The Fat Threeridge (*Amblema neislerii*), the Surprisingly Common Endangered Mussel in the Apalachicola River, Florida

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Abstract

Native freshwater mussels (Family: *Unionidae*) are the most 'endangered' organisms in North America; in January 2006 the U.S. Fish and Wildlife Service listed 70 species as threatened or endangered. Although some species are widely distributed throughout the central and eastern United States, many others are localized and found only in certain watersheds. For example, the fat threeridge mussel, *Amblema neislerii* (Lea, 1858), is now restricted to the Apalachicola River, Florida. Although results of surveys conducted during the 20th century suggest that this species was always rare in the river, our findings indicate that in moderately depositional areas near shore, *A. neislerii* is common-to-abundant and exhibits good evidence of recent recruitment. In 6 surveys between 1996 and 2003, divers and waders searched for mussels at approximately 100 sites in the 171-km-long river. Over 4,500 live mussels were collected and 19 species were identified. *Amblema neislerii* dominated the bivalve fauna at moderately depositional sites where it constituted approximately 36% of the fauna. Evidence of recent recruitment (live individuals less than 30 mm total shell length) was evident at many sites. This article examines the status of *A. neislerii* in the Apalachicola River based on a literature review and recent surveys.

Resumen

Mejillones nativos de agua fresca son los organismos mas amenazados en América del Norte; en enero del 2006 el Servicio de Pesca y Vida Silvestre de EE.UU. listó 70 especies como amenazadas o en peligro. A pesar de que algunas especies están ampliamente distribuidas por todo el centro y la parte este de los EE.UU., muchas otras están localizadas y se encuentran solo en ciertos acuíferos. Por ejemplo, el mejillón Amblema neislerii (Lea, 1858) está ahora restricto al Río Apalachicola, Florida. Aunque los resultados de conteos realizados durante el siglo 20 sugieren que esta especie siempre fue rara en el río nuestros resultados indican que en áreas cerca de la orilla de deposición moderada, A.neislerii es de común a abundante y hay buena evidencia de reclutamiento reciente. En 6 conteos de 1996 a 2003, buzos y vadeadores buscaron mejillones en aproximadamente 100 lugares en el estrecho de 171 km del río. Más de 4,500 mejillones vivos fueron recolectados y se identificaron 19 especies. Amblema neislerii domina la fauna bi-valvular en lugares de deposición moderada, donde formaba parte del 36% de la fauna. Evidencia de reclutamiento reciente (individuos vivos de menos de 30mm de largo de concha) estaba presente en muchos de los lugares. Este artículo examina el estatus de A.neislerii en el Río Apalachicola basado en una revisión de la literatura y conteos recientes.

Introduction

The Apalachicola River provides habitat for an endemic freshwater mussel (family: Unionidae) the fat threeridge, *Amblema neislerii* (Lea, 1858), which was listed as endangered on 15 April 1998. The decision to list this and 6 other mussel species in the Southeast was partially based on results of a status survey conducted at 324 sites in the Apalachicola-Chattahoochee-Flint (ACF) river basin and 77 sites along the Ochlockonee River Systems, southeast Alabama, southwest Georgia, and north Florida (Federal Register 63(50): 12664-12687). Jayne Brim Box and James D. Williams conducted the status survey in 1991-93 using scuba and snorkeling, and by handpicking in shallow water. These and other studies (Butler 1993) were synthesized for the Technical/Agency Draft Recovery Plan (Butler and Alam 1999) and for the Final Recovery Plan (Butler et al. 2003).

As of January 2006 the total number of federally listed threatened and endangered species was 1,272, which included 527 animals and 745 plants (US Fish and Wildlife Service 2006). When compared with charismatic species such as mammals and birds, concern has been expressed by some that invertebrates have been largely overlooked by the Endangered Species Act (ESA) (Kellert 1993; Opler 1987; Bean 1993; Murphy 1991; Hughes et al. 2000; Black et al. 2001). Regardless, of the 297 mussel species in the United States (Williams et al. 1993), 62 are endangered and 8 are threatened; therefore 24% have federal protection. Considering this comparatively high percentage, one could conclude that either native mussels are in serious trouble (Stansbery 1970; Fuller 1974; Master 1990; Bogan 1993; Seddon et al. 1998; Hayes 1998; Williams et al. 1993; Neves 1999; and Strayer et al. 2004) or they benefit from strong advocates (Yaffee 1982). Most likely, it is a combination of both.

Between 1996 and 2003 six mussel surveys were conducted in the Apalachicola River for the U.S. Army Engineer District, Mobile. These studies were designed to obtain information on distribution and abundance of federally listed mussels to avoid impacts of dredged material disposal. During this period nearly 211 hours were expended searching at approximately 100 sites in the 171-km-long river. As a result of these surveys and a critical review of previous papers on *A. neislerii*, it became apparent that this species is more common in the Apalachicola River than results of previous surveys would suggest. The purpose of this paper is to discuss survey results and the status of *A. neislerii* in the Apalachicola River. The other federally-listed mussel in the Apalachicola River is the purple bank climber, *Elliptoideus sloatianus* (Lea, 1840), listed as threatened on 15 April 1998.

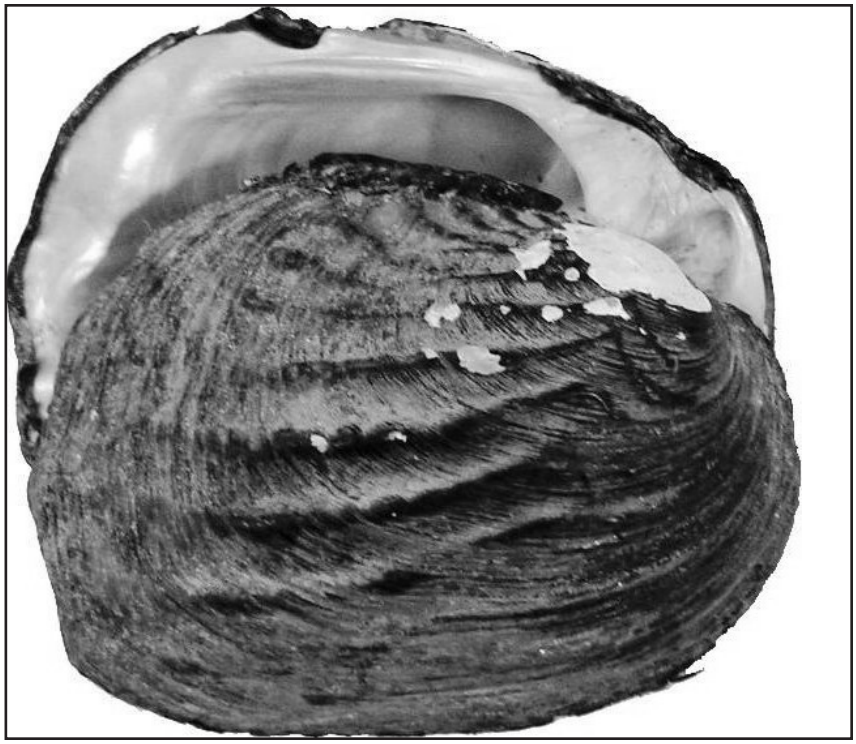

Figure 1. The fat threeridge, *Amblema neislerii.*

Study Area

The Apalachicola River, formed by the confluence of the Flint and Chattahoochee Rivers, originates at Navigation Mile (NM) 106.3, just south of Lake

Seminole in the tailwater of Jim Woodruff Lock and Dam. This 171-km river is the largest in Florida with a mean annual flow of 690 m^3/sec (Light et al. 1998). The Apalachicola-Chattahoochee-Flint (ACF) River Basin, in Georgia and northeastern Florida, drains approximately 210,448 hectares. The river enters the Apalachicola Bay at Apalachicola, Florida.

Jim Woodruff Dam is located at Navigation Mile 106.3 on the Apalachicola River and forms the Lake Seminole impoundment. Jim Woodruff Dam and Lake Seminole are operated as a run-of-the-river reservoir with the capability for only limited water storage. The tailwaters below Jim Woodruff Dam on the Apalachicola River are free-flowing and unobstructed, but can be affected by upstream reservoir operations and releases. The USACE allows basin outflows from Jim Woodruff Dam to approximately equal inflows from the upstream reservoirs in the basin except when upstream reservoirs are refilling. However, to avoid having discharge fall below 141.6 cms (minimum flow) during low flow periods, flows can be augmented by releases from Jim Woodruff Dam and/or other upstream reservoirs along the Chattahoochee River.

In 1875 the USACE was authorized to maintain a navigation channel in the Apalachicola River (U.S. Army Engineer District, Mobile 1987). In the early 20th century sediments were dredged from the main channel, oxbows, tributaries, and sloughs and placed on the floodplain within natural riverbanks. In the 1980s nearly 150 disposal areas were permitted throughout the river, although in any single year relatively few are used. Dredging was restricted to the main channel and material was only placed at specifically designated disposal areas primarily along shore in within-bank disposal sites. Although maintained for commercial navigation, commercial river traffic on the Apalachicola River in recent years has been light and has consisted mainly of recreational vessels. A number of factors have led to an unreliable navigation channel and the observed reduction in commercial navigation on the river, including recurrent drought conditions, dredged material capacity shortfalls, increasing restrictions on dredged material disposal, and funding limitations. The continued use of within-bank disposal areas has remained controversial within the State of Florida. However, mussel surveys have been conducted at all proposed within-bank disposal sites prior to their use in order to avoid impacts to threatened and endangered mussels or their habitat.

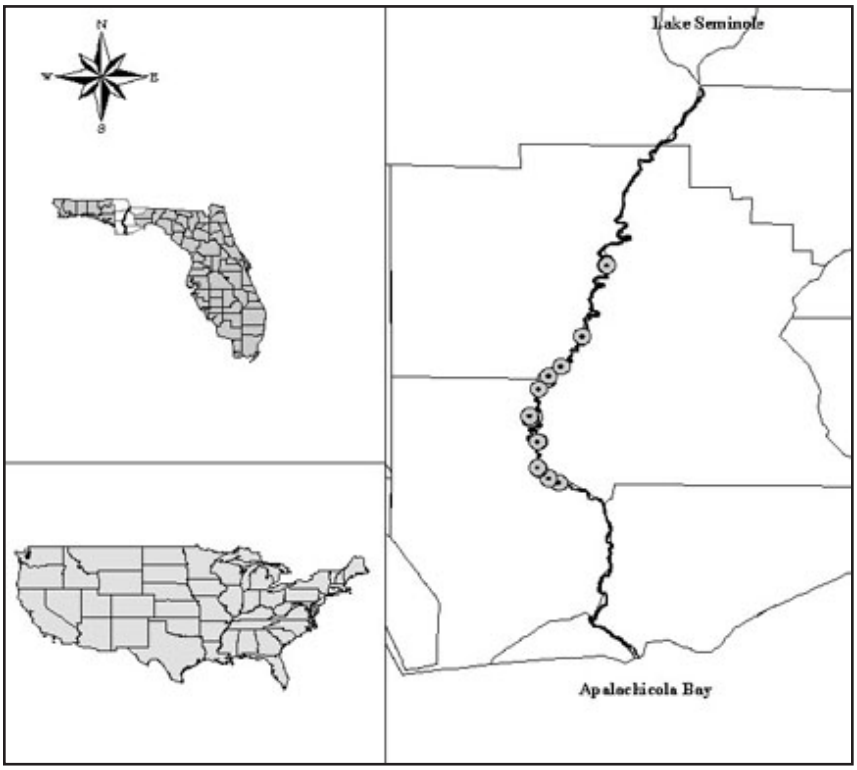

Figure 2. Sites surveyed for *A. neislerii*, Apalachicola River, Florida, November, 2003.

Most dredged material disposal areas are now located on erosional point bars, typically at a bend in the river so high flow redistributes sediments downriver. As is the case with all rivers, downriver of the erosional point bar is a zone of moderate sediment deposition. Concerning sediment deposition, the term 'moderate' is used to indicate that during low flow fine-grained sediments

or silts will be deposited and gradually increase in depth. Moderately depositional areas are firm but muddy and will support benthic invertebrates such as mussels, snails, worms (oligochaeta) and dipterans (chironomidae). A period of high-velocity water will scour sediments and remove most of the smaller, short-lived fauna, although the site usually recolonizes quickly. Depending on conditions, these moderately depositional areas could scour several times a year, or simply maintain a dynamic equilibrium between erosion and deposition which is not detrimental to the fauna. Many shoals in large rivers such as the Ohio, Tennessee, and upper Mississippi that support dense and diverse mussel assemblages meet these latter criteria

Methods

Mussels were collected by 2-4 waders in shallow water and by 2 divers in water deeper than 1 m. Searches were timed and usually lasted 15-20 minutes. Collecting was done tactilely since underwater visibility was poor. Divers were equipped with a pneumofathometer to record water depth and were tethered to the boat with a 100-m line. All live mussels were taken to the boat or a station onshore and counted, identified, and returned to a location unlikely to be disturbed by future maintenance. Demographic data were obtained at a single site by collecting total substratum quantitative samples using a 0.25-m^2 quadrat (Miller and Payne 1993). Mussel taxonomy is consistent with Williams et al. (1993).

The major objective during most study years was to assess presence/absence of threatened and endangered mussels in areas likely to be affected by dredged material disposal operations. In 1996, 1997, 1999, and 2002 these surveys were conducted immediately up- and downriver of 57 disposal areas. In 2001 searches were conducted immediately up- and downriver of 34 sloughs scheduled for maintenance dredging for ecosystem restoration. All sites were chosen by USACE and state environmental resource agency personnel and included both high quality benthic habitats as well as erosional zones not inhabited by live mussels or other benthic organisms.

A second objective was to analyze *A. neislerii* size demography, and abundance with respect to water depth at sites where this species was known to be common to abundant. These investigations were initiated to obtain a more complete understanding of this species in the Apalachicola River during low flow conditions. Population structure and evidence of recent recruitment were examined in 1999 by collecting quantitative total substratum samples using a 0.25-m2 quadrat. Total shell length of each live *A. neislerii* was measured with digital calipers, and then it was returned to the river unharmed. These samples were taken from a moderately depositional area along the right descending bank of the Chipola Cutoff immediately downriver of the point where it exits the Apalachicola River at NM 41.7. As part of this objective, the distribution of *A. neislerii* with respect to water depth was investigated in November 2003 at 11 moderately depositional sites between NM 30.0 and 73.3. Transects perpendicular to shore were established that ran from shallow (0.6 m) to deep (2.7 m) water. At 0.3-m depth increments along

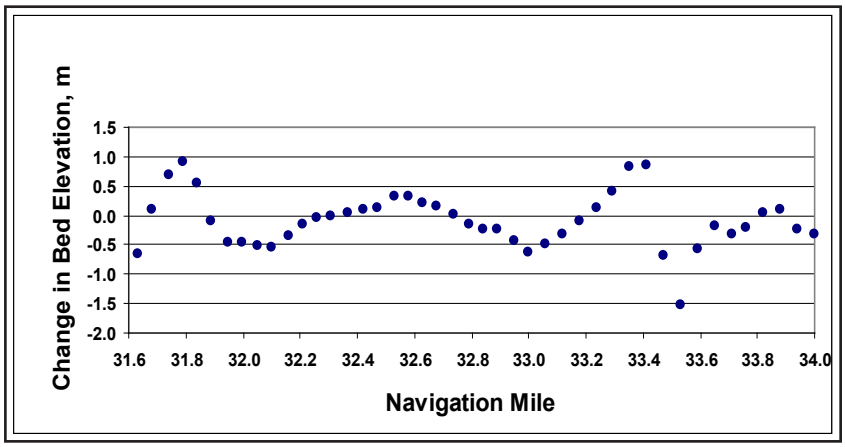

Figure 3. Results of the HEC-2 SED model, which depict depositional and erosional reaches of the Apalachicola River (indicated by positive and negative changes in bed load, respectively) and identify suitable habitat for mussels and *A. neislerii*. The vertical lines indicate downriver (lower Navigation Miles) and upriver reaches of Disposal Areas 32A and 33A. Mussels were typically found in slightly depositional reaches immediately downriver of the disposal areas.

each transect 2 divers searched for mussels for 15 minutes. A total of 100 timed searches were conducted. Gauge height and discharge at the nearest gauge near Blountstown, Florida (NM 78) was 1.11 m, 266.7 cms (18 Nov 03); 1.27 m, 291.7 cms (19 Nov 03); and 1.50 m 325.6 cms (20 Nov 03).

Results

Data from the first objective, to search for endangered species at sites likely to be affected by dredged material disposal, are summarized in Table 1. More than 4,200 live mussels were collected at approximately 100 sites in the Apalachicola River. *A. neislerii* constituted 10% of the fauna and ranked 4th of 19 species. The most abundant species at these sites was *Lampsilis teres* (Rafinesque, 1820), which constituted 35.2% of the fauna. This species is usually common in sandy substratum in rivers, streams, and lakes throughout the Midwest (Cummings and Mayer 1992). Overall Collection per Unit Effort (CPUE; mussels collected per person hour) for all mussels was 21.9 and for *A. neislerii* was 2.2. As noted above, these sites included some where *A. neislerii* was common to abundant and others where virtually no benthic organisms were found.

It became apparent that freshwater mussels, including *A. neislerii*, were most abundant in moderately depositional areas often located 1-2 km or less downriver of point bars. Output from the CH3D-SED model (Raphelt and Alexander 2001) identifies areas of moderate sediment deposition downriver of point bars and disposal areas (Figure 3). A different impression of the relative abundance of *A. neislerii* emerges when collecting was restricted to moderately depositional sites (Objective 2). At 11 depositional sites (8 separate locations) *A. neislerii* ranked 1 of 12 and constituted 35.8% of the fauna. Average CPUE was 37.9 for all mussels and 13.6 for *A. neislerii*. CPUE ranged from 0.5 to 20.2 for *A. neislerii* and from 6.3 to 55.9 for total mussels on transects located perpendicular to shore (Figure 4). Total shell length varied from 30 to 90 mm with 12% less than 40 mm total shell length. Mussels were most abundant at a depth of 1.2 m. Mussels were virtually absent at water depths less than 1.2 m likely because of predation and aerial exposure. At depths greater than 2.7 m flow became erosional and few live mussels were found.

To investigate *A. neislerii* population demography, total substratum quantitative samples were taken at a moderately depositional site along the Chipola Cutoff where it connects with the Apalachicola River (approximate NM 41.7). CPUE for all mussels was 145, and A. neislerii was collected at the rate of nearly 90 per hour and constituted slightly more than 61% of the molluscan fauna. Total shell length ranged from 12.8 to 63.7 mm with good evidence of recent

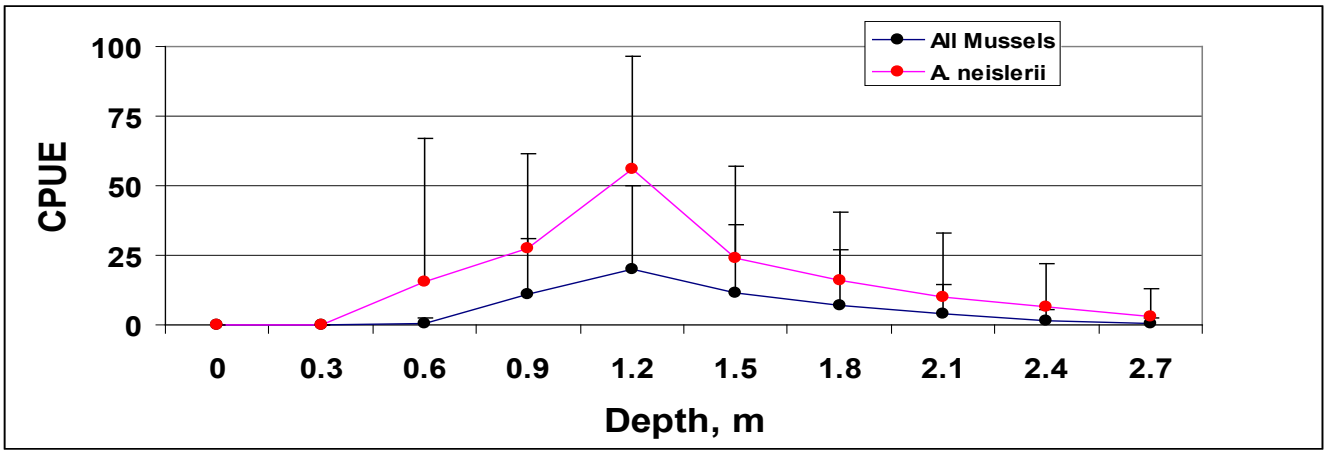

Figure 4. CPUE of *Amblema neislerii* and total mussels at 11 depositional sites in the Apalachicola River, Florida, 2003.

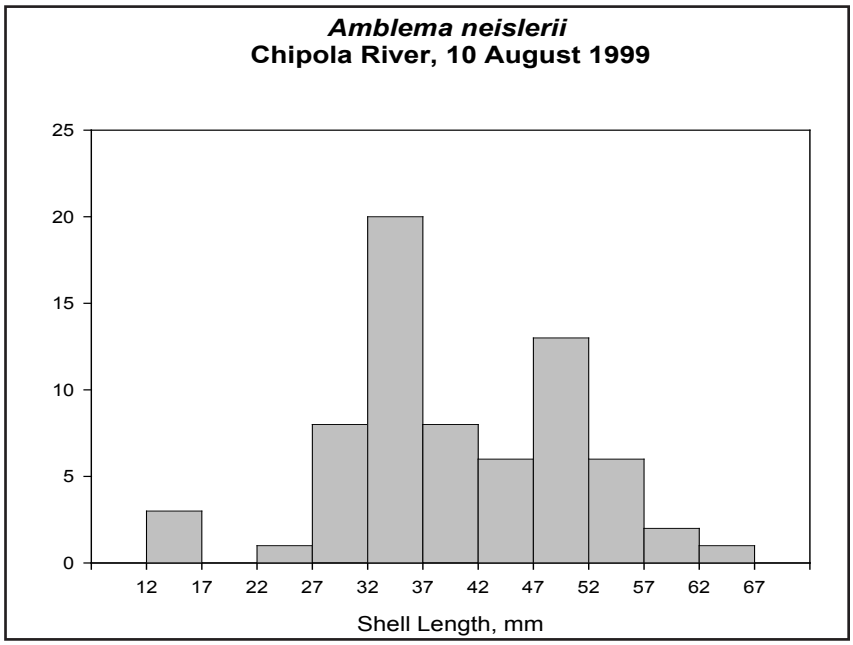

Figure 5. Length-frequency histogram for *A. neislerii*, mouth of Chipola River, 10 August 1999.

recruitment (Figure 5). We can only quantify the presence of small mussels, however, when total substratum samples were obtained. Mean density of A. neislerii was 27.2 individuals/m2, and mean density for all mussels was 34.8 individuals/m2.

Discussion

The first published reference to *A. neislerii* in the ACF basin was by Hyning (1925) who considered this species to be 'rare.' He made this statement after receiving an unreported number of *A. neislerii* from the Chipola River that were given to him by a fisherman. Later van der Schalie (1940) summarized early mussel studies in the mainstem Chipola River and tributaries. He reported that *A. neislerii* was not found in tributaries but was collected at 2 sites in the Chipola River where it constituted 1.49 % of the unionid fauna. Clench and Turner (1956) reported that *A. neislerii* was rare in the watershed, although when present it could be locally abundant. They considered it to be extinct in the upper Flint River where it had not been taken since the latter part of the previous century, although they did find some specimens in the lower Flint, Apalachicola, and Chipola Rivers. They reported that *A. neislerii* was 'amazingly abundant' in a natural impoundment in the lower Chipola River (referred to as Dead Lake) where 10-15 *Crenodonta* (=*Amblema*) *neislerii* could be found in "every square meter" along a 200-meter reach.

In a survey conducted for the Office of Endangered Species, Heard (1975) collected mussels at 150 locations in the Gulf and Southeastern States; 3 were in the Apalachicola and 4 were in the Chipola River. He collected live *A. neislerii* only in the lower Chipola River (Dead Lake). Heard (1975) reported no live *A. neislerii* in the Apalachicola River although he did find shells at 1 of 3 sites. He provided no information on sampling methods, intensity, or locations.

Richardson and Yokley (1996) collected mussels in the lower Apalachicola River using quantitative (6-0.25-m2 quadrats and total substratum removal) samples at each of 3 sites where adult *A. neislerii* or *E. sloatianus* had been found by previous investigators. *Amblema neislerii* was found at 1 of 3 sites (NM 21.8) where it constituted 25% of the assemblage. Three live organisms were smaller than 50 mm total shell length. Richardson and Yokley (1996) concluded that appropriate search methods (total substratum removal) would likely yield additional evidence of recent recruitment for *A. neislerii* in the Apalachicola River.

In 1991-92, Brim Box and Williams (2000) surveyed 324 sites in the ACF River Basin. They identified 33 species from a collection of 5,757 live individuals and 2,988 shells. Most sites were in the Chattahoochee and Flint Rivers upriver of Jim Woodruff Lock and Dam. In the Apalachicola River, Brim Box and Williams (2000) collected 32 live *A. neislerii* at 7 sites.

Early studies (Hyning 1925, van der Schalie 1940, Clench and Turner 1956, Heard 1975) give an impression that *A. neislerii* is rare in the ACF basin, but

Species	% Abundance	% Occurrence	CPUE, hr
A. neislerii	35.8	47	13.57
G. rotundata	32.36	55	12.26
L. teres	10.67	28	4.04
E. icterina	8.26	21	3.13
Q. infucata	4.13	14	1.57
E. complanata	2.75	7	1.04
P. grandis	2.75	9	1.04
M. nervosa	1.03	4	0.39
U. peggyae	0.86	4	0.33
T. paulus	0.69	4	0.26
E. crassidens	0.34	2	0.13
V. lienosa	0.34	2	0.13
Total collections	**100**		
Total individuals	**581**		
Total species	**12**		
Time, hr	**15.3**		
CPUE, Catch per person hour	**37.9**		

Table 1. Summary of timed searches for mussels at disposal areas, slough mouths, or banks requiring maintenance in the Apalachicola River, Florida (1996, 1997, 1999, 2001, and 2002).

it is difficult to critically evaluate their results without knowing details of the surveys. It is also true that this species would accurately be described as common-to-abundant in the Apalachicola River but uncommon in the ACF Basin as a whole. Richardson and Yokley (1996) collected just 6 quantitative samples at a site in the Apalachicola River where they knew *A. neislerii* was present and reached conclusions similar to ours but different from previous workers. Over 200 hours were spent searching at approximately 100 sites in the Apalachicola River. Over 4,800 live mussels were processed and more than 600 live *A. neislerii* were collected. This is far more than any previous surveys, even those upon which the decision to list *A. neislerii* as endangered was based.

Amblema neislerii survives best in slightly depositional, low-flow reaches of medium-to-large sized rivers, and is less common in small streams. Therefore it was probably never common in the smaller Flint or Chipola Rivers. It is endemic to the ACF basin because it has been isolated from the Mississippi drainage by marine conditions to the south and physiography to the east, north, and west. It was concluded that *A. neislerii* is common to abundant at moderately depositional sites in the Apalachicola River. If earlier workers had access to powerboats and divers and conducted intensive and extensive surveys, they would likely have concluded that this species was common in the Apalachicola River and uncommon in smaller tributaries. An alternative hypothesis seems unlikely. It is difficult to believe that *A. neislerii* was previously uncommon in the Apalachicola River and that its abundance has greatly increased during the last 30 years.

These studies were initiated as-

Table 2. Summary of results from timed searches at multiple depths (0.3 – 2 m) at 11 locations along the mainstem Apalachicola River, November 2003.

Species	% Abundance	% Occurrence	CPUE
Lampsilis teres	35.22	58.3	7.7
Glebula rotundata	23.81	46.9	5.2
Elliptio icterina	14.48	22.9	3.16
Amblema neislerii	10	22.9	2.19
Quincuncina infucata	2.76	22.9	0.6
Elliptio crassidens	1.64	16.7	0.36
Megalonaias nervosa	1.55	15.6	0.34
Elliptoideus sloatianus	1.69	9.4	0.37
Pyganodon grandis	1.31	19.8	0.29
Elliptio complanata	6.12	15.6	1.34
Toxolasma paulus	0.4	8.3	0.09
Utterbackia imbecillis	0.21	6.3	0.05
Villosa villosa	0.19	3.1	0.04
Pyganodon cataracta	0.16	3.1	0.04
Uniomerus caroliniana	0.12	3.1	0.03
Elliptio arctata	0.19	3.1	0.04
Utterbackia peggyae	0.07	2.1	0.02
Pyganodon heardi	0.05	2.1	0.01
Lampsilis claibornensis	0.05	2.1	0.01
Total locations	**96**		
Total individuals	**4,268**		
Total species	**19**		
Time, hr	**195.3**		
CPUE, Catch per person hour	**21.9**		

suming that *A. neislerii* was extremely uncommon and that intensive field searches would be needed to find live specimens. However, results of these field studies indicated that this species is not in imminent danger of becoming extirpated in the Apalachicola River; conversely, in appropriate habitat it is abundant and exhibits good evidence of recent recruitment. In the Apalachicola River, *A. neislerii* could even be used as an indicator of good quality moderately depositional mussel habitat. The ESA provided protection and raised awareness of abundance and distribution of *A. neislerii*. A similar situation was noted for the endangered bivalve *Potamilus capax* in the St. Francis basin, Arkansas (Miller and Payne 2005).

Depending on need, the USACE has dredged along the Apalachicola River and has typically placed the dredged material near shore. Dredging impacts, water levels, commercial uses of the river, and protection of endangered species is central to coordination among conservation groups, navigation interests, and the USACE. A complete understanding of the distribution and abundance of *A. neislerii* is therefore critical to managing the waterway.

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