SEDAR 63: Gulf Menhaden

Ageing and Maturity/Fecundity

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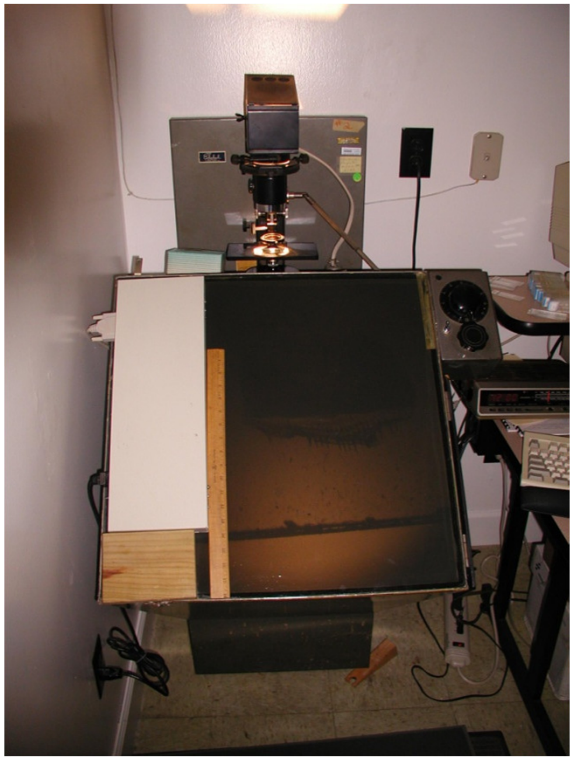
Ageing

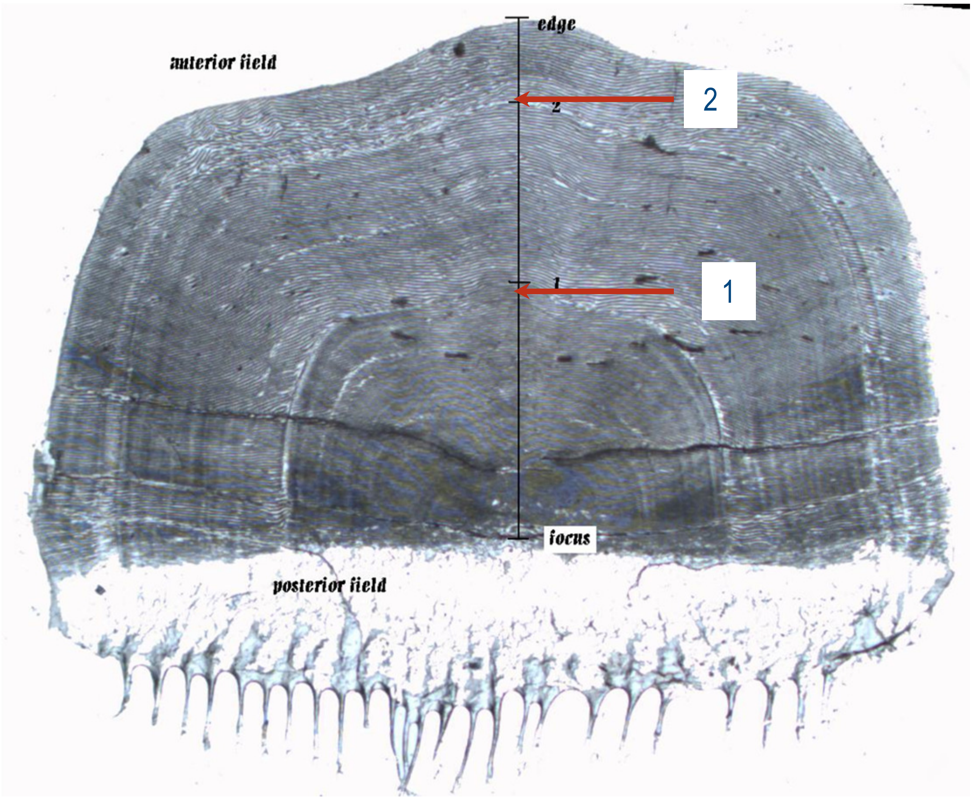
- In 1964, NMFS Beaufort Lab began monitoring Gulf Menhaden fishery for size and age composition of the catch
- Otoliths were deemed impractical to age Gulf Menhaden
  - Otoliths are minute, fragile, and difficult to extract
  - Also, large sample sizes (1,000s) necessary
    - landings of half million metric tons
- Like Atlantic Menhaden, scales used to age Gulf Menhaden

Ageing

- Nicholson and Schaaf (1978)
  - Found rings to be reliable annuli (especially for ages-0–2)
  - Difficulty for older ages because of oddly spaced rings
    - only ~50% of scale samples from 1971-73 could be aged by scale annuli
  - Developed criteria for ageing
    - Number and spacing of rings
    - Fork length at time of capture
    - Used length freq distributions to determine age for fish w/ illegible scales

Ageing





Ten fish processed for:

- Fork Length (in mm)
- Weight (g)
- Scale patch for ageing

Ageing

- Prior to ~1992, for each specimen, six gulf menhaden scales mounted between microscope slides, labeled w/ unique specimen number, then shipped to NMFS Beaufort Lab for ageing
  - Some yrs, up to a third lacked discernable rings

- ~1992, samplers asked to mount ten scales per specimen in effort to increase probability of acquiring a legible scale

- Percent legibility of scales has increased
  - For example:
    - 2015: 90.5% of scales legible (n = 9,663)
    - 2016: 84.8% of scales legible (n = 6,957)
    - 2017: 83.1% of scales legible (n = 6,312)

Ageing

- Early years (prior to 1970), scales were read by two readers
- Due to budget constraints in early 1970s, ageing task reduced to one reader
- During 1970-2015, same person, Ethel A. Hall, aged both Atlantic and gulf menhaden scale samples
  - Through 2017, she read close to 1 million menhaden scale samples from reduction fishery
    - Ethel retired in 2015
- New Technician, Amanda Myers has taken Ethel's place
- Equipment Updates
  - Early 2000s Dell computer "1" key
  - 2018: sonic digitizer (~1985)
  - 2018: Dell Computer HD

Ageing Error Matrix

- Accounting for age estimation error is important for age composition data used in stock assessments

- Ageing error analysis using a program called “agemat” developed by André Punt

  - Provides estimates of the SD and CV

  - Creates an ageing error matrix

Ageing Error Matrices

In SEDAR 63 Review Report, Tables 3.1 and 3.2

Table 3.1 Ageing error matrix from a scale to scale comparison of ages done by Hall over four decades.

	0	1	2	3	4+
0	0.994	0.006	0	0	0
1	0.006	0.987	0.117	0.008	0.001
2	0	0.006	0.765	0.202	0.03
3	0	0	0.117	0.58	0.235
4+	0	0	0	0.21	0.734

- Scale-to-scale comparison looks at reader error within a reader
  - Addressed concerns of a drift in bias with time

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Table 3.2 Ageing error matrix from a scale to scale comparison of ages done by Myers and Price as blind reads.

	0	1	2	3	4+
0	0.905	0.095	0	0	0.242
1	0.095	0.811	0.095	0	0.067
2	0	0.095	0.81	0.114	0.074
3	0	0	0.095	0.772	0.078
4+	0	0	0	0.114	0.54

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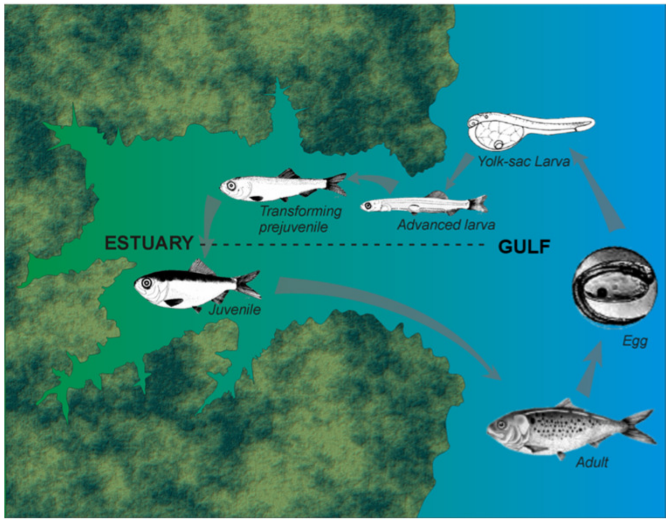
- Table 3.2 has blind reads by relatively novice readers

Reproduction: Maturity and Fecundity

Spawning cycle

- Typical of most estuarine-dependent species in the GOM
  - Spawning occurs offshore in the GOM proper
  - Larvae move into estuarine nursery areas where they metamorphose into juveniles and spend their first yr of life
  - Maturing adults return to offshore waters to spawn and complete the cycle



Spawning times

- **Lewis and Roithmayr (1981)** – Seminal paper on gulf menhaden reproduction:
  - Ova released in batches or fractions over a protracted spawning season
    - Between October–March (Peaks from December–February)
  - Peak spawning probably fluctuates from year to year depending on environmental conditions
- **Brown-Peterson et al. (2017)** – Histological update
  - Potential weekly spawns from October–March
  - 25 spawns a season
  - Fecundity indeterminate
  - Total fecundity may be 10x greater than thought

Spawning locations

- Actual sites have not been determined
  - Data suggest nearshore locations more likely
- Combs (1969): only in high salinity waters
- Turner (1969): eggs inshore of 5 fathom curve (9m) off Florida
- Shaw et al. (1985): highest egg densities at 10–23m contours
- Fore (1970): over shelf from AL to TX
  - greatest egg densities 4 to 40 fathoms (7–73m)
- Sogard et al. (1987): highest larval densities near mouth of Miss. River

Maturity schedule

- Previous Assessment (2011)
  - Lewis and Roithmayr (1981)
    - “gulf menhaden spawn for the first time at age 1, after they have completed two seasons of growth, and then continue to spawn each year thereafter”.
  - By convention in our previous assessments, fish surviving two growing seasons become age-2 fish on January 1, their theoretical birth date

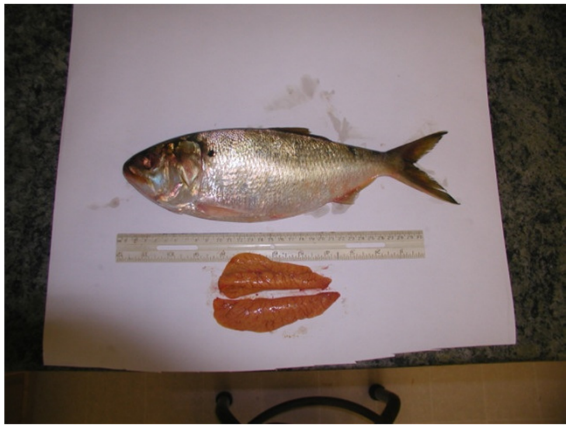
Maturity schedule

Table 3.10 (Summarized) in Assessment Report: Estimated FL, weight, and percent mature of gulf menhaden at middle of fishing year.

Year	FL (mm)	Wgt (g)	Maturity (%)
0	121.2	35.9	0
1	161.9	89.3	80
2	186.9	140.4	100
3	202.3	179.9	100
	211.7	207.6	100

- Maturity schedule updated from previous stock assessment
  - 0% mature at age-0
  - 80% at age-1
  - 100% mature for age-2+
    - (Nelson and Ahrenholz 1986; Vaughan 1987, Vaughan et al. 1996, 2000, 2007, Brown-Peterson et al 2017)

Fecundity



- Lewis and Roithmayr (1981) reproductive potential of gulf menhaden:

$$\text{Eggs} = 0.000051604 \times \text{fork length}^{3.8775}$$

- Brown-Peterson et al (2017) reproductive potential:

$$\text{Eggs} = 107.8 \times W_g$$

  - Formula like this often unavailable in other assessments, for which spawning stock biomass (SSB) is the typical default.
  - Ascribes a greater measure of reproductive output to larger females