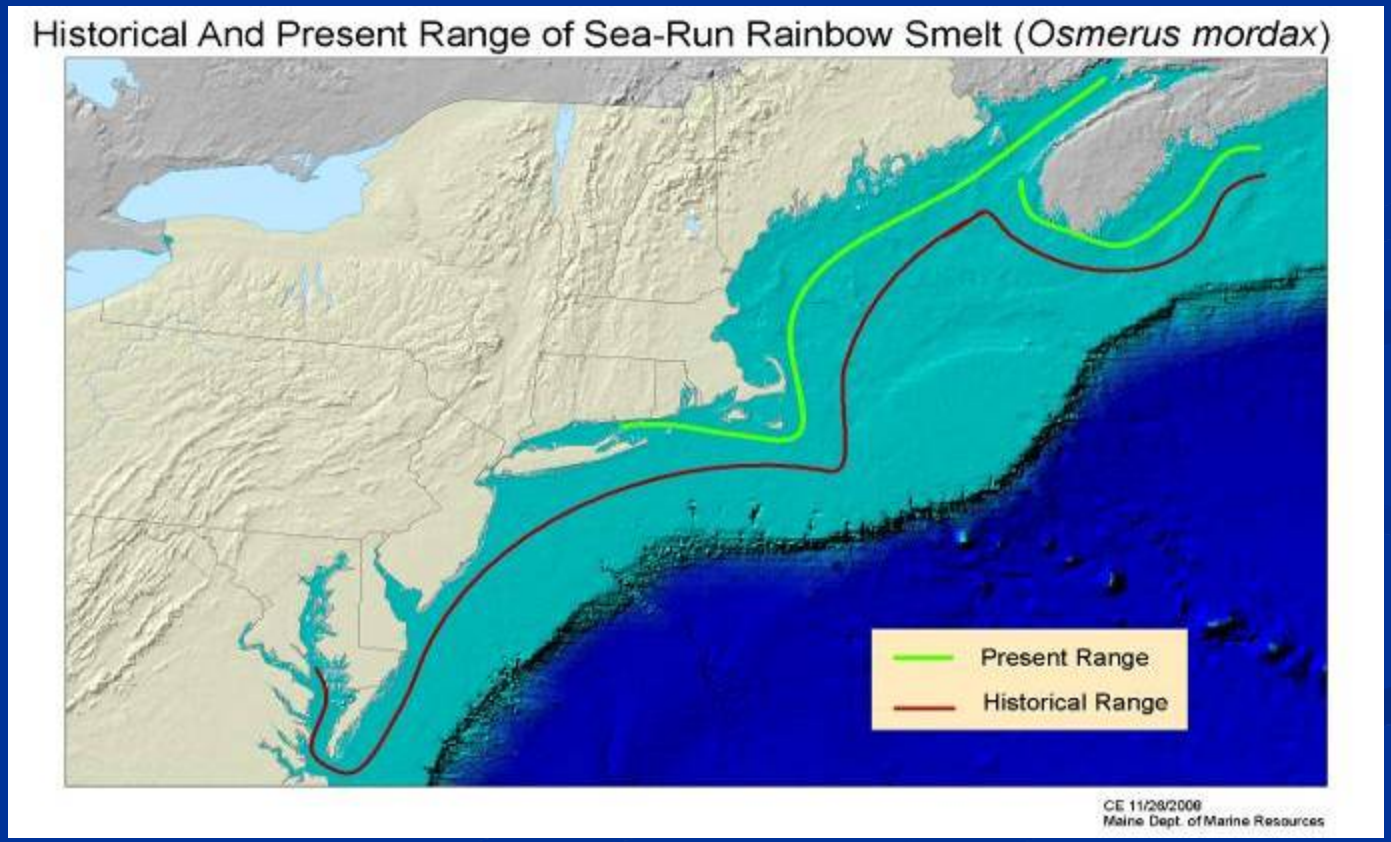
Variation in genetic structure of populations > four distinct regions



Sources: Kendall, 1926; Buckley, 1989; Murawski *et. al.* 1980

Rainbow Smelt: Species of Concern

- Threats to spawning:
  - Obstructions
  - pH (acid rain, land use)
  - Habitat alteration
  - Eutrophication
- Possible threats to adults:
  - Historical commercial fishery
  - Rising ocean temperature
  - Marine predation

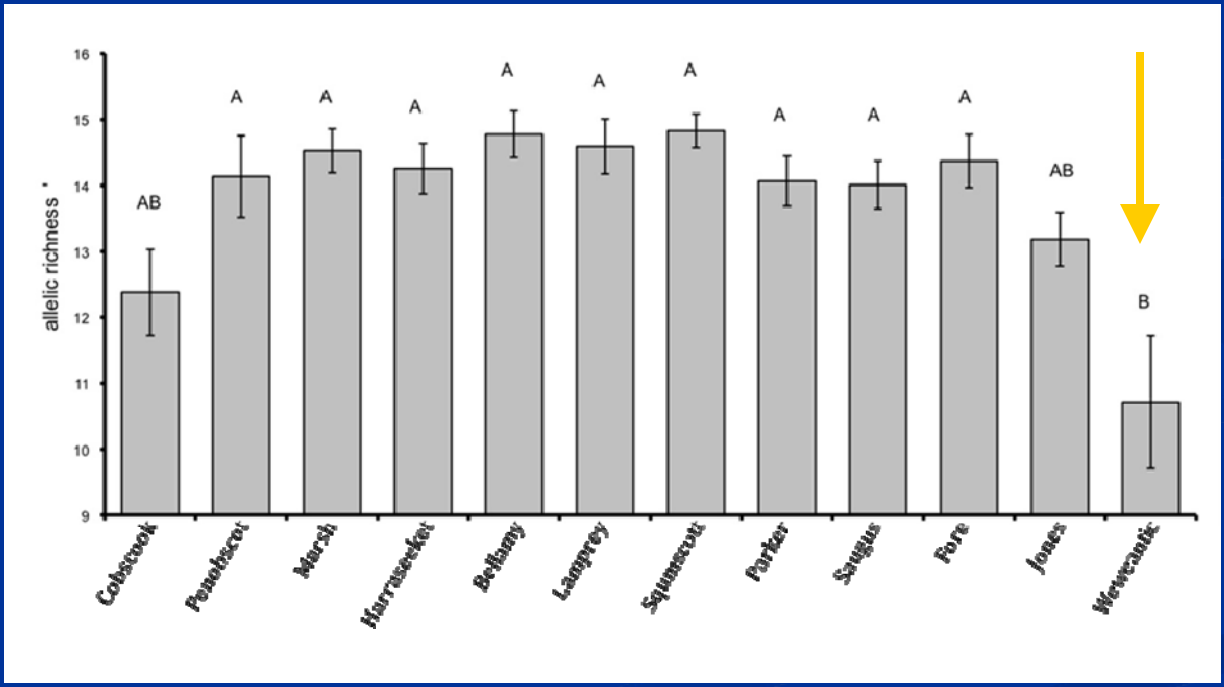


Sources: Fuda *et. al.*, 2007; Geffen, 1990

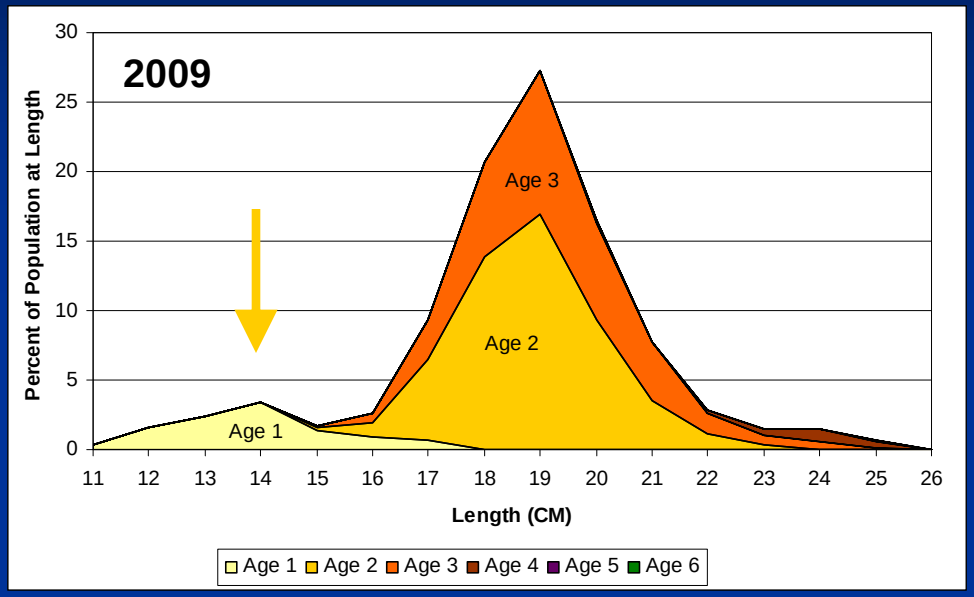
Ageing Objectives and Current Research

Smelt in stressed populations may mature at smaller sizes

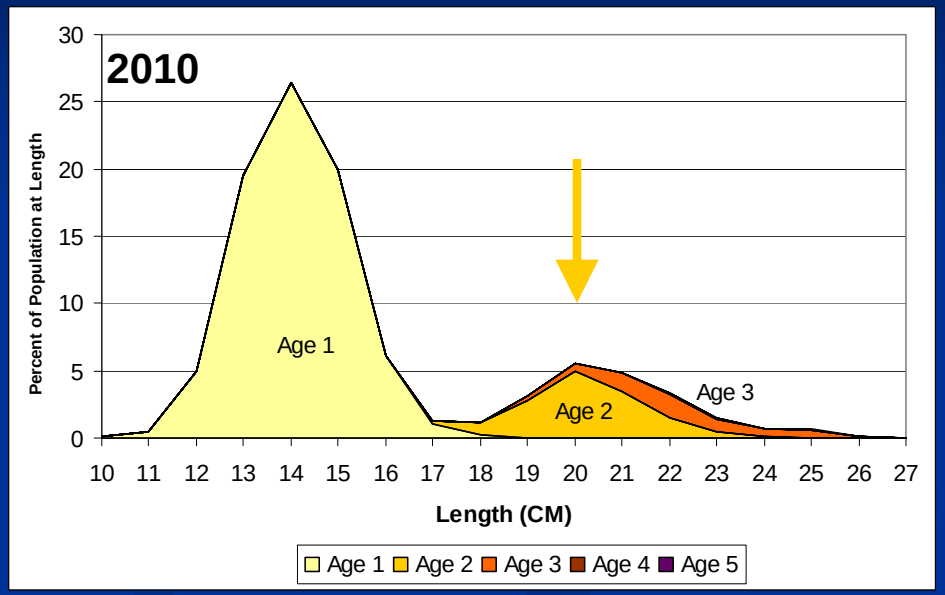
- Genetic work shows lack of allelic diversity in rivers where smallest average length at age 1 is observed, southern edge of range



Ageing Objectives and Current Research



Massachusetts Division of Marine Fisheries, Spring Fyke Net Survey



Massachusetts Division of Marine Fisheries, Spring Fyke Net Survey

Monitoring year class strength

- Small Age 1 year class in 2009 is seen as small age 2 year class in 2010

Develop mortality estimates

Conservation plan based on findings

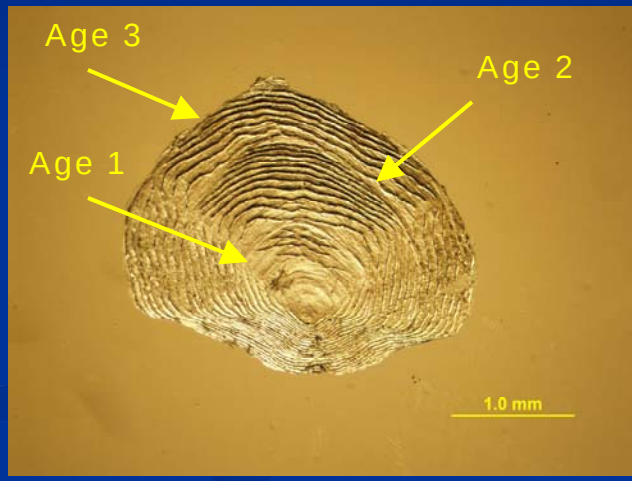
Otoliths, Finrays, or Scales?




- Short life span > outer annuli are easily visible on scales
- Rainbow smelt spawning is not violent > fewer regenerated scales
- Whole and sectioned smelt otoliths and finrays: unclear and open to more interpretation
- Otolith collection is lethal

Existing Knowledge

- Scar forms at the scale edge at the end of each growing season, the "shiny line"
- Females have a faster growth rate than males
- Average length at age decreases through the spawning season for all ages
- Existing keys and assumptions are site specific (Miramichi River, Lake Superior)
- Discrepancies: when the annuli are formed and characteristics of the first annulus



Sources: Bailey, 1964; McKenzie, 1958

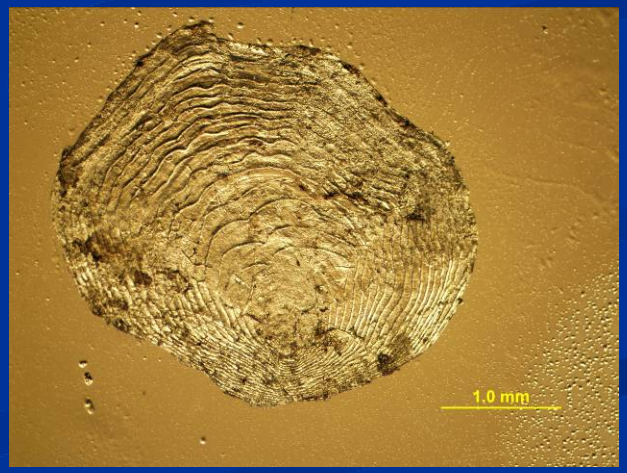
There are currently no region-wide reference collections or comparisons of age at length keys

Traditional Methods

Projected Image

Projector Scope

Cleaned with brush:
Damaged circuli and possible annulus



Uncleaned scale

Improved Cleaning Methods

- 5% diluted solution of pancreatin to digest mucus
- 15 minute bath in a high-frequency sonic cleaner
- Toothbrush removes any excess mucus

Source: Whaley, 1991

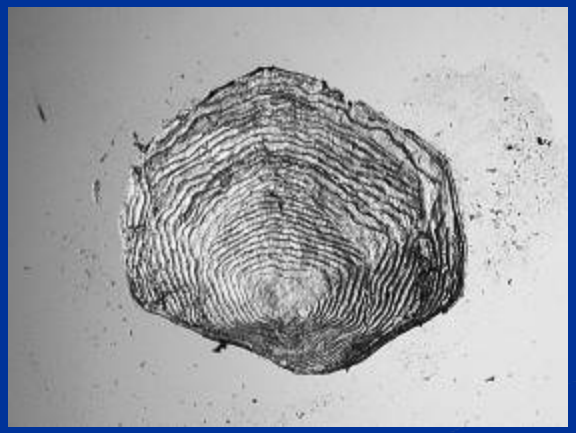
Process multiple batches simultaneously

Fewer remounts

(28% using brush method, 14% using sonicator, Maine DMR)

Higher agreement rates

=



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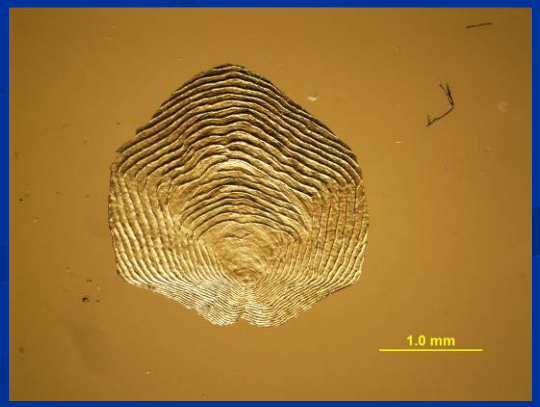
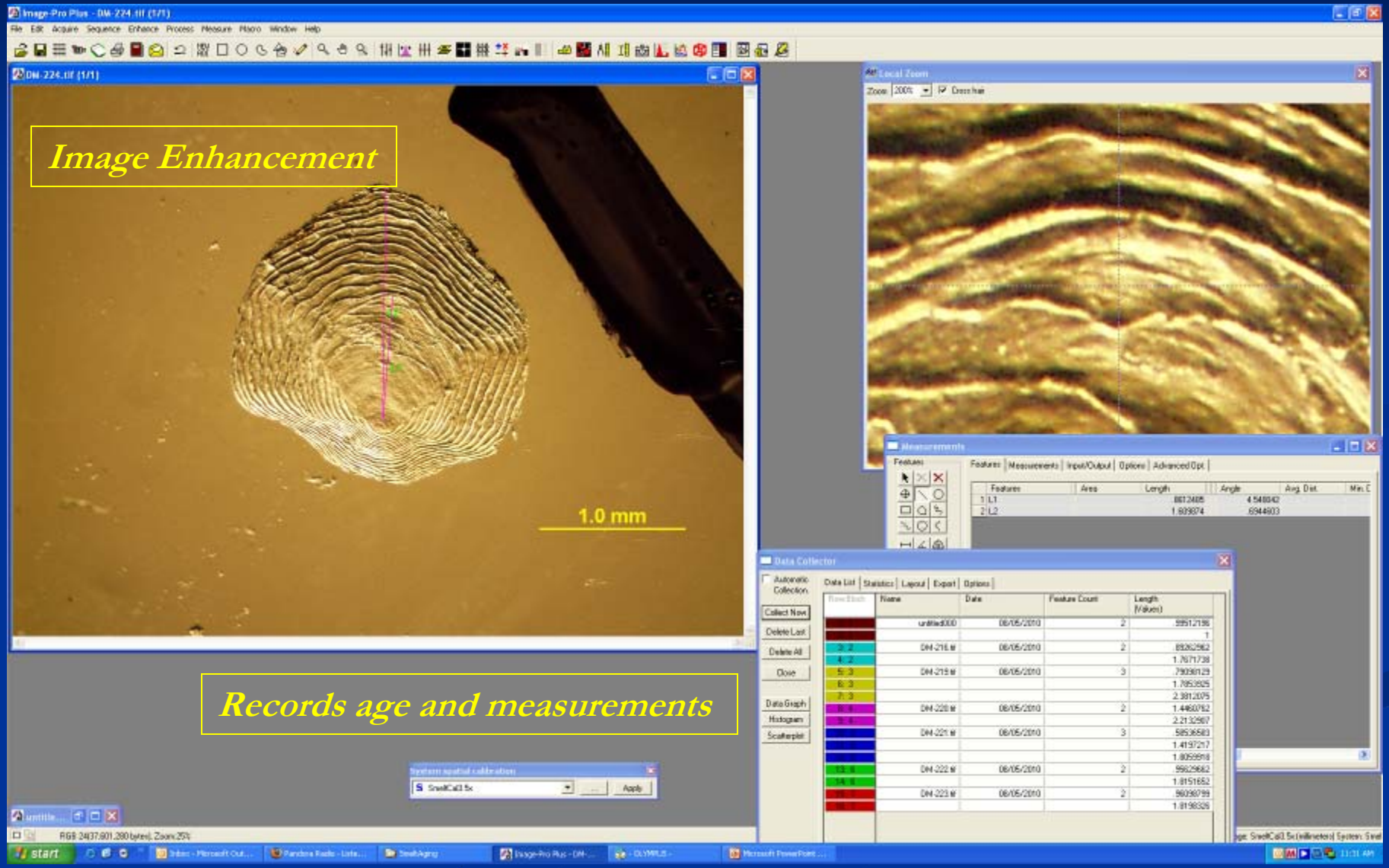


Digital Microscope

- Image Pro (V6.2) drives a digital video camera mounted atop a dissecting microscope with transmitted lighting
- Emphasize true and false annuli
- Image enhancement
- Digitally archives images, ages, and measurements

False 2nd annulus does not have "shiny line"

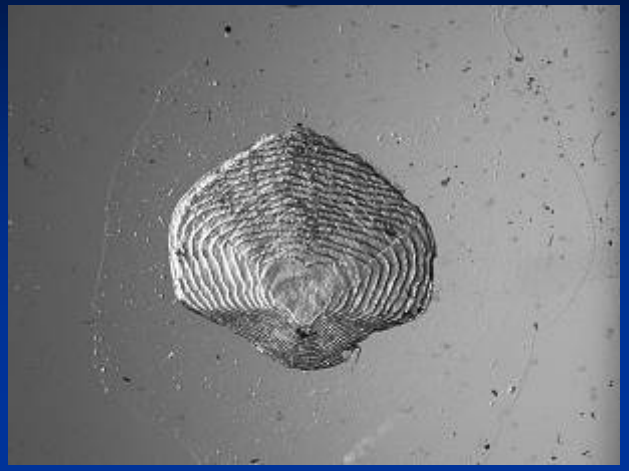
Image Pro Interface



Digital Reference Collections

- Quality Assurance: agers review collections periodically
  - Agreement has increased from 80% to over 90% (MA DMF)
- River specific: growth rates and false markings vary
- Compiled from preceding four years of scales
  - Updated annually to reflect current growth rates
- River specific collections are combined into regional set
  - Future studies better informed
- Collections are currently consensus aged, will be validated by OTC marking and tagging

Validation



Age 1:

- Yolk-sac larvae are marked with oxytetracycline hydrochloride (OTC) and released as part of stock enhancement in an annual survey site
  - 14 OTC marked smelt recaptured year after released, scales independently given age 1

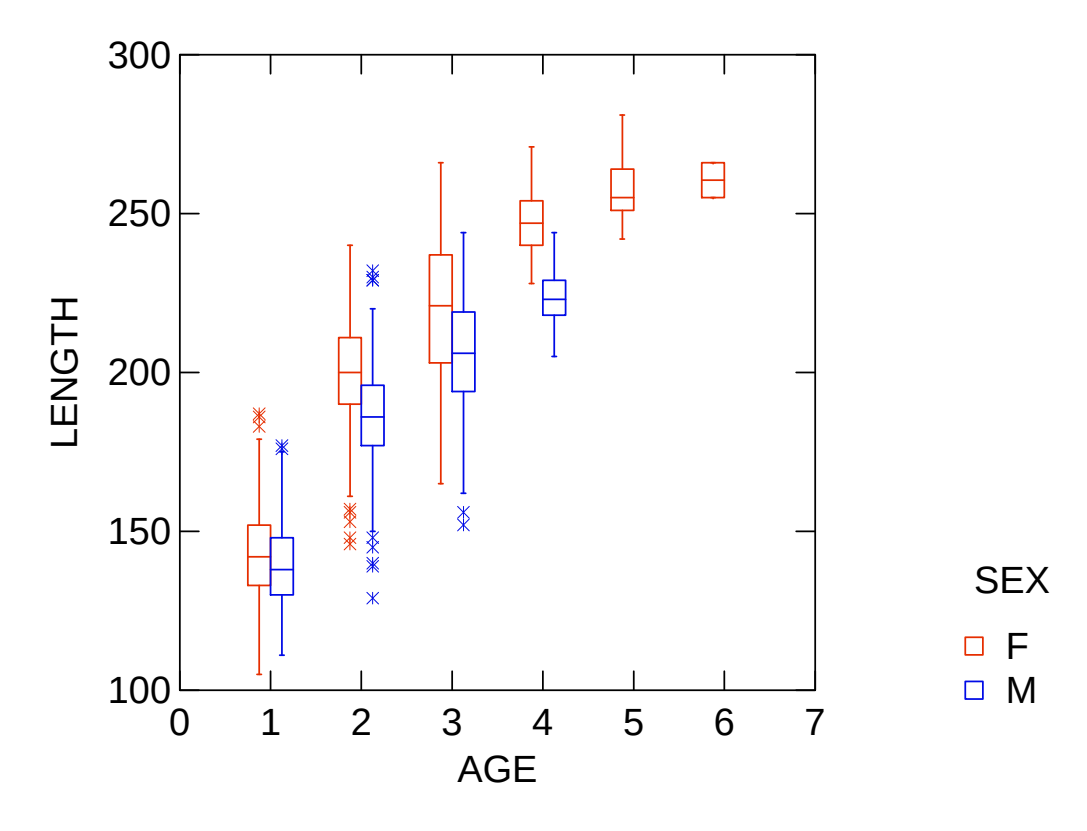
Age 2 and up (not tested):

- Mark captured spawning adults with OTC through osmotic induction, OTC mark would be visible on the scales
- Implant adults with coded wire tags - may be less accurate because comparing scales to scales

Preliminary Results

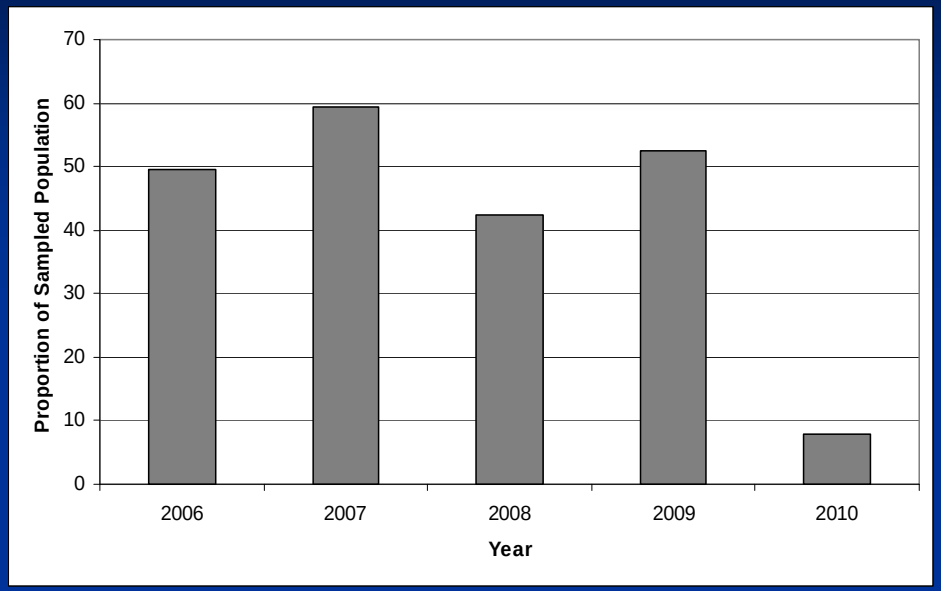
Age can be predicted by length and sex.

(Linear Regression: R^2=0.74, age Std Coef=0.84, sex Std Coef=0.12; p=0.000<0.005; Fore River, all years combined)

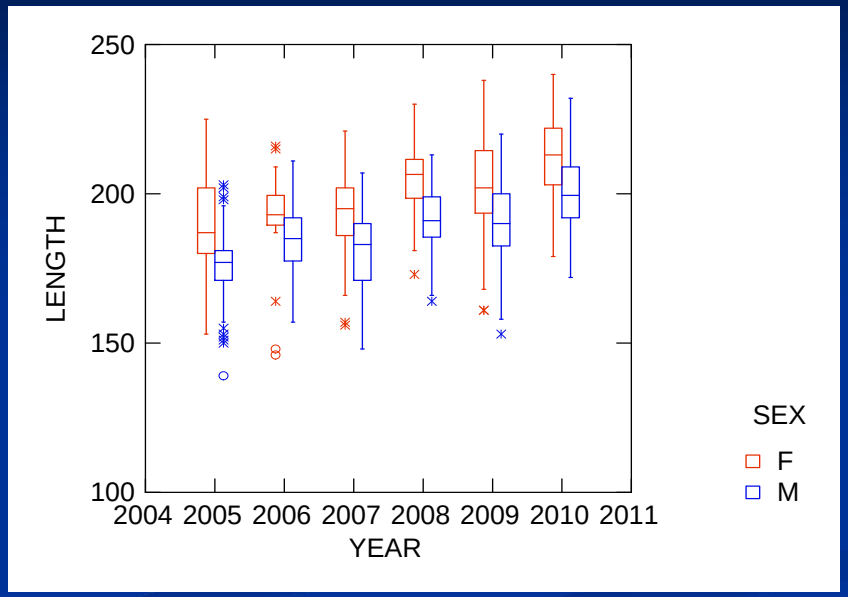


Length at age separated by sex. Data combined 2005-2010. Fore River, MA.

Preliminary Results: Age Cohorts



Proportion of sampled population composed of age-2 individuals. Fore River, MA DMF.



Average length of age-2 males and females increases over the sample period. Fore River, MA DMF.

Age-2 individuals compose a smaller proportion of the sampled population over the sample period.

Average length of Age-2 increases for both sexes 2006-2010.

(Linear Regression: R^2=0.27, year Std Coef=0.34, sex Std Coef=0.35; p=0.000<0.005; Fore River)

In sum…

Standardizing and updating cleaning and ageing procedures increases precision

Digital archiving allows reference collections to be easily shared and updated

Reference collections need to be updated through time as growth rates change

Compiling reference collections for the entire region informs future studies

Standard ageing protocols allow regional data to be analyzed to understand population trends

Project partners

Maine Department of Marine Resources

New Hampshire Department of Fish and Game

Great Bay National Estuarine Research Reserve

Massachusetts Division of Marine Fisheries

University of New Hampshire

USGS Conte Anadromous Fish Research Laboratory

Funding through NOAA, NMFS Office of Protected Species

Questions?

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