Science, Service, Stewardship

SEDAR 27: 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

- Program managers realized using otoliths to age gulf menhaden impractical because:
  - Otoliths are minute, fragile, and difficult to extract
  - Also, large N's (1,000s) needed to characterize a fishery w/ landings of several hundred thousand metric tons

- Like Atlantic menhaden, scales chosen to age gulf menhaden

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Ageing

- Nicholson and Schaaf (1978) determined rings on gulf menhaden scales are reliable age marks
  - Fish w/ one or two rings usually reliable age marks
  - But ageing problematic; some scales w/ oddly spaced rings
    - only ~50% of scale samples from 1971-73 could be aged by scale annuli
  - Admitting some subjectivity, developed criteria for ageing based on:
    - Number and spacing of rings
    - Fork length at time of capture
    - Used length freq distributions to determine age for fish w/ illegible scales

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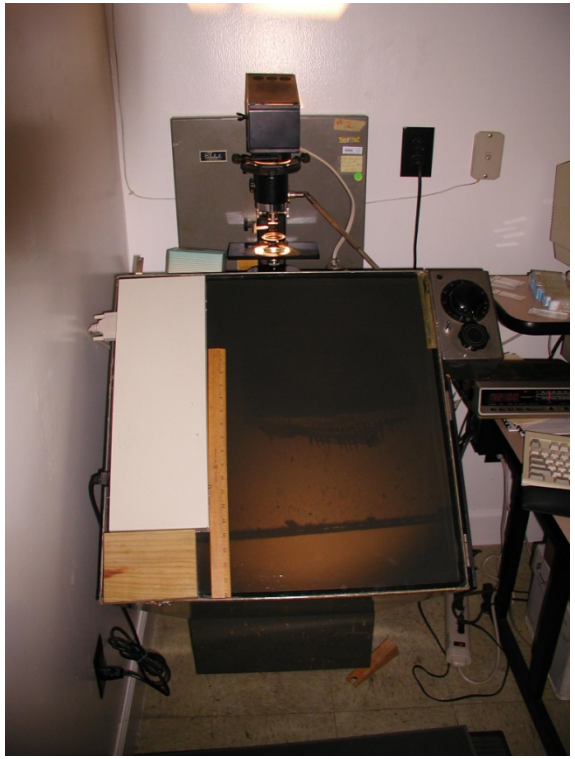
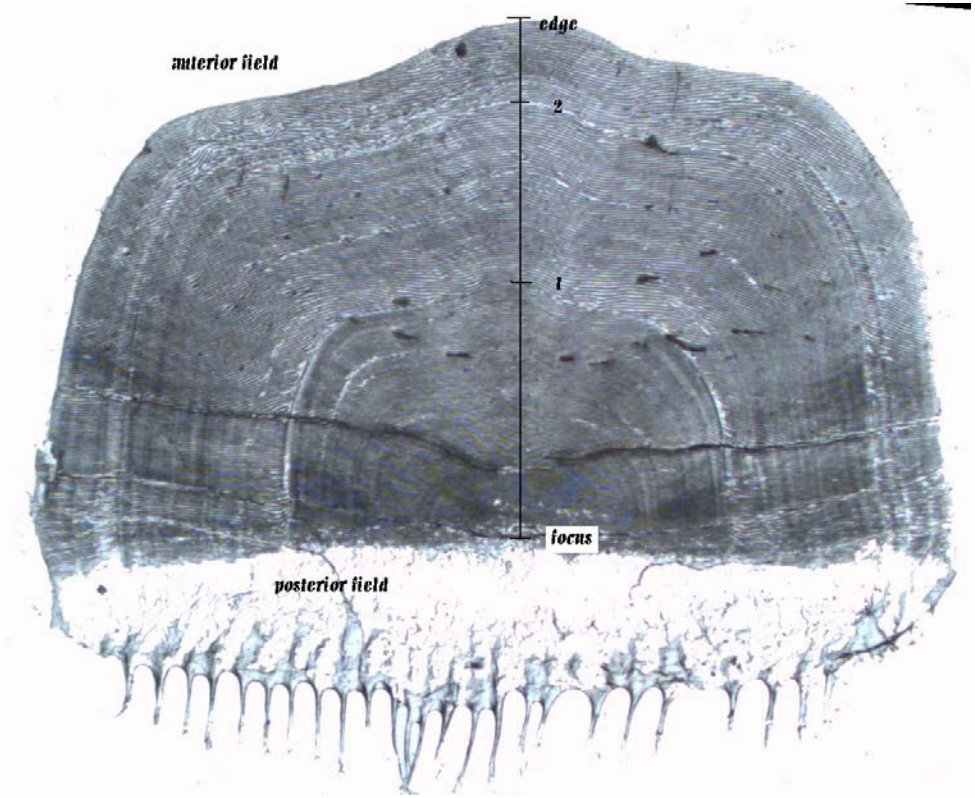
Ageing





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Ten fish processed for:

- Length (mm FL)
- Weight (g)
- Scale patch for ageing

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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, 30-40% of scale samples w/o discernable annual rings
- ~1992, samplers asked to mount ten scales per specimen in effort to increase probability of acquiring a legible scale
- Percent legibility of scales increased
  - For example:
    - 2008: 81% of scales legible (n = 3,737)
    - 2009: 82% of scales legible (n = 5,057)
    - 2010: 88% of scales legible (n = 3,210)

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Ageing

- Through ~early 1970s, scale samples “read “ by two independent scale readers
- Due to budget constraints in early 1970s, ageing task reduced to one reader
- Since ~1969, same person, Ethel A. Hall, has aged both Atlantic and gulf menhaden scale samples
  - Through 2007, she read ~660,000 menhaden scale samples over her NMFS career; still an FTE in 2011

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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” provided by André Punt

  - Provides estimates of the cv and st dev

  - Provides ageing error matrix

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Ageing Error Matrix

- Data for ageing error analyses come from two unpublished NMFS Beaufort documents:
  - Smith and Levi (1990) looked at paired scale:sagittal otolith age estimates
    - Specimens went through standard port sampling routines, then sagittal otoliths removed, “aged” via opaque rings, and compared to scale ages (n = 228)
    - 71% agreement
  - Smith and Hall (2009): Same scale reader (EAH) aged all specimens in 2005 Gulf port samples
    - Then re-read ~55% (n = 3,405) of the scales several months later
    - Reading 1 compared to Reading 2
    - 82% agreement

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Ageing Error Matrices

In SEDAR 27 Review Report, Tables 3.1 and 3.2

Table 3.1 Ageing error matrix from a scale to otolith comparison of ages.

	0	1	2	3	4	5	6
0	1.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	1.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.11	0.78	0.11	0.00	0.00	0.00
3	0.00	0.00	0.16	0.68	0.16	0.00	0.00
4	0.00	0.00	0.00	0.17	0.65	0.17	0.00
5	0.00	0.00	0.00	0.00	0.18	0.64	0.18
6	0.00	0.00	0.00	0.00	0.00	0.18	0.82

Table 3.2 Ageing error matrix from a scale to scale comparison of ages.

	0	1	2	3	4	5	6
0	1.00	0.00	0.00	0.00	0.00	0.00	0.00
1	0.00	1.00	0.00	0.00	0.00	0.00	0.00
2	0.00	0.08	0.85	0.08	0.00	0.00	0.00
3	0.00	0.00	0.14	0.71	0.14	0.00	0.00
4	0.00	0.00	0.00	0.16	0.67	0.16	0.00
5	0.00	0.00	0.00	0.00	0.17	0.65	0.17
6	0.00	0.00	0.00	0.00	0.00	0.17	0.82

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Ageing Error Matrix

- Both comparisons indicate a relatively low level of ageing error and had similar ageing error matrices
- Scale to otolith comparison gives an indication of the error using scales compared to the true age of the fish
    - Requires the assumption that the otolith provides an accurate true age for each individual
- Scale to scale comparison looks at reader error within a reader

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REPRODUCTION: MATURITY AND FECUNDITY

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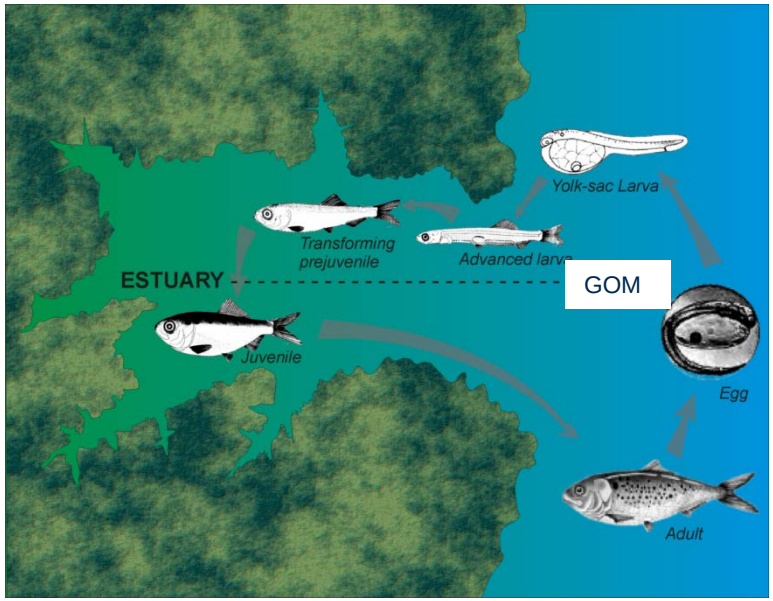
Spawning cycle

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



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Spawning times

- Peak spawning probably fluctuates from year to year depending on environmental conditions
  - Lewis and Roithmayr (1981) summarized many earlier studies:
    - Spawning generally begins in October and ends in March
    - Peaks between December and February
- Lewis and Roithmayr (1981): gulf menhaden multiple, intermittent spawners
  - Ova released in batches or fractions over a protracted spawning season

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Spawning locations

- Actual sites have not been determined
  - Data suggest more nearshore locations, than offshore sites

- Turner (1969): eggs inshore of 5 fathom (9 m) curve off Florida
- Combs (1969): only in high salinity waters
- Fore (1970): over shelf from AL to TX
  - greatest egg densities 4 to 40 fathoms (7 – 73 m)
- Sogard et al. (1987): highest larval densities near mouth of Miss. River
- Shaw et al. (1985): highest egg densities at 10 to 23 m contours

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Maturity schedule

- Lewis and Roithmayr (1981) concluded that:
  - “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 models, fish surviving two growing seasons become age-2 fish on January 1, their theoretical birth date

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Maturity schedule

Table 3.10 in Assessment Report
Shows age-0 and age-1 fish immature and age-2 and older fish fully mature.

Year	FL (mm)	Wgt (g)	Maturity (%)
0	118.7	31.9	0
1	152.4	70.4	0
2	183.1	126.1	100
3	202.8	174.6	100
4	215.5	211.8	100
5	223.7	238.4	100
6	229.0	256.7	100

- Maturity schedule similar to that above has been used in earlier stock assessments
  - (Nelson and Ahrenholz 1986; Vaughan 1987, Vaughan et al. 1996, 2000, 2007)
- In most recent stock assessment (Vaughan et al. 2007), *a sensitivity run was added* with 20% of age-1 fish assumed to be mature.

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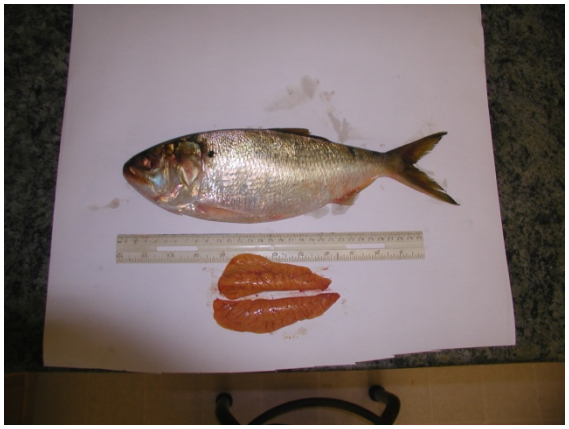
Fecundity



- Lewis and Roithmayr (1981) described the reproductive potential of gulf menhaden via this equation:

  Eggs = 0.000051604 x Fork Length $^{3.8775}$

  - 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 (see next slide)

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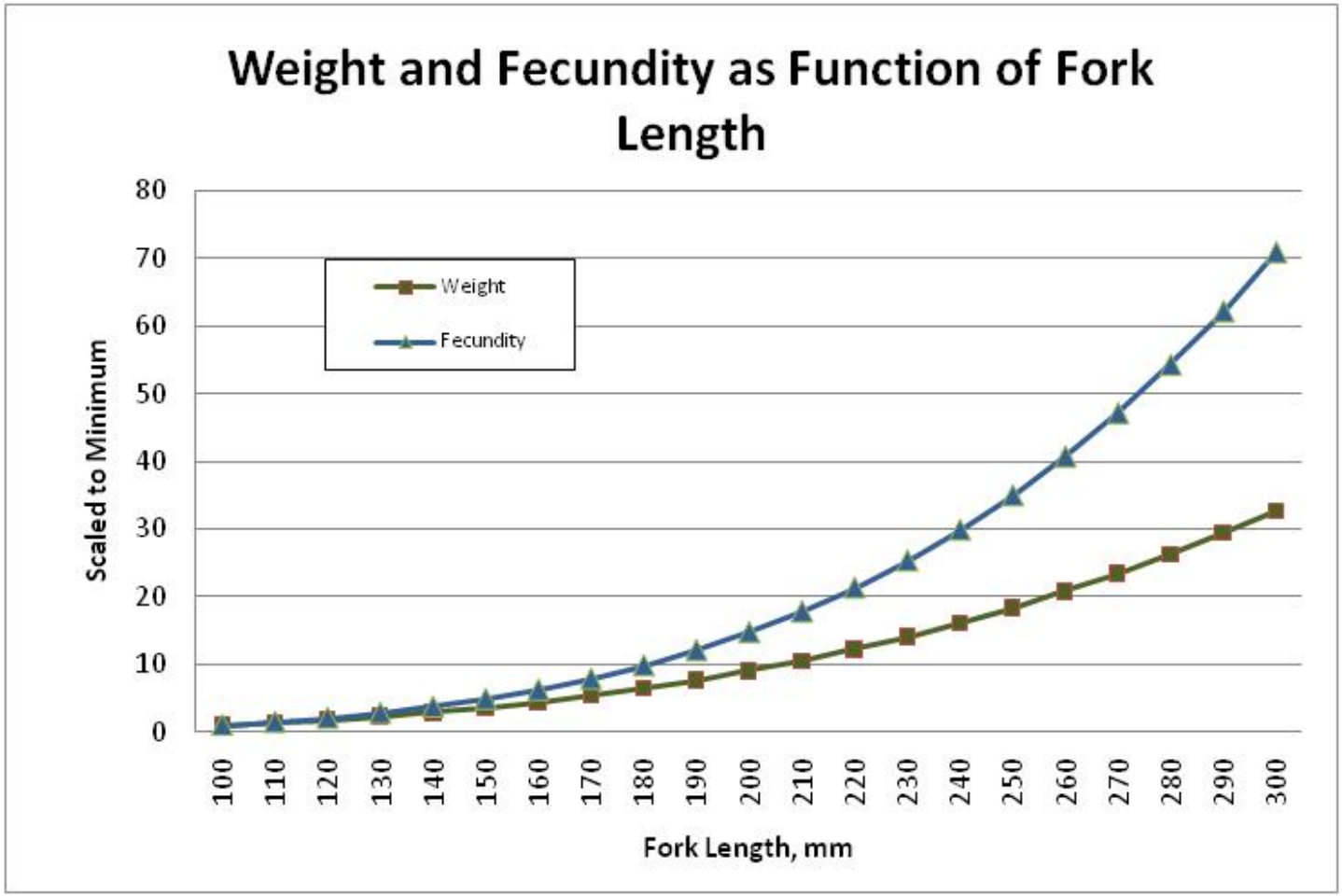

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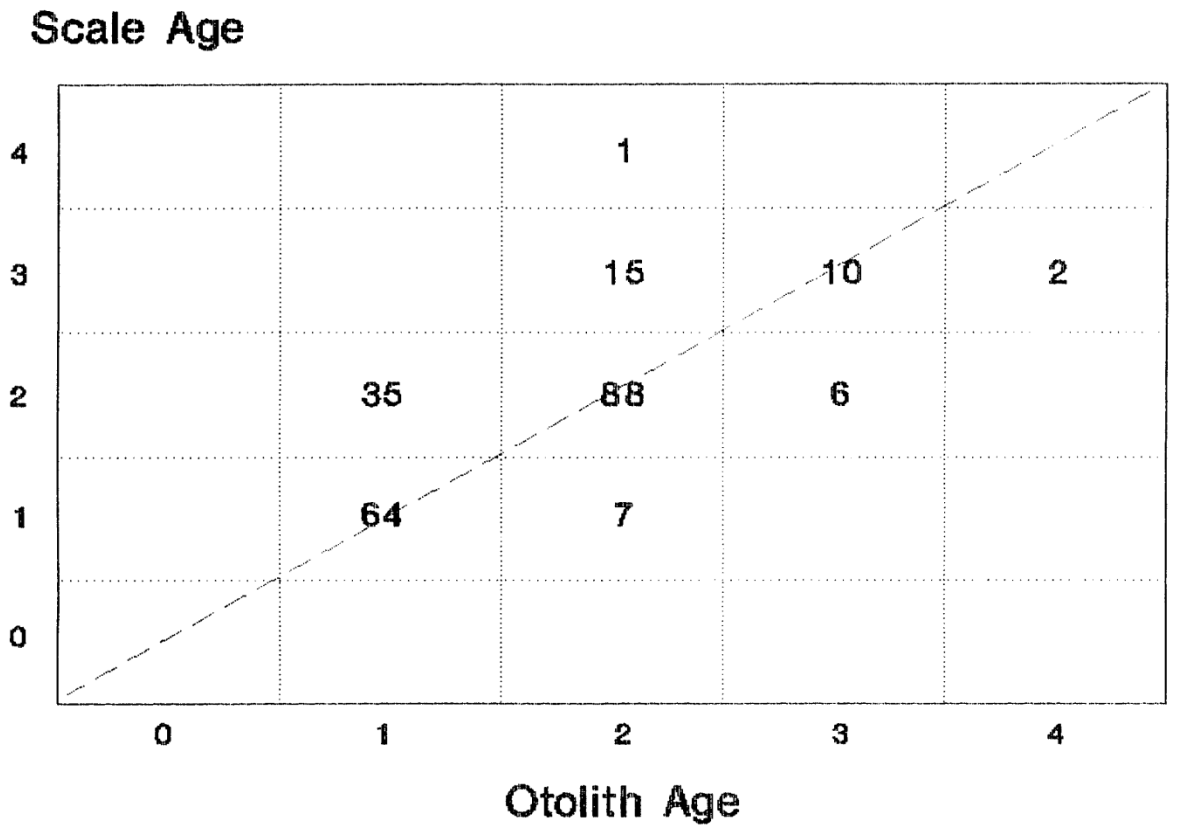
Scale:Otolith Ageing Matrix



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Scale:Scale Ageing Matrix

Second reading age (in yrs)

4		7	2	3
3	4	54	76	4
2	172	1530	40	6
1	1185	313	8	1
	1	2	3	4

First reading age (in yrs)