

**New Jersey Division of Fish and Wildlife
Endangered and Nongame Species Program**

Species Status Review of Freshwater Mussels

Presented to the
NJ Endangered and Nongame Species Advisory Committee
on July 18, 2012

Prepared by:
Michael J. Davenport
Conserve Wildlife Foundation of New Jersey



Freshwater Mussel Status Review

Executive Summary:

- Project Manager for this status review was Michael J. Davenport, Marine Species and GIS Programs Manager, Conserve Wildlife Foundation of New Jersey.
- The statuses of 13 freshwater mussel species were reviewed using the Delphi process. Species were chosen based on NJ Natural Heritage and Endangered and Nongame Species Program (ENSP) survey data, panelists' survey data, and additional literature and web sources such as NatureServe Explorer.
- Eleven reviewers initially agreed to participate, but one dropped-out during Round 1; reviewers included experts from NJDEP, New Jersey and other Northeastern academic institutions, The Nature Conservancy, and several environmental consultants with expertise on NJ's freshwater mussel species.
- Reviewers were provided information pertaining to the species under review, including distribution maps by ENSP and NatureServe, freshwater mussel element occurrence data from ENSP's Biotics database, and U.S. Fish and Wildlife Service reports. Information was provided to each reviewer via a CD.
- Reviewers were also sent standardized instructions, definitions for status terms, and explanation of confidence levels (Appendix III).
- Round 1 began on November 17, 2011 and Round 4, the final round, was completed on May 17, 2012.
- Consensus was achieved on 13 out of 13 species.
 - 3 species were voted Endangered (brook floater, dwarf wedgemussel, green floater).
 - 5 species were voted Threatened (eastern lampmussel, eastern pondmussel, tidewater mucket, triangle floater, yellow lampmussel).
 - 1 species was voted Special Concern (creeper)
 - 3 species were voted Secure/Stable (alewife floater, eastern elliptio, eastern floater).
 - 1 species was voted Not Applicable (eastern pearlshell).
- No unresolved species.
- On July 18, 2012, the Project Manager presented the New Jersey Endangered and Nongame Species Advisory Committee (ENSAC) with the findings of the status review. ENSAC voted to accept the recommendations of the panel for all species.
- Minutes of the July 18, 2012 ENSAC meeting, with ENSAC's recommendations, were approved on September 26, 2012.

TABLE 1: Results After 4 Rounds, Freshwater Mussels:

Species	Current NJ Status	Consensus Reached Round #	Consensus Status	Confidence Level (0 – 8)
<i>Alasmidonta heterodon</i> - Dwarf Wedgemussel	Endangered	1	Endangered	7.0
<i>Alasmidonta undulata</i> - Triangle Floater	Threatened	2	Threatened	6.4
<i>Alasmidonta varicosa</i> - Brook Floater	Endangered	1	Endangered	6.3
<i>Anodonta implicata</i> - Alewife Floater	None	2	Secure/Stable	6.6
<i>Elliptio complanata</i> - Eastern Elliptio	None	1	Secure/Stable	7.5
<i>Lampsilis cariosa</i> - Yellow Lampmussel	Threatened	3	Threatened	6.6
<i>Lampsilis radiata</i> - Eastern Lampmussel	Threatened	2	Threatened	5.9
<i>Lasmigona subviridis</i> - Green Floater	Endangered	1	Endangered	5.7
<i>Leptodea ochracea</i> - Tidewater Mucket	Threatened	1	Threatened	5.9
<i>Ligumia nasuta</i> - Eastern Pondmussel	Threatened	2	Threatened	6.3
<i>Margaritifera margaritifera</i> - Eastern Pearlshell	None	2	Not Applicable ¹	5.6
<i>Pyganodon cataracta</i> - Eastern Floater	None	1	Secure/Stable	7.0
<i>Strophitus undulatus</i> - Creeper	Special Concern	4	Special Concern	6.7

¹ For this species, the status of “Not Applicable” was based upon the species being native to New Jersey, although it has not been documented within the state recently and is likely extirpated.

TABLE 2: Delphi Review - Freshwater Mussels Presented to ENSAC on July 18, 2012

Species	Final Delphi Status	Final “S” Rank*
<i>Alasmidonta heterodon</i> - Dwarf Wedgemussel	Endangered	S1
<i>Alasmidonta undulata</i> - Triangle Floater	Threatened	S2
<i>Alasmidonta varicosa</i> - Brook Floater	Endangered	S1
<i>Anodonta implicata</i> - Alewife Floater	Secure/Stable	S4
<i>Elliptio complanata</i> - Eastern Elliptio	Secure/Stable	S4
<i>Lampsilis cariosa</i> - Yellow Lampmussel	Threatened	S2
<i>Lampsilis radiata</i> - Eastern Lampmussel	Threatened	S2
<i>Lasmigona subviridis</i> - Green Floater	Endangered	S1
<i>Leptodea ochracea</i> - Tidewater Mucket	Threatened	S2
<i>Ligumia nasuta</i> - Eastern Pondmussel	Threatened	S2
<i>Margaritifera margaritifera</i> - Eastern Pearlshell	Not Applicable	SX
<i>Pyganodon cataracta</i> - Eastern Floater	Secure/Stable	S4
<i>Strophitus undulatus</i> - Creeper	Special Concern	S3

* “S” Ranks are subnational (state) conservation rankings defined by NatureServe and used within NJ ENSP’s Biotics database. The conservation status of a species is designated by a number from 1 to 5. The numbers have the following meaning: 1 = critically imperiled; 2 = imperiled; 3 = vulnerable; 4 = apparently secure; 5 = secure. Please refer to Table 3 for more details.

TABLE 3: “S” Rank Definitions

“S” Rank	NatureServe Definition¹	Equivalent NJ ENSP Delphi Status
S1	Critically Imperiled: At very high risk of extinction due to extreme rarity, very steep declines, or other factors.	Endangered
S2	Imperiled: At high risk of extinction due to very restricted range, very few populations, steep declines, or other factors.	Threatened
S3	Vulnerable: At moderate risk of extinction due to a restricted range, relatively few populations, recent and widespread declines, or other factors.	Special Concern
S4	Apparently Secure: Uncommon but not rare; some cause for long-term concern due to declines or other factors.	Secure/Stable
S5	Secure: Common; widespread and abundant.	Secure/Stable
SNA	Not Applicable: A conservation status rank is not applicable because the species is not a suitable target for conservation activities.	Not Applicable
SU	Unrankable—Currently unrankable due to lack of information or due to substantially conflicting information about status or trends.	Undetermined
SX	Presumed Extirpated: Species believed to be extirpated from the state. Not located despite intensive searches of historical sites and other appropriate habitat, and virtually no likelihood that it will be rediscovered.	Not Applicable
SH	Possibly Extinct: Species occurred historically in the state, and there is some possibility that it may be rediscovered. Its presence may not have been verified in the past 20-40 years. A species could become SH without such a 20-40 year delay if the only known occurrences in a state were destroyed or if it had been extensively and unsuccessfully looked for. The SH rank is reserved for species for which some effort has been made to relocate occurrences, rather than simply using this status for all elements not known from verified extant occurrences.	Not Applicable
SNR	Unranked: State conservation status not yet assessed.	Not Ranked

¹ NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web application]. Version 7.1. NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer/nsranks.htm> (Accessed: January 30, 2012).

APPENDIX I

Species Status Assessments **Freshwater Mussels** **Final (after four rounds)**

1. Dwarf Wedgemussel (*Alasmidonta heterodon*)

Consensus: Endangered

Status	# of People	Confidence Level
E	10	7
T		
SC		
S		
U		
NO		
NA		

Round 1 Comments:

Limited range in NJ. Federal status requires state status of E. Thanks to federal status & funding, more data & locations have been found for this and other mussel species. (E) - - - Only occurs in Flatbrook, Paulins Kill, and Pequest River. Errant individual reported in the Delaware River. Federally listed species that was negatively impacted (in the Pequest River) by 2011 flooding events. Particularly sensitive to habitat and water quality changes. (E) - - - Listed by the USFWS as Endangered and hence must be so designated in NJ. The largest known population here is in the upper Paulins Kill with another smaller one in the Flat Brook. Paulins Kill population is threatened by possible nearby development and the presence of several impoundments throughout the watershed. The Flat Brook population may be the most protected. Viability and size of the Pequest population uncertain. (E) - - - I have no personal knowledge of the distribution of dwarf wedgemussel in New Jersey other than in the Paulinskill River. I believe that "E-Endangered" status is justified, based on the few localities in New Jersey at which it has been found. (E) - - - Surveys conducted have resulted in poor results. Only spent valves have been observed. (E) - - - This species is found in a few systems within the state. I can count the number of sites for this species on one hand and when I think about those sites, I would consider very few to be healthy (showing signs of successful recruitment and continually finding a reasonable number of individuals). (E) - - - I have personal experience conducting dwarf wedgemussel surveys in New Jersey, especially in the Paulins Kill. I feel that the Endangered status is justified, based on its limited presence in New Jersey. (E) - - - Federally endangered and limited in distribution throughout historic range. (E) - - - Once thought extirpated from the state, it is only known from a single site in the Pequest River (anonymous, 1995; 2000; Strano et al., 1996) and Delaware River (Delaware-Mongaup-Brodhead drainage), Sussex Co. (anonymous, 2000; NJ NHP, pers. comm., 2007), in New Jersey. All populations from New Jersey south maintain only a few to a few hundred individuals only (USFWS, 2007). The nearby Neversink River population in New York is probably the best population globally. (E) - - - Documentation of UFWS and personal observations of Lellis et al. at USGS. Never personally encountered, limited to just one tributary in the Delaware currently. (E)

2. Triangle Floater
(*Alasmidonta undulata*)

Consensus: Threatened

Status	# of People	Confidence Level
E		
T	9	6.4
SC	1	5
S		
U		
NO		
NA		

Round 1 Comments:

Fairly wide distribution throughout the state; fair numbers where found based on data provided. Suspect that significant populations may be found in some drainages with increased survey effort. May be Stable in state, as it is in neighboring states. (SC) - - - Widespread but typically not abundant. Especially vulnerable to dispersal and possible mortality due to shifting sediments/scouring. (T) - - - While the element occurrence data would suggest this species is stable in NJ this is not the case. In most instances the species is encountered in small numbers, often represented by a uniformity of older age classes suggestive of a lack of reproduction. The largest populations appear to be in the Paulinskill and upper Musconetcong watersheds. The latter, in Lubbers Run must be re-surveyed to ascertain any negative impacts from Hurricane Irene and Tropical Storm Lee. These weather events resulted in unusually high rainfall and destructive flooding throughout the region. (T) - - - I have no personal knowledge of the distribution of triangle floater in New Jersey other than in the Delaware River. Based on my personal experience in the Delaware River and my limited knowledge of Bill Lellis' (USGS) unpublished data, triangle floater presently is distributed in the free-flowing (non-tidal) Delaware River from the head of tide (near Trenton) upstream to Port Jervis, NY. The species appears to be present in very small numbers at individual locations scattered in this reach. I do not know triangle floater to be present in the tidal Delaware River. (T) - - - Species more prevalent than thought. I come across *A. undulata* with some frequency and have identified a recently unknown drainage. (T) - - - This species is found throughout many systems. The overall health of these different locations can vary greatly from being sporadic by consistently found in the Delaware River mainstem to one of the dominant species like in the Paulins Kill. The Paulins Kill population is one of the healthiest I have encountered in all the systems I have worked in. (SC) - - - I have found triangle floater at several locations in northwestern New Jersey and in the Delaware River. The abundance of this species was typically very small numbers at individual locations so I feel that a Threatened status for this species is appropriate. (T) - - - Numerous recent surveys collected only a few weathered dead shells from various river systems (i.e. Walkkill River, Ringwood Creek, Delaware River) indicating once present. (T) - - - There is not very much information on New Jersey populations, but populations in New York and neighboring New England are, for the most part, doing well compared to those along the southern portion of the range North Carolina, South Carolina, Virginia, West Virginia and Georgia; as well as the western edge of its range (western New York. In streams just over the border in the Delaware River basin in New York, it has been found in the west branch of the Delaware River above Cannonsville Reservoir (not as close to New Jersey as east branch Delaware River) (Strayer and Ralley, 1991). Of the dozen or so known occurrences in Maryland, only 4 are not historical with only two that are viable (in Queen Annes and Caroline Cos.- counties fairly close to New Jersey). In the Delmarva Peninsula, this species was found in Norwich Creek (Choptank River system) in Queen Anne's Co., Maryland (Counts et al., 1991). It has been collected in Paulins Kill (Warren Co.) and Ramapo River (Bergen Co.) (Strano et al., 1996). Despite around 60 or so occurrences in New Jersey over the years, most are not viable (few individuals, no evidence of reproduction) with only about a half dozen with at least decent populations. (T) - - - A much more commonly encountered taxa. Many documented observations. However, occurs in small numbers. Possible SC. (S)

Round 2 Comments:

I ranked this SC during the first round. Based on comments of others, two of those could be persuaded to rank SC this round. I believe the stable status is not warranted. When you compare the distribution and relative abundance of occurrences for this species, compared to the two *Lampsilis* species (which the group is tending toward Threatened), I have difficulty giving it the Threatened status. I believe this species is more widespread and secure than those two. I would like to see more data available on populations (but it is probably not available). I still feel SC is a better rank however, given 7 people thought Threatened and the low numbers reported with lack of evidence of reproduction at most locales, I have changed my status to Threatened. (T) - - - Widespread but typically not abundant, although there are a few exceptions such as Lubber’s Run and Paulins Kill. Southern populations not doing well. Vulnerable to increased frequency/intensity of storms and associated flooding. (T) - - - Survey evidence seem to point to continued observations however always in small numbers. Other comments indicate stable populations are known within the state. This does not sound like a threatened species but maybe SC. (SC) - - - Round 1 comments indicated that *A. undulata* is found at several locations in NJ, although it is not common. However the number of specimens at those locations is typically low and populations do not appear to be viable, therefore threatened. (T) - - - Based on my review of all Round 1 Comments, I continue to believe that Threatened (T) Status is justified and I have increased my confidence level from 5 to 6. (T) - - - Threatened status should be maintained. I have not witnessed a lot of recruitment. Populations observed are in moderate numbers, but appear to be mostly older individuals. (T) - - - Typically encountered in small numbers, those being of older age classes. Only a small number of populations appear viable. (T) - - - Historical occurrences (1940s) are known from the Raritan River (SE of Bound Brook) and Hackensack River (in New City) (Athearn Collection- NCSM). Recent occurrences are more widespread than indicated, however viability is not great for many sites with few small individuals (could result from sampling bias) and many well-weathered older adults as well as relatively poor numbers per sampling effort (except perhaps Paulins Kill). (T)

3. Brook Floater

(Alasmidonta varicosa)

Consensus: Endangered

Status	# of People	Confidence Level
E	9	6.3
T	1	5
SC		
S		
U		
NO		
NA		

Round 1 Comments:

Limited range in NJ; severe impacts in some relict watersheds. Low numbers found even though this is one of the most easily recognized of the freshwater mussels. (E) - - - Only a few populations in the northern half of the state and appears to be declining. Never found in abundance. Little evidence of reproduction occurring at most known locations. The species is now being evaluated by USFWS to determine if federal listing is warranted. (E) - - - Small populations in the upper Musconetcong and Flat Brook Watersheds may be our only viable ones. The Stony Brook population is likely impaired and certainly not large. It is certainly faced by many threats throughout that watershed. This species is rarely found in numbers even at prime locations. I am only aware of one site where different age classes are regularly encountered. (E) - - - I have no personal knowledge of the distribution of brook floater

anywhere in New Jersey. I believe that “E-Endangered” status is justified, based on the few localities in New Jersey at which it has been found. (E) - - - - This species is very scarce in my experience. (E) - - - - This species is not doing well at all. I would almost gauge this species as worse off than dwarf wedgemussel. It does not seem to be doing well anywhere it historically was found or currently is found. (E) - - - - I have no personal knowledge of the distribution of brook floater anywhere in New Jersey; however I have found brook floater at several locations in a large river in New England. I believe that the Endangered status is justified, because of the few localities in New Jersey at which it has been found. (E) - - - - This species is declining across its range and is a likely candidate for federal Endangered status. Of the two dozen or so occurrences known from New Jersey only one are two are likely extant with poor viability. In New Jersey, it has been reported from Stony Brook, Musconetcong, Raritan, Lamington and upper Delaware Rivers. Live specimens, shells and relics were recorded in the Musconetcong River, Warren County (Strano et al., 1996). Essentially Maine is driving the global rank or otherwise it would be a G2 species. (E) - - - - Observations of mostly single individuals and historic (museum) specimens. Not common in personal observations and surveys. (T)

4. Alewife Floater
(*Anodonta implicata*)

Consensus: Secure/Stable

Status	# of People	Confidence Level
E		
T		
SC		
S	10	6.6
U		
NO		
NA		

Round 1 Comments:

Seems to be fairly common in NJ although I have not specifically worked with this species. (S) - - - - Abundant in much of the state, esp. in the Delaware River and southern tributaries. (S) - - - - While not as common as the Eastern Floater this species is becoming abundant. It is especially common in mud bottomed lakes and ponds, perhaps an artifact of fish stocking. (S) - - - - I have no personal knowledge of the distribution of alewife floater in New Jersey other than in the Delaware River. Based on my personal experience in the Delaware River and my limited knowledge of Bill Lellis’ (USGS) unpublished data, alewife floater is distributed throughout the free-flowing (non-tidal) Delaware River from the head of tide (near Trenton) upstream to Port Jervis, NY. In addition, recent collections (2009 and 2010) made by The Academy of Natural Sciences of Philadelphia indicate that alewife floater is present in the tidal Delaware River between Newbold Island and Philadelphia. I have selected “S-Secure-Stable” status for this species. However, “U-Undetermined-Unknown” or even “SC-Special Concern” could be considered because alewife, the fish host for alewife floater, appears to be in decline in the Delaware River. (S) - - - - This species is not observed frequently, but when found, it is found in large numbers. (S) - - - - This species can be found in good numbers in a few places. Since alewife floater is known to use a single host or very few species as a host and the known host is migratory, the alewife floater should be watched. Impoundments within systems are not good for this species when those impoundments restrict the movement of host fish. (SC) - - - - I have found alewife floater at several locations in New Jersey, primarily in the Delaware River; however it is not a common species. In my opinion I feel that the Secure-Stable status for this species is justified, although I would also consider a change to Special Concern because alewife, the fish host for alewife floater, appears to be in decline in the Delaware River. (S) - - - - This wide ranging Atlantic slope species is considered relatively common and secure

throughout most of its range, with some localized small scale declines; but is limited to only the coastal areas of the North Atlantic Slope from North Carolina to Maine with disjunct populations in North Carolina. New Jersey populations are likely secure like their neighbors in New England. In New York, records are known from the freshwater tidal Hudson River from Dutchess Co. north to the confluence with the Mohawk River at Waterford, and from the lower Delaware and Neversink Rivers. The species was recently rediscovered in 2000 in large numbers in the upper Delaware River system between Hancock and Port Jervis, including in the Neversink River tributary (Lellis, 2001) as well as the first record from Staten Island at Wolf’s Pond (J. Cordeiro, pers. comm., 2012; ID not confirmed). These areas are currently free of invasive zebra mussels, which have caused extreme declines of alewife floater (and other mussels) in the Hudson River estuary (Strayer and Smith, 1996). To the south, in Maryland, it is known from the Upper Potomac River, Elk River, Chester River, and Choptank River drainages (Bogan and Proch, 1995); and recently the Lower Susquehanna. (Ashton, 2009). Johnson (1970) cites the southern range limit as the Potomac River, Virginia. Only Delaware seems to have few occurrences with only one or two that are viable (Deep Creek in Sussex Co.- probably the most diverse mussel bed in the state) of the dozen or so total sites. This species is likely experiencing range expansion due to improvements in anadromous fish passage in the northeast (anadromous fish restoration programs, dam removal, fish ladders, etc.) and access of alewife (host fish) to formerly inaccessible upstream habitat (see Smith, 1985). (S) - - - - No information available. No personal observations. (SC)

Round 2 Comments:

I agree with panelists who generally stated ‘the alewife floater should be watched’. But it does seem to be found in good abundance where found, and within our major river systems despite decades/centuries of heavy impact. Stable. (S) - - - - Our third most abundant species. Tolerant of water quality/habitat changes. (S) - - - - This species is often encountered and can be locally abundant. Based on the Round 1 comments, this species appears to be on an upswing and should be considered stable. (S) - - - - Based on my review of all Round 1 Comments, I continue to believe that Secure-Stable (S) Status is justified and I have increased my confidence level from 5 to 6. (S) - - - - Because this species appears to be able to handle somewhat comprised water quality and a variety of substrates, I feel that the population is stable and will remain so. (S) - - - - Extremely abundant in a wide variety of habitats and expanding through fish stocking into a wider range. (S) - - - - Can be abundant in the right habitat. Check in headwater regions of rivers that flow to the ocean above the tidal wedge. No reason to believe it not secure especially in light of anadromous fish passage expansion efforts. (S)

5. Eastern Elliptio
(*Elliptio complanata*)

Consensus: Secure/Stable

Status	# of People	Confidence Level
E		
T		
SC		
S	10	7.5
U		
NO		
NA		

Round 1 Comments:

Found just about everywhere in NJ; evidence of reproduction despite water quality issues. (S) - - - - The most abundant and widespread freshwater mussel species in NJ. (S) - - - - Ubiquitous and common. Environmentally elastic species capable of inhabiting a wide array of habitat conditions. (S) - - - - Based

on my personal experience in the Delaware River and my limited knowledge of Bill Lellis' (USGS) unpublished data, eastern elliptio is distributed throughout the free-flowing (non-tidal) Delaware River from the head of tide (near Trenton) upstream to Port Jervis, NY. It is present in large numbers at many locations. Recent collections (2009 and 2010) made by The Academy of Natural Sciences of Philadelphia indicate that eastern elliptio is present in the tidal Delaware River between Newbold Island and Philadelphia. Based on my personal experience, eastern elliptio is present in the Raritan River near Manville. (S) - - - - Observed in large numbers in nearly every drainage in western New Jersey. (S) - - - - This species is found in almost every system where mussels are found and normally there are good signs of recruitment within the populations. Impounded river systems with limited fish host movement might not be as secure. (S) - - - - Based on my personal experience in New Jersey, eastern elliptio is distributed throughout most waterbodies in New Jersey. It is present in large numbers at many locations. My recommendation is to maintain its current status as Stable. (S) - - - - Secure. (S) - - - - This species is the most common species in the northern Atlantic Slope and is an extreme habitat generalist that survives in small streams, large rivers, freshwater tidal waters, and all types of ponds and lakes. In streams just over the border in the Delaware River basin in New York, it is the most abundant and widespread mussel species (Strayer and Ralley, 1991). (S) - - - - Very common in personal surveys of the Delaware and tributaries. Abundantly occurring in groups of 100's of mussels. Also, personal observations of Lellis et al. in northern Delaware main channel. (S)

6. Yellow Lampmussel
(*Lampsilis cariosa*)

Consensus: Threatened

Status	# of People	Confidence Level
E	1	7
T	9	6.6
SC		
S		
U		
NO		
NA		

Round 1 Comments:

Found only in the Delaware River although in large numbers at some locations; very limited range. Threat of 'all eggs in one basket'. Seems to have persisted under some major water quality issues. (E) - - - - Restricted to the Delaware River, and although relatively abundant, the species is threatened by pending instream work such as the I-95/Scudders Falls Bridge Improvement Project. Also threatened by the possible introduction of the invasive Chinese Pond Mussel from Wickecheoke Creek. (T) - - - - Restricted to limited segments of the Delaware River from Trenton to Sussex County. Limited to segments that still retain appropriate substrates. Such microhabitat has been impaired due to armoring of this river due to two dams in New York State. (T) - - - - I have no personal knowledge of the distribution of yellow lampmussel in New Jersey other than in the Delaware River. Based on my personal experience in the Delaware River and my limited knowledge of Bill Lellis' (USGS) unpublished data, yellow lampmussel presently is distributed in the free-flowing (non-tidal) Delaware River from the head of tide (near Trenton) upstream to Port Jervis, NY. The species appears to be present in greatest numbers at the downstream end of this reach near Trenton and only sparsely distributed near Phillipsburg and upstream of this location. Recent collections (2009 and 2010) made by The Academy of Natural Sciences of Philadelphia indicate that yellow lampmussel is present in the tidal Delaware River between Newbold Island and Philadelphia. (T) - - - - Healthy population in Delaware River, but not in other tributaries. More intensive surveys of the Delaware should show that this population is stable in this particular river.

(T) - - - This species is generally a larger river mussel species. It can be found in the downstream portions of rivers. This species shows good numbers within the mainstem Delaware River and some of its larger tributaries. (SC) - - - I have very little knowledge of the distribution of yellow lampmussel in New Jersey other than in the Delaware River. At these locations it was never in great abundance. However, in Maine and New York where I have conducted mussel surveys I have found yellow lampmussels to be quite abundant at some locations. I feel that the Threatened status is justified. (T) - - - This species is nearly extirpated in New Jersey where it is known from the Ramapo and upper Delaware (formerly in Passaic and Raritan) (Cordeiro, 2003). Of the two dozen extant occurrences in New Jersey, most are not viable with only six or seven with decent viability. In Maryland, it is known from the Upper Potomac, Washington Metro, and Susquehanna River drainages but is believed to be only extant in a few localities in the Upper Potomac (Bogan and Proch, 1995) to the North Branch Potomac (Patterson Creek) in neighboring West Virginia (Clayton et al., 2001). It has been extirpated from neighboring Delaware (Delaware River only, based on museum specimens). The best populations in the northern part of its range are probably in Maine (Nedeau et al., 2000) and New Brunswick (Metcalf-Smith and Cudmore-Vokey, 2004; COSEWIC, 2004). Although there are a lot of occurrences globally, it is in decline nearly everywhere it occurs. Maine, Pennsylvania, and New Brunswick appear to be driving the global rank of this species. (T) - - - Personal observation of Lellis and Kreuger. Large populations exist between Trenton and Delaware Water Gap in main channel. No personal encounters but I will be sampling these in 2012. (SC)

Round 2 Comments:

I'll stick to my guns with Endangered. Could someone provide data from the tributaries to the Delaware River in NJ where this species has been documented? I think the reference to Ramapo is incorrect (*Lampsilis radiata* had been documented in the Ramapo). There is also a questionable 1800s record from the Passaic River, the only one in that river. So, this is found only in the Delaware River with its stronghold near the Fall Line, an area of significant pressure from development, run off, silt loads, etc. Definitely not SC. (E) - - - Should remain T due to Delaware River threats. (T) - - - Most recent survey data confirm presence of large population between Philadelphia and Port Jervis NY. Prefers main channel large rivers, which may explain absence from tributaries. Common in other northern states, and abundant in northern Susquehanna main channel. (SC) - - - *L. cariosa* is primarily limited to the Delaware River and larger tributaries and can be abundant when found, but it is not found frequently. I recommend maintaining the threatened status since it is encountered so infrequently. (T) - - - Based on my review of all Round 1 Comments, I continue to believe that Threatened (T) Status is justified and I have increased my confidence level from 5 to 6. (T) - - - This species status should remain as threatened due to its limited distribution and concentration in a single river – the Delaware. (T) - - - Limited number of sites with appropriate substrates on the Delaware River. This is the limiting factor for this species continued survival here. Threatened status is certainly justified. (T) - - - Although known from standing water (coastal ponds- generally only in Maine), this species is a large river species with little tolerance for impoundment. Such conditions are rare in New Jersey with the exception of parts of the Delaware River (upstream of Trenton) where some populations may have numerous individuals and be viable. In other areas populations are not stable and the same is true of the neighboring portions of surrounding states. The Delaware River population would be susceptible as a whole rather than in portions to most imminent threats making the Delaware River population a single unit, from the standpoint of threat impacts. As such, this population appears to be what is keeping the species from an even greater conservation rank than it otherwise would be. (T)

Round 3 Comments:

I am changing my vote from T to E. Given the mounting threats to the Delaware River, combined with the species' preference for the river vs. tributaries, the "all eggs in one basket" argument seems reasonable. (E) - - - Regarding the comment "Most recent survey data confirm presence of large population between Philadelphia and Port Jervis NY", how large is the population? During my limited

surveys throughout the Delaware River I found it relatively common in the Trenton area but not so in the upper Delaware River nor in the Philadelphia area. Is there evidence of reproduction or its host species in these areas? We all know that this species could be just hanging on for decades if not. And it is not found elsewhere in large rivers in NJ. To reach consensus I will revised my status from E to T but I doubt its abundance throughout the Delaware River. Whether it is common in other states or not is not pertinent to the population status in New Jersey. (T) - - - - My opinions on Status (T-Threatened) and Confidence Level (6) are unchanged from Round 2. (T) - - - - I agree with the general consensus that the threatened status is most appropriate for this species. In my opinion, since it is primarily limited to one river, it should have more protection than what is provided by an SC status; however the Delaware River population appears to be somewhat stable so I do not think an endangered status is warranted. (T) - - - - While the population I have seen in the Delaware River is encouraging, if this truly is the only location within the state, this confirms my “threatened” status. While this species is thought to be a larger river species, I have encountered healthy reproducing and spreading populations in small to medium sized water bodies in PA. I have increased my confidence level in my rating based upon the additional comments from round 1&2. (T) - - - - Population status of this mussel should be investigated (recruitment etc) in the Delaware river. Occurs in large numbers when found in large rivers. Refugia populations in New Bruswick and Maine, Common in PA Northern Sussquehanna. (T) - - - - Assessments should be based on (1) the rarity category factors are Population Size (for species), extent of range, area of occupancy, # of occurrences (i.e., distinct populations), # of occurrences or % of area with good viability, and environmental specificity; (2) the trends factors are long- and short-term trend in population size or area; (3) threats factors are overall threat impact, which is determined by considering the scope and severity (i.e., magnitude or impact) of major threats, and intrinsic vulnerability (i.e. natural factors that might make the species vulnerable to extirpation irrespective of threats). For this species, population size is not known, extent of range is moderate (but historically much larger), area of occupancy is very small as is # of occurrences (remember, this is # of EXTANT occurrences that are VIABLE only), species is environment specific (main channel in moderate to high flow river systems with good water quality only; at least in NJ). Trends, based on area and # of occurrences is decreasing. Threats are large in scope and moderate to large in severity. It is not common in other northern states (possibly except Maine but still viable populations have limited extend there). Sounds threatened bordering on endangered to me. (T)

7. Eastern Lampmussel
(*Lampsilis radiata*)

Consensus: Threatened

Status	# of People	Confidence Level
E		
T	10	5.9
SC		
S		
U		
NO		
NA		

Round 1 Comments:

Limited range in NJ with low numbers at most occurrences. Could prove to be more common in northeast part of state with more survey effort. (E) - - - - More lake/pond surveys are needed before downgrading to SC. Haven’t seen many eastern lampmussels in NJ. One live individual recently reported in the Delaware River. (T) - - - - Ramapo River population appears to be severely impaired. Largest viable population is in a lake in Sussex County. Other populations in the Walkill and lower

Paulinskill are likely small. (T) - - - - I have no personal knowledge of the distribution of eastern lampmussel in New Jersey, other than in the Delaware River. Based on my personal experience in the Delaware River and my limited knowledge of Bill Lellis' (USGS) unpublished data, eastern lampmussel presently is known from only two individuals – one observed in the downstream end of the free-flowing (non-tidal) Delaware River near the head of tide at Trenton and one observed in tidal waters immediately downstream of the head of tide. I have selected “T-Threatened” status for this species, but “E-Endangered” status could be considered because it is presently known from only a few localities statewide. (T) - - - - Pretty rare find, but I have encountered more in the past two years than in previous years. Seems to thrive in medium sized streams where two tributaries merge. (T) - - - - I can only think of a few locations, in the systems I have surveyed, where this species can be found. An interesting one is in the Paulins Kill where only 4 individuals were found fairly “high-up” in the system and then no other individuals were found in the system. (SC) - - - - I have found eastern lampmussel in the Delaware River and at smaller streams and rivers, but again, it was not too abundant. I selected the Threatened status for this species, but would consider changing to Endangered status because it is presently known from only a few localities statewide. (T) - - - - A thriving reproducing population exists in areas of the Wallkill River, Sussex, Co. Although appears rare throughout much of the state. (T) - - - - Globally, this is a wide-ranging species with most populations secure. In New Jersey, of the two dozen or so occurrences very few (likely a half dozen) are extant with only one or two maintaining good viability. In Maryland, it is somewhat secure; known from the Upper Potomac, Washington Metro, Elk, Bush River, Chester, Choptank, and Naticoke River drainages (Bogan and Proch, 1995); and lower Susquehanna basin (Ashton, 2009). In Delaware, it is very rare (state Endangered) with only one or two occurrences, neither of which are likely viable. Note this species may be undersurveyed because its ability to flourish in large rivers makes it difficult to collect in such habitats. (T) - - - - Common elsewhere, usually occurring in large numbers. (S)

Round 2 Comments:

This has to be no less than Threatened in NJ. Where has it been found recently to warrant Stable (or SC)? The comment “common elsewhere, usually occurring in large numbers” must refer to NY since it is rare in both PA and DE. When compared to the distribution of *Alasmindonta undulata* and *Strophitus undulatus*, both of which remain unresolved during this round, this species is much, much rarer! I am leaning towards my original status of E but will support the T status. (T) - - - - Despite the species doing well in other areas, it should remain T due to low #'s at most NJ occurrences. (T) - - - - Common taxa in northern states (perhaps more common than *E. complanata* in some habitats). A rare species in New Jersey, with few viable populations in the state. (T) - - - - *L. radiata* is rarely encountered, typically in low numbers when found, and they do not appear to be thriving populations. I concur with the general opinion that *L. radiata* should be listed as threatened. (T) - - - - Based on my review of all Round 1 Comments, I continue to believe that Threatened (T) Status is justified. I have maintained my confidence level at 5. (T) - - - - I would maintain the threatened status of this species due to its limited distribution, but based on some healthy populations observed, this species may be more abundant than thought. (T) - - - - This species is by no means abundant in any of its known occurrences. The only viable population may be at a lake in the upper Pequest watershed though the dynamics of this population require far more study. (T) - - - - Although occurrences are infrequent in large rivers, this species may be undersurveyed in lakes and ponds, where it often thrives in the northeastern portion of its range. Based on the lack of information, I would not rank it above Threatened and even then with some hesitation toward Special Concern. (T)

8. Green Floater
(*Lasmigona subviridis*)

Consensus: Endangered

Status	# of People	Confidence Level
E	10	5.7
T		
SC		
S		
U		
NO		
NA		

Round 1 Comments:

Most restricted range of mussels in our state. Have never seen one in NJ. (E) - - - Last live individual was recorded from the Stony Brook, Mercer County, 1996. Since then, several older, partial shells have been found in the Pequest River, Warren County. More surveys should be conducted in the river, esp. near Great Meadows, before the species is declared extirpated in NJ. The species is now being evaluated by USFWS to determine if federal listing is warranted. (E) - - - One live individual confirmed on the Stony Brook mid 1990's. No other individuals have been found since then after numerous surveys. Possible old shells (ID pending) and one live (not confirmed) from the middle Pequest. Otherwise this species is documented from a few historical records only. Further survey effort is of course needed. (E) - - - I have no personal knowledge of the distribution of green floater anywhere in New Jersey. I believe that "E-Endangered" status is justified, based on the few localities in New Jersey at which it has been found. (E) - - - I have never found a live specimen or spent valve, even in areas of historic occurrence. (E) - - - Sparse records, historic records of this species throughout the state but not a lot of recent observational data. (E) - - - I have no experience with the distribution of green floater anywhere in New Jersey. I believe that Endangered status is justified, based on the few localities in New Jersey where it has been found. (E) - - - Limited historical distribution and occurrence data in NJ, extremely rare. (E) - - - This species was always erratic in distribution but could be abundant when present (Ortmann, 1919). Few large populations remain and there has been a sharp decline in numbers where present (e.g., North Fork Shenandoah River, Susquehanna River in New York) and is extant at very few historic occurrences. In New Jersey, where it is state Endangered, it is historical in the middle Delaware and Raritan and still extant in Stony Brook (Cordeiro, 2003). Most New Jersey sites are historical with possibly a single remaining population with poor viability. In neighboring Maryland, it is known from the Upper Potomac, Middle Potomac, and Washington Metro drainages (Bogan and Proch, 1995), but is also state Endangered with only 9 or 10 extant occurrences (only one of which is likely viable). Although once widespread and common in the Susquehanna River drainage in New York, populations have declined in recent years, probably due to pollution (Strayer and Jirka, 1997); and is extirpated in the Hudson River, Mohawk River, and is rare in the Oswego, Genesee, and Susquehanna basins (Strayer and Jirka, 1997). (E) - - - Based only on the documented observations provided. Very rare in the Delaware. Personal observations in the Upper Susquehanna drainage only. (E)

9. Tidewater Mucket
(*Leptodea ochracea*)

Consensus: Threatened

Status	# of People	Confidence Level
E	1	7
T	8	5.9
SC		
S		
U		
NO	1	
NA		

Round 1 Comments:

Very restricted range, similar to *Lampsilis cariosa*, which I suspect it sometimes is confused with (when young). Delaware River and its tributaries south of the Fall Line is the stronghold. Rare in neighboring states as well. (E) - - - Present in lower half of the Delaware River and lower tributaries. Tends to occur in hard to survey areas. More work is needed, esp. in Manantico and Alloway creeks. Threatened by salt water intrusion due to future sea level rise. Also threatened by dam failures due to extreme flooding events. (T) - - - Though several recent records exist most of from shells alone. No records of live individuals in large numbers or multiple age classes. (T) - - - I have no personal knowledge of the distribution of tidewater mucket in New Jersey other than in the Delaware River. In my personal experience in the Delaware River, I know tidewater mucket to be present in the tidal Delaware River, near Burlington Island and near Camden. Recent collections (2009 and 2010) made by The Academy of Natural Sciences of Philadelphia also indicate that tidewater mucket is present in the tidal Delaware River between Newbold Island and Philadelphia. (T) - - - Because this species is typically in the lower Delaware, its population diminished significantly. However, I have had many encounters more recently which shows the population may be rebounding due to better water quality. (T) - - - Have not surveyed this species in NJ. Since this is generally a coastal river species and NJ has a very long coastline, they seem like they should be more locations with this species. This species sits super low in the substrate with only the siphons visible. It is generally a VERY hard species to survey for since it response super quickly to movement in the water column and close up for long periods of time (which would cause the individuals to be missed). (NO) - - - I have no personal knowledge of the distribution of tidewater mucket in New Jersey other than in the Delaware River. I have found this species in New England and New York and it was often quite abundant at those locations. Since its distribution in New Jersey is limited, I would maintain its Threatened status. (T) - - - This is a very widespread species. In New York (Hudson River) it has declined considerably since the introduction of the zebra mussel (Strayer and Jirka, 1997). Highest population density appears to be centered on central and northern New England in coastal areas, but declines have been documented there as well. In neighboring Maryland, it occurs from the Upper Potomac, Washington Metro, Susquehanna, Elk, and Chester River drainages (Bogan and Proch, 1995); and recently the lower Susquehanna (Ashton, 2009); but only three are extant with the remainder historical only. It is known from the Middle, Lower, and Upper Delaware River basin in New Jersey. Many New Jersey populations are extirpated with around two dozen occurrences, only one or two of which have decent viability. It is a state Endangered species in Delaware with three extant occurrences; the viability of which are questionable. (T) - - - Based only on the documented

observations provided. Very rare in the Delaware. Personal observations in the Upper Susquehanna drainage only. (T)

10. Eastern Pondmussel
(*Ligumia nasuta*)

Consensus: Threatened

Status	# of People	Confidence Level
E		
T	9	6.3
SC	1	4
S		
U		
NO		
NA		

Round 1 Comments:

Limited range in NJ with decent population in the Delaware River south of Fall Line and continuing south in tributaries to this river. Low numbers elsewhere and may be even extirpated in some of that range. (E) - - - Present in lower half of the Delaware River and a few tributaries. Also found live in the Stony Brook, Mercer County. Populations in lower Delaware River and tributaries may be threatened by salt water intrusion due to future sea level rise. Threatened by dam failures due to extreme flooding events (e.g. Cohansey River). (T) - - - Few known sites where large numbers of live individuals found. Most populations tend to be in intertidal areas which are threatened by chemical and other spills in the Delaware River. Other populations (e.g. Stony Brook) are obviously impaired and not reproducing. (T) - - - I have no personal knowledge of the distribution of eastern pondmussel anywhere in New Jersey. Recent collections (2009 and 2010) made by The Academy of Natural Sciences of Philadelphia indicate that eastern pondmussel is present in the tidal Delaware River between Newbold Island and Philadelphia. (T) - - - Recently found the remnants of a population in a previously unidentified drainage. This population declined due to a dam breach. There were huge numbers in the lake before the breach. Additional surveys may indicate that this population is more stable than previously thought. (T) - - - I have not surveyed for this species within the state. (NO) - - - I have found this species in Massachusetts and it was rather abundant; however I have no experience finding it in New Jersey so I feel the Threatened status is justified. (T) - - - This species has a wide range from Lake Ontario and Lake Erie in Canada and Minnesota south and east to the Atlantic drainages in North Carolina. In New Jersey, approximately 15 or 16 extant populations are known but only 5 or 6 have decent viability. Occurrences are known from Swartswood Lake (upper Delaware River watershed), Delaware River, Cohansey Creek, Mantua Creek, Pennsauken Creek tributary and Raccoon Creek in Gloucester County, Pompeston Creek in Riverton (lower Delaware River watershed), Raritan River (Cordeiro and Bowers-Altman, 2003). In Maryland, it is known from the Upper Potomac, Washington Metro, Choptank, and Pocomoke River drainages (Bogan and Proch, 1995). It has experienced some declines in New England (Nedeau et al., 2000). Although not widespread in the New York, *L. nasuta* can still be encountered regularly, and is sometimes abundant (Strayer and Jirka, 1997), despite recent declines following zebra mussel invasion. (T) - - - Only personal observation of 7 individuals in the Delaware. However, this species is common elsewhere. Possibly stable, however, the rare and limited distribution earned this species an SC. (SC)

Round 2 Comments:

Regionally restricted with some populations showing little sign of reproduction (Stony Brook and Raritan River). Rare in all surrounding states. Threatened at best. (T) - - - - Seem to be doing okay in Pompeston and Maurice rivers. Several individuals recently found in the Cohansey. Undetermined in other areas. Should remain T due to Del. River threats and until more survey work is completed. (T) - - - - Documented populations in the state, with some that are stable. Common elsewhere and widespread. (SC) - - - - I have never found this species in New Jersey but based on general consensus and its reported low viability I would classify this species as threatened. (T) - - - - Based on my review of all Round 1 Comments, I continue to believe that Threatened (T) Status is justified. I have maintained my confidence level at 5. (T) - - - - More study is warranted for this species. I feel that it is more abundant than thought, but until more populations are documented, I would maintain the threatened status. (T) - - - - With most of the significant known occurrences associated with Delaware tributaries a variety of threats face this species. Most occurrences are represented by low counts with older age classes being dominant. (T)

11. Eastern Pearlshell

(Margaritifera margaritifera)

Consensus: Not Applicable

Status	# of People	Confidence Level
E		
T		
SC		
S		
U		
NO	1	
NA	9	5.6

Round 1 Comments:

I am not aware of this species in NJ. (NA) - - - - I have never seen this species in NJ. (NA) - - - - Though historically known from the Hackensack Watershed in New York State this species has not been documented in New Jersey though it should be sought. (NA) - - - - I have no personal knowledge of the distribution of eastern pearlshell anywhere in New Jersey. Presently, it is believed to be extirpated. However, it could be present in a coldwater stream somewhere in the state and just not recognized, understanding that brook trout is the fish host species. (NO) - - - - I have only come across valves in PA waters. (NA) - - - - Never surveyed for this species within the state of NJ. At the same latitude in PA there are some populations left so it would make sense there could be a few populations left in the ridge and valley systems within the states in isolated pockets. Either way it should either be endangered or extirpated. (E) - - - - I have no personal experience on the distribution of eastern pearlshell anywhere in New Jersey. (NO) - - - - If present, should have some level of protection. (E) - - - - This species has a circumboreal distribution in northern Europe, eastern North America, and Eurasia. Its range includes the arctic and temperate regions of western Russia, westwards through Europe to the north-eastern seaboard of North America and southwards to the Iberian peninsula and "central" Europe. In North America it is distributed from Newfoundland and Labrador down to Pennsylvania (Burch, 1975) and Delaware and west to the Appalachian mountains (Ziuganov et al., 1994). It is in serious decline in most western European countries or is already extirpated. In the United States and Canada, it is declining and of special concern but somewhat stable in New England and northward to Canada- some large populations remain and threats are few, Population stability deteriorates in the United States from Rhode Island southward. Three newly discovered individuals were discovered in the Delaware River, Pennsylvania (Lellis et al., 2007). Overall status in New Jersey is questionable and more survey work is needed. (SC) -

- - - Did this species ever exist in Delaware drainage? No information available, no personal observations. Habitat specialist, habitat may not occur in New Jersey, or habitat degradation? (E)

Round 2 Comments:

The comments from the three who wrote Endangered should be NA in my opinion. For instance “if present” and “habitat may not occur in NJ” do not warrant endangered status. NO comment should also be NA. Not a single panelist reported this as being present in NJ nor provided the documentation that it ever was present in NJ. (NA) - - - Will someone please provide the Lellis et al. 2007 reference, or at least explain where on the river the individuals were found?? (NA) - - - Does not seem to occur in New Jersey. No records, no observations. Common in habitats in New Brunswick and Nova Scotia, Canada. Possible remnant populations in Pennsylvania. (NA) - - - Based on my review of all Round 1 Comments and the paragraph concerning this species in Michael Davenport’s 23 January email, I have changed my suggested status to Not Applicable (NA). I have reduced my confidence level from 8 to 7 because I believe that it may be present, but unnoticed by mussel biologists, in a coldwater stream somewhere in the state. (NA) - - - With no credible evidence of this species occurring in NJ discussion of listing it not warranted. Further surveys may be useful but listing it would create confusion. (NA) - - - It once likely occurred in the Hackensack River in Rockland County, New York, possibly into neighboring New Jersey (no documented occurrences, outside New York, though) but it is likely gone due to intensive residential development (summarized in Strayer and Jirka, 1997). Otherwise, I am only aware of three individuals discovered in the Delaware River in neighboring Pennsylvania (again, not in New Jersey per se). GBIF lists some 190 records of freshwater mussels from New Jersey, but none are this species. The MCC Collection at Harvard also has no specimen records from New Jersey. Simpson (1900) and (1914) do not list New Jersey in the species descriptions although Massachusetts, New York and Pennsylvania are listed. (NA)

12. Eastern Floater
(*Pyganodon cataracta*)

Consensus: Secure/Stable

Status	# of People	Confidence Level
E		
T		
SC		
S	10	7
U		
NO		
NA		

Round 1 Comments:

Wide distribution and common in NJ. (S) - - - One of the most abundant and widespread freshwater mussel species in NJ. (S) - - - This is an extraordinarily common and elastic species in New Jersey. Found in a wide range of habitat situations, sometimes under highly impaired conditions. It appears that this species is spread via fish stocking due to its occurrence in a variety of mountain ponds and lakes, many of which are not directly connected to the surrounding watershed. (S) - - - I have no personal knowledge of the distribution of eastern floater in New Jersey, other than in the Delaware River. Based on my personal experience in the Delaware River and my limited knowledge of Bill Lellis’ (USGS) unpublished data, eastern floater presently is distributed in the free-flowing (non-tidal) Delaware River from the head of tide (near Trenton) upstream to Port Jervis, NY. The species appears to be present in small numbers at individual locations. Recent collections (2009 and 2010) by The Academy of Natural

Sciences of Philadelphia indicate that eastern floater is present in the tidal Delaware River between Newbold Island and Philadelphia. (S) - - - - I encounter this species in large numbers in a variety of habitats. (S) - - - - Multiple systems with good signs of recruitment. (S) - - - - I have limited knowledge on the distribution of eastern floater in New Jersey, other than in the Delaware River and a few smaller rivers. The species appears to be present in small numbers at individual locations; I would consider it uncommon but not rare, threatened, or endangered. I feel that the Stable status is appropriate. (S) - - - - Secure, also prolific in ponds and reservoirs (i.e. Holiday Lake, Sussex Co., NJ and also present in Monksville Reservoir, Wanaque Reservoir system, Passaic Co., NJ). (S) - - - - This species is common and wide ranging in the Atlantic drainages from the Lower St. Lawrence River basin south to the Altamaha River basin and west to the Great Lakes, Georgia, and in the Alabama-Coosa River drainage, and the Apalachicola and Choctawhatchee River basins, Georgia. It is very common in all of the New England states. In the Delaware River basin (which borders New Jersey), it has been recorded in the Middle Delaware- Mongaup- Broadhead drainage in New York to bordering Pennsylvania (Strayer and Ralley, 1991). In the Delmarva peninsula, this species was found in the Susquehanna, Bohemia, Sassafras, Chester, Choptank, Nanticoke, Wicomico, Appoquinimik, Leipsic, St. Jones, Murderkill, Mispillion, Cedar Creek, and Indian River systems in Delaware and Maryland (Counts et al., 1991); recently in Williams Pond (Nanticoke system) in Sussex Co., Delaware (Blaine, 2010). In Maryland, it is known from the Upper Potomac, Washington Metro, Gunpowder, Susquehanna, Elk, Choptank, Chester, and Nanticoke River drainages (Bogan and Proch, 1995; Ashton, 2009), but may be extirpated from the upper Potomac in West Virginia (Taylor, 1987). The species has a wide habitat tolerance and is likely common throughout New Jersey. (S) - - - - Commonly encountered in the Delaware. Many documented observations with high numbers of individuals. (S)

13. Creeper
(*Strophitus undulatus*)

Consensus: Special Concern

Status	# of People	Confidence Level
E		
T	1	7
SC	9	6.7
S		
U		
NO		
NA		

Round 1 Comments:

Fairly wide distribution in the state; from inner coastal plain to ridge & valley. Possibly SC but seems to be documented at more sites when freshwater mussel surveys are conducted. (S) - - - - Although widespread, this species is never abundant and appears to be declining in certain areas. (T) - - - - Although the element occurrence and range data suggest this to be widespread and common this is simply not the case. This species finds it's stronghold here in the upper Paulins Kill Watershed. This river itself is partitioned by a series of dams beginning at the mouth of the Delaware. These impoundments have in essence isolated various Unionid species, the Creeper included into smaller groups. Outside this watershed the species is generally encountered in small numbers, or as old shells alone. Outside the Paulins Kill different age classes are rarely observed. Suggest this species by listed as threatened and studied in greater depth. (T) - - - - I have no personal knowledge of the distribution of creeper in New Jersey, other than in the Delaware River. Based on my personal experience in the Delaware River and my limited knowledge of Bill Lellis' (USGS) unpublished data, creeper appears to be concentrated in its distribution in the Delaware River upstream of Columbia. However, creeper also has been observed in

the downstream end of the free-flowing (non-tidal) reach at Trenton. Recent collections (2009 and 2010) made by The Academy of Natural Sciences of Philadelphia indicate that creeper is present in the tidal Delaware River between Newbold Island and Philadelphia. (SC) - - - - I have been encountering more and more *S. undulatus* every year. They seem to be rebounding. (S) - - - - This species is generally found in most sites but never in high numbers. It often shows some signs of recruitment. Since this species utilizes so many fish host species, it probably has successful recruitment events on a regular basis. (SC) - - - - I have personal knowledge of the distribution of creeper in New Jersey in the Delaware River and the Paulins Kill. Based on my personal experience, creeper appears to be concentrated in its distribution within these waterbodies. I would maintain the Special Concern status. (SC) - - - - Numerous sighting and occurrence data exist, although in most cases only limited populations are present which may be susceptible to stream impairment and/or degradation. (SC) - - - - The creeper is distributed very widely throughout the Ohio and Mississippi Rivers and Great Lakes systems, northern Atlantic Coast drainages, and parts of Canadian Interior Basin as far west as Texas and Saskatchewan (Burch, 1975; Parmalee and Bogan, 1998) and historically into Kansas and Nebraska (Hoke, 2005). Of the two dozen or so known occurrences in New Jersey, most can be considered viable and none are extirpated. It has been collected in the Pequest River, Warren Co., as well as Paulins Kill (Warren Co.) and Ramapo River (Bergen Co.) (Stano et al., 1996). In Maryland, it is in the Upper Potomac, Washington Metro, Chester, and Choptank drainages (Bogan and Proch, 1995); lower Susquehanna (Ashton, 2009). In Rhode Island, it is in the middle to southern portions of the state (Raithel and Hartenstein, 2006). In Connecticut, it occurs in the Connecticut, Housatonic, Thames drainages (Nedeau and Victoria, 2003; J. Cordeiro, pers. obs., 2006). In Massachusetts, it is in most drainages where it is uncommon except in Connecticut River tributaries (Smith, 2000). In the Delaware basin, it is in all drainages (Middle Delaware- Mongaup- Broadhead, Upper Delaware, E Branch Delaware); New York to Pennsylvania (Strayer and Ralley, 1991). Although uncommon, it is either not in decline in the northeast or in minor decline. Only Rhode Island and Massachusetts list it as a Special Concern species and this is likely a reflection of under-collecting and identification difficulties (at least for Rhode Island). (S) - - - - Commonly encountered in the Delaware. Many documented observations with high numbers of individuals. (S)

Round 2 Comments:

SC seems warranted. I think more data should be collected before making this T. Biotics data only reflects recent data. Historical range could be gathered from specimen collections at major tri-state museums and drive survey efforts. Our neighboring states with shared rivers show that it is secure in those states. (SC) - - - - Widespread but never abundant. Vulnerable to water quality and habitat degradation. In addition to few individuals recorded at occupied sites, many (approx. 70%?) of NJ streams are classified by NJDEP as impaired. It seems prudent to change ranking from SC to T, which allows for (for example) protection of water quality and riparian areas via C1 designations. From what I'm reading, it appears as though NJ hasn't been provided with all available data. (T) - - - - Comments seem to confirm the common status of this mussel in NJ and elsewhere. (S) - - - - There appears to be a real dichotomy about classifying *S. undulatus* as stable or a species of special concern. I have found this species at several locations in New Jersey but never in large numbers and usually with limited age classes. At several other locations outside of New Jersey I have also found it, but again, not in high abundance or a wide range of age classes. I am not committed strongly either way but I conservatively feel that a special concern status is valid. (SC) - - - - Based on my review of all Round 1 Comments, I continue to believe that Special Concern (SC) Status is justified and I have increased my confidence level from 5 to 6. (SC) - - - - This is a species that is locally abundant, but most of my observations were of older individuals. I think this species warrants closer inspection to insure that recruitment is occurring. (SC) - - - - Recommend maintaining the SC status the goals of further field research and data analysis to better clarify the status of this species here. (SC) - - - - This species is often widespread globally in its range but never abundant. Its wide range of host fish (over 45) as well as one salamander and an unconfirmed report of transformation without a host testifies to its adaptability. In light of the numerous accounts listed by other reviewers, I would list this species as Secure in New Jersey. (S)

Round 3 Comments:

My opinion of T has not changed. The creeper is never abundant and is often represented by a single individual. The lack of range in age classes is troubling, and although the species is faring better in surrounding states, this isn't necessarily the case in the most densely populated state in the nation. I believe strongly that T is warranted, especially if we're considering longer-term impacts of climate change on stream habitats. (T) - - - - I continue with SC status. Further research is needed to convince me this is either T or S in New Jersey. The majority of panelists agree with SC, so I believe this is the most appropriate status in NJ. (SC) - - - - My opinions on Status (SC-Special Concern) and Confidence Level (6) are unchanged from Round 2. (SC) - - - - Comments provided during Round 2 confirm my belief that the SC status is most appropriate for this species. (SC) - - - - I think the SC designation would be warranted for this species. As I have previously mentioned, I often find this species with sites and river systems but never in high numbers. These findings with NJ are similar to my findings within other states where this species is present. The concerning issue with this species is that even though it could be called a host generalist (personal observations during host trials for this species), a majority of the individuals of this species found in surveys are older/larger individuals. I have increased my confidence level for this rating based upon personal observations and reflection on others round 1&2 comments. (SC) - - - - Again I agree that the status of this species needs to be reviewed again. Seems that reports are common and abundant but limited to a few rivers. (SC) - - - - This species has always been widespread. It is one of the most widespread species in North America (nearly 40 states and 4 Canadian provinces). It is the only Mississippi basin species in the state to have made it across the Great Lakes into the North Atlantic slope. It has a very low degree of host specificity (Gray et al., 2002) with nearly 30 hosts; even transforming on amphibians and can possibly transform without a host (Lefevre and Curtis, 1911). It is rarely common but always widespread and there is no evidence of decline (a very important factor in assessment). Further, it is not easy to differentiate from eastern elliptio, the most common and widespread species in the state. I would characterize as stable not an edge of range SC. (S)

Round 4 Comments:

My vote remains unchanged. I am seeing fewer of these in the field each year, and the individuals I'm finding tend to be older. (T) - - - - In this last round, based upon the comments, my experience with this species in NJ, and majority of reviewers, I will again suggest SC. 1) Only one panelist feels there is sufficient evidence to suggest Threatened. SC would trigger additional data collection for future status review. 2) Only one person feels it is stable, and I am not sure if this person is considering its status in NJ or within its full range in other states. It really doesn't matter how it is doing in other states, this is an assessment for this species in New Jersey. SC. (SC) - - - - Special Concern (SC) status is appropriate for creeper. (SC) - - - - Based on the responses from the panel, and personal experience with collecting creeper throughout the Atlantic and Ohio basins, I would keep the species listed as SC in New Jersey. (SC) - - - - Opinion is that this is a stable species in NJ. I will vote to keep the SC status until the recruitment issue is investigated. However, with high recruitment and high numbers at several populations, and considering it occurs elsewhere in decent numbers, then this should be changed to S. (SC) - - - - I continue to think this species should be listed as SC. It has been pointed out and this has been my observation in the rivers I have surveyed that it is widespread but often only represented by one or two individuals. The lack of size/age variation in the individuals I have encountered is also troubling. (SC) - - - - I strongly believe that more well targeted field research is warranted regarding this species. Though much evidence would suggest that a threatened status is warrant I must with all conservatism recommend that we retain the SC status for now with the serious intent to collect more data. (SC) - - - - Based upon the strong conflicting opinions, I think it prudent that a Special Concern status be maintained to insure that we remain vigilant in studying this species in the weeks and months ahead to gain a better understanding of population trends. (SC) - - - - I still feel that SC status for this species is most appropriate, especially after reading the Round 3 comments. (SC) - - - - Age class is a reflection of the size of individuals and collecting methodology. Typically individuals less than 20 mm long are excluded from qualitative sampling methods (see Beekey and Hornbach, 2004); <http://www.macalester.edu/~hornbach/WebPageFiles/summary/methods.html>). Also, the creeper is

never abundant across its huge range and is a host generalist (although much rarer species like *Alasmidonta varicosa* can also be host generalists). It appears the western edge of the range (South Dakota, Kansas, Nebraska, Colorado- see Anderson, 2005, Cordeiro, 1999) is in decline. With the eastern edge (North Carolina- Jennifer Price, NC NHP), New Jersey (Endangered and Threatened Wildlife of New Jersey, 2003 and 2010), Massachusetts (pers. obs.), Rhode Island (Raithel and Hartenstine), and New York (Metcalf-Smith et al., 2003) range also in decline, it seems this widespread species is declining at range edge limits. As such, modify to SC. (SC)

ADDITIONAL ROUND 1 COMMENTS SUBMITTED BY REVIEWERS:

One anonymous reviewer submitted the following statements:

ADDITIONAL SPECIES:

The Chinese pond mussel, *Sinanodonta woodiana*, was reported in New Jersey in ponds of what was previously a fish pond in Franklin Township, Hunterdon Co., in 2010 and all were eradicated with chemical treatment.

WORTH NOTING:

I pulled 170 museum records off the Global Biodiversity Information Facility (GBIF) database; including 2 *Alasmidonta heterodon*, 14 *Alasmidonta undulata*, 5 *Alasmidonta varicosa*, *Anodonta implicata*, 2 *Elliptio complanata*, 2 *Lampsilis cariosa*, 4 *Lampsilis radiata*, 4 *Leptodea ochracea*, 5 *Ligumia nasuta*, *Margaritifera margaritifera*, 2 *Pyganodon cataracta*, and 1 *Strophitus undulatus*. Records are available upon request.

1 *Lampsilis hydeana* [- *hydiana*]- almost certainly a misidentification

1 *Pyganodon grandis* [likely misidentification for *Pyganodon cataracta*]

1 *Unio pressus* [= *Lasmigona compressa*, a likely misidentification for *Lasmigona subviridis*]

FURTHER NOTE:

Reports of *Toxolasma parvum* in New Jersey are almost certainly in error.

ADDITIONAL ROUND 2 COMMENTS SUBMITTED BY REVIEWERS:

One anonymous reviewer submitted the following statements and photographs:

It is unknown whether Chinese pond mussels were completely eradicated with the 2010 chemical treatment. Surveys are ongoing. There is no evidence that the species is resident in Wickecheoke Creek, which is unsuitable mussel habitat for much of its length.

To address “Further Note” above, live individuals observed and shells collected in Salem Creek, NJ are indeed *Toxolasma parvum*. Voucher specimens are housed at the NC Natural History Museum (NCSM 30076) and were positively identified by Dr. Arthur Bogan. See attached images.



ADDITIONAL ROUND 3 COMMENTS SUBMITTED BY REVIEWERS:

One anonymous reviewer submitted the following statements:

Are we adding *Toxolasma parvum* to the list to be assessed? It would be pretty far outside the range. Possibly an introduction? Established? If we are adding it, I'd list it as NO.

APPENDIX II

FRESHWATER MUSSELS

REFERENCE MATERIALS PROVIDED TO DELPHI PANELISTS

Davenport, Mike. 2011. New Jersey freshwater mussel range maps:
<http://www.conservewildlifenj.org/protecting/projects/freshwaterinvertebrates/mussels/>.
Accessed 2011.

Global Biodiversity Information Facility Database. Accessed through GBIF Data Portal,
data.gbif.org, 2011.

NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web
application]. Version 7.1. NatureServe, Arlington, Virginia. Available
<http://www.natureserve.org/explorer>. (Accessed: September 2, 2011).

NatureServe. 2011. NatureServe Explorer: An online encyclopedia of life [web
application] - NatureServe species' range maps for freshwater mussels. Version 7.1.
NatureServe, Arlington, Virginia. Available <http://www.natureserve.org/explorer>.
(Accessed: October 31, 2011).

N.J. Endangered and Nongame Species Program. 2011. Biotics Database. Accessed
September 28, 2011.

U. S. Fish and Wildlife Service. 1993. Dwarf Wedgemussel, *Alasmidonta heterodon*.
Recovery Plan.

U. S. Fish and Wildlife Service. 2007. Dwarf Wedgemussel, *Alasmidonta heterodon*. 5-
Year Review: Summary and Evaluation.

APPENDIX III

Instructions for Delphi panelists

BACKGROUND OF THE DELPHI TECHNIQUE

The Delphi Technique is a systematic method for reaching consensus among experts in which absolute, quantitative answers are either unknown or unknowable. It is an iterative process characterized by anonymity among the participating experts, controlled feedback via the principal investigator (in this case, ENSP), and a statistical estimator of group opinion. By structuring the group communication process, the Delphi Technique helps the group reach a consensus of opinion by incorporating all available data and disseminating those data among all participants.

By using the Delphi Technique, species reviewers are able to state their opinion on each species' status and provide information to support it. Through the process of successive rounds, participants may modify their opinion based on information provided by all panelists. This process of sharing information and opinions promotes learning and allows modification of opinions where appropriate. Alternatively, those who believe strongly in their position may continue to assert that position and present additional data to support it.

Thus, it is essential to the process that participants provide the reasons for their status votes in the "explanation" field. In particular, reviewers should provide justification for votes for endangered, threatened and special concern statuses. In successive rounds, reviewers should read those justifications and use their judgment and knowledge to evaluate the information as they select (again) the species rank. Similarly, reviewers select a confidence level with each status vote, and reviewers should consider the resulting confidence averages associated with species ranks as they make subsequent decisions. Through subsequent rounds and the sharing of information, reviewers who may have had "no opinion" on species in the early rounds should be able to vote for species ranks, even if those votes are associated with relatively low confidence levels.

INSTRUCTIONS TO EXPERT PANELISTS FOR PREPARING STATUS ASSESSMENTS

Please read these instructions carefully before filling out the questionnaire.

The following pages list a select number of species for which status should be officially defined in New Jersey. Many of you participated in the initial status review, and some of that work has led to this more refined list.

For each species, please select the status code that best applies to the species in New Jersey. With each selection, also indicate your level of confidence in your assessment by circling the appropriate number.

The key and explanation of the letter and numeric codes are as follows:

STATUS ASSESSMENTS

E - Endangered: Applies to a species whose prospects for survival within the state are in immediate danger due to one or several factors, such as loss or degradation of habitat, over-exploitation, predation, competition, disease or environmental pollution, etc. An endangered species likely requires immediate action to avoid extinction within NJ.

T - Threatened: Applies to species that may become Endangered if conditions surrounding it begin to or continue to deteriorate. Thus, a Threatened species is one that is already vulnerable as a result of, for example, small population size, restricted range, narrow habitat affinities, significant population decline, etc.

SC - Special Concern: Applies to species that warrant special attention because of inherent vulnerability to environmental deterioration or habitat modification that would result in their becoming Threatened if conditions surrounding the species begin or continue to deteriorate. This category includes species that meet the foregoing criteria and for which, in addition, there is little understanding of their current population status.

S – Secure-Stable: Applies to species that appear to be secure in NJ and not in any immediately foreseeable danger of becoming “endangered,” “threatened,” or “special concern.”

U – Undetermined-Unknown: Applies to species that cannot be assigned a status of endangered, threatened, special concern or secure-stable because not enough information exists on which to base a judgment.

NO - No Opinion: Applies to any species for which you feel that you do not possess sufficient information or experience on which to base a judgment, although other people may have such information.

NA – Not Applicable: The species does not occur in New Jersey with regularity or predictability.

CONFIDENCE LEVELS

Please rate your level of confidence for your status assessments by indicating a numeric designation for every choice that you make. Ratings run on a continuous scale that goes from 1 to 8, defined as:

Unreliable	Risky	Reliable	Certain
1 2	3 4	5 6	7 8

These four categories are defined loosely for this exercise as:

Unreliable: Great risk of being wrong; of no use as basis for a decision.

Risky: Substantial risk of being wrong; unwilling to use as basis for decision without other information.

Reliable: Some risk of being wrong; willing to make a decision based on this but recognizing some chance of error.

Certain: Low risk of being wrong; decision based on this will not be totally wrong because of at least some supporting fact(s).

EXPLANATION

In this space, please indicate briefly the basis for your choice for Endangered, Threatened, and Special Concern designations, including your underlying assumptions, views, facts and/or data to support your position. Provide the information you think will be helpful to the panel members in explaining your decision. Explanations should be as specific as possible but need not be exhaustive. If there is new published documentation in support of your assessment, please provide the citation for it (here and to ENSP, who will make it available for the next round). If you are hand-writing your submission, please write legibly so that your input can be used for round 2; you may use extra sheets or the back of the sheet.