Freshwater Mollusca of Plummers Island, Maryland

Author(s): Timothy A. Pearce and Ryan Evans
Source: Bulletin of the Biological Society of Washington, 15(1):20-30.
Published By: Biological Society of Washington
DOI: http://dx.doi.org/10.2988/0097-0298(2008)15[20:FMOPIM]2.0.CO;2
URL: http://www.bioone.org/doi/full/10.2988/0097-0298%282008%2915%5B20%3AFMOPIM%5D2.0.CO%3B2

Freshwater Mollusca of Plummers Island, Maryland

Timothy A. Pearce and Ryan Evans

(TAP) Carnegie Museum of Natural History, Section of Mollusks, 4400 Forbes Avenue, Pittsburgh, Pennsylvania 15213, U.S.A.,
e-mail: pearcet@Carnegiemnh.org;
(RE) Pennsylvania Natural Heritage Program, Pittsburgh Office, 209 Fourth Avenue, Pittsburgh, Pennsylvania 15222, U.S.A.

Abstract.—We found 19 species of freshwater mollusks (seven bivalves, 12 gastropods) in the Plummers Island area, Maryland, bringing the total known for the Middle Potomac River to 42 species. We found seven species not previously known from the Middle Potomac River, but we failed to find 23 species that had been reported there previously. The new records probably reflect our searching in backwater and woodland pools, habitats that had been poorly searched previously. Species not found but represented by historical records (including 15 bivalves, of which 13 are Unionidae) may represent extirpations or species missed owing to low search effort for mussels. The introduced bivalve *Corbicula fluminea,* apparently absent from the Middle Potomac in 1978, was the third most numerous species collected in our survey. We found three bivalve species not previously reported in the Middle Potomac: *Utterbackia imbecillis* (Unionidae), and *Pisidium compressum* and *Pisidium nitidum* (both Sphaeriidae).

Key Words.—Middle Potomac River, new records, bivalves, gastropods, threatened and endangered species.

The global epicenter of freshwater mollusk diversity is North America. At least 344 species of bivalves (including 39 species of Sphaeriidae) and 675 species of freshwater gastropods (Bogan 2006, Korniushin 2006) are known from the continental United States. However, freshwater mollusks are currently in decline (Lydeard et al. 2004), and recent conservation trends project that the future rate of decline of freshwater mollusks will be the highest of any animal group (Ricciardi & Rasmussen 1999). In contrast to the increasing awareness of conservation needs of freshwater mussels and efforts to protect and restore them, freshwater snails have received much less attention, in part because few workers currently study freshwater snails in the United States. Our poor knowledge of distributional data is one impediment to understanding which species are scarce or in decline, and to developing comprehensive conservation initiatives for imperiled snail species.

Previous literature records and museum collections document 35 species of freshwater mollusks in the Middle Potomac River (Table 1). Notable previous records are *Bithynia tentaculata,* an invasive European species; and *Lampsilis cariosa,* a globally rare species that Fuller (1978) considered to have been extirpated at the time of his survey.

The primary goal of this study is to document the freshwater mollusks and their habitats in the Plummers Island area, Montgomery Co., Maryland. Given the historical records of rare and invasive mollusks in the Middle Potomac River, a secondary goal was to survey for rare and invasive mollusks.

Materials and Methods

Plummers Island is situated along the left descending bank of the Middle Potomac River about 15 km upstream from and northwest of Washington, D.C. In this paper, we define the Middle Potomac River as the section of the Potomac flowing in and beside Washington, D.C. and Montgomery County, Maryland. We define Plummers Island to be the Island proper plus the adjacent mainland from the Potomac River north to the Chesapeake and Ohio Canal towpath, and extending on the west from the Highway 495 Bridge (American Legion Memorial Bridge) to Rock Run in the east. This area lies within the upland section of the Piedmont Plateau province (Edwards 1981).

To establish a list of species likely to occur at Plummers Island, we acquired historical records for the Middle Potomac River by examining published literature and obtaining museum records. Museum records were obtained using on-line Internet database searches at the Academy of Natural Sciences in Philadelphia (ANSP), Field Museum of Natural History

Table 1.—Previous records of freshwater mollusks from the Middle Potomac River from literature and museum collections.

Species	Common name	Family	Source of record
Bivalvia			
Alasmidonta heterodon (I. Lea, 1830)	dwarf wedgemussel	Unionidae	Reardon (1929), Gerberich (1985) [pre-1960]; Bogan & Proch (1997)
Alasmidonta marginata Say, 1818	elktoe	Unionidae	Marshall (1918), Reardon (1929), NMNH
Alasmidonta undulata (Say, 1817)	triangle floater	Unionidae	Marshall (1918), Reardon (1929), Johnson (1970), Bogan & Proch (1997), FLMNH, NMNH
Alasmidonta varicosa (Lamarck, 1819)	brook floater	Unionidae	Fuller (1978), Gerberich (1985) [pre-1960]; Bogan & Proch (1997); NMNH
Anodonta implicata Say, 1829	alewife floater	Unionidae	Johnson (1970)
Corbicula fluminea (Müller, 1774)	Asian clam	Corbiculidae	Dresler & Cory (1980), Cohen et al. (1984), Kennedy & van Heukelem (1985)
Elliptio angustata (I. Lea, 1831)	Atlantic spike	Unionidae	Marshall (1918) [as *Unio productus*], Reardon (1929) [as *E. productus*], Johnson (1970) [as *E. lanceolata*], Fuller (1978) [as *E. lanceolata*]; Bogan & Proch (1997) [as *E. angustata*]
Elliptio complanata (Lightfoot, 1786)	eastern elliptio	Unionidae	Marshall (1918, 1930), Reardon (1929), Johnson (1970), Fuller (1978), Bogan & Proch (1997), CMNH, FLMNH
Lampsilis cardium Rafinesque, 1820	plain pocketbook	Unionidae	Marshall (1917, 1918, 1930) [as *L. ventricosa cohongoronta*], Johnson (1970) [as *Lampsilis ovata*, syn. of *L. v. cohongoronta*], Fuller (1978) [as *L. v. cohongoronta*], Bogan & Proch (1997); NMNH [as *L. ventricosa*]
Lampsilis cariosa (Say, 1817)	yellow lampmussel	Unionidae	Marshall (1918, 1930), Reardon (1929), Johnson (1970), Fuller (1978, extirpated), Bogan & Proch (1997), CMNH, FLMNH, NMNH
Lampsilis radiata radiata (Gmelin, 1791)	eastern lampmussel	Unionidae	Reardon (1929) [as *L. radiatus*], Johnson (1970), Bogan & Proch (1997) [as *L. radiate*], NMNH
Lasmigona subviridis (Conrad, 1835)	green floater	Unionidae	Marshall (1918) [as *Symphynota viridis*], Johnson (1970), Fuller (1978), Gerberich (1985), Bogan & Proch (1997), NMNH
Leptodea ochracea (Say, 1817)	tidewater mucket	Unionidae	Reardon (1929), Johnson (1970), Bogan & Proch (1997)
Ligumia nasuta (Say, 1817)	eastern pondmussel	Unionidae	Reardon (1929), Johnson (1970), Fuller (1978), Bogan & Proch (1997)
Musculium transversum (Say, 1829)	long fingernailclam	Sphaeriidae	Fuller (1978), ANSP
Pyganodon cataracta (Say, 1817)	eastern floater	Unionidae	Reardon (1929), Johnson (1970), Fuller (1978), Bogan & Proch (1997), FLMNH
Sphaerium simile (Say, 1817)	grooved fingernailclam	Sphaeriidae	Fuller (1978)
Sphaerium striatinum (Lamarck, 1818)	striated fingernailclam	Sphaeriidae	CMNH
Strophitus undulatus (Say, 1817)	creeper	Unionidae	Marshall (1918), Reardon (1929), Johnson (1970), Fuller (1978), Bogan & Proch (1997), NMNH
Gastropoda			
Amnicola limosus (Say, 1817)	mud amnicola	Hydrobiidae	Fuller (1978)
Bithynia tentaculata (Linnaeus, 1758)	mud bithynia	Bithyniidae	Fuller (1978), Hamilton (1979, 1980)
Campeloma decisum (Say, 1817)	pointed campeloma	Viviparidae	Fuller (1978) [as *Campeloma* sp.], FLMNH
Elimia virginica (Say, 1817)	piedmont elimia	Pleuroceridae	Fuller (1978), Hamilton (1979, 1980), Gerberich (1985); ANSP
Fontigens bottimeri (Walker, 1925)	Bottimers springsnail	Hydrobiidae	NMNH
Galba humilis (Say, 1822)	marsh fossaria	Lymnaeidae	Fuller (1978)
Galba modicella (Say, 1825)	rock fossaria	Lymnaeidae	ANSP
Gillia altilis (I. Lea, 1841)	buffalo pebblesnail	Hydrobiidae	Fuller (1978)
Leptoxis carinata (Bruguière, 1792)	crested mudalia	Pleuroceridae	Fuller (1978), Hamilton (1979, 1980)
Lioplax subcarinata (Say, 1816)	ridged lioplax	Viviparidae	Fuller (1978)
Micromenetus dilatatus (Gould, 1841)	bugle sprite	Planorbidae	Fuller (1978), ANSP
Physa acuta (Draparnaud, 1805)	pewter physa	Physidae	Hamilton (1980) [as *P. heterostropha*]
Planorbella trivolvis (Say, 1817)	marsh rams-horn	Planorbidae	Fuller (1978), Hamilton (1980)
Pseudosuccinea columella (Say, 1817)	mimic lymnaea	Lymnaeidae	Fuller (1978)
Pyrgulopsis lustrica (Pilsbry, 1890)	boreal marstonia	Hydrobiidae	NMNH
Valvata tricarinata (Say, 1817)	threeridge valvata	Valvatidae	Fuller (1978)

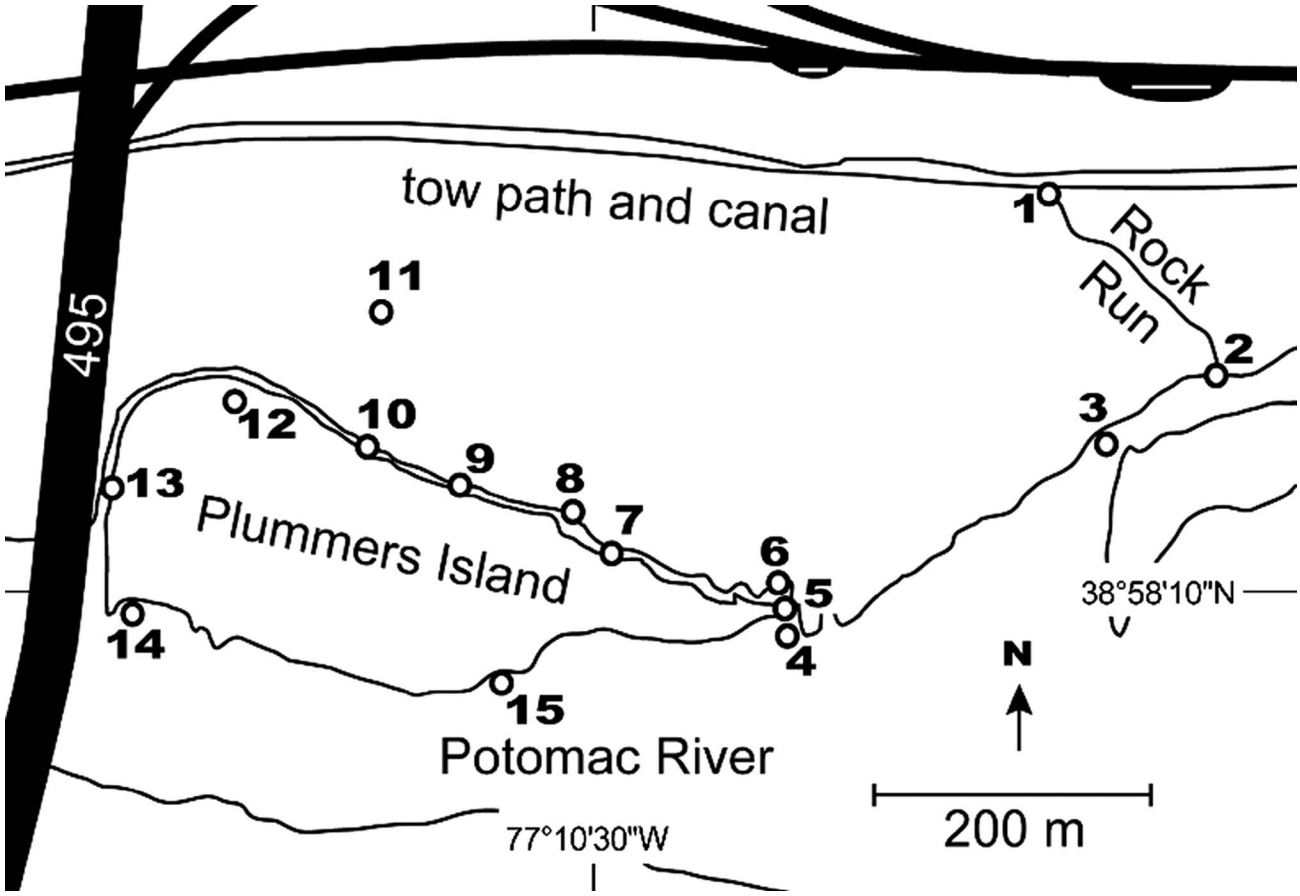

Fig. 1. Locations sampled for freshwater mollusks in the Plummers Island area, Montgomery Co., Maryland.

(FMNH), Florida Museum of Natural History (FLMNH), and National Museum of Natural History (USNM), Smithsonian Institution. We searched offline collection databases at Carnegie Museum of Natural History (CMNH) and Delaware Museum of Natural History (DMNH), searching for freshwater mollusks from the Middle Potomac River in Montgomery County, Maryland. We did not verify identities of these museum records. Because museums likely have additional records not on the Internet, we note that additional records might be found by examining actual specimens in museum collections. For example, USNM seems to present only Unionidae and some Hydrobiidae on their Internet site, and ANSP is likely to have additional records, since Fuller's (1978) specimens are reportedly deposited there but were not found in the Internet-accessible database.

To determine the species actually occurring at Plummers Island, we took samples in the Plummers Island area at sites along the shoreline of the Potomac main channel, in the backwater channel that runs along the north side of the Island, in a seasonal pool wetland, and in Rock Run just to the east of Plummers Island proper (Fig. 1).

Methods of sampling included timed hand collecting of live animals and shells, scoops into woody debris and loose substrates, use of a glass-bottomed bucket in current, and snorkeling in water up to 3 m deep in the main channel of the Potomac River. Surveying was conducted on 10 April and 4–5 September 2004. Most specimens were immediately preserved in 70% ethanol. Hydrobiid snails were narcotized using menthol crystals before preservation to facilitate examining the male verge. Voucher specimens are deposited at CMNH (CM70423–70549).

Literature used for identification included Burch & Tottenham (1980), Burch (1982), Jokinen (1992), and Smith (2000). The mollusk research collection at the CMNH provided comparative specimens to verify identifications. The second author identified most of the specimens and reviewed the validity of historical records, with additional identifications by A. E. Bogan for Unionidae, R. T. Dillon for pulmonate gastropods, and the first author for Sphaeriidae. Taxonomy follows the nomenclature presented in Turgeon et al. (1998), except we consider *Physella heterostropha* (Say, 1817) and *Physella integra* (Haldeman, 1841) to be synonyms of *Physa acuta* (Wethington et al. 2000, Dillon et al. 2002, 2005; although see Taylor 2003, who considered *Haitia acuta,* and *Haitia integra* valid, and *P. heterostropha* a synonym of *H. acuta*). Also, we follow Falkner et al. (2001) in

Table 2.—Freshwater mollusks collected in the Plummers Island area during this study. Number collected refers to live and freshly dead individuals.

Species	Common name	Family	Number Collected
Bivalvia			
Corbicula fluminea (Müller, 1774)	Asian clam	Corbiculidae	130
Elliptio complanata (Lightfoot, 1786)	eastern elliptio	Unionidae	11
Musculium transversum (Say, 1829)	long fingernailclam	Sphaeriidae	29
Pisidium compressum Prime, 1852	ridgebeak peaclam	Sphaeriidae	5
Pisidium nitidum Jenyns, 1832	shiny peaclam	Sphaeriidae	4
Strophitus undulatus (Say, 1817)	creeper	Unionidae	1
Utterbackia imbecillis (Say, 1829)	paper pondshell	Unionidae	1
Gastropoda			
Amnicola limosus (Say, 1817)	mud amnicola	Hydrobiidae	15
Bithynia tentaculata (Linnaeus, 1758)	mud bithynia	Bithyniidae	6
Campeloma decisum (Say, 1817)	pointed campeloma	Viviparidae	1
Elimia virginica (Say, 1817)	piedmont elimia	Pleuroceridae	211
Ferrissia rivularis (Say, 1817)	creeping ancylid	Ancylidae	23
Galba modicella (Say, 1825)	rock fossaria	Lymnaeidae	33
Gyraulus parvus (Say, 1817)	ash gyro	Planorbidae	10
Laevapex fuscus (C. B. Adams, 1841)	dusky ancylid	Ancylidae	33
Leptoxis carinata (Bruguière, 1792)	crested mudalia	Pleuroceridae	95
Micromenetus dilatatus (Gould, 1841)	bugle sprite	Planorbidae	56
Physa acuta (Draparnaud, 1805)	European physa	Physidae	200
Planorbula armigera (Say, 1821)	thicklip rams-horn	Planorbidae	10

using the name *Galba* in place of *Fossaria* because when *Buccinum truncatulum* Müller, 1774 was fixed as the type species of *Galba* [ICZN (1998)], *Fossaria* (having the same type species) became an objective younger synonym of *Galba.*

The identity of the lanceolate *Elliptio* species in the Middle Potomac River remains uncertain. As explained below in the species accounts, we follow Bogan & Proch (1997) in using the name *Elliptio angustata* for the lanceolate *Elliptio.*

Catch-per-unit effort (CPUE) statistics represent the number of live or fresh dead specimens collected/total number of person-hr search time. Number of species (S) statistics represent the number of species found live or fresh dead at a site. In order to test for difference in CPUE and S among flow types, we categorized sites into three flow types: 1) lotic, medium to swift flow, 2) lotic, slow flow, and 3) lentic habitats with no discernable flows. We omitted the April samples because with high water and low CPUE, they were not from the same statistical population as the September samples. We omitted the one remaining lentic sample as insufficient for statistics, and then compared CPUE and S between the four swift and five slow flow September stations with a Mann-Whitney U test.

Results

We obtained literature and museum records for 35 species of freshwater mollusks from the Middle Potomac River (Table 1). Literature references giving many species records (more than 10) for the Middle Potomac were Reardon (1929), Johnson (1970), Fuller (1978), and Bogan & Proch (1997); those and additional references are listed in Table 1. We retrieved records of freshwater mollusks from the Potomac River in Montgomery County from the collection databases at ANSP, CMNH, FLMNH, and USNM but no records from DMNH or FMNH. One unionid record from USNM was from the Plummers Island area; all other USNM historical literature and museum records were from other parts of the Middle Potomac.

Our field survey located 19 species of freshwater mollusks in the Plummers Island area (Table 2). The species collected in greatest numbers were *Elimia virginica, Physa acuta,* and *Corbicula fluminea.* Also notable were living specimens of three bivalve species not previously reported in the Middle Potomac: one Unionidae, *Utterbackia imbecillis,* and two Sphaeriidae, *Pisidium compressum* and *Pisidium nitidum.*

Time searched at sites varied from 0.17–1.5 person-hr ($\bar{X}$ = 0.93, median = 1.0, Appendix 1). Catch-per-unit-effort (CPUE) values for live or fresh dead specimens were highest in the small rock pool at station 12 and, ignoring station 8, which had only dead shells from the shore, CPUE values were lowest at stations 2 and 6 (Appendix 1). CPUE values were lower during high water in April ($\bar{X}$ = 10) and greater during low water of September ($\bar{X}$ = 83). CPUE values are not strictly comparable because different methods were used at different stations and habitats (e.g., some were snorkel only, others were dip net only), but the CPUE values provide one quantitative measure of mollusk abundance. We found greater

CPUE at low flow than high flow (low flow $\bar{X}$ = 102 specimens/person-hr, high flow $\bar{X}$ = 34/person-hr; Mann-Whitney U test, p = .027). Furthermore, we found more species (S) at low flow sites than high flow (S at low flow $\bar{X}$ = 10.2, S at high flow $\bar{X}$ = 4.0, Mann-Whitney U test, p = .012).

Bivalve species were not distributed evenly among stations. The invasive bivalve *C. fluminea* was widespread around Plummers Island in the Potomac or in water flowing from the Potomac but was absent from isolated pools and up Rock Run. The unionid mussels *Elliptio complanata, U. imbecillis,* and *Strophitus undulatus* were found in the main channel of the Potomac around Plummers Island. The small sphaeriid pill clams were in calmer waters: *Musculium transversum* in the backwater and in the woods pool in the Plummers Island area and *P. compressum* and *P. nitidum* at only one station each in the backwater.

Gastropods also were not evenly distributed among stations. The pleurocerids tended to be in larger, faster moving water, with *Leptoxis carinata* more abundant (and found alive) in the main channel of the Potomac, and *E. virginica* being widespread in the Potomac and in water flowing from the Potomac but absent from isolated pools and up Rock Run. Other gastropods, such as *Amnicola limosus, B. tentaculata, Campeloma decisum, Galba modicella,* and *P. acuta,* tended to be distributed in the slower moving backwater. The ancylid limpets and *Gyraulus parvus* were only in the backwater. *Ferrissia rivularis* and *Laevapex fuscus* were found throughout the backwater, while *G. parvus* was found at the upstream end of the backwater. *Micromenetus dilatatus* was in the backwater and up Rock Run. *Planorbula armigera* was found only in the woodland pool.

We found live individuals of two invasive species not native to the United States, *C. fluminea* and *B. tentaculata. Corbicula fluminea* was abundant, representing 16% of the live or fresh dead specimens collected, while *B. tentaculata* represented <1% of the specimens collected.

Discussion

The 19 species of freshwater mollusks we found in the Plummers Island area include seven species not previously reported in the Middle Potomac River in literature or museum records. On the other hand, we did not find at Plummers Island 23 of the species historically reported from the Middle Potomac River. We found greater species richness of freshwater snails than reported in the Middle Potomac by Fuller (1978), but we found less richness of bivalves (Table 2).

We attribute the new gastropod finds to greater sampling effort for snails and perhaps to the greater diversity of freshwater snail habitats that island areas typically offer. For example, our sampling in seasonal pool habitats, in which Fuller did not sample, located *P. armigera.* We found more individuals and greater diversity in habitats with lower flow, but it is not clear whether low flow sites were richer or if they were easier to sample. The fact that some of the April sites (during high water) had low catches and low numbers of species in sites located close to September sites (during low water) having high catches and high numbers of species suggests that to some extent, greater catches at lower flow sites were because they were easier to sample. The lower bivalve richness in this study probably reflects low search effort for mussels (<3 person-hr search targeting mussels). Furthermore, the qualitative nature of our survey is not sufficient to allow inferences about individual species trends. Generally, qualitative sampling finds more species in contrast to quantitative sampling, which would be more effective in generating demographic trend data.

The seven species of freshwater bivalves we found in the Plummers Island area include three not previously reported in the Middle Potomac: the unionid *U. imbecillis,* and the sphaeriids *P. compressum* and *P. nitidum.* In contrast, we did not find at Plummers Island 15 species of bivalves that were known from the Middle Potomac River historically, 13 of which are Unionidae. Some of those previously reported species might be absent from the Plummers Island area, either not ever present or more recently extirpated. Fuller (1978) noted that freshwater mussels were nearly exterminated in the Middle Potomac River, and he considered *L. cariosa* to be extirpated. He noted that the species surviving in the Middle Potomac River at the time of his paper were those that are tolerant of environmental disturbance. However, due to low search effort for mussels, absences in this survey may or may not represent real absences from the Plummers Island area. The search time required to locate rare species of freshwater mussels is high (Strayer & Smith 2003). In the Potomac River in particular, mussel beds are highly localized and sporadic (Villella & Smith 2005). Future investigators and greater search effort could certainly improve information on freshwater mussels around the Plummers Island area.

Only three species of Sphaeriidae have been reported historically from the Middle Potomac area (and a fourth taxon, *Pisidium* sp. reported by Fuller 1978). Of those previous records, we found the common *M. transversum* in the Plummers Island area, plus two species of Sphaeriidae not previously reported in the Middle Potomac, *P. compressum* and *P. nitidum.* In contrast, we did not find at Plummers Island two species reported historically, *Sphaerium simile* and *Sphaerium striatinum.*

Absences of some relatively common species are

surprising. For example, *Helisoma anceps* (Menke, 1830) is a commonly encountered species in most riverine systems in the mid-Atlantic region of the U.S.A., and *Pseudosuccinea columella* frequently occurs in backwaters (Jokinen 1983, 1992). However, we did not find either at Plummers Island.

Fuller (1978) mentioned that water quality in the Middle Potomac River declined from the late 1950s to the late 1970s. He noted that animals surviving at the time of his survey are species tolerant of environmental disturbance. Water quality in the Middle Potomac has been extremely poor in the past due to land clearing for timbering, agriculture, and urbanization in past decades. Point sources of pollution are one of the most threatening trends to water and habitat quality in this section of the Potomac River. Currently, approximately 55% of the land use in this portion of the Potomac is urban (Maryland Department of Natural Resources 2005). Sedimentation is a long-term habitat quality concern for many species of aquatic molluscs; approximately 2.4 million metric tons of sediment pass through the Potomac River per year, representing about a third of the total sediment contribution to the Chesapeake Bay (Cronin et al. 2003). Data from 1985 to 1999 indicate that flow adjusted concentrations of total nitrogen, total phosphorus, and total dissolved solids/suspended sediment are generally decreasing (Langland et al. 2003). With water quality improved in recent years, some recovery of the molluscan fauna may be possible.

Most of the species we found at Plummers Island appear to be globally widespread, abundant, and secure as they have been assigned global heritage ranks of secure (G5) by NatureServe (2006). However, two unionid species that we found are considered to be less than secure within the state: *S. undulatus* (state rare; S2) and *U. imbecillis* (rare to uncommon; S3) (Maryland Department of Natural Resources 2003). Furthermore, nine of the historically reported species that we did not find appear to be less than secure. One snail, *Fontigens bottimeri* (Hydrobiidae), is listed as imperiled (G2) by NatureServe (2006) and state rare (S2) by Maryland Department of Natural Resources (2003). Of the 13 historically reported Unionidae that we did not find, eight have global heritage or Maryland State ranks less than secure (G1–G3, S1–S3) (Maryland Department of Natural Resources 2003, NatureServe 2006): *Alasmidonta heterodon, Alasmidonta undulata, Alasmidonta varicosa, Anodonta implicata, E. angustata, L. cariosa, Lasmigona subviridis, Leptodea ochracea.* We include *E. angustata* on this list because, although that species is ranked globally as apparently secure and unranked for the state (as *Elliptio lanceolata*), two other species that we are grouping under the name *E. angustata* are less than secure (*Elliptio fisheriana,* G4, S3; *Elliptio producta*, G3, S2–S3). Extirpation due to environmental disturbance might explain why we did not find globally imperiled species that were known historically.

Selected Species Accounts

We include species account entries for all species having global or state status ranks less than secure (G5, S5). In addition, we discuss selected species that are secure.

Bivalvia

Alasmidonta heterodon (Unionidae)

We did not find this species at Plummers Island. The absence of ''Johnson (1970)'' from the entry for this species in Table 1 is because the only Potomac drainage record of *A. heterodon* he reported (about 90 km SE of Plummers Island at McIntosh Run, 4 mi N of Leonardtown in St. Mary's Co.) is not in the Middle Potomac as we defined it. Gerberich (1985), who reported this species at Washington, D.C. from before 1960, considered *A. heterodon* to be endangered because of its rarity. It is federally endangered (Bogan & Proch 1997, Turgeon et al. 1998), and it is considered apparently secure (G4) globally but critically imperiled (S1) in Maryland (Maryland Department of Natural Resources 2003, NatureServe 2006).

Alasmidonta marginata (Unionidae)

We did not find this species at Plummers Island. Gerberich (1985) noted that *A. marginata* had not been collected in the state of Maryland, but that it should be expected, and if Maryland populations were found, he noted that they should be of special concern because Maryland is at the edge of their range. It is considered apparently secure (G4) globally (NatureServe 2006).

Alasmidonta undulata (Unionidae)

We did not find this species at Plummers Island. Bogan & Proch (1997) noted that it is of special concern in Maryland. It is considered apparently secure (G4) globally but critically imperiled (S1) in Maryland (Maryland Department of Natural Resources 2003, NatureServe 2006).

Alasmidonta varicosa (Unionidae)

We did not find this species at Plummers Island. The absence of ''Johnson (1970)'' from Table 1 for this species is because his report of this species from the Potomac is at Hancock, Washington County, Maryland, which is 118 km northwest and upstream from Plummers Island. Gerberich (1985), who reported one Potomac River occurrence of *A. varicosa*

at Washington, D.C. from before 1960 and one about 15 km upstream from there after 1960, considered this species to be endangered because of its rarity. Bogan & Proch (1997) reported it as threatened in Maryland. It is considered vulnerable to extirpation or extinction (G3) globally but critically imperiled (S1) in Maryland (Maryland Department of Natural Resources 2003, NatureServe 2006).

Anodonta implicata (Unionidae)

We did not find this species at Plummers Island. Johnson (1970) listed it (as *Pyganodon implicata*) from ''Potomac River, District of Columbia,'' and since he separately listed *Pyganodon cataracta* and *U. imbecillis,* his record is not likely to be a misidentification of those species. Gerberich (1985) listed it from Maryland but did not indicate whether it occurs in the Potomac. Bogan & Proch (1997) reported it in the Potomac, but from upstream, not in the Middle Potomac, and indicated its status as currently stable. It is considered secure (G5) globally but rare to uncommon in Maryland (Maryland Department of Natural Resources 2003, NatureServe 2006).

Corbicula fluminea (Corbiculidae)

We found this introduced species at Plummers Island. *Corbicula fluminea* was first observed in the tidal Potomac River (downstream from Plummers Island) in November 1977 (Dresler & Cory 1980), but Fuller (1978) noted its absence in the Middle Potomac, although he reported it present in the James River to the south and the Delaware River to the north. A reproducing population was found at Whites Ferry, Maryland (upstream from Plummers Island) in December 1981 (Kennedy & van Heukelem 1985). *Corbicula fluminea* competes with freshwater mussels (Fuller 1978) and survives well in polluted environments. When it occurs in high densities, it can raise ammonia levels during seasonal die-offs (Cherry et al. 2005). This species was introduced from Southeast Asia into the U.S.A. before 1938. Being adaptable to a wide range of niches, it is an excellent colonizer to new habitats (Britton & Morton 1982, Counts 1986), and it has successfully colonized many major southeastern and mid-Atlantic river systems (Foster et al. 2005). Once established, as with almost any exotic aquatic mollusk, it is extremely difficult to eliminate through management actions. It is considered secure (G5) globally (NatureServe 2006).

Elliptio angustata (Unionidae)

We did not find this or any of the members of the species complex at Plummers Island. The identity of the lanceolate *Elliptio* species in the Middle Potomac River remains unresolved. In this paper, we follow the suggestion of Bogan & Proch (1997) to use the name *E. angustata* because they did not consider *E. lanceolata* to occur in Maryland, and of the other three species that the lanceolate form in Maryland could be, *E. angustata* was described first. Gerberich (1985:255) listed four names for this species complex in eastern U.S.A.: *E. angustata* (I. Lea, 1831), *E. fisheriana* (I. Lea, 1838), *E. lanceolata* (I. Lea, 1828), and *E. producta* (Conrad, 1836). Although he was uncertain about the validity of all the names, he thought *E. angustata* and *E. fisheriana* occur in Maryland, but he did not include or exclude either in the Potomac. Similarly, Bogan & Proch (1997) noted that several names have been used for this group in Maryland including *E. fisheriana, E. producta,* and *E. angustata.* Both *E. angustata* and *E. fisheriana* were considered to be of special concern by Gerberich (1985:255) and Bogan & Proch (1997). Globally, NatureServe (2006) considers *E. angustata* and *E. fisheriana* to be apparently secure (G4) and *E. producta* to be vulnerable to extirpation or extinction (G3). In Maryland, *E. angustata* (as synonym of *E. lanceolata*) is considered status uncertain (SU), *E. fisheriana* as rare to uncommon (S3), and *E. producta* as rare, to rare to uncommon (S2–S3) (Maryland Department of Natural Resources 2003).

Elliptio complanata (Unionidae)

We found this species at Plummers Island. Bogan & Proch (1997) reported this species to be currently stable in Maryland. It is considered secure (G5) globally (NatureServe 2006).

Lampsilis cardium (Unionidae)

We did not find this species at Plummers Island. It was originally native to the Ohio Basin (Parmalee & Bogan 1998). It was first noted in the Potomac system by Ortmann (1912) who described this probably introduced population as the new subspecies, *Lampsilis ventricosa cohongoranta* Ortmann, 1912 [later synonymized with *Lampsilis ventricosa* (Barnes, 1823)]. Other investigators reported it, and Villella & Smith (2005) noted it to be the most abundant lampsiline (Unionidae: Lampsilinae) in the Potomac system. Fuller (1978) suggested that *L. cardium* competes with the native lampsiline *L. cariosa.* Bogan & Proch (1997) reported *L. cardium* to be of special concern in Maryland. It is considered secure (G5) globally (NatureServe 2006).

Lampsilis cariosa (Unionidae)

We did not find this species at Plummers Island. It is in decline in many states and is believed to be extirpated in Maryland (Fuller 1978, Bogan & Proch 1997, Maryland Department of Natural Resources

2003). It is considered vulnerable to apparently secure (G3–G4) globally (NatureServe 2006) but threatened (Bogan & Proch 1997) or endangered (S1) (Maryland Department of Natural Resources 2003) in Maryland.

Lampsilis radiata (Unionidae)

We did not find this species at Plummers Island. Bogan & Proch (1997) reported this species as currently stable in Maryland. It is considered secure (G5) globally (NatureServe 2006) and status uncertain (SU) in Maryland (Maryland Department of Natural Resources 2003).

Lasmigona subviridis (Unionidae)

We did not find this species at Plummers Island. Gerberich (1985), who reported two Middle Potomac occurrences from before 1960 and one occurrence after 1960, considered *L. subviridis* to be rare and probably endangered in Maryland because of few records of its occurrence. It is considered vulnerable (G3) globally (NatureServe 2006) but threatened (Bogan & Proch 1997) or endangered (S1) (Maryland Department of Natural Resources 2003) in Maryland.

Leptodea ochracea (Unionidae)

We did not find this species at Plummers Island. Globally it is vulnerable to apparently secure (NatureServe 2006), but it is reported as of special concern in Maryland (Bogan & Proch 1997) or status uncertain (SU) by Maryland Department of Natural Resources (2003).

Ligumia nasuta (Unionidae)

We did not find this species at Plummers Island. It is considered apparently secure to secure (G4–G5) globally (NatureServe 2006), but of special concern (Bogan & Proch 1997) or status uncertain (SU) (Maryland Department of Natural Resources 2003) in Maryland.

Musculium transversum (Sphaeriidae)

We found this species at Plummers Island. Fuller (1978) made particular note of *M. transversum* being tolerant of organic loading, siltation, and other environmental damage. It is considered secure (G5) globally (NatureServe 2006).

Pisidium compressum (Sphaeriidae)

We found this species at Plummers Island; it has not previously been reported from the Middle Potomac. It is readily identifiable by the characteristic ridges on the beak (Burch 1975). It is considered secure (G5) globally (NatureServe 2006).

Pisidium nitidum (Sphaeriidae)

We found this species at Plummers Island; it has not previously been reported from the Middle Potomac. The shell is 2.5 mm long, with 40 striae per mm, and the hinge is more than 0.75 of shell length, indicating that these specimens are *P. nitidum* (Burch 1975).

Pyganodon cataracta (Unionidae)

We did not find this species at Plummers Island. It is reported as currently stable in Maryland (Bogan & Proch 1997). It is considered secure (G5) globally (NatureServe 2006).

Strophitus undulatus (Unionidae)

We found this species at Plummers Island. It is considered secure (G5) globally (NatureServe 2006). Although it was reported as currently stable in Maryland by Bogan & Proch (1997), it is considered imperiled (S2) by Maryland Department of Natural Resources (2003).

Utterbackia imbecillis (Unionidae)

Our specimen of *U. imbecillis* at Plummers Island is a new record for the Middle Potomac River. The closest locality where Johnson (1970) reported it was ''Maryland: Gunpowder River, Loch Raven Dam, Loch Raven, Baltimore Co. (ANSP).'' It is considered secure (G5) globally (NatureServe 2006). Bogan & Proch (1997), who did not report *U. imbecillis* from the Potomac River, reported it as currently stable in Maryland, but Maryland Department of Natural Resources (2003) reported it as rare to uncommon (S3).

Gastropoda

Amnicola limosus (Hydrobiidae)

This is the only species of Hydrobiidae we found at Plummers Island although that and three other species are known historically from the Middle Potomac. The family Hydrobiidae is often under-collected or not reported because identifying the tiny specimens is difficult. It is considered secure (G5) globally (NatureServe 2006).

Fontigens bottimeri (Hydrobiidae)

We did not find this species at Plummers Island. It is known from the Middle Potomac in museum collections but is not likely to be living in the Plummers Island area (R. Hershler, pers. comm. 3 May 2006). It is considered imperiled (G2) globally (NatureServe 2006) and imperiled (S2) in Maryland (Maryland Department of Natural Resources 2003).

Gillia altilis (Hydrobiidae)

We did not find this species at Plummers Island. Maryland Department of Natural Resources (2003) did not currently list any of the aquatic snails found in this study among its invertebrates of special concern, but *G. altilis* is of conservation concern in New York and Pennsylvania, and is being considered for state protection in South Carolina (R. Dillon pers. comm.). The status of this species in the Potomac River, particularly given the presence of invasive species such as *B. tentaculata* and few recent records nationwide, is currently unclear, so it certainly needs more study to establish current distribution, temporal trends, and basic life history patterns. It is considered secure (G5) globally (NatureServe 2006).

Pyrgulopsis lustrica (Hydrobiidae)

We did not find this species at Plummers Island. It is known from the Middle Potomac in museum collections but is not likely to be living in Plummers Island area (R. Hershler, pers. comm. 3 May 2006). It is considered secure (G5) globally (NatureServe 2006).

Bithynia tentaculata (Bithyniidae)

We found this introduced species at Plummers Island. It was first found in the Potomac River at Alexandria, Virginia (Pilsbry 1932, Marshall 1933). It may have been introduced into the Potomac through shipping canals. It has been known to establish itself in great numbers and has even been shown to fowl domestic water supply pipes (Baker 1902), which gave rise to one of its common names, the faucet snail. Unlike many other snails, *B. tentaculata* can suspension feed in addition to grazing (Brendelberger & Jürgens 1993), so this species might be expected to compete well with native snails, as it is not as directly affected by sedimentation as native grazers. Hamilton (1979) found that *B. tentaculata* coexisted with other gastropod species in the Potomac River at Great Falls. She found that *B. tentaculata* was more susceptible to crayfish predation and was less tolerant of rapid water currents, but that the presence of *B. tentaculata* eggs on rocks significantly reduced the egg densities of *E. virginica* and *L. carinata.* Long-term effects of this species on the local aquatic gastropod fauna are unclear. It is considered secure (G5) globally (NatureServe 2006).

Elimia virginica (Pleuroceridae)

We found this species at Plummers Island. Gerberich (1985) considered *E. virginica* to be threatened because it is declining. He noted only two thriving populations in the state of Maryland, one of which is above Great Falls in the Middle Potomac. Despite Gerberich's report, it is considered secure (G5) globally (NatureServe 2006) and was not assigned special status by Maryland Department of Natural Resources (2003).

Planorbula armigera (Planorbidae)

We found this species at Plummers Island only in a seasonal woodland pool on the mainland. It is an obligate inhabitant of ephemeral wetlands (Jokinen 1992). It is considered secure (G5) globally (NatureServe 2006).

Acknowledgments

We are grateful to people who assisted with field sampling: A. W. Doolittle, C. L. Harvey, and A. Örstan. A. Zimmerman drew the map. L. Skibinski searched for database records in the Delaware Museum of Natural History collection. We are grateful to A. E. Bogan and R. T. Dillon for verifying identifications. A. Norden alerted us to the need for this study and provided guidance and encouragement. We thank the Washington Biologists' Field Club for funding this study. Helpful comments from two reviewers improved the manuscript.

Literature Cited

Baker, F. C. 1902. The Mollusca of the Chicago area. Part II. The Gastropoda.—Bulletin of the Chicago Academy of Science 3:131–418.

Bogan, A. E. 2006. Chapter 30. Conservation and extinction of the freshwater molluscan fauna of North America. Pp. 373–383 *in* C. F. Sturm, T. A. Pearce, & A. Valdés, eds., The Mollusks: A Guide to Their Study, Collection, and Preservation. American Malacological Society, Special Publication 4. Universal Publishers, Inc., Boca Raton, Florida. 445 pp.

———, & T. Proch. 1997. Manual of the freshwater bivalves of Maryland. Printed by Chesapeake Bay and Watershed Programs, Monitoring and Non-tidal Assessment. CBWP-MANTA-EA-96-03. ii + 1–68, 18 maps, 3 color pls.

Brendelberger, H., & S. Jürgens. 1993. Suspension feeding in *Bithynia tentaculata* (Prosobranchia: Bithyniidae) as affected by body size, food, and temperature.—Oecologia 94:36–42.

Britton, J. C., & B. Morton. 1982. A dissection guide, field and laboratory manual for the introduced bivalve *Corbicula fluminea.*—Malacological Review Supplement 3, vi + 82 pp.

Burch, J. B. 1975. Freshwater Sphaeriacean Clams (Mollusca: Pelecypoda) of North America. Malacological Publications, Hamburg, Michigan, xi + 96 pp.

———. 1982. North American freshwater snails: identification keys, generic synonymy, supplemental notes, glossary, references, index.—Walkerana 1:217–365.

———, & J. L. Tottenham. 1980. North American freshwater snails: species list, ranges, and illustrations.—Walkerana 1: 81–215.

Cherry, D. S., J. L. Scheller, N. L. Cooper, & J. R. Bidwell. 2005. Potential effects of Asian clam (*Corbicula fluminea*) die-offs on native freshwater mussels (Unionidae) I: water-column ammonia levels and ammonia toxicity.—Journal of the North American Benthological Society 24:369–380.

Cohen, R. R. H., P. V. Dresler, E. J. P. Phillips, & R. L. Cory. 1984. The effect of the Asiatic clam, *Corbicula fluminea,* on phytoplankton of the Potomac River, Maryland.—Limnology and Oceanography 29:170–180.

Counts, C. L. 1986. The zoogeography and history of the invasion of the United States by *Corbicula fluminea* (Bivalvia: Corbiculidae).—American Malacological Bulletin, Special Edition 2:7–39.

Cronin, T., J. Halka, S. Phillips, & O. Bricker. 2003. Chapter 5. Estuarine sediment sources. *In* M. Langland & T. Cronin, eds., A Summary Report of Sediment Processes in Chesapeake Bay and Watershed.—U.S. Geological Survey Water-Resources Investigations Report 03–4123, 109 pp.

Dillon, R. T., Jr., A. R. Wethington, J. M. Rhett, & T. P. Smith. 2002. Populations of the European freshwater pulmonate *Physa acuta* are not reproductively isolated from American *Physa heterostropha* or *Physa integra.*—Invertebrate Biology 121:226–234.

———, J. D. Robinson, T. P. Smith, & A. R. Wethington. 2005. No reproductive isolation between freshwater pulmonate snails *Physa virgata* and *P. acuta.*—Southwestern Naturalist 50(4):415–422.

Dresler, P. V., & R. L. Cory. 1980. The Asiatic clam, *Corbicula fluminea* (Müller), in the tidal Potomac River, Maryland.—Estuaries 3:150–151.

Edwards, J., Jr. 1981. A brief description of the geology of Maryland. Maryland Department of Natural Resources, Baltimore, 4 pp.

Falkner, G., R. A. Bank, & T. von Proschwitz. 2001. Check-list of the non-marine molluscan species-group taxa of the states of Northern, Atlantic and Central Europe (CLECOM I).—Heldia 4:1–76.

Foster, A. M., P. Fuller, A. Benson, S. Constant, & D. Raikow. 2005. *Corbicula fluminea.* USGS nonindigenous aquatic species database, Gainesville, Florida. Website: http://nas.er.usgs.gov/queries/FactSheet.asp?speciesID=92. Revision date 12 January 2005.

Fuller, S. L. H. 1978. Changes in the molluscan community of the Middle Potomac River during the past two decades. Pp. 124–131 *in* K. C. Flynn & W. T. Mason, eds., Biological resources of the Potomac basin streams. Interstate Commission on the Potomac River Basin, Rockville, Maryland, 194 pp.

Gerberich, A. G. 1985. The endangered and threatened freshwater mollusks of Maryland. Pp. 245–266 *in* A. Norden, D. C. Forester, & G. H. Fenwick, eds., Threatened and Endangered plants and animals of Maryland. Maryland Natural Heritage Program Special Publication 84-I.

Hamilton, S. 1979. *Bithynia tentaculata*—a replacement for North American pleurocerid snails?—Bulletin of the American Malacological Union 1979:68.

———. 1980. Reproduction or shell armor—a trade off in freshwater gastropods.—Bulletin of the American Malacological Union 1980:71.

ICZN (International Commission on Zoological Nomenclature). 1998. Opinion 1896. *Galba* Schrank, 1803 (Mollusca, Gastropoda): *Buccinum truncatulum* Müller, 1774 designated as the type species.—Bulletin of Zoological Nomenclature 55: 123.

Johnson, R. I. 1970. The systematics and zoogeography of the Unionidae (Mollusca: Bivalvia) of the southern Atlantic slope region.—Bulletin of the Museum of Comparative Zoology 140(6):263–449, pls. 1–22.

Jokinen, E. H. 1983. The freshwater snails of Connecticut. State Geological and Natural History Survey Bulletin 109, 83 pp.

———. 1992. The freshwater snails (Mollusca: Gastropoda) of New York State.—New York State Museum Bulletin 482: 1–112.

Kennedy, V. S., & L. van Heukelem. 1985. Gametogenesis and larval production in a population of the introduced Asiatic clam, *Corbicula* sp. (Bivalvia: Corbiculidae), in Maryland.—Biological Bulletin 168:50–60.

Korniushin, A. V. 2006. Chapter 26. Non-unionoid freshwater bivalves. Pp. 327–337 *in* C. F. Sturm, T. A. Pearce, & A. Valdés, eds., The Mollusks: A Guide to Their Study, Collection, and Preservation. American Malacological Society, Special Publication 4. Universal Publishers, Inc., Boca Raton, Florida, 445 pp.

Langland, M. J., S. W. Phillips, J. P. Raffensperger, & D. L. Boyer. 2003. Changes in streamflow and water quality in selected nontidal sites in the Chesapeake Bay Basin, 1985–2003.—U.S. Geological Survey Scientific Investigations Report 2004–5259, 50 pp.

Lydeard, C. et al. 2004. The global decline of nonmarine mollusks.—BioScience 54(4):321–330.

Marshall, W. B. 1917. *Lampsilis ventricosa cohongoronta* in the Potomac River.—Nautilus 31:40–41.

———. 1918. *Lampsilis ventricosa cohongoronta* in the Potomac River valley.—Nautilus 32:51–53.

———. 1930. *Lampsilis ventricosa cohongoronta* in the Potomac River.—Nautilus 44:19–21.

———. 1933. *Bulimus tentaculatus* (L.) (*Bithynia tentaculata*) living in the Potomac River.—Nautilus 47:141–142.

Maryland Department of Natural Resources. 2003. Rare, threatened, and endangered animals of Maryland. Maryland Department of Natural Resources. Annapolis, Maryland, 16 pp.

———. 2005. Maryland tributary strategy, Middle Potomac River Basin summary report for 1985–2003 data. Maryland Department of Natural Resources. Annapolis, Maryland, 47 pp.

NatureServe. 2006. NatureServe explorer: An online encyclopedia of life. Version 5.0. NatureServe, Arlington, Virginia. Website: http://www.natureserve.org/explorer. Accessed 8 October 2006.

Ortmann, A. E. 1912. *Lampsilis ventricosa* (Barnes) in the upper Potomac drainage.—Nautilus 26:51–54.

Parmalee, P. W., & A. E. Bogan. 1998. The freshwater mussels of Tennessee. University of Tennessee Press, Knoxville, 328 pp.

Pilsbry, H. A. 1932. *Bithynia tentaculata* in the Potomac.—Nautilus 48:69.

Reardon, L. 1929. A contribution to our knowledge of the anatomy of the fresh-water mussels of the District of Columbia.—Proceedings of the United States National Museum 75(11): 1–12, pls. 1–5.

Ricciardi, A., & J. B. Rasmussen. 1999. Extinction rates of North American freshwater fauna.—Conservation Biology 13: 1220–1222.

Smith, D. G. 2000. Pennak's freshwater invertebrates of the United States. John Wiley and Sons, New York, 638 pp.

Strayer, D. L., & D. R. Smith. 2003. A guide to sampling freshwater mussel populations.—American Fisheries Society Monograph 8:1–103.

Taylor, D. W. 2003. Introduction to Physidae (Gastropoda: Hygrophila); biogeography, classification, morphology.—Revista de Biología Tropical 51, Supplement 1:1–287.

Turgeon, D. D. et al. 1998. Common and scientific names of aquatic invertebrates from the United States and Canada: Mollusks, 2nd edition. American Fisheries Society, Special Publication 26, Bethesda, Maryland, 526 pp.

Villella, R. F., & D. R. Smith. 2005. Two-phase sampling to esti-

mate river-wide populations of freshwater mussels.—Journal of the North American Benthological Society 24:357–368.

Wethington, A. R., E. R. Eastman, & R. T. Dillon. 2000. No premating reproductive isolation exists among populations of a simultaneous hermaphrodite, the freshwater snail *Physa.* Pp. 153–160 *in* R. A. Tankersley, D. I. Warmolts, G. T. Watters, B. J. Armitage, P. D. Johnson, & R. S. Butler, eds., Freshwater Mollusk Symposia Proceedings. Part II. Proceedings of the First Freshwater Mollusk Conservation Society Symposium. Ohio Biological Survey Special Publication, Columbus, 274 pp.

Appendix 1

Station information in the Plummers Island area, Montgomery Co., Maryland, including month of sampling, UTM location coordinates (all in UTM zone 18), flow regime (1 = medium to swift flow, 2 = slow flow, 3 = no flow), person-h of search per station, and CPUE (specimens per person-h).

Station	Habitat	Mo	UTM E	UTM N	Flow	Person-h	CPUE
1	Rock Run	Apr	311,944	4,315,925	2	0.25	8
2	Potomac River, at mouth of Rock Run	Apr	312,046	4,315,820	1	0.33	3
3	Potomac River, downstream from Island	Sep	311,939	4,315,530	1	1.50	73
4	Potomac River at downstream end of Island	Sep	311,713	4,315,421	1	1.35	14
5	slow flowing creek at E end of Island	Sep	311,727	4,315,438	2	1.25	159
6	small pool and backwater, rock and sand, at Potomac	Apr	311,737	4,315,667	2	1.00	3
7	stagnant backwater, mud and rocks, small rock pool	Sep	311,599	4,315,472	2	1.25	74
8	dry shells on shore of backwater creek	Apr	311,550	4,315,796	—	0.75	0
9	non-flowing creek, mud and muck, N side of Island	Sep	311,486	4,315,534	2	1.25	48
10	stagnant creek, NW side of Island	Sep	311,390	4,315,560	2	1.00	108
11	vernal pool, muddy	Apr	311,440	4,315,856	3	0.50	24
12	small rocky pool	Sep	311,301	4,315,572	3	0.17	210
13	stagnant creek, W end of Island	Sep	311,209	4,315,540	2	1.25	97
14	Potomac River, W end of Island	Sep	311,208	4,315,449	1	1.50	40
15	Potomac River, mid-portion of Island	Sep	311,455	4,315,382	1	0.58	7

Appendix 2

Molluscan species occurrences at stations in the Plummers Island area. Station numbers as in Fig. 1 and Appendix 1. Number of specimens collected live or freshly dead (in parentheses) are given. Station with zero indicates species found but all specimens there were dead.

Species	Stations (number specimens)
Bivalvia	
Corbicula fluminea	2(1), 3(19), 4(3), 5(38), 6(2), 7(9), 8(0), 9(5), 10(35), 13(11), 14(7)
Elliptio complanata	2(0), 4(7), 14(4)
Musculium transversum	5(4), 7(3), 8(0), 9(6), 10(7), 11(2)
Pisidium compressum	9(5)
Pisidium nitidum	10(4)
Strophitus undulatus	14(1)
Utterbackia imbecillis	14(1)
Gastropoda	
Amnicola limosus	3(6), 5(7), 6(0), 7(1), 8(0), 9(0), 10(1)
Bithynia tentaculata	3(0), 4(0), 5(1), 10(5), 15(0)
Campeloma decisum	5(0), 6(0), 8(0), 13(1), 15(0)
Elimia virginica	2(0), 3(24), 4(9), 5(82), 6(0), 7(4), 8(0), 9(6), 10(1), 13(28), 14(38), 15(4)
Ferrissia rivularis	5(6), 7(6), 8(0), 13(11)
Galba modicella	5(1), 7(10), 8(0), 10(14), 13(6), 14(2)
Gyraulus parvus	5(4), 6(0), 7(1), 8(0), 9(4), 13(1)
Laevapex fuscus	4(1), 5(9), 6(0), 7(2), 8(0), 10(10), 13(11)
Leptoxis carinata	3(61), 4(0), 5(34), 6(0), 7(0), 8(0), 9(0), 14(0)
Micromenetus dilatatus	1(2), 5(8), 6(0) 7(13), 8(0), 9(8), 10(5), 13(20)
Physa acuta	4(0), 5(11), 6(0), 7(59), 8(0), 9(30), 10(29), 12(35), 13(30), 14(6)
Planorbula armigera	11(10)