Herring Diversity (Family Clupeidae and Dussumieriidae) in North Carolina

North Carolina is home to 13 species of herrings, but most people only know of or heard of the more common ones such as American Shad, Hickory Shad, Alewife, Blueback Herring, Atlantic Menhaden, Gizzard Shad, and Threadfin Shad (Table 1; NCWRC undated – a). Except for perhaps some fishermen along the coast, few people have ever heard of or seen Round Herring, Yellowfin Menhaden, Atlantic Herring, Scaled Sardine, Atlantic Thread Herring, or Spanish Sardine.

Table 1. Species of herrings found in or along the coast of North Carolina.

Scientific Name/ American Fisheries Society Accepted Common Name	Scientific Name/ American Fisheries Society Accepted Common Name
Alosa aestivalis - Blueback Herring	*Dorosoma cepedianum* - Gizzard Shad
Alosa mediocris - Hickory Shad	*Dorosoma petenense* - Threadfin Shad
Alosa pseudoharengus - Alewife	*Etrumeus sadina* - Round Herring[1]
Alosa sapidissima - American Shad	*Harengula jaguana* - Scaled Sardine
Brevoortia tyrannus - Atlantic Menhaden	*Opisthonema oglinum* - Atlantic Thread Herring
Brevoortia smithi - Yellowfin Menhaden	*Sardinella aurita* - Spanish Sardine
Clupea harengus - Atlantic Herring	

[1] Until recently, Round Herring, *Etrumeus sadina* (previously known as *E. teres*), was placed, along with all the other clupeids found in North Carolina, in the Family Clupeidae. Fish taxonomists now place this species in the Family Dussumieriidae.

Alewife and Blueback Herring are often referred to as “River Herring”; other colorful names applied to this family of fishes include glut herring, bigeye herring, nanny shad, stink shad, or just plain “shad”. Each species has an American Fisheries Society-accepted common name (Page et al. 2013) and a scientific (Latin) name (Table 1; Appendix 1).

Herring occur across the state in freshwater and saltwater environments, but especially in many of our reservoirs, coastal rivers, estuaries, and offshore (Tracy et al. 2020; NCFishes.com). Most species are found along the coast, but Gizzard Shad is our most widely distributed species found in all basins, except for the New, Watauga, and Savannah.

Able to convert phytoplankton and zooplankton into fish biomass and as important prey species for commercially and recreationally important piscivorous species such as Striped Bass and Largemouth Bass, Gizzard Shad and Threadfin Shad have been stocked in many reservoirs across the state as forage fish. Threadfin Shad, a nonindigenous (nonnative) species was stocked, at times illegally, as a forage fish in many of Piedmont reservoirs in the Roanoke, Yadkin, Catawba, Broad, Savannah, Little Tennessee, and Hiwassee basins. Over time it has found its way downstream to the coast and is now widely distributed from the Albemarle to the Shallotte basins. Alewife, indigenous to our Atlantic Slope streams, was illegally introduced into Lake Norman as wishfully new forage fish for the Striped Bass and Largemouth Bass fishery. Like most poorly thought-out introductions, Alewife and Blueback Herring have caused more harm than good to the fisheries in reservoirs such as lakes James, Norman, and Hiwassee.

As a family, herrings vary greatly in size. On the short-end-of-the-stick, Threadfin Shad and Scaled Sardine reach a maximum size of about 180 mm (~ 7 inches) whereas a mature American Shad may reach close to 760 mm (30 inches). Because of their size and abundance, herring were historically and remain today a commercially and recreationally important group of fishes with seasonal and river-basin specific creel and landing limits (e.g., NCDMF 2020; NCWRC 2019, 2020).

Species of *Alosa*, except for land-locked reservoir populations, make late Winter-early Spring migratory spawning runs up the coastal rivers. Historically the runs occurred far upstream into the Piedmont until dam construction along the Fall Zone and over-fishing halted their migrations. Implementation of strict harvesting quotas has helped some of the species on their road to recovery, but recovery may take a long time to succeed. Although some populations are severely depleted, no species is listed as imperiled (NCNHP 2020; NCWRC 2017).

Key characteristics for their proper identification include the shape and position of the upper jaw; presence or absence of a long filament in the dorsal fin; body, caudal fin, and peritoneum pigmentation in

North Carolina. However, several species can co-occur within the same habitats at the same time, rendering field identifications a challenge.

Identification Key to the Freshwater and Marine Species of Herrings (Family Clupeidae and Dussumieriidae) in North Carolina

1a. A single, W-shaped pelvic scute present (Figure 1); other abdominal scutes absent..... .....Round Herring, *Etrumeus sadina*

1b. W-shaped pelvic scute absent; pelvic scute (and most others) with lateral arms; series of abdominal scutes present, often keeled 2

Figure 1. Left - Cross section of abdominal area at the pelvic fin of Round Herring; Right - Round Herring. Photograph courtesy of the Smithsonian Tropical Research Institute's Shorefishes of the Greater Caribbean online information system, https://biogeodb.stri.si.edu/caribbean/en/pages/random/8754, accessed December 09, 2020.

2a. Upper jaw with a deep median notch (Figure 2) ..... 3[1]

2b. Upper jaw without a median notch (Figure 2) ..... 10[1]

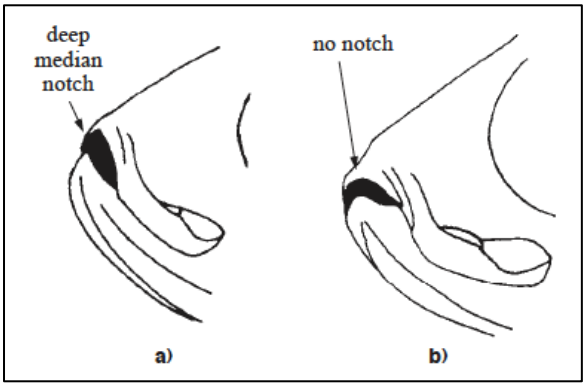

Figure 2. Upper jaws showing the presence or absence of a deep notch. Illustrations courtesy of Munroe and Nizinski (2002).

3a. Last dorsal fin ray filamentous (Figure 3) 4

3b. Last dorsal fin ray not filamentous 5

[1] Also see Couplet Nos. 13a and 13b for fishes possessing a filamentous last dorsal fin ray

4a. Mouth inferior, subterminal (snout bulbous and fleshy, projecting past upper jaw). Upper jaw with a notch in the posterior ventral margin. Anal-fin rays 25-37. More than 50 (52 to 70) scales in lateral series. Color of caudal fin dusky (Figure 3) .....Gizzard Shad, *Dorosoma cepedianum*

4b. Mouth terminal (snout more pointed and not extending anterior to upper jaw). Upper jaw without a notch in the posterior ventral margin. Anal-fin rays 17-27. Fewer than 50 (41 to 48) scales in lateral series. Color of caudal fin yellow (Figure 3).....Threadfin Shad, *Dorosoma petenense*

Figure 3. Red arrows pointing to the filamentous last dorsal fin rays and the pigmentation of the caudal fins. Left – Gizzard Shad; Right – Threadfin Shad.

5a. Modified predorsal scales present on either side of dorsal midline (Figure 4); other scales deeply overlapping and irregular with serrate posterior margins. Six branched pelvic fin rays 6

5b. Predorsal scales along dorsal midline normal, not enlarged and fringed; other scales with smooth posterior margins. Eight branched pelvic fin rays 7

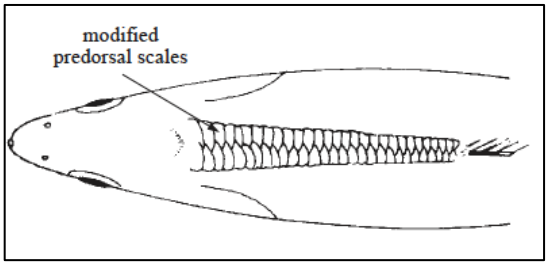

Figure 4. Modified predorsal scales on *Brevoortia* spp. Illustration courtesy of Munroe and Nizinski (2002).

6a. Pelvic fin with oblique and almost straight posterior margin, inner rays markedly shorter than outer rays when folded back (Figures 5 and 6)..... Yellowfin Menhaden, *Brevoortia smithi*

6b. Pelvic fin with rounded posterior margin, inner rays equal or nearly equal with outer rays when folded back (Figures 5 and 6) ..... Atlantic Menhaden, *Brevoortia tyrannus*

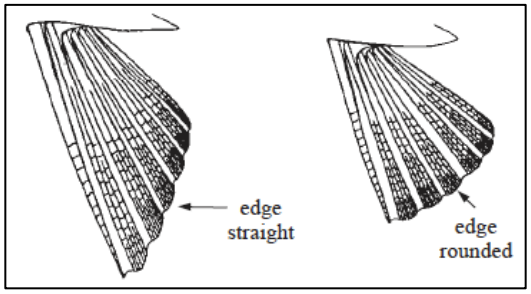

Figure 5. Pelvic fins of *Brevoortia* sp. Left – Yellowfin Menhaden; Right – Atlantic Menhaden. Illustrations courtesy of Munroe and Nizinski (2002).

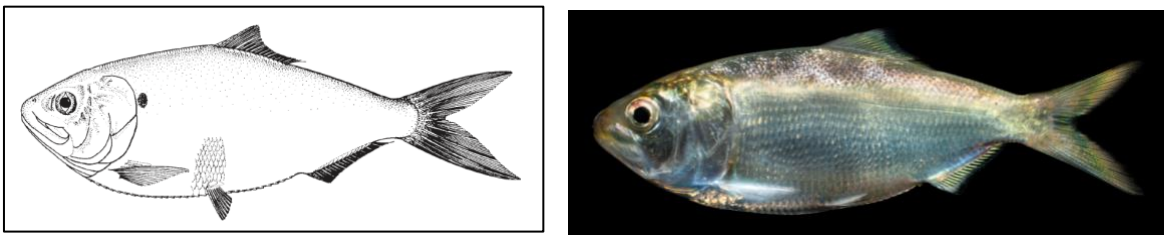

Figure 6. Left - Yellowfin Menhaden; Right – Atlantic Menhaden. Illustration courtesy of Munroe and Nizinski (2002).

7a. Upper margin of lower jaw rising steeply within mouth (Figures 7 and 8) 8

7b. Upper margin of lower jaw rising gradually not steeply within mouth (Figures 7 and 8) 9

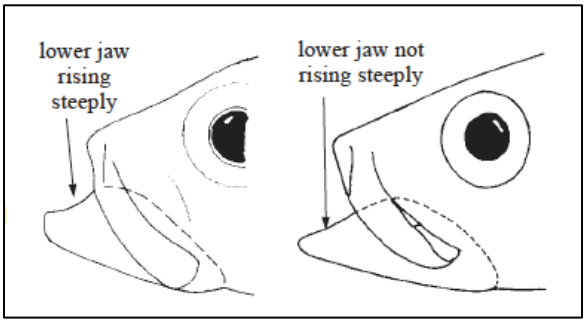

Figure 7. Left - Upper margin of lower jaw rising steeply within mouth; Right - Upper margin of lower jaw rising gradually not steeply within mouth. Illustration courtesy of Munroe and Nizinski (2002).

Figure 8. Black arrows pointing to the upper jaws. Left – American Shad; Right - Blueback Herring.

8a. Peritoneum silvery to pale gray (visible upon dissection), dorsum grayish green (Figure 9). Eye diameter greater than length of snout .....Alewife, *Alosa pseudoharengus*

8b. Peritoneum sooty or black (visible upon dissection), dorsum distinctly blue (Figure 9). Eye diameter less than length of snout .....Blueback Herring, *Alosa aestivalis*

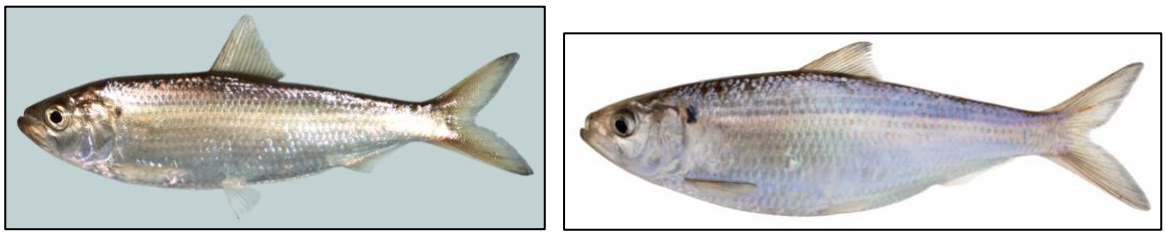

Figure 9. Left – Alewife; Right – Blueback Herring.

9a. Mouth superior; lower jaw part of the dorsal profile with tip projecting forward of the snout when mouth is closed (Figures 10 and 11). Jaw teeth present. Cheek about as deep as wide. Gill rakers on lower limb of anterior arch 18-23 and widely spaced .....Hickory Shad, *Alosa mediocris*

9b. Mouth terminal; lower jaw not part of the dorsal profile with tip even with or projecting slightly forward of the upper jaw when mouth is closed (Figures 10 and 12). Jaw teeth minute or absent in adults. Cheek deeper than wide. Gill rakers on lower limb of the first gill arch number 59-76 (26-43 in specimens less than 125 mm Total Length) and crowded ..... American Shad, *Alosa sapidissima*

Figure 10. Red bars showing the positioning of the lower jaw in relation to the snout. Left – Hickory Shad, Right – American Shad.

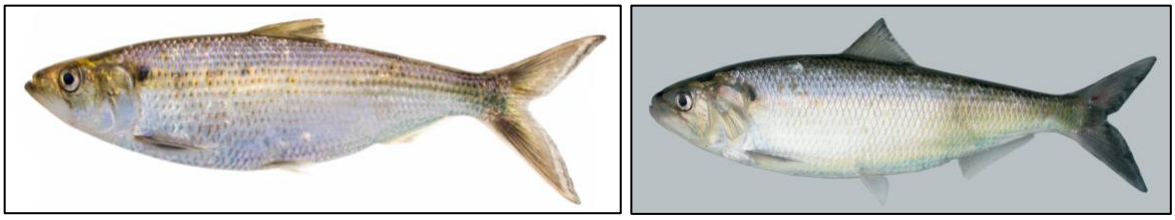

Figure 11. Left – Hickory Shad; Right - American Shad.

10a. Posterior border of gill opening with two fleshy knobs (Figure 12)..... 11

10b. Posterior border of gill opening evenly rounded (Figure 13) ..... Atlantic Herring, *Clupea harengus*

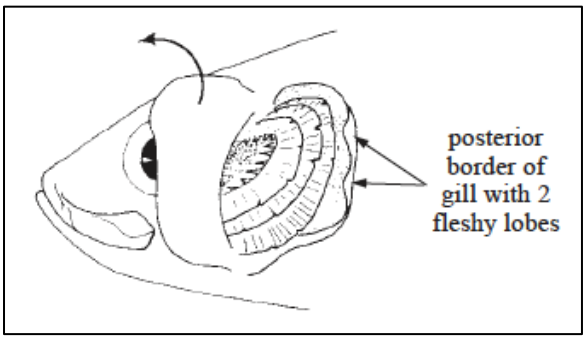

Figure 12. After raising the operculum seeing the posterior border of the gills with two fleshy lobes. Illustration courtesy of Munroe and Nizinski (2002).

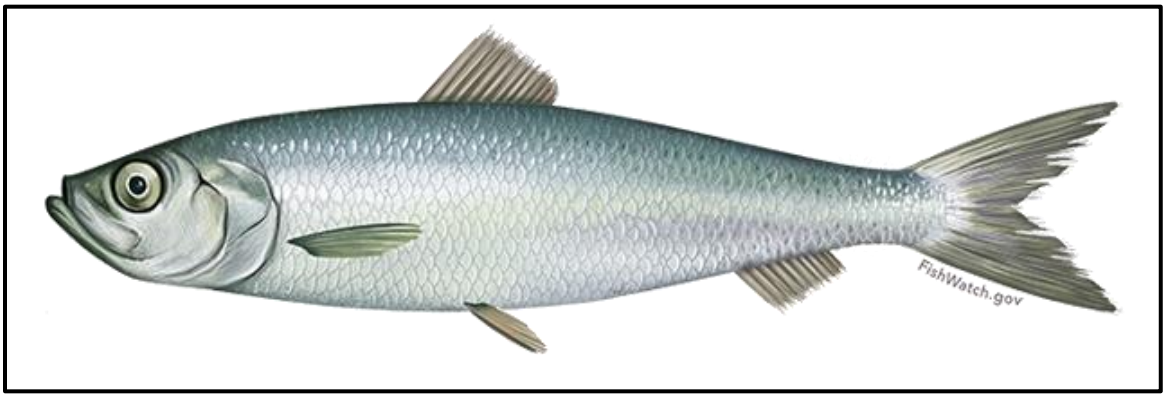

Figure 12. Atlantic Herring. Illustration courtesy of https://www.fisheries.noaa.gov/species/atlantic-herring.

11a. Small, toothed hypomaxilla present between posterior tip of premaxilla and expanded blade of maxilla (Figures 13 and 14) ..... Scaled Sardine, *Harengula jaguana*

11b. No small, toothed hypomaxilla between posterior tip of premaxilla and expanded blade of maxilla 12

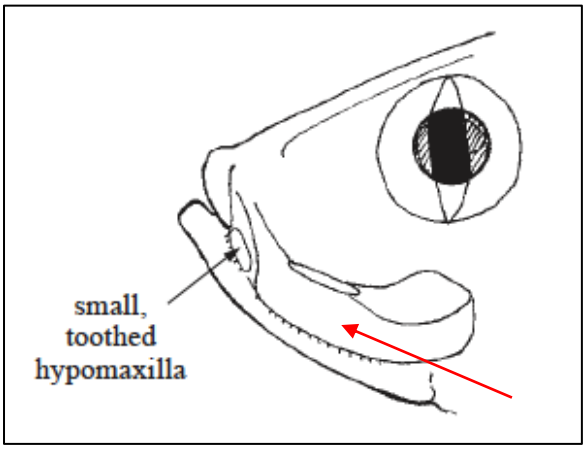

Figure 13. Small, toothed hypomaxilla of Scaled Sardine. Red arrow is pointing to the maxilla. Illustration courtesy of Munroe and Nizinski (2002).

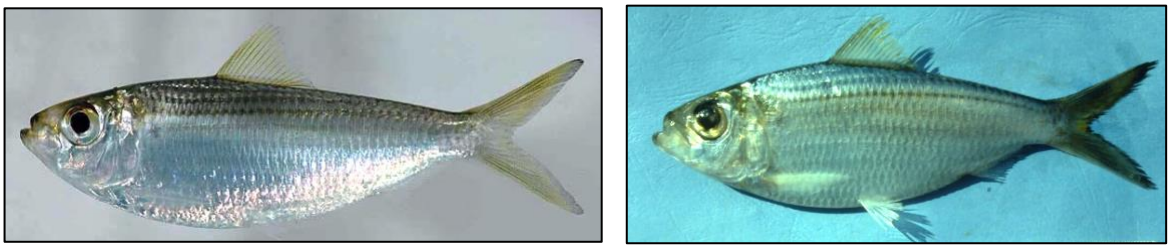

Figure 14. Scaled Sardine. Left – Photograph courtesy of the Smithsonian Tropical Research Institute's Shorefishes of the Greater Caribbean online information system, https://biogeodb.stri.si.edu/caribbean/en/pages/random/3359, accessed December 09, 2020; Right - Photograph courtesy of George H. Burgess.

12a. Last dorsal fin ray filamentous (Figure 15). Seven branched pelvic fin rays .... *Atlantic Thread Herring, Opisthonema oglinum*

12b. Last dorsal fin ray normal (Figure 16). Eight branched pelvic fin rays .... Spanish Sardine, *Sardinella aurita*

Figure 15. Thread Herring. Left- red arrow pointing to last dorsal ray which is filamentous.

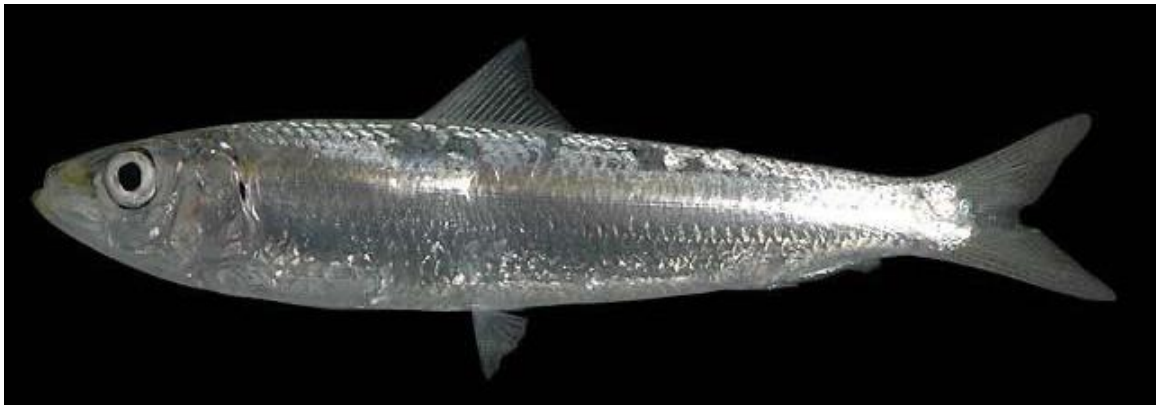

Figure 16. Spanish Sardine. Photograph courtesy of the Smithsonian Tropical Research Institute's Shorefishes of the Greater Caribbean online information system, https://biogeodb.stri.si.edu/caribbean/en/pages/random/5909, accessed December 09, 2020.

13a. Posterior border of gill opening with two fleshy knobs (Figures 12 and 17). Upper jaw without a deep median notch (Figure 2)..... Atlantic Thread Herring, *Opisthonema oglinum*

13b. Posterior border of gill opening evenly rounded (Figure 17). Upper jaw with a deep median notch 14

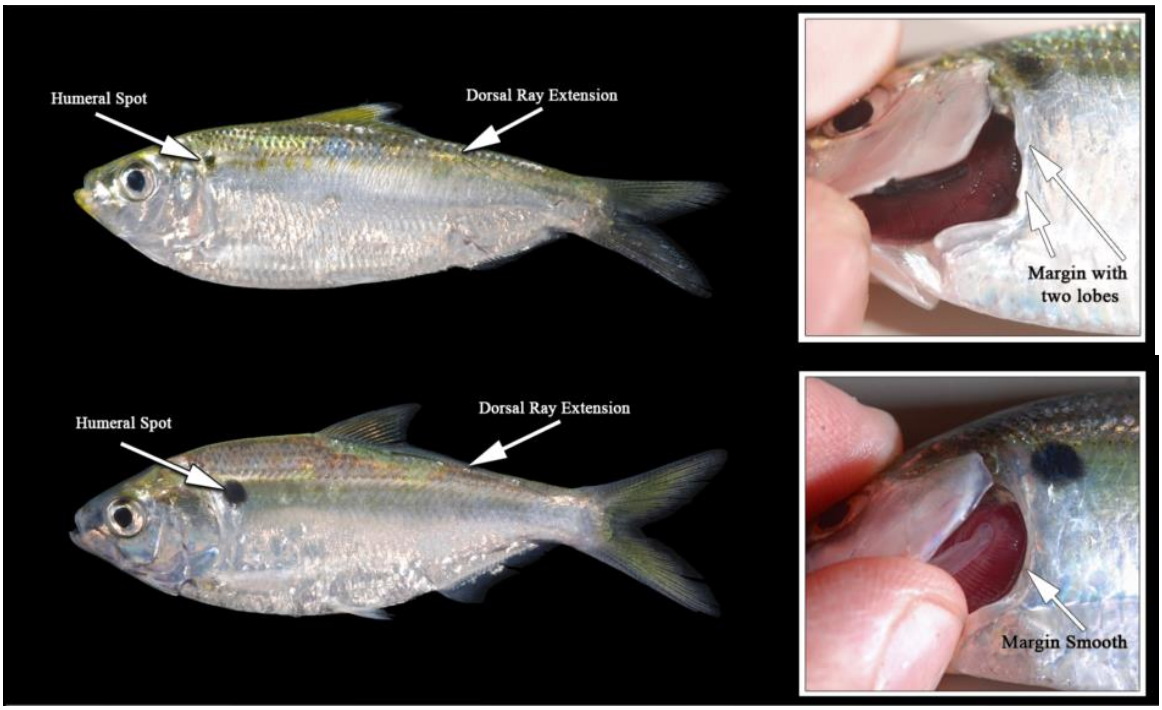

Figure 17. Top – Atlantic Thread Herring with posterior border of gill opening with two fleshy knobs; Bottom – Threadfin Shad with posterior border of gill opening evenly rounded. Photographs courtesy of Robert Aguilar, Smithsonian Environmental Research Center, Edgewater, MD.

14a. Mouth inferior, subterminal (snout bulbous and fleshy, projecting past upper jaw). Upper jaw with a notch in the posterior ventral margin. Anal-fin rays 25-37. More than 50 (52 to 70) scales in lateral series. Color of caudal fin dusky (Figure 18) .....Gizzard Shad, *Dorosoma cepedianum*

14b. Mouth terminal (snout more pointed and not extending anterior to upper jaw). Upper jaw without a notch in the posterior ventral margin. Anal-fin rays 17-27. Fewer than 50 (41 to 48) scales in lateral series. Color of caudal fin yellow (Figure 18).....Threadfin Shad, *Dorosoma petenense*

Figure 18. Red arrows pointing to the filamentous last dorsal fin rays and the pigmentation of the caudal fins. Left – Gizzard Shad; Right – Threadfin Shad.