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

Species Status Review of Freshwater Crustaceans (crayfish & fairy shrimp only)

Presented to the
NJ Endangered and Nongame Species
Advisory Committee on October 20, 2010

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NEW JERSEY DIVISION OF
Fish and Wildlife

CONSERVE WILDLIFE
FOUNDATION OF NEW JERSEY

Freshwater Crustacean (Crayfish & Fairy Shrimp Only) 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 17 crayfish and fairy shrimp species were reviewed using the Delphi process. Species were chosen based on NJ Department of Environmental Protection's Bureau of Freshwater and Biological Monitoring data, reference collection and list provided by the Academy of Natural Sciences Philadelphia (ANSP), NJ Natural Heritage and Endangered and Nongame Species Program (ENSP) survey data, panelists' survey data, US Geological Survey (USGS) data, and additional literature and web sources such as NatureServe Explorer.
- Five reviewers participated; reviewers included experts from ANSP , NatureServe, The College of New Jersey, Massachusetts Natural Heritage & Endangered Species Program, and one environmental consultant recognized as a global authority on fairy shrimp.
- Species reviewed included 12 crayfish and five fairy shrimp.
- Reviewers were provided information pertaining to the species under review, including a 2007 American Fisheries Society report on the conservation status of crayfish species, distribution maps by USGS and ENSP, and additional literature cited un Appendix II. Information was provided to each reviewer via a CD.
- Round 1 began on October 26, 2009 and Round 4, the final round, was completed on May 14, 2010.
- Consensus was achieved on 13 out of 17 species.
    - 1 species was voted Special Concern (eastern fairy shrimp).
    - 3 species were voted Secure/Stable (common crayfish, spinycheek crayfish, white river crawfish).
    - 9 species were voted Not Applicable.
- 4 unresolved species (devil crawfish, knobbedlip fairy shrimp, springtime fairy shrimp, spinytail fairy shrimp) – fall into 3 general groups.
    - Group 1 – species documented in New Jersey but inadequate data available to assign status. Two panelists recommended "Undetermined" status, one recommended "Special Concern", and two had no opinion (devil crawfish).
    - Group 2 – species not documented within New Jersey. Three panelists recommended "Not Applicable" status, one recommended "Undetermined", and one had no opinion (knobbedlip fairy shrimp).
    - Group 3 – species documented in New Jersey and while some panelists recommended "Secure/Stable" status, one or more panelists, after four rounds, recommended "Special Concern" status (springtime fairy shrimp, spinytail fairy shrimp). Although potentially widespread and abundant, much habitat has been lost and they have been inadequately surveyed. A status of "Undetermined" may be the proper designation until such time that further survey work can be conducted. For the springtime fairy shrimp, three panelists recommended "Secure/Stable", one recommended "Special Concern", and one had no opinion. For the spinytail fairy shrimp, two panelists recommended "Special Concern", one recommended "Secure/Stable", one recommended "Undetermined", and one had no opinion.
- On October 20, 2010, staff 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 those species for which consensus had been reached. For those species for which consensus had not been reached, ENSAC voted to recommend the following statuses: devil crawfish = "Undetermined"; knobbedlip fairy shrimp = "Not Applicable"; springtime fairy shrimp = "Undetermined"; and spinytail fairy shrimp = "Undetermined".
- The results of ENSAC status recommendations will, after DEP rulemaking, add all species, other than those with a status of "Not Applicable", to the state's list of indigenous nongame wildlife species.
- Minutes of the October 20, 2010 ENSAC meeting, with ENSAC's recommendations, were approved on December 8, 2010.

Delphi Review: Results After 4 Rounds, Freshwater Crustaceans (Crayfish & Fairy Shrimp Only)

Species	Current NJ Status	Consensus Reached Round #	Consensus Status	Confidence Level
Cambarus bartonii - Common Crayfish	None	1	Secure/Stable	6.0
Cambarus diogenes - Devil Crawfish	None	N/A	Undetermined[4]	N/A
Cambarus robustus - Big Water Crayfish	None	3	Not Applicable[2]	7.5
Eubranchipus bundyi - Knoppedlip Fairy Shrimp	None	N/A	Not Applicable[4]	N/A
Eubranchipus holmanii - Eastern Fairy Shrimp	None	2	Special Concern	5.0
Eubranchipus intricatus - Smoothlip Fairy Shrimp	None	4	Not Applicable[2]	6.3
Eubranchipus vernalis - Springtime Fairy Shrimp	None	N/A	Undetermined[4]	N/A
Orconectes immunis - Calico Crayfish	None	3	Not Applicable[2]	7.0
Orconectes limosus - Spinycheek Crayfish	None	1	Secure/Stable	6.3
Orconectes menae - Mena Crayfish	None	2	Not Applicable[3]	8.0
Orconectes obscures - Allegheny Crayfish	None	3	Not Applicable[1]	7.3
Orconectes propinquus - Northern Clearwater Crayfish	None	3	Not Applicable[2]	7.3
Orconectes rusticus - Rusty Crayfish	None	4	Not Applicable[1]	7.8
Orconectes virilis - Virile Crayfish	None	4	Not Applicable[1]	7.8
Procambarus acutus - White River Crawfish	None	2	Secure/Stable	5.8
Procambarus clarkii - Red Swamp Crawfish	None	3	Not Applicable[1]	7.3
Streptocephalus sealii - Spinytail Fairy Shrimp	None	N/A	Undetermined[4]	N/A

[1] For these species, the status of "Not Applicable" was based upon the species not being native to New Jersey, although it has been documented within the state.

[2] For these species, the status of "Not Applicable" was based upon the species not being documented within New Jersey.

[3] For this species, the status of "Not Applicable" was based on the likelihood that, although documented within a NJDEP reference collection, it was most likely misidentified and does not occur within New Jersey.

[4] Consensus was not reached by the panelists after four rounds for these four species. Therefore, their status was determined following review, discussion, and vote by the NJ Endangered and Nongame Advisory Committee on October 20, 2010.

APPENDIX I

Species Status Assessments
Freshwater Crustaceans (Crayfish & Fairy Shrimp)
Final (after four rounds)

Common Crayfish (*Cambarus bartonii*) **Status: Secure/Stable**

Status	# of People	Confidence Level
E		
T		
SC		
S	4	6.0
U		
NO	1	
NA		

Round 1 Comments: Globally, the nominal species very widespread and abundant, found in New Brunswick, Canada, west to Kentucky and Tennessee, south to Alabama, Georgia, and South Carolina and east to the Atlantic Ocean. Fowler (1912) lists Schooley's Mountian, Trenton and Princeton; and Schwartzwood Lake in Trenton. Francois (1959) cites it in New Jersey in Bergen (2 localities), Essex (2 localities), Hunterdon (2 localities), Mercer (3 localities), Morris (3 localities), Passaic (1 locality), Sussex (5 localities), Union (2 localities), and Warren (2 localities) Cos., as well as three neighboring counties in Pennsylvania (4 localities). Horowitz and Flinders (2004) found it to be the most common species encountered (9 of 15 stations) in the Piedmont, Ridge and Valley and Highlands regions of New Jersey. It is often the most abundant and dominant species when found (Woodall and Wallace, 1972; Huryn and Wallace, 1987, Griffith *et al.,* 1994; 1996, Seiler and Turner, 2004).
MCZ museum records: East of Cape May, Schooley's Mt., Trenton, Ramsey Brook
YPM museum records: Orange in Essex Co. ----- *C. bartonii* is currently common in a number of small streams throughout the northern part of the state. However, the species may be vulnerable to invasion by other species, especially *O. rusticus*. I don't know of a category to reflect this situation. ----- I have collected individuals of this species from numerous localities in NJ. However, I have not assessed population sizes at those sites, so I cannot comment more strongly about the status. ----- Appears to have adequate habitat to remain stable for the foreseeable future but should be reevaluated after more focused surveys are complete.
Round 2 Comments: Hagen (1870) mentions an occurrence near Schooley's Mountain in Morris.
Round 3 Comments: Crocker (1957) notes it probably occurs throughout New York including the Hudson River drainage abutting New Jersey.

Devil Crawfish (*Cambarus diogenes*) **Status: No Consensus**

Status	# of People	Confidence Level
E		
T		
SC	1	6.0
S		
U	2	7.0
NO	2	
NA		

Round 1 Comments: It is extremely widespread; from the Rockies to southern Canada to New Jersey and throughout the Mississippi River basin and Great Lakes (Hobbs, 1989). Pflieger (1996) lists range as much of the eastern United States east of a line from eastern Texas to central Minnesota, except the Florida peninsula and much of the Appalachians, and westward along the Missouri and Platte Rivers to southern North Dakota, eastern Wyoming and Colorado. Fowler (1912) lists near Trenton, Schooley's Mountain, Piney Creek in Cecil Co., Maryland, and just over the state line Fannel's Branch in Chestertown,Maryland. Francois (1959) cites it in New Jersey from Cape May (1 locality), Cumberland (4 localities), Mercer (2 localities), and Morris (1 locality) Cos. as well as three counties (3 localities) in neighboring Pennsylvania. New Jersey likely represents the northeastern range limit. Simon and Morris (2008) found this species to be much more tolerant of high concentrations of sediment contaminants in the Patoka River watershed, Indiana, than aquatic tertiary burrowing species.
MCZ museum records: Delaware River in Hamilton, Delaware Meadows in Hamilton, near Trenton in Hamilton ----- Have not caught *C. Diogenes*, but probably haven't sampled adequately. ----- I have not encountered any of these animals in my fieldwork, because my work to date has been outside of their documented distribution in NJ. ----- Historical records indicate that it is probably undersurveyed.
Round 2 Comments: NONE.
Round 3 Comments: New Jersey may represent the northeastern range limit (Hobbs, 1974). More surveys are definitely warranted especially since existing surveys (the very few that have been done) have found few or no occurrences. ----- Others seem to have adequate knowledge, so no need for me guess. NO's don't affect consensus, correct? ----- More work is needed before a definitive assessment can be made. I agree with other reviewers who suggest that it is likely undersurveyed.
Round 4 Comments: Considering the absence of recent records, I did some museum collection searching. The NCSM has collections from Selem Co. (Delaware River) collected in June 2007 (2 spms.), the Tuckahoe River in Cape May Co. collected in June 2002 (7 spms.), and Mullica River in Camden Co. collected in April 2002 (2 spms.). None of these records have been verified for identification. I think it is just a lack of survey effort in the state. If NJ were the center of the range, I would list this species as stable considering its widespread global distribution, tolerance to a wide variety of habitat conditions, and lack of major threats, but because it is at the edge of its northeastern range in NJ, I am inclined to list it as SC.

Big Water Crayfish (*Cambarus robustus*) **Status: Not Applicable**

Status	# of People	Confidence Level
E		
T		
SC		
S		
U		
NO	1	
NA	4	7.5

Round 1 Comments: This widespread species occurs from southern Ontario east to New York, west to Illinois, and south to North Carolina and Virginia (Hobbs, 1989). This species does not occur in New Jersey but is present in nearby states. Although probably not native east of the Hudson River drainage, records exist for New England including the Thames River drainage in Connecticut (1950s), the Connecticut River, Thames River, Mount Hope Bay drainage systems in Massachusetts, Connecticut and Rhode Island; also populations are known from the West Branch of The Farmington River, Otis, Connecticut; Slocum Brook, Tolland, Connecticut; Dickinson Brook, Granville, Massachusetts; Sawmill Brook, Monson, Massachusetts; and Sucker Brook, Fall River, Massachusetts (Smith, 2000). In New York's Hudson River drainage, Smith (1979) added Rensselaer Co. The species shows an unusually high tolerance to heavy metal pollutants (Taylor et al., 1995). It is able to occupy a range of habitats including roadside ditches indicating a tolerance to pollution. ----- We haven't caught this species in NJ, although we have caught it in NY in habitats and using techniques we've used in NJ. ----- To the best of my knowledge, this species does not occur in NJ. I have not encountered any of these animals in my fieldwork. ----- Insufficient information to arrive at a determination.
Round 2 Comments: NONE.
Round 3 Comments: Ortmann (1906) was unable to find it in the Susquehanna or Delaware drainage in Pennsylvania and restricted it to watersheds of the Allegheny River and Lake Erie (except a Chartiers Creek occurrence in Allegheny Co.; which enters the Ohio River opposite the entrance of the Allegheny). It is similarly reported absent from these drainages in New York by Crocker (1957). Records listed for VA, MD, and IL by Faxon (1885; 1890) were subsequently dropped by him (Faxon, 1914). Fowler (1912) does not report it from New Jersey. I believe it does not occur in NJ. ----- Is there any question of native status? If not, it should be concensus NA.

Knobbedlip Fairy Shrimp (*Eubranchipus bundyi*) **Status: No Consensus**

Status	# of People	Confidence Level
E		
T		
SC		
S		
U	1	5.0
NO	1	
NA	3	7.0

Round 1 Comments: It is broadly distributed in subarctic, alpine, and subalpine regions of Canada and the USA (Rogers, 1996). It has not yet been documented in New Jersey. In southern New England its occurrence is based solely on its mention in the region by Pratt (1935) and Dexter (1959) in Massachusetts (see Smith, 2000). ----- I have no experience with any of the fairy shrimp. ----- I do not study fairy shrimp and therefore cannot comment on their status. ----- This is a very widely distributed species, but is not common anywhere except in the subarctic. It is known from only one or two records each from each state across the northern US, New Mexico, California and Colorado. In Canada it is found

in nearly all provinces, but still is uncommon except in the subarctic. Its current status in New Jersey and adjacent states needs to be evaluated. ----- Paucity of recent or historical records prevents ranking at this time.

Round 2 Comments: My opinion has not altered. This is widely distributed, but nowhere really common except in the subarctic. Considering the amount of habitat conversion in the New England area, coupled with the paucity of recent surveys, I think that the status of this and all the other anostracan species must needs be evaluated.

Round 3 Comments: This species is not known from New Jersey and the only New York citation does not mention any specific locality. Ranking this species as anything other than NA would justify ranking any species with occurrences in neighboring states; which seems wrong (rank on what you know not what you might find if you looked). ----- Same as for other shrimp. ----- My opinion is the same as last round. ----- The evaluation/assessment suggested in Round 2 would generate enough information to determine its status in NJ. A G5 SU. If the survey work indicated it was a Special Concern Species then it should be listed as such.

Round 4 Comments: A search of online museum records did not find any occurrences in the state. This species is not known from New Jersey.

Eastern Fairy Shrimp (*Eubranchipus holmanii)* **Status: Special Concern**

Status	# of People	Confidence Level
E		
T		
SC	3	5.0
S		
U		
NO	2	
NA		

Round 1 Comments: It is broadly distributed in northeastern U.S. and adjacent Canada. Pannak (1989) includes the following subnations: Connecticut, Georgia, Maryland, New Jersey, North Carolina, Ohio, Tennessee, and Virginia. It was originally described from New Jersey (Ryder, 1879). Fowler (1912) reports the type locality as ditches near Woodbury (same for *Eubranchipus vernalis*) where it has been collected subsequently. Dexter (1953; 1956) reports occurrences from New Haven, and along a roadside pool in New London, Connecticut; Long Island, New York; Emory University Field Station at Springfield Pond and Putney Pond in Newton, Georgia; and a pool in the flood plain of Rocky River in Cabarrus Co., North Carolina. Dexter (1959) reported this species from Long Island, New York, and Connecticut, but without locality information and no specimens exist to verify these records (see Smith, 2000). The Connecticut occurrence was thought extirpated for over 50 years until a single population was rediscovered in 2009 by Erik Lazo-Wasem (Yale Peabody, Museum, pers. comm.., 2009). ----- I have no experience with any of the fairy shrimp. ----- I do not study fairy shrimp and therefore cannot comment on their status. ----- This species is not common anywhere in its range and many localities do not appear to support this species any longer. Its current status in New Jersey and adjacent states needs to be evaluated. ----- Widespread and likely overlooked but probably stable.

Round 2 Comments: My opinion has not altered. This species is reported from eastern North American highlands: Minnesota, Ohio, to Pennsylvania, Connecticut, New York, New Jersey, south to Virginia, Maryland, North Carolina, South Carolina, Tennessee, Alabama, Georgia and northern Alabama. This is a large geographic range for most anostracans. However, many localities that were revisited by colleagues of mine did not appear to support the animal any longer, either due to habitat conversion or elimination.

Smoothlip Fairy Shrimp (*Eubranchipus intricatus*) **Status: Not Applicable**

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

Round 1 Comments: It is broadly distributed in southeastern Canada and adjacent U.S. but is sporadic and extremely disjunct. It has not yet been documented in New Jersey. Hartland-Rowe's (1967) original description mentioned specimens collected from Waltham, Massachusetts. In recent years, it has been collected in a small number of sites in the Connecticut River valley region of Massachusetts but is likely rare in southern New England (see Smith, 2000). ----- I have no experience with any of the fairy shrimp. ----- I do not study fairy shrimp and therefore cannot comment on their status. **-----** This species is not common anywhere in its range. Very little is known about it. Its current status in New Jersey and adjacent states needs to be evaluated. ----- Widespread and likely overlooked.
Round 2 Comments: My opinion has altered. This species is reported from Alberta, Saskatchewan, and Manitoba, Canada; Wyoming and Massachusetts, USA. However, nowhere is it common, and it has only been reported in the literature a handful of times. There are only 10 collections (from 5 localities) of *E. intricatus* at the Smithsonian, unlike the previous two species: *E. bundyi* (52 collections) and *E. holmanii* (20 collections). However, there are no records of this species from New Jersey, although it is possible that may or may have occurred in New Jersey.
Round 3 Comments: There are no records of this species in New Jersey or neighboring New York or Connecticut so rank should be NA. ----- My opinion is the same as last round.
Round 4 Comments: A search of online museum records did not find any occurrences in the state. This species is not known from New Jersey.

Springtime Fairy Shrimp (*Eubranchipus vernalis*) **Status: No Consensus**

Status	# of People	Confidence Level
E		
T		
SC	1	4.0
S	3	4.3
U		
NO	1	
NA		

Round 1 Comments: This species is widely distributed east of the Appalachian Mountains, with a few scattered localities west to Illinois and Tennessee. Dexter (1953) cites occurrences in Massachusetts, Rhode Island, Connecticut, New York, New Jersey, Pennsylvania, Ohio, Indiana, Illinois, Michigan, and Ontario; with newer records from West Virginia, Tennessee, and North Carolina. Fowler (1912) indicates there are only a few places in New Jersey where it has been observed: Woodbury and near Trenton. Rick Dutko, New Jersey Natural Heritage Program, reports collecting it in northwestern New Jersey in March 1998. The Rhode Island record is based upon a specimen at Harvard MCZ from Weaver's goldfish pond in Newport collected in 1876 but no other Rhode Island records are known except a species list by Williams (1907). It is the most common and widespread of the phyllopod branchiopods occurring in southern New England and is known from upland and floodplain vernal ponds in the interior and coastal

part of the region in Connecticut and Massachusetts (Smith, 2000). ----- I have no experience with any of the fairy shrimp. ----- I do not study fairy shrimp and therefore cannot comment on their status. **-----** This is probably the most common fairy shrimp east of the Appalachian mountains. However, its status should be assessed by distribution studies. Much habitat has been lost, many localities no longer seem to support this species. Its current status in New Jersey and adjacent states needs to be evaluated. ----- Likely to be widespread and abundant.

Round 2 Comments: My opinion has not altered. This is widely distributed species, occurring east of the Appalachian Mountains, from Massachusetts south, through Rhode Island, New York, Connecticut, New Jersey, Pennsylvania, and South Carolina, USA. That being said, its current status does need to be evaluated.

Round 3 Comments: My opinion is the same as last round. **-----** I would not recommend listing as a justification for a status evaluation. This sp is easily detected and a volunteer effort would likely result in many records. We find it in forested pools, unforested pools, artificial pools, urban, suburban, agricultural, and rural settings.

Round 4 Comments: A search of online museum records did not find any additional occurrences in the state. Although it is the most common and widespread of the phyllopod branchiopods occurring in southern New England, records for New Jersey are very few (less than 5) so warrants some degree of concern.

Calico Crayfish (*Orconectes immunis*) **Status: Not Applicable**

Status	# of People	Confidence Level
E		
T		
SC		
S		
U		
NO	1	
NA	4	7

Round 1 Comments: This is a wide-ranging species that occurs from southern Quebec and New England westward across the upper Midwest to Wyoming and eastern Colorado and the Dakotas and south to extreme northwestern Tennessee (Hobbs, 1989; Pflieger, 1996) and has been introduced into parts of Europe. In New England, where scattered (occasionally large) populations are known from every major drainage system except the eastern coastal drainage systems, occurrences are likely the result of early introductions (Smith, 2000). This species does not occur in New Jersey but occurs as an exotic nearby in New England and parts of New York. ----- We have not documented this species in the state. ----- To the best of my knowledge, this species does not occur in NJ. I have not encountered any of these animals in my fieldwork. ----- Need to clarify whether the sp is native, if possible.

Round 2 Comments: NONE.

Round 3 Comments: Crocker (1957) does not list it for southeastern New York. It is also not in the Allegheny River in New York or Pennsylvania (Crocker, 1957). Ortmann (1906) did not find it in Pennsylvania. The first Hudson River record is by Ortmann (1906) for Rensselaer Lake, Rennsselaer Co. and now it is spotty in the Hudson River basin in New York (Mills et al., 1997), however his distribution could easily be explained by human introductions (e.g., bait bucket discards) (Mills et al., 1997). It has still not yet been documented in NJ, and if it were, it would be considered an exotic so rank should be NA either way. ----- Again, this should be NA by definition. No indication from anyone that it is native.

Spinycheek Crayfish (*Orconectes limosus*) **Status: Secure/Stable**

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

Round 1 Comments: It ranges along the Atlantic watersheds from Maine to Virginia. It as been introduced into western Europe (Hobbs 1989). Although first introduced into Europe in 1890 (Germany), secondary introductions have occurred throughout continental Europe in over 20 countries (not yet in the Iberian Peninsula) making it one of the most common crayfish there (Parvulescu et al., 2009; Holdich and Black, 2007; Baitchorov and Giginiak, 2009; Puky, 2009). Fowler (1912) cites Mantua Creek at Mantua (Camden Co.), Pitman, Burlington, Burlington Island, Duck Island, Trenton, and Hurd Cove of Lake Hopatcong. In New Jersey, Francois (1959) cites it for Bergen (3 localities), Burlington (9 localities), Camden (4 localities), Gloucester (4 localities), Hunterdon (3 localities), Mercer (8 localities), Monmouth (1 locality), Morris (9 localities), Passaic (4 localities), Sussex (4 localities), Sommerset (2 localities), and Warren (1 locality) Cos. Horowitz and Flinders (2004) found it to be uncommon (2 of 15 stations) in the Piedmont, Ridge and Valley and Highlands regions of New Jersey.
MCZ museum records: Trenton, Eight Mile Run (a tributary of Assumquick Creek) which enters Delaware River at Trenton, Schooley's Mountain, creek emptying into Delaware River near Trenton, Hamilton near Delaware River, Dover (Morris), Pompton Lake in Passaic, ----- *O. limosus* is widespread in the Delaware R and tributaries of the Delaware, and we have caught it in some Raritan tributaries. However, it may be vulnerable to expansion of other *Orconectes*, e.g., *O. rusticus.* ----- I have collected individuals of this species from numerous localities in NJ. However, I have not assessed population sizes at those sites, so I cannot comment more strongly about the status. ----- Appears to have plenty of appropriate habitat in NJ and historically documented at many.

Mena Crayfish (*Orconectes menae*) **Status: Not Applicable**

Status	# of People	Confidence Level
E		
T		
SC		
S		
U		
NO	1	
NA	4	8

Round 1 Comments: This species has a restricted range, occurring from Polk and Montgomery Counties, Arkansas, and LeFlore and McCurtain Counties, Oklahoma (Williams, 1954; Bergey et al., 2005). It does not occur in New Jersey. The area in which this species is distributed is rural. There are a number of potential threats in the area such as forestry activity and sedimentation, however there are no documented impacts on this species and at present, these are not thought to pose a threat to the species (C. Taylor, pers. comm.., 2009). ----- I have no knowledge of this species. Online references and Taylor's paper seem to place it as a Ouachita Mt endemic. I think I may have seen a NJ record of it from

the AMNET bioassessment survey, but I don't know of any work to document that it really was O. menae. ----- To the best of my knowledge, this species does not occur in NJ. I have not encountered any of these animals in my fieldwork. ----- Insufficient information, probably non-native.
Round 2 Comments: NONE.

Allegheny Crayfish (*Orconectes obscurus*) **Status: Not Applicable**

Status	# of People	Confidence Level
E		
T		
SC		
S		
U		
NO	1	
NA	4	7.25

Round 1 Comments: This species ranges from southeastern Ontario and New York to Pennsylvania and eastern Ohio, south to West Virginia, northern Virginia, and western Maryland (Hobbs, 1989). Fitzpatrick (1967) included the Ohio River drainage east of the 81st meridian; Susquehanna, Potomac, and upper Rappahannock River drinages; miscellaneous Lake Erie and Lake Ontario drainages in extreme western New York, northern Pennsylvania, and extreme northeastern Ohio. It does not range as far east as New Jersey. This species has been introduced to Massachusetts in the North Branch of the Housic River and some of its tributaries; and in Goose Pond in Lee, Greenwater Pond in Becket, Konkapot Brook in Stockbridge (all Housatonic River system); and in the Housatonic River in Stockbridge (Smith, 2000). Smith (1979) noted that although it occurs in limited areas of the upper Mohawk River system, Fitzpatrick's (1967) deptiction of its presence also in the lower Hudson River and upper Delaware River systems of New York is erroneous. *Orconectes obscurus* has been displaced by *Orconectes rusticus* in areas where this invasive crayfish has encroached, as *O. rusticus* is less vulnerable to predation than *O. obscurus* (Kuhlmann et al., 2008). *O. obscurus* has been replaced entirely by *O. rusticus* in the Sunfish Creek watershed, Ohio (Jezerinac, 1986; R. Thoma, pers. comm., 2009.). This is known to have occurred within a 30 year period. ----- We have documented *O. obsccurus* at only one site (West Branch Middle Brook) in NJ and have assumed it to be exotic. We have found this species in several large streams in the Delaware drainage, so it presumably has access to NJ. ----- To the best of my knowledge, this species does not occur in NJ. I have not encountered any of these animals in my fieldwork. ----- Insufficient information.
Round 2 Comments: NONE.
Round 3 Comments: The first published record for the Hudson River basin in New York is in 1934 for the upper Mohawk River (Nevin and Townes, 1935). Crocker (1957) gives two records from the Susquehanna drainage in New York from disjunct, isolated ponds (also upper Mohawk River basin) and postulated they may have arrived there via the Erie Canal. Bait bucket introduction is another potential dispersal mechanism. In the upper Susquehanna drainage in New York, Orconectes obscurus and Orconectes propinquus occur in the upper portions of rivers with Orconectes rusticus, introduced probably at the headwaters of the Susquehanna in the late 1970s, occurring in the lower, with a broad area of overlap in the middle; however, O. rusticus is expanding down the Susquehanna River and up smaller tributaries (at the expense of O. obscurus and O. propinquus) (Kuhlmann et al., 2008). It still has not yet been documented in NJ, and if it were, it would be considered exotic. ----- Again, no indication is native, so should be NA.

Northern Clearwater Crayfish (*Orconectes propinquus*) **Status: Not Applicable**

Status	# of People	Confidence Level
E		
T		
SC		
S		
U		
NO	1	
NA	4	7.25

Round 1 Comments: It occurs in glaciated areas from Hudson Bay south through Ontario to west Massachusetts, south Wisconsin, and east Iowa (Hobbs, 1989). Fitzpatrick (1967) lists range as the Great Lakes Drainage of the U.S. and Canada, northern Hudson River drainage, Rock River drainage in Illinois and Wisconsin. Also Minnesota in Saint Louis River basin (Kutka et al., 1996). It has not yet been documented in New Jersey. In New York's Hudson River drainage, Smith (1979) added Rensselaer and Washington Cos. It is found in the Hoosic River basin in Massachusetts where it is possibly native, and outside this system in southern New England it has been introduced into the Housatonic River drainage system with several established disjunct populations plus two small populations from the Connecticut River drainage system (Mill Brook in Plainfield and Swift River in Ashfield, both Westfield River basin in Massachusetts) (Smith, 2000). Kuhlmann (2008) found that although there were some reproductive differences between sympatric and allopatric areas in the Susquehanna River watershed where *Orconectes rusticus* is invading native *Orconectes propinquus* habitat, they are not strongly indicative of reproductive interference, but instead are more likely the result of the size differences among females collected from allopatric and sympatric areas. Although ruling out reproductive interference, Kuhlmann (2008) did note the apparent success of *O. rusticus* as an invader in the upper Susquehanna River watershed, often at the apparent expense of *O. propinquus* (see Kuhlmann and Hazelton, 2007). Various studies have shown that introduced *O. rusticus* has a higher growth rate than its congeners contributing to its dominance over other crayfish species (Hill et al., 1993; Mather and Stein, 1993); however studies by Pintor and Sih (2009) indicate higher growth rates is a characteristic of introduced but not native populations of *O. rusticus* (higer foraging activity and exploitation of bait of introduced versus native populations; as well as bait piracy). ----- We have not caught this species in NJ. However, it has been found sold for bait by at least on dealer in the Delaware drainage. ----- To the best of my knowledge, this species does not occur in NJ. I have not encountered any of these animals in my fieldwork. ----- Widespread and spreading via bait trade and casual releases.
Round 2 Comments: NONE.
Round 3 Comments: Crocker (1957) does not list it from southeastern New York. It still has not yet been documented in NJ, and if it were, it would be considered exotic. ----- As with other exotics, should be NA.

Rusty Crayfish (*Orconectes rusticus*) **Status: Not Applicable**

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

NA	4	7.8

Round 1 Comments: The native range was described by Taylor (2000) to include the lower middle Ohio River drainage of central Kentucky, western Ohio, and eastern and central Indiana and the western Lake Erie drainage in southeastern Michigan and northwestern Ohio. It has been introduced (mostly as fishing bait) across the United States with large populations in Connecticut, Illinois, Iowa, Maine, Massachusetts, Minnesota, New Hampshire, New Jersey, New Mexico, New York, Pennsylvania, Tennessee, Vermont, West Virginia, and Wisconsin (Taylor and Schuster, 2004; Lodge et al., 2000). Hobbs (1989) documented it as an exotic in New Jersey. It has invaded Maryland from neighboring Pennsylvania into the Monocacy River (Knauer, 2007). It is a recently introduced species in southern New England and is spreading throughout the Connecticut River system (Smith, 2000). This species of crayfish is highly invasive and consistently out competes other species outside of its native range. It has a generalist nature, an ability to dominate and out compete other crayfish species and an expanding range. ----- To date, we have documented *O. rusticus* at only one site in NJ (in a pond tributary to Flat Brook). We have not found in it a number of samples in nearby portions of Flat Brook and the Delaware. We have found *O. rusticus* to be common in one Schuylkill River drainage and have found it several other Delaware drainage sites in PA, so it probably has access to NJ. I don't see why it won't eventually expand more into NJ and would expect it to have large impacts in the state. ----- The literature suggests that these animals are present in NJ as an exotic species, but I have not encountered any during my fieldwork. ----- Spreading throughout area via bait industry and casual translocations by anglers and very hardy.
Round 2 Comments: NONE.
Round 3 Comments: According to Ortmann (1906) it is absent from Pennsylvania. This species is not native to the area (Interior Basin) but there is some evidence it may have spread here post-glacially so the final decision on whether it is native or exotic is not settled. It was first found in neighboring New York in 1968 in an artificial pond 6 miles west of Schenectady, Schenactady Co., in the Hudson Basin (Crocker, 1979). It has been introduced in sites around southeastern New York including Titicus River in Westchester County and neighboring Fairfield County, Connecticut (Mills et al.,1997). ----- As exotic, should be NA ----- In light of the revised definition of "Not Applicable" to include established exotics, I am confident in the assertion that this species should be NA.
Round 4 Comments: Despite some evidence that it may have spread to NJ post-glacially, it seems the general consensus (Mills et al., 1997; Smith et al., 2000; Taylor et al., 2007) is that it is exotic so rank changed accordingly to NA.

Virile Crayfish (*Orconectes virilis*) **Status: Not Applicable**

Status	# of People	Confidence Level
E		
T		
SC		
S		
U		
NO	1	
NA	4	7.8

Round 1 Comments: This species ranges very widely, occurring farther north in Canada than any other crayfish species. Its native range extends as far north as the southern tip of Hudson Bay; southward it occurs from New England to western Montana and through the Missouri, Mississippi and Ohio River basins to Oklahoma and northern Arkansas; and it has also been widely introduced outside its native range (Pflieger, 1996). Specific locality records for New Jersey are not known although it is cited as an exotic in the state by Taylor et al. (1996; 2007). Horowitz and Flinders (2004) found it to be uncommon (2 of 15 stations) in the Piedmont, Ridge and Valley and Highlands regions of New Jersey. In New York's Hudson River drainage, Smith (1979) added Columbia and Rensselaer Cos., New York. Based on museum records, it has been known in southern New England since about 1935 and has been widely introduced throughout the region to such an extent that today only the southeastern coastal drainage

areas (South Shore, Buzzards Bay, Cape Cod and the Islands) are still free of it (Smith, 2000). ----- We have found this species in a number of sites in the Passaic drainage and in a few sites in the Raritan drainage. We have found it at one site in the lower Delaware River drainage in PA. ----- I have collected individuals of this species from numerous localities in NJ. However, I have not assessed population sizes at those sites, so I cannot comment more strongly about the status. ----- Spreading throughout area via bait industry and casual translocations by anglers and very hardy.
Round 2 Comments: This should be NA, since it's non-native.
Round 3 Comments: This species may not be native to the region. Crocker (1957) noted two localities in the Hudson River basin in New York: near Saratoga Springs and eastern Westchester County. He postulated a potential post-glacial spread from the Mississippi basin, but later (Crocker, 1979) attributed its occurrence to human introduction. Mills et al. (1997) notes it is now everywhere in the Hudson drainage in New York. If it is deemed exotic, rank should be changed to NA. ----- This should be NA, since it's non-native. ----- In light of the revised definition of "Not Applicable" to include established exotics, I am confident in the assertion that this species should be NA. ----- I was reading this as non-native and secure so I followed the Round 2 comment.
Round 4 Comments: Despite some evidence that it may have spread to NJ post-glacially, it seems the general consensus (Mills et al., 1997; Smith et al., 2000; Taylor et al., 2007) is that it is exotic so rank changed accordingly to NA.

White River Crawfish (*Procambarus acutus*) **Status: Secure/Stable**

Status	# of People	Confidence Level
E		
T		
SC		
S	4	5.8
U		
NO	1	
NA		

Round 1 Comments: Complete and accurate range is ambivalent because of taxonomic confusions and widespread introductions; it probably was originally from the Tombigbee basin, northeast along coastal plain and piedmont to New England. According to Hubbs (1989), it ranges from Maine to the Florida panhandle west to Texas and north to Minnesota. Fowler (1912) cites (as *Procambarus blandingi*) Crosswics Creek near Trenton, Repaupo Creek near Repaupo, and Mantua Creek near Mantua. It was reported in New Jersey (as *Procambarus blandingi blandingi*) from Atlantic (3 localities), Burlington (2 localities), Cumberland (3 localities), Essex (1 locality), Gloucester (4 localities), Mercer (5 localities), Middlesex (2 localities), Ocean (3 localities), Passaic (1 locality), and Salem (4 localities) Cos.; plus six additional unconfirmed localities Horowitz and Flinders (2004) found it to be uncommon (2 of 15 stations) in the Piedmont, Ridge and Valley and Highlands regions of New Jersey. It has been introduced by aquaculturists in many places. It is questionable whether it is native or exotic in southern New England but it is restricted to an area extending from the Blackstone River drainage system eastward through all the southeastern coastal drainage systems, including Cape Cod but not north of the Charles River basin; with populations outside this range in the Spicket River in Methuen (Merrimack River drainage), a few tributaries in the Northampton and Amherst vicinity (Connecticut River drainage), and the Millers River in Ashburnham (Connecticut River drainage); all in Massachusetts (Smith, 2000). It is a habitat generalist, being able to utilize both stream and pond habitats.
MCZ museum records: Plainsboro, Essex, creek emptying into Delaware River near Trenton, Hamilton, Mercer. ----- We have caught this species in the Delaware drainage in the southern part of the Piedmont. We have not caught large numbers at any one site. I have also caught it in the Pine Barrens. It is probably more common in Southern NJ, where we haven't done a lot of crayfish identification. ----- I have not encountered any of these animals in my fieldwork, because my work to date has been outside of their documented distribution in NJ. ----- Descriptions of historical habitat suggest the sp is probably secure.
Round 2 Comments: Hagen (1870) mentions the species from Essex.

Red Swamp Crawfish (*Procambarus clarkii*) **Status: Not Applicable**

Status	# of People	Confidence Level
E		
T		
SC		
S		
U		
NO	1	
NA	4	7.25

Round 1 Comments: Native range extends from the Mississippi-Ohio confluence down the Mississippi River floodplain to Louisiana, and along the Gulf coastal Plain southwest to Alabama, to the Rio Grande basin in south New Mexico and north Mexico. Mexican distribution includes Baja California, Baja California Sur, Chihuahua, Sonora, Sinaloa, Durango, Coahuila, Nuevo Leon, and Tamaulipas (Hernandez et al., 2008). It was widely introduced in many places throughout Africa, Asia, and Europe, and also outside its native range in North America. (See Hobbs, 1989). This species has not yet been confirmed in New Jersey, but there is the possibility of an introduction via bait fishing. The species has been introduced to Massachusetts (University of Massachusetts campus pond, Amherst) and Rhode Island (University of Rhode Island campus pond, Kingston) (Smith, 2000). It is an extreme generalist and colonizer. It is able to survive extensive periods of burrowing, including periods of air exposure, by recovering haemolymph levels rapidly following oxygen depravation and rapid excretion in burrows (McMahon and Stuart, 1999). ----- We have caught this species at only one site in NJ (below New Market Pond dam), but we have caught it at several places in PA near the Delaware River. I would expect it to be found in the lower Delaware drainage in NJ. ----- To the best of my knowledge, this species does not occur in NJ. I have not encountered any of these animals in my fieldwork. ----- If native (unlikely) sp is probably secure due to unlimited habitat.
Round 2 Comments: NONE.
Round 3 Comments: Although established as an exotic in New York and Massachusetts, it has not yet been documented in New Jersey except the one questionable site mentioned in Round 1 comments (definitely introduced) so rank should be NA. ----- As non-native, should be NA. **-----** It does not appear to disperse unaided so I changed my rank.

Spinytail Fairy Shrimp (*Streptocephalus sealii*) **Status: No Consensus**

Status	# of People	Confidence Level
E		
T		
SC	2	5.0
S	1	5.0
U	1	7.0
NO	1	
NA		

Round 1 Comments: This species is found from prairie provinces in Canada, east to New York, and south to Vera Cruz, Mexico (Fitzpatrick, 1983). Creaser (1930) reports the type locality as a pond that periodically dries up near Woodbury, New Jersey. Dexter (1953) cites New Jersey, Virginia, Illinois,

Minnesota, South Carolina, Florida, Alabama, Mississippi, Louisiana, Texas, Oklahoma, Kansas, Colorado, Arizona, Oregon, Alberta, and Vera Cruz, Mexico. It appears that all references to New Jersey refer to the original description. Fowler (1912) reports it has not been rediscovered at the type locality since the original description in 1879. ----- I have no experience with any of the fairy shrimp. ----- I do not study fairy shrimp and therefore cannot comment on their status. ----- Extremely widespread species. Reported from southern Canada to southern Mexico, from the Atlantic states to the Sierra Nevada Mountains in California. However, preliminary molecular data demonstrates that this is probably a complex of at least six species, with S. sealii probably limited to the Atlantic coastal states. Its current status in New Jersey and adjacent states needs to be evaluated. ----- Insufficient information to make a determination.

Round 2 Comments: My opinion has not altered. This is widely distributed species, occurring east of the Appalachian Mountains, from New Jersey south to Florida. My continuing research is demonstrating that all other populations are separate species. That being said, its current status does need to be evaluated.

Round 3 Comments: Go with SC despite widespread range in North America because only known locality in the state is the type locality and survey work is desperately needed (resurvey type locality and look elsewhere). ----- My opinion has not altered. ----- Round 2 comments convinced me.

Round 4 Comments: Considering the absence of recent records, I did some museum collection searching. No additional online museum records could be found. If NJ were the center of the range, I would list this species as stable considering its widespread global distribution and lack of major threats, but because it is at the edge of its northeastern range in NJ and is currently only known (with viability uncertain at best) in NJ from the type locality, I am inclined to list it as SC.

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Taylor, C.A., G.A. Schuster, J.E. Cooper, R.J. DiStefano, A.G. Eversole, P. Hamr, H.H. Hobbs III, H.W. Robison, C.E. Skelton, and R.F. Thoma. 2007. A reassessment of the conservation status of crayfishes of the United States and Canada after 10+ years of increased awareness. Fisheries, 32(8): 371-389.

***The preceding list of citations was provided by one of the Delphi panelists during Round 3 and was provided to all review panelists at the beginning of Round 4 along with all comments provided by reviewers. Therefore it is provided here along with all commentary shared by panelists in the course of this status review.**

APPENDIX II

FRESHWATER CRUSTACEANS

REFERENCE MATERIALS PROVIDED TO DELPHI PANELISTS

Brown, L.J. and R.E. Jung. 2005. An Introduction to Mid-Atlantic Seasonal Pools. Report to the USEPA.

Francois, D.D. 1959. The crayfish of New Jersey. Ohio J. Sci. 59(2):108-127.

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Pecor, Keith. Unpublished and proprietary map of collection sites for several crayfish species within Hunterdon and Mercer Counties, NJ provided to Delphi panel on January 4, 2010.

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USGS Nonindigenous Aquatic Species Program. 2009. Crayfish range maps: http://nas.er.usgs.gov/taxgroup/crustaceans/crayfish.html Accessed 2009.

Maps created by Conserve Wildlife Foundation of NJ (CWF) staff in 2009 based upon field surveys by CWF and the NJ Department of Environmental Protection's Natural Heritage Program as well as the Endangered and Nongame Species Program.