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ARTICLE

THE KNOWN AND POTENTIAL HOSTS OF TEXAS MUSSELS: IMPLICATIONS FOR FUTURE RESEARCH AND CONSERVATION EFFORTS

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ABSTRACT

North America is home to the most diverse freshwater mussel fauna (Mollusca: Unionidae) in the world; however, at least 70% of native mussel species are considered imperiled to some degree. Texas has 52 currently recognized mussel species, and many of these have experienced significant population declines. These declines are anticipated to worsen as the population and water demands continue to grow throughout the state. The life history of unionids includes a unique reproductive strategy involving an obligate ectoparasitic larval stage; therefore, suitable host organisms are required for a mussel population to remain viable. Because of this relationship, the identification of host organisms is an important component for successful mussel conservation efforts. Data on host organisms are often difficult to locate or may be incomplete or completely lacking. We performed a comprehensive literature review to compile the known and/or potential host species for the mussels of Texas. Data was organized by mussel species and information including the total number of hosts identified in the literature review, type of host study methodology, and whether the mussel and/or host is a state or federally listed species was incorporated into a reference table. Identified host species were grouped by family, and the percentages for each host family were then compared for each mussel species using a chi-square goodness of fit analysis. The information compiled during this literature review exposes areas in need of future research and should be considered during the development of future mussel management and conservation protocols within Texas.

KEY WORDS - glochidia, unionid, mussel, host, fish, Texas, threatened

INTRODUCTION

North America is home to the most diverse freshwater bivalve fauna in the world, with the majority of species belonging to the Unionidae. Of the nearly 300 mussel species native to North America, approximately 70% are currently imperiled to some degree (Williams et al. 1993; Master et al. 2000; Lydeard et al. 2004; Strayer et al. 2004). Mussel declines have been attributed to the destruction and modification of their habitat, water withdrawal for human usage, pollution, droughts, and aquatic invasive species (Williams et al. 1993; Strayer et al. 2004; Bogan 2008; Haag 2012). In addition, freshwater mussels have a highly specialized life history, which makes them uniquely vulnerable to habitat disturbances. Adult mussels are relatively sedentary filter-feeders with reduced dispersal abilities and may remain in the same relative location during the majority of their adult lives (Kat 1984; Vaughn and Hakenkamp 2001). Their larvae (glochidia) are obligate parasites on the gills and/or fins of fish or more rarely, on amphibians (Kat 1984; Haag and Warren 1997).

Mussel host specificity varies among species and ranges from specialists that utilize only a few closely related host species, to generalists that use a wide variety of host species (Haag and Warren 1999). Currently, host species information is incomplete or completely lacking for a large number of mussel species in North America (Haag and Warren 1997), including many species found in Texas (Braun et al. 2014). Suitable freshwater mussel host organisms are typically identified through either laboratory or field-based studies, though most recent studies have primarily utilized laboratory-based methodology (Haag 2012; Levine et al. 2012).

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In laboratory-based studies, glochidia are exposed to potential host organisms under artificial conditions to observe whether or not attachment and metamorphosis occurs (Hove et al. 2011). If a high enough percentage of glochidia successfully metamorphose, then the species may be considered a usable host for the mussel species in question (Haag and Warren 1997; Sietman et al. 2010; Hove et al. 2011; Daniel and Brown 2012). However, these types of studies circumvent the natural behavioral and ecological obstacles that may inhibit a mussel species from utilizing a potential host organism. Often laboratory-based studies fail to consider crucial life history traits of the host and mussel species as well as other environmental factors that may influence the infection rate, survival, and transformation of glochidia (Levine et al. 2012). Because of these limitations, laboratory-based studies have the potential to over-represent the taxonomic breadth of the host organisms naturally available to a mussel species (Levine et al. 2012).

Field-based studies for identifying a host organism involve the capture of infected hosts in a natural ecological setting (Hove et al. 2011). Captured hosts are either held in the laboratory until the glochidia metamorphose into juvenile mussels, or the gills and/or fins of the host are removed and searched for encysted glochidia (Zale and Neves 1982; Hove and Neves 1994; Boyer et al. 2011). Studies such as these indicate the natural infection of a host organism and identify a potential host species that interacts with a mussel species in a natural ecological setting (Hove et al. 2011). Field-based studies also have potential limitations. For example, glochidia have the potential to remain attached to inanimate objects and non-suitable hosts for a period of time (Haag 2012); therefore, a natural infection may not necessarily indicate that the purported host organism is usable. In addition, not all host species are likely to be obtained during field collections, such as those host species too small to notice or to be easily located (Levine et al. 2012) or those species that are used as host organisms by a mussel species which releases its glochidia during a time other than when collections occurred.

Host identification is critical to the success of future freshwater mussel conservation, management, and propagation endeavors (Burlakova et al. 2011; Daniel and Brown 2012; Johnson et al. 2012; Levine et al. 2012). Texas has 52 currently recognized species of native freshwater mussels. One of these species is federally listed as endangered, and 15 species are listed as threatened at the state level. Of the state-listed species, six are also currently listed as candidates for further federal protection, and six have been petitioned for a federal listing and have received positive 90-day findings (USFWS 2011a). To assist in future research prioritizations, mussel and fish conservation management, and potential water management evaluations, we performed an extensive review of the available mussel host literature. This information was then combined into a database indicating the host species for Texas' mussels.

METHODS

An extensive literature review was conducted to compile the known and/or potential host species for the mussels of Texas. Only those sources which identified host organisms to the species level were used to create Table 1. Both native and non-native fish were included as host organisms in Table 1, provided that the non-native species had an established and reproducing population in Texas (Howells 2001b; Thomas et al. 2007; Hendrickson and Cohen 2012). Both laboratory and field-based studies were included in this literature review. Species determined to not serve as hosts for a given species were not included in Table 1.

Table 1 is organized by mussel species, and information including the total number of hosts identified in the literature review, whether the mussel is a state or federally listed species, and whether the host is a state or federally listed or non-native species was incorporated into the "Species" column. To identify the source of the host species information, numbers were included under the "Host Species" column in Table 1 which correspond with numbers added to the sources in the Literature Cited section. In addition, the type of study for each source used to create Table 1 is included in the Literature Cited section. Each source is categorized by a two-letter code devised by Hoggarth (1992) and included LI (laboratory infestation; host parasitized in experimental conditions but metamorphosis not observed), LT (laboratory infestation; host parasitized in experimental conditions and metamorphosis observed), NI (natural infestation; parasite found on wild-caught fish but metamorphosis not observed), NT (natural infestation; parasite found on wild-caught fish and metamorphosis observed), and NS (not stated in original source). Both the LI and LT categories were classified as laboratory-based studies and the NI and NT categories were classified as field-based studies.

For each mussel species, identified host species were grouped by family, and the total percentage that each host family was utilized by a mussel species was calculated. These percentages were included in Table 1. The percentages for each host family were then compared for each mussel species using a chi-square goodness of fit analysis. A significant value for this analysis indicates that a mussel species was found more often on a host in a particular family than would be expected by random chance. This information was also included in Table 1 within the "Species" column.

Table 2 includes information regarding the number of host species per family as determined by the literature review. Texas mussel species with no available host data are shown in Table 3 with their corresponding state and/or federal listing status.

RESULTS & DISCUSSION

The literature review identified a total of 95 known and/or potential host organisms for at least one Texas mussel species (Tables 1, 2). Of the 89 papers used as sources for Table 1,

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Table 1. The known and/or potential host species for the unionids of Texas. The total number of known and/or potential host organisms used by a mussel species is shown in parentheses.

Species	Host Family	Total Hosts	% of Total	Host Species
Amblema plicata^{+} (21)	Catostomidae	1	4.8%	*Moxostoma erythrurum*[85, 86]
	Centrarchidae	8	38.1%	*Ambloplites rupestris**[15,16,37,86], *Lepomis cyanellus*[15,16,37,86], *Lepomis gulosus*[8,15,16,28,37], *Lepomis macrochirus*[15,16,28,37,85,86], *Lepomis megalotis*[43,49,86], *Micropterus salmoides*[8,15,16,28,37,46,86], *Pomoxis annularis*[8,15,16,28,37,63,86,87], *Pomoxis nigromaculatus*[8,15,16,28,37,46,86]
	Cyprinidae	3	14.3%	*Cyprinella lutrensis*[49], *Cyprinella venusta*[49], *Notropis atherinoides*[85,86]
	Ictaluridae	2	9.5%	*Ictalurus punctatus*[14,15,28,37,64,85,86], *Pylodictis olivaris*[14,15,16,28,37,64]
	Lepisosteidae	2	9.5%	*Lepisosteus oculatus*[43,86], *Lepisosteus platostomus*[8,15,16,29,37]
	Moronidae	1	4.8%	*Morone chrysops*[8,15,16,37,86,87]
	Percidae	3	14.3%	*Perca flavescents**[8,16,28,37,46,83,86], *Percina caprodes*[85,86], *Sander canadensis**[8,15,16,28,37,63,86,87]
	Sciaenidae	1	4.8%	*Aplodinotus grunniens*[36,85,86]
Anodonta suborbiculata^{+} (8)	Centrarchidae	5	62.5%	*Lepomis cyanellus*[34,86], *Lepomis gulosus*[3,4,34,86], *Lepomis megalotis*[34,86], *Micropterus salmoides*[3,4,34,36,86], *Pomoxis annularis*[3,4,34,36,86]
	Cyprinidae	1	12.5%	*Notemigonus crysoleucas*[3,4,34,36,86]
	Ictaluridae	1	12.5%	*Ictalurus punctatus*[34,36,64,86]
	Poeciliidae	1	12.5%	*Gambusia affinis*[36]
Arcidens confragosus^{+} (21)	Anguillidae	1	4.8%	*Anguilla rostrata*[15,37,86,87]
	Catostomidae	4	19.0%	*Carpiodes cyprinus*[70], *Erimyzon oblongus*^{X}[70], *Ictiobus bubalus*[70], *Moxostoma macrolepidotum*[25,70]
	Centrarchidae	4	19.0%	*Ambloplites rupestris**[15,37,63,86,87], *Lepomis cyanellus*[34,70], *Lepomis humilis*[70], *Pomoxis annularis*[15,37,63,86,87]
	Clupeidae	1	4.8%	*Dorosoma cepedianum*[15,37,63,86,87]
	Cyprinidae	5	23.8%	*Cyprinus carpio**[25], *Luxilus chrysocephalus*[70], *Notemigonus crysoleucas*[70], *Rhinichthys cataractae*[70], *Semotilus atromaculatus*[25,70]
	Fundulidae	1	4.8%	*Fundulus olivaceous*[70]
	Ictaluridae	1	4.8%	*Ictalurus punctatus*[34,36,37,64,70,86]
	Percidae	2	9.5%	*Perca flavescens**[25], *Sander vitreus**[36,70]
	Poecilliidae	1	4.8%	*Poecilia reticulata**[70]
	Sciaenidae	1	4.8%	*Aplodinotus grunniens*[37,86,87]
Arkansia wheeleri^{X} (1)	Cyprinidae	1	100.0%	*Lythrurus umbratilis*[68]
Cyrtonaias tampicoensis^{+} (5)	Centrarchidae	1	20.0%	*Lepomis megalotis*[36]
	Cichlidae	1	20.0%	*Herichthys cyanoguttatum* [35,36]
	Cyprinidae	1	20.0%	*Notemigonus crysoleucas*[35,36]
	Lepisosteidae	2	40.0%	*Lepisosteus oculatus*[35], *Lepisosteus osseus*[34,35,36]

approximately 65% (58 sources of the LT and/or LI categories) were laboratory-based studies, 12% (11 sources of the NI category) were field-based studies, and 14% (12 sources of the NS category) did not state host species determination methodology. The remaining 9% (8 sources) included both laboratory and field-based investigations, and notably, only four of these studies were conducted after 1975.

From the literature review, a total of 95 host species from 24 different host families were identified (Tables 1, 2). Of these 95 host species identified, 92 are a species of fish and three are a species of amphibian. The majority of host species (61%) were from four families, including the Cyprinidae (22.1%, 21 host species), Centrarchidae (16.5%, 16 host species), Percidae (12.4%, 12 host species), or Ictaluridae (9.5%, 9 host species). In addition, 15 of the 24 host families (16.5%) had only a single species utilized as a host (Table 2).

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Table 1, continued.

Species	Host Family	Total Hosts	% of Total	Host Species
Elliptio dilatata^{+} (23)	Anguillidae	1	4.3%	*Anguilla rostrate*[58]
	Centrarchidae	8	34.8%	*Ambloplites rupestris**[12,16,58,86], *Lepomis cyanellus*[58], *Lepomis macrochirus*[58], *Lepomis megalotis*[58], *Micropterus dolomieu**[58], *Micropterus salmoides*[12,58], *Pomoxis annularis*[12,14,15,16,28,37,86,87], *Pomoxis nigromaculatus*[12,14,15,16,28,37,58,86]
	Clupeidae	1	4.3%	*Dorosoma cepedianum*[12,14,15,16,37,86,87]
	Cyprinidae	2	8.7%	*Notemigonus crysoleucas*[58], *Rhinichthys cataractae*[58]
	Fundulidae	1	4.3%	*Fundulus olivaceus*[58]
	Ictaluridae	1	4.3%	*Pylodictis olivaris*[12,14,15,16,28,37,64,86]
	Lepisosteidae	1	4.3%	*Lepisosteus osseus*[58]
	Percidae	8	34.8%	*Etheostoma caeruleum*[12,16,58,86], *Perca flavescens**[12,14,16,37,58,86], *Percina caprodes*[58], *Percina maculata*^{X}[58], *Percina phoxocephala*[58], *Percina shumardi*[58], *Sander canadensis**[12,28,58,86], *Sander vitreus**[58]
Fusconaia askewi^{X+} (17)	Centrarchidae	3	17.7%	*Lepomis macrochirus*[49], *Lepomis megalotis*[49], *Micropterus punctulatus*[49]
	Clupeidae	1	5.9%	*Dorosoma cepedianum*[49]
	Cyprinidae	7	41.2%	*Cyprinella lutrensis*[49], *Cyprinella venusta*[49], *Hybopsis ammis*[49], *Notemigonus crysoleucas*[49], *Notropis texanus*[49], *Pimephales promelas*[49], *Pimephales vigilax*[49]
	Esocidae	1	5.9%	*Esox americanus*[49]
	Fundulidae	1	5.9%	*Fundulus notatus*[49]
	Ictaluridae	2	11.8%	*Ictalurus punctuatus*[49], *Noturus nocturnus*[49]
	Percidae	1	5.9%	*Percina sciera*[49]
	Poeciliidae	1	5.9%	*Gambusia affinis*[49]
Fusconaia flava^{+} (4)	Centrarchidae	3	75.0%	*Lepomis macrochirus*[14,15,16,28,36,37], *Pomoxis annularis*[8,14,15,16,28,36,37,87], *Pomoxis nigromaculatus*[8,14,15,16,28,36,37,63,87]
	Cyprinidae	1	25.0%	*Semotilus atromaculatus*[16,50,74]
Glebula rotundata (7)	Achiridae	1	14.3%	*Trinectes maculatus*[36,37,53,86]
	Centrarchidae	2	28.6%	*Lepomis cyanellus*[36,37,53,86], *Lepomis macrochirus*[36,37,53,86]
	Cyprinidae	1	14.3%	*Cyprinus carpio**[36,37,53,86]
	Engraulidae	1	14.3%	*Anchoa mitchilli*[36,37,53,86]
	Lepisosteidae	1	14.3%	*Lepisosteus oculatus*[36,37,53,86]
	Moronidae	1	14.3%	*Morone chrysops*[36,37,53,86]
Lampsilis bracteata^{X} (4)	Centrarchidae	4	100.0%	*Lepomis cyanellus*[34,36,37,40], *Lepomis macrochirus*[34,36,37,40], *Micropterus salmoides*[36,40], *Micropterus treculii*[36,40]
Lampsilis cardium^{+} (12)	Ambystomatidae	1	8.3%	*Ambystoma tigrinum*[36,73,75,76]
	Centrarchidae	6	50.0%	*Lepomis cyanellus*[16,50,72], *Lepomis macrochirus*[8,15,16,37,69], *Micropterus dolomieu**[8,15,16,37,69], *Micropterus salmoides*[8,11,15,16,46,69,76,81], *Pomoxis annularis*[2,8,15,16,37,69,87], *Pomoxis nigromaculatus*[11]
	Percidae	3	25.0%	*Perca flavescens**[8,16,69], *Sander canadensis**[2,8,15,16,37,69,87], *Sander vitreus**[16,41,69,87]
	Poeciliidae	2	16.7%	*Poecilia reticulata**[75,76], *Xiphophorus hellerii**[75,76]
Lampsilis hydiana^{+} (3)	Centrarchidae	1	33.3%	*Lepomis cyanellus*[34,36]
	Ictaluridae	2	66.7%	*Ictalurus furcatus*[34,36,64], *Ictalurus punctatus*[34,36,64]

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Table 1, continued.

Species	Host Family	Total Hosts	% of Total	Host Species
Lampsilis satura[X] (1)	Centrarchidae	1	100.0%	*Lepomis macrochirus*[31,32]
Lampsilis teres[+] (21)	Acipenseridae	1	4.8%	*Scaphirhynchus platorynchus*[X36,37,63,86,87]
	Centrarchidae	12	57.1%	*Lepomis auritus**[56,86], *Lepomis cyanellus*[15,37,63,86], *Lepomis gulosus*[15,37,63,86,87], *Lepomis humilis*[9,15,37,63,86], *Lepomis macrochirus*[43,46,56,86], *Lepomis marginatus*[43], *Lepomis megalotis*[43], *Lepomis microlophus*[9], *Micropterus punctulatus**[43], *Micropterus salmoides*[9,15,36,37,42,43,63,86,87], *Pomoxis annularis*[9,15,37,63,86,87], *Pomoxis nigromaculatus*[15,37,63,86]
	Cyprinidae	1	4.8%	*Cyprinella venusta*[9,43]
	Lepisosteidae	4	19.1%	*Lepisosteus oculatus*[43], *Lepisosteus osseus*[1,8,15,37,42,87], *Lepisosteus platostomus*[8,15,29,37,42,86,87], *Lepisosteus spatula*[8,37,86,87]
	Percidae	3	14.3%	*Etheostoma lepidum*[56,86], *Etheostoma stigmaeum*[43], *Perca flavescens**[46]
Lasmigona complanata[+] (10)	Catostomidae	1	10.0%	*Moxostoma congestum*[85]
	Centrarchidae	4	40.0%	*Lepomis cyanellus*[15,16,37,46,51,86,89], *Lepomis humilis*[16,51,86,89], *Micropterus salmoides*[15,16,37,44,51,86,89], *Pomoxis annularis*[15,16,37,44,46,51,86,89]
	Clupeidae	1	10.0%	*Dorosoma cepedianum*[85,86]
	Cyprinidae	2	20.0%	*Cyprinus carpio**[15,16,37,44,46,86], *Notemigonus crysoleucas*[51]
	Lepisosteidae	1	10.0%	*Lepisosteus osseus*[85,86]
	Percidae	1	10.0%	*Sander canadensis**[85,86]
Leptodea fragilis (1)	Sciaenidae	1	100.0%	*Aplodinotus grunniens*[14,15,16,27,29,36,37,60,86,87]
Ligumia subrostrata (5)	Centrarchidae	5	100.0%	*Lepomis cyanellus*[14,36,37,46,62,86], *Lepomis gulosus*[36,62,86], *Lepomis humilis*[14,36,37,46,86], *Lepomis macrochirus*[14,36,37,62,86], *Micropterus salmoides*[14,36,37,46,86]
Megalonaias nervosa[+] (29)	Acipenseridae	1	3.5%	*Scaphirhynchus platorynchus*[X84]
	Amiidae	1	3.5%	*Amia calva*[15,28,36,37,86]
	Angullidae	1	3.5%	*Anguilla rostrata*[8,15,37,86,87]
	Centrarchidae	8	27.6%	*Lepomis cyanellus*[8,28,51,84,86,88], *Lepomis gulosus*[85,86], *Lepomis macrochirus*[8,15,28,37,50,51,77,86], *Lepomis megalotis*[43,50,51,77,86], *Micropterus punctulatus*[85,86], *Micropterus salmoides*[15,28,37,42,50,51,77,84,86], *Pomoxis annularis*[8,15,28,37,51,85,86], *Pomoxis nigromaculatus*[8,15,28,37,86]
	Clupeidae	2	6.9%	*Alosa chrysochloris*[8,15,37,86,87], *Dorosoma cepedianum*[8,15,28,37,85,86]
	Cyprinidae	2	6.9%	*Campostoma anomalum*[51,77,86], *Notemigonus crysoleucas*[84]
	Ictaluridae	6	20.7%	*Ameiurus melas*[8,15,28,37,51,64,84,86,88], *Ameiurus natalis*[64,84], *Ameiurus nebulosus*[8,15,37,51,64,86], *Ictalurus punctatus*[8,15,28,37,51,64,86,88], *Noturus gyrinus*[8,37,64,86], *Pylodictis olivaris*[8,15,28,37,64,85,86]
	Lepisosteidae	2	6.9%	*Lepisosteus oculatus*[43], *Lepisosteus osseus*[50,77,85,86]
	Moronidae	1	3.5%	*Morone chrysops*[8,15,28,37,51,85,86,87]
	Percidae	4	13.8%	*Perca flavescens**[50,51,77,86], *Percina caprodes*[50,77,86], *Percina phoxocephala*[50,77,86], *Sander canadensis**[15,28,37]

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Table 1, continued.

Species	Host Family	Total Hosts	% of Total	Host Species
	Sciaenidae	1	3.5%	*Aplodinotus grunniens*[8,15,28,36,37,51,63,85,87]
Obliquaria reflexa+ (9)	Centrarchidae	4	44.4%	*Lepomis megalotis*[43], *Lepomis miniatus*[43], *Micropterus punctulatus*[43], *Micropterus salmoides*[43]
	Cyprinidae	3	33.3%	*Cyprinella venusta*[43], *Luxilus chrysocephalus*[78], *Rhinichthys cataractae*[36,78,80,86]
	Lepisosteidae	1	11.1%	*Lepisosteus oculatus*[43]
	Percidae	1	11.1%	*Etheostoma stigmaeum*[43]
Plectomerus dombeyanus (2)	Cyprinidae	1	50.0%	*Cyprinella lutrensis*[49]
	Fundulidae	1	50.0%	*Fundulus notatus*[49]
*Pleurobema riddellii*X (2)	Cyprinidae	2	100.0%	*Cyprinella lutrensis*[49], *Pimephales vigilax*[49]
*Popenaias popeii*X+ (28)	Catostomidae	3	10.7%	*Carpiodes carpio*[5,36,47], *Cycleptus elongatus*X[5,47], *Moxostoma congestum*[5,36,47]
	Centrarchidae	5	17.9%	*Lepomis cyanellus*[5,47], *Lepomis macrochirus*[5,47], *Lepomis megalotis*[5,47], *Micropterus punctulatus*[47], *Micropterus salmoides*[5,47]
	Characidae	1	3.6%	*Astyanax mexicanus*[5,35,47]
	Cichlidae	1	3.6%	*Herichthys cyanoguttatum*[5,35]
	Clupeidae	1	3.6%	*Dorosoma cepedianum*[5]
	Cyprinidae	8	28.6%	*Campostoma anomalum*[5,47], *Cyprinella lutrensis*[5,47], *Cyprinus carpio**[5,47], *Dionda episcopa*[5,47], *Hybognathus placitus*[5,47], *Macrhybopsis aestivalis*[5,47], *Notropis jemezanus*[5,47], *Pimephales promelas*[5,47]
	Fundulidae	2	7.1%	*Fundulus zebrinus*[5,47], *Lucania parva*[5,47]
	Ictaluridae	4	14.3%	*Ameiurus natalis*[5,47], *Ictalurus lupus*[47], *Ictalurus punctatus*[5,47], *Pylodictis olivaris*[47]
	Lepisosteidae	1	3.6%	*Lepisosteus osseus*[5,35,47]
	Percidae	1	3.6%	*Etheostoma lepidum*[5,35,47]
	Poeciliidae	1	3.6%	*Gambusia affinis*[5,35,47]
Potamilus ohiensis (3)	Centrarchidae	1	33.3%	*Pomoxis annularis*[15,27,36,37,63,86,87]
	Fundulidae	1	33.3%	*Fundulus notatus*[15]
	Sciaenidae	1	33.3%	*Aplodinotus grunniens*[15,16,27,29,36,37,60,63,86,87]
Potamilus purpuratus+ (4)	Centrarchidae	1	25.0%	*Lepomis gulosus*[30,86]
	Cyprinidae	2	50.0%	*Cyprinella lutrensis*[49], *Notemigonus crysoleucas*[30,86]
	Sciaenidae	1	25.0%	*Aplodinotus grunniens*[29,35,36,37,63,86,87]
Pyganodon grandis+ (33)	Atherinopsidae	1	3.0%	*Labidesthes sicculus*[15,37,65,86]
	Catostomidae	1	3.0%	*Carpiodes carpio*[6]
	Centrarchidae	8	24.2%	*Ambloplites rupestris**[15,37,44,65,67,86], *Lepomis cyanellus*[15,37,65,67,86,87], *Lepomis humilis*[1,86], *Lepomis macrochirus*[6,15,37,44,54,65,81,86,87], *Lepomis megalotis*[15,37,54,86], *Micropterus salmoides*[6,15,37,54,65,81,86,87], *Pomoxis annularis*[6,15,37,44,81,86,87], *Pomoxis nigromaculatus*[15,37,65,86,87]
	Cichlidae	1	3.0%	*Herichthys cyanoguttatum*[34,86]
	Clupeidae	2	6.1%	*Alosa chrysochloris*[15,37,63,86,87], *Dorosoma cepedianum*[15,37,63,86,87]

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Table 1, continued.

Species	Host Family	Total Hosts	% of Total	Host Species
	Cyprinidae	8	24.2%	*Campostoma anomalum*[15,37,65,86], *Carassius auratus**[81,86], *Cyprinus carpio**[6,15,37,44,86], *Luxilus chrysocephalus*[44,57,65], *Lythrurus umbratilis*[15,37,65,86], *Notemigonus crysoleucas*[15,37,44,65,86], *Pimephales notatus*[15,37,65,86], *Semotilus atromaculatus*[37,65,81,86]
	Fundulidae	1	3.0%	*Fundulus chrysotus*[54,86]
	Ictaluridae	2	6.1%	*Ameiurus natalis*[15,37,64,86,87], *Ameiurus nebulosus*[37,86]
	Lepisosteidae	2	6.1%	*Lepisosteus osseus*[15,37,65,86], *Lepisosteus spatula*[15,37,87]
	Moronidae	1	3.0%	*Morone chrysops*[15,86,87]
	Percidae	3	9.1%	*Etheostoma caeruleum*[15,37,65,86], *Perca flavescens**[37,38,39,44,65,86], *Sander vitreus**[41]
	Poeciliidae	2	6.1%	*Gambusia affinis*[86], *Poecilia reticulata**[81,86]
	Sciaenidae	1	3.0%	*Aplodinotus grunniens*[15,36,37,86,87]
Quadrula mortoni^{+} (5)	Centrarchidae	3	60.0%	*Lepomis megalotis*[49], *Micropterus punctulatus*[49], *Micropterus salmoides*[49]
	Clupeidae	1	20.0%	*Dorosoma cepedianum*[49]
	Cyprinidae	1	20.0%	*Cyprinella lutrensis*[49]
Quadrula nobilis (2)	Ictaluridae	2	100.0%	*Ictalurus punctatus*[33,34,36,64,86], *Pylodictis olivaris*[33,34,36,64,86]
Quadrula nodulata (9)	Centrarchidae	4	44.4%	*Lepomis macrochirus*[14,15,28,37], *Micropterus salmoides*[14,15,28,37], *Pomoxis annularis*[8,15,37,61,63,87], *Pomoxis nigromaculatus*[14,15,28,37]
	Ictaluridae	5	55.6%	*Ameiurus melas*[36,61], *Ameiurus nebulosus*[36,61], *Ictalurus furcatus*[36,61], *Ictalurus punctatus*[8,14,15,37,61,64,87], *Pylodictis olivaris*[8,14,15,37,61,64]
Quadrula pustulosa^{+} (6)	Acipenseridae	1	16.7%	*Scaphirhynchus platorynchus*[X][8,14,16,37,86]
	Centrarchidae	1	16.7%	*Pomoxis annularis*[14,15,16,37,63,86,87]
	Ictaluridae	4	66.7%	*Ameiurus melas*[8,14,15,16,27,28,36,37,64,86], *Ameiurus nebulosus*[8,14,15,16,28,36,37,64,86], *Ictalurus punctatus*[8,14,15,16,27,28,29,36,37,64,85,86], *Pylodictis olivaris*[8,14,15,16,27,28,36,37,64,86,87]
Quadrula quadrula (4)	Centrarchidae	2	50.0%	*Lepomis cyanellus*[16,71], *Lepomis megalotis*[16,71]
	Ictaluridae	2	50.0%	*Ictalurus punctatus*[16,36,59,64,86], *Pylodictis olivaris*[15,16,29,37,59,64,86]
Quadrula verrucosa^{+} (6)	Cyprinidae	1	16.7%	*Notropis texanus*[49]
	Ictaluridae	3	50.0%	*Ameiurus natalis*[26,36,55,64,86], *Ameiurus nebulosus*[23,26,36,64,86], *Pylodictis olivaris*[24,26,33,34,36,64,86]
	Percidae	1	16.7%	*Etheostoma asprigene*[49]
	Poeciliidae	1	16.7%	*Gambusia affinis*[49]
Strophitus undulatus^{+} (28)	Centrarchidae	9	32.1%	*Ambloplites rupestris**[17,18,86], *Lepomis auritus**[13], *Lepomis cyanellus*[7,13,14,15,16,37,86], *Lepomis macrochirus*[7,13,16,19,22,86], *Lepomis microlophus*[81,86], *Micropterus dolomieu**[7,86], *Micropterus salmoides*[2,7,15,16,17,18,19,22,37,86], *Pomoxis annularis*[78,79,86], *Pomoxis nigromaculatus*[7,86]
	Cyprinidae	6	21.4%	*Campostoma anomalum*[7,18,86], *Notropis stramineus*[78,79,86], *Pimephales notatus*[7,78,79,86], *Pimephales promelas*[7,16,19,22,86], *Rhinichthys cataractae*[7,17,18,78,79,86], *Semotilus atromaculatus*[2,7,15,16,37,86]
	Fundulidae	1	3.6%	*Fundulus zebrinus*[14,86]

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Table 1, continued.

Species	Host Family	Total Hosts	% of Total	Host Species
	Ictaluridae	4	14.3%	*Ameiurus melas*[7,16,19,22,64,86], *Ameiurus natalis*[7,16,18,19,22,64,86], *Ameiurus nebulosus*[82], *Ictalurus punctatus*[7,64,86]
	Percidae	6	21.4%	*Etheostoma caeruleum*[7,81,86], *Perca flavescents**[7,17,18,86], *Percina caprodes*[7,82,86], *Percina maculata*[X][7,86], *Percina phoxocephala*[7,86], *Sander vitreus**[16,19,22,86]
	Salamandridae	1	3.6%	*Notophthalmus viridescens*[18,86]
	Salmonidae	1	3.6%	*Oncorhynchus mykiss**[18,86]
	Transformation without a host[29,45,46,67,86]			
Toxolasma parvum (6)	Centrarchidae	6	100.0%	*Lepomis cyanellus*[14,16,20,37,48,71,86], *Lepomis gulosus*[15,16,37,48,71,86,87], *Lepomis humilis*[14,16,37,48,71,86], *Lepomis macrochirus*[16,37,48,71,83,86], *Micropterus salmoides*[71], *Pomoxis annularis*[14,16,37,48,71,86]
Toxolasma texasensis (3)	Centrarchidae	3	100.0%	*Lepomis gulosus*[36,37,62], *Lepomis macrochirus*[36,62], *Lepomis megalotis*[36,37,62]
Truncilla donaciformis (2)	Percidae	1	50.0%	*Sander canadensis**[15,16,36,37,63,86,87]
	Sciaenidae	1	50.0%	*Aplodinotus grunniens*[15,16,22,27,29,36,37,60,63,86,87]
Truncilla truncata (2)	Percidae	1	50.0%	*Sander canadensis**[14,15,16,36,37,86,87]
	Sciaenidae	1	50.0%	*Aplodinotus grunniens*[14,15,16,29,36,37,49,60,86,87]
Uniomerus tetralasmus (1)	Cyprinidae	1	100.0%	*Notemigonus crysoleucas*[16,35,36,37,62,86]
Utterbackia imbecillis[+] (20)	Ambystomatidae	1	5.0%	*Ambystoma tigrinum*[75,76]
	Centrarchidae	8	40.0%	*Ambloplites rupestris**[15,37,65,86], *Lepomis cyanellus*[15,37,65,66,67,86], *Lepomis gulosus*[15,37,62,86], *Lepomis macrochirus*[15,37,42,62,65,83,86], *Lepomis marginatus*[37,62,86], *Lepomis megalotis*[15,52,86], *Micropterus salmoides*[15,37,42,65,76,86], *Pomoxis nigromaculatus*[21,86]
	Cyprinidae	4	20.0%	*Carassius auratus**[75,76], *Luxilus chrysocephalus*[83], *Notemigonus crysoleucas*[42,86], *Semotilus atromaculatus*[6,14,15,37,86]
	Ictaluridae	1	5.0%	*Ictalurus punctatus*[42,64,86]
	Percidae	2	10.0%	*Etheostoma lepidum*[34,37,86], *Perca flavescens**[37,65,86]
	Poeciliidae	3	15.0%	*Gambusia affinis*[15,37,62,86], *Poecilia reticulata**[75,76], *Xixphophorus hellerii**[75,76]
	Ranidae	1	5.0%	*Rana catesbeiana*[75,76]
	Transformation without a host[10,29,36,37,67,86]			
Villosa lienosa[+] (12)	Centrarchidae	8	66.7%	*Lepomis cyanellus*[9], *Lepomis humilis*[9], *Lepomis macrochirus*[9,36,42,43,86], *Lepomis marginatus*[43], *Lepomis megalotis*[9,43], *Lepomis microlophus*[9], *Micropterus punctulatus*[43], *Micropterus salmoides*[9,36,42,86]
	Cyprinidae	1	8.3%	*Cyprinella venusta*[43]
	Ictaluridae	2	16.7%	*Ameiurus nebulosus*[36,64,86], *Ictalurus punctatus*[36,42,64,86]
	Lepisosteidae	1	8.3%	*Lepisosteus oculatus*[43]

* - A non-native fish species.

[X] - A state or federally-listed species.

[+] - Unequal ($P<0.05$) host family usage by a mussel species.

Four state-listed threatened fish species were identified as hosts, including *Percina maculata*, a host for *Quadrula verrucosa* and *Strophitus undulatus*; *Erimyzon oblongus*, a host for *Arcidens confragosus*; *Scaphirhynchus platorynchus*, a host for *Lampsilis teres*, *Megalonaias nervosa*, and *Quadrula pustulosa*; and *Cycleptus elongates*, a host for *Popenaias popeii*, which is also state-threatened (Table 1). Several non-native fish species known to occur in Texas were identified as hosts for Texas mussels, including *Perca flavescens*, *Cyprinus carpio*, and *Poecilia reticulata*, which are hosts to nine, five, and four mussel species, respectively (Table 1).

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Table 2. The host families and the number of host species of each family utilized by the mussels of Texas.

Host Family	Total Species Utilized	% Host Family is Utilized
Achiridae	1	1.1%
Acipenseridae	1	1.1%
Ambystomatidae*	1	1.1%
Amiidae	1	1.1%
Anguilidae	1	1.1%
Atherinopsidae	1	1.1%
Catostomidae	8	8.2%
Centrarchidae	16	16.5%
Characidae	1	1.1%
Cichlidae	1	1.1%
Clupeidae	2	2.1%
Cyprinidae	21	22.1%
Engraulidae	1	1.1%
Esocidae	1	1.1%
Fundulidae	5	5.3%
Ictaluridae	9	9.5%
Lepisosteidae	4	4.2%
Moronidae	1	1.1%
Percidae	12	12.4%
Poeciliidae	3	3.2%
Ranidae*	1	1.1%
Salamandridae*	1	1.1%
Salmonidae	1	1.1%
Sciaenidae	1	1.1%
Total	**95**	**100%**

* - An amphibian species.

The vast majority of host studies to date have focused on fish species, with little research conducted on amphibian species as hosts for mussels. From the literature review, three mussel species were found to utilize amphibian larvae as hosts, specifically, *Lampsilis cardium* utilizes *Ambystoma tigrinum*; *S. undulatus* utilizes *Notophthalmus viridenscens*; and *Utterbackia imbecillis* utilizes both *A. tigrinum* and *Rana catesbeiana* (Table 1). The literature review also revealed evidence that the glochidia of two Texas mussel species, *S. undulatus* and *U. imbecillis,* can metamorphose into juvenile mussels without the use of a host (Table 1), instead the glochidia transformed while still within the female and were released as full formed juvenile mussels. Notably, both mussel species also utilize a fairly wide range of host organisms including amphibians and non-native fish species (Table 1).

Of Texas' 52 mussel species, 39 had some host data available (Table 1). The chi-square goodness of fit analysis indicated that 22 mussel species used a particular host family significantly more than other host families (Table 1). For example, we found that *Anodonta suborbiculata* utilized Centrarchidaes as hosts significantly more than any of its other known host families. Only seven mussel species utilized host families evenly, and the remaining ten mussel species only had host data available for host species from a single family (Table 1). It should be noted that these host family preferences were calculated using only the host data currently available in the literature and may not indicate a true preference for a host family by the mussel species in a natural setting. The indication of a preferred host family could have been caused by bias in the research toward a particular host family or the lack of available data regarding all host species utilized by a particular mussel species; therefore, as more host species research is conducted, host family preferences indicated within Table 1 are likely to be modified.

Because laboratory studies often over estimate the number of hosts usable by a mussel species (Levine et al. 2012) and the majority (65%) of available sources were laboratory-based studies, it is important to note that future studies for Texas mussel host identification may not support all findings compiled in Table 1. Additionally, there are likely other species utilized as hosts for mussels in Texas that have not yet been investigated, especially those species which are rare and/or endemic to Texas (Table 1).

Because of the limitations relating to laboratory and field-based studies, neither type of study alone is likely to provide a complete picture of the host species utilized by a mussel species in a natural setting (Levine et al. 2012). Due to these limitations, it is ideal that a combination of these studies be utilized when attempting to confirm host species. For example, it is recommended that laboratory-based studies conducted to demonstrate whether an organism may be used as a host be followed with field-based studies to further verify that the host in question is utilized by the mussel species in a natural setting. Conversely, it is recommended that researchers observe the transformation of glochidia on wild-caught fish, rather than determining the species to be a useable host simply based on the presence of glochidia.

Of the 13 mussel species in Texas with no available host data, ten of these are state threatened species (Table 3). Very little life history information of any kind was available for the majority of Texas' state threatened mussel species, though some data was available for *P. popeii* (Carman 2007; Levine et al. 2012). Typically, reports and papers only indicate locations where state-listed threatened species have been found along with some generalized habitat information, but do not expand in depth on life history information (Howells 1995; Howells 1996a, 1996b, 1997a, 1998, 1999, 2000, 2001a, 2002a, 2003, 2004, 2005, 2006, 2010; Howells et al. 1996; Bordelon and Harrel 2004; Karatayev and Burlakova 2007, 2008; Ford et al. 2009, 2010; Randklev et al. 2009, 2011; Burlakova and Karatayev 2010; Perry et al. 2010; Burlakova et al. 2011). Though occurrence information is essential for determining those locations in need of conservation, extensive research into the life histories of state-listed threatened mussels in Texas is crucial if conservation efforts are to be successful.

As previously discussed, ten of the 15 state-listed threatened mussel species currently have no available data

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Table 3. The unionids of Texas with no available host species data and their corresponding state and federal listing status.

Species	State Status	Federal Status	Texas Endemic (Y/N)
Fusconaia lananensis	Threatened	Positive 90-day finding; 12-month finding after FY 2016	Y
Obovaria jacksoniana	Threatened	N/A	N
Potamilus amphichaenus	Threatened	Positive 90-day finding; 12-month finding after FY 2016	N
Potamilus metnecktayi	Threatened	Positive 90-day finding; 12-month finding after FY 2016	N
Quadrula apiculata	N/A	N/A	N
Quadrula aurea	Threatened	Candidate*; Proposed rule after FY 2016	Y
Quadrula couchiana	N/A	N/A	N
Quadrula houstonensis	Threatened	Candidate*; Proposed rule after FY 2016	Y
Quadrula mitchelli	Threatened	Positive 90-day finding; 12-month finding after FY 2016	N
Quadrula petrina	Threatened	Candidate*; Proposed rule after FY 2016	Y
Truncilla cognata	Threatened	Positive 90-day finding; 12-month finding after FY 2016	N
Truncilla macrodon	Threatened	Candidate*; Proposed rule after FY 2016	Y
Uniomerus declivis	N/A	N/A	N

Notes: N/A = Not Applicable, no specific listing status; **FY** = Fiscal Year.

* On October 6, 2011, the United States Fish and Wildlife Service (the Service) announced the completion of a status review and determined that the mussel species warranted listing under the Endangered Species Act (ESA).

Explanation for "Positive 90-day finding, and 12-month finding". Section 4(b) of ESA requires the Service to make a finding on whether a petition presents substantial scientific or commercial information to indicate that the petitioned action may be warranted; this is referred to as a 90-day finding. If the Service finds the petitioned action may be warranted, the ESA requires the Service to initiate a formal review to determine if the petitioned action is warranted and, if so, how it intends to proceed with the requested action. This second determination is referred to as a 12-month finding, and is normally made 12-months following the receipt of the petition.

Explanation for "after FY 2016". Depending on the species, the Service will either issue a 12-month finding or develop a proposed rule to list the species. The Service recently created a work plan and entered into two settlement agreements resulting from past lawsuits regarding actions under the listing program nationwide. This work plan focuses on preparing proposed and final rules for listing species that were already candidates (as of December 2010) and outlines the Service's intended listing activities from Fiscal Year (FY) 2011 through FY 2016. Therefore, the earliest the Service expects to begin work on a proposed rule for the central Texas mussels would be in FY 2017 (USFWS 2011a, 2011b).

Qon host species (Table 3). In addition, 12 of the 15 state-listed threatened species have been petitioned for federal listings (USFWS 2014). Six of these 12 species, including *P. popeii*, *Lampsilis bracteata*, *Quadrula aurea*, *Quadrula houstonensis*, *Quadrula petrina*, and *Truncilla macrodon* are currently candidate species for federal protection, and a proposed rule to list or withdraw the species is anticipated after fiscal year 2016 (USFWS 2014). The remaining six mussel species including *Fusconaia lananensis*, *Pleurobema riddellii*, *Potamilus amphichaenus*, *Potamilus metnecktayi*, *Quadrula mitchelli*, and *Truncilla cognata* have had positive 90-day findings and will undergo 12-month status reviews to determine if they warrant federal protection after fiscal year 2016 (USFWS 2014). Of these 12 species petitioned for federal listings, only two species, *P. popeii* and *L. bracteata*, have any host data available (Tables 1, 3).

This literature review on the known and/or potential hosts for the mussels of Texas is intended as a reference tool and foundation for future Texas host research. The threatened status of many Texas mussels at the state level and the potential addition of federal protection in the near future underscore the need for host information, which will greatly enhance the effectiveness of conservation and management of the remaining populations. A management protocol for the joint protection of mussel species and their respective host(s) species will likely be a fundamental component for the successful future conservation of imperiled mussels within Texas.

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REFERENCES

Note: The numbers added to the literature cited section identify the source of the host species information included in the "host species" column within Table 1.

[1] [LT]. Arey, L.B. 1932. The formation and structure of the glochidial cyst. Biological Bulletin 62:212-221.

[2] [LT]. Baker, F.C. 1928. The fresh water Mollusca of Wisconsin. Part II Pelecypoda. Bulletin of the Wisconsin Geological and Natural History Survey, University of Wisconsin 70(2):1-495.

[3] [LT]. Barnhart, M.C., A.D. Roberts, and A.P. Farnsworth. 1995. Fish hosts of four unionids from Missouri and Kansas. Triannual Unionid Report 7:23.

[4] [LT]. Barnhart, M.C. and A. Roberts. 1997. Reproduction and fish hosts from the Ozark Uplifts. Pages 16-20 *in* Cummings, K.S., Buchanan, A.C., Mayer, C.A. & T.J. Naimo (eds.), Conservation and Management of Freshwater Mussels II: Initiatives for the Future. Proceedings of a UMRCC symposium, 16-18 October 1995, St. Louis, Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois.

Bogan, A.E. 2008. Global diversity of freshwater mussels (Mollusca, Bivalvia) in freshwater. Hydrobiologia 595:139-147.

Bordelon, V.L. and R.C. Harrel. 2004. Freshwater mussels (Bivalvia:

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Unionidae) of the Village Creek drainage basin in southeast Texas. Texas Journal of Science 56:63-72.

Boyer, S.L., A.A. Howe, N.W. Juergens, and M.C. Hove. 2011. A DNA-barcoding approach to identifying juvenile freshwater mussels (Bivalvia: Unionidae) recovered from naturally infested fishes. Journal of the North American Benthological Society 30:182-194.

Braun, C.L., C.L. Stevens, P.D. Echo-Hawk, N.A. Johnson, and J.B. Moring. 2014. Abundance of host fish and frequency of glochidial parasitism in fish assessed in field and laboratory settings and frequency of juvenile mussels or glochidia recovered from hatchery-held fish, central and southeastern Texas, 2012-2013. Scientific Investigations Report No. 2014-5217. United States Geological Survey.

Burlakova, L.E. and A.Y. Karatayev. 2010. Statewide assessment of unionid diversity in Texas. State Wildlife Grant Report. Texas Parks and Wildlife Department, Austin, Texas.

Burlakova, L.E., A.Y. Karatayev, V.A. Karatayev, M.E. May, D.L. Bennett, and M.J. Cook. 2011. Endemic species: Contribution to community uniqueness, effect of habitat alteration, and conservation priorities. Biological Conservation 144:155-165.

[5] [NS] Carman, S.M. 2007. Texas Hornshell *Popenaias popeii* Recovery Plan. New Mexico Game and Fish Conservation Services Division. Santa Fe, New Mexico.

[6] [NS]. Clarke, A.H. and C.O. Berg. 1959. The freshwater mussels of central New York. Memoir Cornell University Agricultural Experiment Station, N.Y. State College of Agriculture, Ithaca, N.Y. 367:1-79.

[7] [LT]. Cliff, M., M.C. Hove, and M. Haas. 2001. Creeper glochidia appear to be host generalists. Ellipsaria 3(1):18-19.

[8] [LI, LT, NI, NT]. Coker, R.E., A.F. Shira, H.W. Clark, and A.D. Howard. 1921. Natural history and propagation of fresh-water mussels. Bulletin of the Bureau of Fisheries. 37:77-181.

[9] [LT]. Daniel, W.M. and K.M. Brown. 2012. Reproductive biology and host fishes of four unionids from the Lake Pontchartrain Basin, Louisiana, U.S.A. Walkerana 15:11-16.

[10] [LT]. Dickson, B.D. and B.E. Sietman. 2008. Recent observation of metamorphosis without parasitism in *Utterbackia imbecillis*. Ellipsaria 10(1):7-8.

[11] [LT]. Draxler, B., M. Hove, S. Schieffer, M. Berg, G. Widiker, B. Sietman, D. Allen, and D. Hornbach. 2006. Suitable host fishes for Fat Mucket (*Lampsilis siliquoidea*) and Pocketbook (*Lampsilis cardium*) evaluated by high school and university researchers. Ellipsaria 8(1):11-12.

[12] [LT]. Duncan, A.E. and N.L. Eckert. 2009. Confirmation of glochidia hosts for Spike (*Elliptio dilatata*) from the Clinch River. Ellipsaria 11(3):17.

[13] [LT]. Eads, C.B., M.E. Raley, E.K. Schubert, A.E. Bogan, and J.F. Levine. 2007. Propagation and culture of freshwater mussels for release into North Carolina waters. Final Report. North Carolina Department of Transportation.

Ford, N.B., J. Gullet, and M.E. May. 2009. Diversity and abundance of unionid mussels in three sanctuaries on the Sabine River in northeast Texas. Texas Journal of Science 61:279-294.

Ford, N.B., L. Williams, and M. Williams. 2010. Surveys of rare freshwater unionids and fish in the upper reaches of the Sabine River to gather population information on threatened species. State Wildlife Grant Report. Texas Parks and Wildlife Department, Austin, Texas.

[14] [NS]. Fuller, S.L.H. 1978. Fresh-water mussels (Mollusca: Bivalvia: Unionidae) of the Upper Mississippi River: Observations at selected sites within the 9-foot channel navigation project on behalf of the U.S. Army Corps of Engineers. Final Report. U.S. Army Corp of Engineers No. 78-33.

[15] [NS]. Gordon, M.E. and J.B. Layzer. 1989. Mussels (Bivalvia: Unionoidea) of the Cumberland River. Review of Life Histories and Ecological Relationships. Biological Report 89(15.

[16] [NS]. Grabarkiewicz, J.D. and T.C. Crail. 2013. Freshwater mussels of the Maumee Drainage, 2nd edition. Lucas Soil and Water Conservation District, Maumee, Ohio.

[17] [LT]. Gray, E.V.S., W.A. Lellis, J.C. Cole, and C.S. Johnson. 1999. Hosts of *Pyganodon cataracta* (Eastern Floater) and *Strophitus undulatus* (Squawfoot) from the Upper Susquehanna River Basin, Pennsylvania. Triannual Unionid Report 18:6.

[18] [LT]. Gray, E.V.S., W.A. Lellis, J.C. Cole, and C.S. Johnson. 2001. Host identification for *Strophitus undulatus* (Bivalvia: Unionidae), the Creeper, in the Upper Susquehanna River Basin, Pennsylvania. American Midland Naturalist 147:153-161.

Haag, W.R. 2012. North American freshwater mussels: natural history, ecology, and conservation. Cambridge University Press, Cambridge.

Haag, W.R. and M.L. Warren Jr. 1997. Host fishes and reproductive biology of 6 freshwater mussel species from the Mobile Basin, U.S.A. Journal of the North American Benthological Society 16:576-585.

Haag, W.R. and M.L. Warren Jr., 1999. Mantle displays of freshwater mussels elicit attacks from fish. Freshwater Biology 42:35-40.

Hendrickson, D.A. and A.E. Cohen. 2012. Fishes of Texas project and online database. The Texas Natural History Collection, a division of the Texas Natural Science Center, University of Texas at Austin. Available at www.fishesoftexas.org (accessed June, 2014)

Hoggarth, M.A. 1992. An examination of the glochidia-host relationships reported in the literature for North American species of Unionacea (Mollusca: Bivalvia). Malacology Data Net 3:1-30.

[19] [LT]. Hove, M.C. 1995. Early life history research on the Squawfoot, *Strophitus undulatus*. Triannual Unionid Report 7:28-29.

[20] [LT]. Hove, M.C. 1995. Suitable fish hosts of the Lilliput, *Toxolasma parvus*. Triannual Unionid Report 8:9.

Hove, M.C. and R.J. Neves. 1994. Life history of the endangered James Spinymussel *Pleurobema collina* (Conrad, 1837) (Mollusca: Unionidae). American Malacological Bulletin 11:29-40.

[21] [LT]. Hove, M.C., R.A. Engelking, M.E. Peteler, and E.M. Peterson. 1995. *Anodontoides ferussacianus* and *Anodonta imbecillis* host suitability tests. Triannual Unionid Report 6:23.

[22] [LT]. Hove, M.C., R.A. Engelking, M.E. Peteler, E.M. Peterson, A.R. Kapuscinski, L.A. Sovell, and E.R. Evers. 1997. Suitable fish hosts for glochidia of four freshwater mussels. Pages 21-25 *in* Cummings, K.S., A.C. Buchanan, C.A. Mayer, and T.J. Naimo (eds.), Conservation and Management of Freshwater Mussels II: Initiatives for the Future. Proceedings of a UMRCC symposium, 16-18 October 1995, St. Louis, Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois.

[23] [LT]. Hove, M.C., J.E. Kurth, and A.R. Kapuscinski. 1998. Brown Bullhead suitable host for *Tritogonia verrucosa*; *Cumberlandia monodonta* host(s) remain elusive. Triannual Unionid Report 15:13.

[24] [LT]. Hove, M.C., M. Berg, S. Schieffers, G. Widiker, V. Kanodia, K. Yngve, C. Nelson, M. Marzec, D. Hornbach, and A.R. Kapuscinski. 2004. High school and university researchers verify Flathead Catfish as host for Pistolgrip (*Tritogonia verrucosa*). Ellipsaria 6(3):16-18.

[25] [LT]. Hove, M.C., A. Fulton, K. Wolf, B. Sietman, D. Hornbach, S. Boyer, and N. Ward. 2011. Additional suitable hosts identified for Rock Pocketbook (*Arcidens confragosus*). Ellipsaria 13(3):6-7.

[26] [LT]. Hove, M.C., B.E. Sietman, J.E. Bakelaar, J.A. Bury, D.J. Heath, V.E. Pepi, J.E. Kurth, M.J. Davis, D.J. Hornbach, and A.R. Kapuscinski. 2011. Early life history and distribution of Pistolgrip (*Tritogonia verrucosa* (Rafinesque, 1820)) in Minnesota and Wisconsin. American Midland Naturalist 165:338-354.

[27] [NI]. Howard, A.D. 1913. The catfish as a host for fresh-water mussels. Transactions of the American Fisheries Society 42:65-70.

[28] [LI, LT, NI]. Howard, A.D. 1914. Experiments in propagation of fresh-water mussels of the *Quadrula* group. Report of the U.S. Commissioner of Fisheries for 1913, Appendix 4:1-52.

[29] [LI, LT, NI]. Howard, A.D. and B.J. Anson. 1922. Phases in the parasitism of the Unionidae. Journal of Parasitology 9:68-82.

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Howells, R.G. 1995. Distributional surveys of freshwater bivalves in Texas: progress report for 1993. Texas Parks and Wildlife Department Management Data Series 119. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas.

[30] [LT]. Howells, R.G. 1995. Rio Grande Bleufer. Info-Mussel Newsletter 3(1):1.

Howells, R.G. 1996a. Distributional surveys of freshwater bivalves in Texas: progress report for 1994. Texas Parks and Wildlife Department Management Data Series 120. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 57 pp.

Howells, R.G. 1996b. Distributional surveys of freshwater bivalves in Texas: progress report for 1995. Texas Parks and Wildlife Department Management Data Series 125. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 45 pp.

[31] [LT]. Howells, R.G. 1996c. Host determination work. Info-Mussel Newsletter 4(6):6.

[32] [LT]. Howells, R.G. 1996d. Host determination work. Info-Mussel Newsletter 4(7):11.

[33] [LT]. Howells, R.G. 1996e. Pistolgrip and Gulf Mapleleaf hosts. Info-Mussel Newsletter 4(3):3.

Howells, R.G. 1997a. Distributional surveys of freshwater bivalves in Texas: progress report for 1996. Texas Parks and Wildlife Department Management Data Series 144. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 58 pp.

[34] [LT]. Howells, R.G. 1997b. New fish hosts for nine freshwater mussels (Bivalvia: Unionidae) in Texas. Texas Journal of Science 49:255-258.

Howells, R.G. 1998. Distributional surveys of freshwater bivalves in Texas: progress report for 1997. Texas Parks and Wildlife Department Management Data Series 147. Texas Parks and Wildlife Inland Fisheries Division Austin, Texas. 30 pp.

Howells, R.G. 1999. Distributional surveys of freshwater bivalves in Texas: progress report for 1998. Texas Parks and Wildlife Department Management Data Series 161. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 34 pp.

Howells, R.G. 2000. Distributional surveys of freshwater bivalves in Texas: progress report for 1999. Texas Parks and Wildlife Department Management Data Series 170. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 56 pp.

Howells, R.G. 2001a. Distributional surveys of freshwater bivalves in Texas: progress report for 2000. Texas Parks and Wildlife Department Management Data Series 187. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 50 pp.

Howells, R.G. 2001b. Introduced non-native fishes and shellfishes in Texas waters: An updated list and discussion. Texas Parks and Wildlife Department, Austin, Texas. 27 pp.

Howells, R.G. 2002a. Distributional surveys of freshwater bivalves in Texas: progress report for 2001. Texas Parks and Wildlife Department Management Data Series 200. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 28 pp.

[35] [NS]. Howells, R.G. 2002b. Project WER49(90): Survey of abundance, distribution, and general biology of Texas Hornshell (*Popenaias popei*) and other unionids in the Rio Grande, Texas. Texas Parks and Wildlife Department, Austin, Texas. 90 pp.

Howells, R.G. 2003. Distributional surveys of freshwater bivalves in Texas: progress report for 2002. Texas Parks and Wildlife Department Management Data Series 214. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 42 pp.

Howells, R.G. 2004. Distributional surveys of freshwater bivalves in Texas: progress report for 2003. Texas Parks and Wildlife Department Management Data Series 222. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 48 pp.

Howells, R.G. 2005. Distributional surveys of freshwater bivalves in Texas: progress report for 2004. Texas Parks and Wildlife Department Management Data Series 233. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 23 pp.

Howells, R.G. 2006. Statewide freshwater mussel survey. State Wildlife Grant Report. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 106 pp.

Howells, R.G. 2010. Rare mussels: Summary of selected biological and ecological data for Texas. Biostudies, Kerrville, Texas. 122 pp.

[36] [NS]. Howells, R.G. 2014. Field guide to Texas freshwater mussels, 2nd Edition. BioStudies, Kerrville. 141 pp.

[37] [NS]. Howells, R.G., R.W. Neck, and H.D. Murray. 1996. Freshwater mussels of Texas. Texas Parks and Wildlife Inland Fisheries Division, Austin, Texas. 218 pp.

[38] [NI]. Jansen, W.A. 1991. Seasonal prevalence, intensity of infestation, and distribution of glochidia of *Anodonta grandis simpsoniana* Lea on Yellow Perch, *Perca flavescens*. Canadian Journal of Zoology 69:964-972.

[39] [NI]. Jansen, W.A. and J.M. Hanson. 1991. Estimates of the number of glochidia produced by clams (*Anodonta grandis simpsoniana* Lea) attaching to Yellow Perch (*Perca flavescens*), and surviving to various ages in Narrow Lake, Alberta. Canadian Journal of Zoology 69:973-977.

[40] [LT]. Johnson, M.S., P.D. Caccavale, C.R. Randklev, and J.R. Gibson. 2012. New and confirmed fish hosts for the threatened freshwater mussel *Lampsilis bracteata* (Gould, 1855), the Texas Fatmucket (Bivalvia: Unionidae). The Nautilus 126:148-149.

[41] [NI]. Jurgens, N.W., S.L. Boyer, M.C. Hove, J.B. Eckstein, and J.N. Ramirez. 2011. Survey of unionid mussels naturally infesting Walleye in the Saint Croix River. Ellipsaria 13(1):14.

Karatayev, A.Y. and L.E. Burlakova. 2007. East Texas mussel survey. State Wildlife Grant Report. Texas Parks and Wildlife Department, Austin, Texas. 40 pp.

Karatayev, A.Y. and L.E. Burlakova. 2008. Distributional survey and habitat utilization of freshwater mussels. Interagency Final Report. Texas Water Development Board. 47 pp.

Kat, P.W. 1984. Parasitism and the Unionacea (Bivalvia). Biological Reviews 59:189-207.

[42] [LT]. Keller, A.E. and D.S. Ruessler. 1997. Determination or verification of host fish for nine species of unionid mussels. American Midland Naturalist 138:402-407.

[43] [NI]. Kennedy, T.B. 2009. Aquatic community organization in a diverse floodplain river fish fauna of the southeastern United States. Ph.D. Dissertation, The University of Alabama, Tuscaloosa Alabama. 256 pp.

[44] [LT, NI]. Lefevre, G. and W.C. Curtis. 1910. Reproduction and parasitism in the Unionidae. Journal of Experimental Zoology 9:79-115.

[45] [LT]. Lefevre, G. and W.C. Curtis. 1911. Metamorphosis without parasitism in the Unionidae. Science 33:863-865.

[46] [LI, LT]. Lefevre, G. and W.C. Curtis. 1912. Studies on the reproduction and artificial propagation of fresh-water mussels. Bulletin of the Bureau of Fisheries 30(1910):105-201.

[47] [LT, NI]. Levine, T.D., B.K. Lang, and D.J. Berg. 2012. Physiological and ecological hosts of *Popenaias popeii* (Bivalavia: Unionidae): Laboratory studies identify more hosts than field studies. Freshwater Biology 57:1854-1864.

Lydeard, C., R.H. Cowie, F.P. Winston, A.E. Bogan, P. Bouchet, S.A. Clark, K.S. Cummings, T.J. Frest, O. Gargominy, D.G. Herbert, R. Hershler, K.E. Perez, B. Roth, M. Seddon, E.E. Strong, and F.G. Thompson. 2004. The global decline of nonmarine mollusks. Bioscience 54:321–330.

[48] [LT]. Mermillirod, W. 1973. An investigation of the natural host of the glochidia of Toxolasma parva. Undergraduate research paper, Louisiana State University, Baton Rouge. Pages 215-273 *in* Hart, C.W. and S.L.H. Fuller (eds.), Clams and mussels (Mollusca: Bivalvia). Pollution ecology of freshwater invertebrates. Academic Press, New York.

[49] [NI]. Marshall, N.T. 2014. Identification of potential fish hosts from wild populations of state-threatened east Texas freshwater mussels using a

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molecular identification dataset. Master's thesis, The University of Texas at Tyler, Tyler, Texas. 112 pp.

Master, L.L., B.A. Stein, L.S. Kutner, and G.A. Hammerson. 2000. Vanishing assets: conservation status of U.S. species. Pages 93-118 *in* Stein, B.A., L.S. Kutner, and J.S. Adams (eds.). The Status of Biodiversity in the United States. Precious Heritage. Oxford University Press, Oxford.

[50] [LT]. O'Dee, S.H. and G.T. Watters. 2000. New or confirmed host identifications for ten freshwater mussels. Pages 77-82 *in* Proceedings of the Conservation, Captive Care, and Propagation of Freshwater Mussels Symposium, 1998.

[51] [NS]. Pandolfo, T., T.J. Kwak, and W.G. Cope. 2012. Thermal tolerances of freshwater mussels and their host fishes: Species interactions in a changing climate. Walkerana 15:69-82.

[52] [LT]. Parker, R.S., M.F. Vidrine, and C.T. Hackney. 1980. A new centrarchid host for the Paper Pondshell, *Anodonta imbecillis* Say (Bivalvia: Unionidae). Association of Southeast Biologists Bulletin 27:54-55.

[53] [LT, NI]. Parker, R.S., C.T. Hackney, and M.F. Vidrine. 1984. Ecology and reproductive strategy of a south Louisiana freshwater mussel, *Glebula rotundata* (Lamarck) (Unionidae: Lampsilini). Freshwater Invertebrate Biology 3:53-58.

[54] [LT]. Penn, G.H. 1939. A study of the life cycle of the freshwater mussel, *Anodonta grandis*, in New Orleans. The Nautilus 52:99-101.

[55] [LT]. Pepi, V.E. and M.C. Hove. 1997. Suitable fish hosts and mantle display behavior of *Tritogonia verrucosa*. Triannual Unionid Report 11:5.

Perry, H., T. Jackson, and M. Scoggins. 2010. Inventory of freshwater mussels (Unionidae) in Austin, Texas. *Report*. Watershed Protection, City of Austin. 10 pp.

[56] [LT]. Prentice, J. 1994. Student wins science fair with mussel project. Info-Mussel Newsletter 2(3):5-6.

Randklev, C.R., J.H. Kennedy, and B.J. Lundeen. 2009. Distributional survey and habitat utilization of freshwater mussels (Family Unionidae) in the Lower Brazos and Sabine River Basins. Interagency Final Report. Texas Water Development Board. 78 pp.

Randklev, C.R., B.J. Lundeen, J.H. Kennedy, and S. Wolverton. 2011. Toledo Bend Relicensing Project: Lower Sabine River mussel study. Final Report. Sabine River Authority. 19 pp.

[57] [NI]. Read, L.B. and K.H. Oliver. 1953. Notes on the ecology of the fresh-water mussels of Dallas County. Field and Laboratory 21:75-80.

[58] [LT]. Schroeder, L., A. Edgcumbe, K. Murphy, S. Bump, A. Londo, and B. Sietman. 2014. Host fishes and glochidia release behavior of *Elliptio dilatata*. Ellipsaria 16(4):32-34.

[59] [LT]. Schwebach, M., D. Schriever, V. Kanodia, N. Dillon, M. Hove, M. McGill, and C. Nelson. 2002. Channel Catfish is a suitable host species for Mapleleaf glochidia. Ellipsaria 4(3):12-13.

[60] [LT]. Sietman, B.E., K. Bloodsworth, B. Bosman, A. Lager, M. Lyons, M.C. Hove, and S.L. Boyer. 2009. Freshwater Drum confirmed as a suitable host for *Leptodea*, *Potamilus*, and *Truncilla* species. Ellipsaria 11(3):18-19.

[61] [LT]. Sietman, B., M.C. Hove, K. Baumann, A. Edgcumbe, J. Jaka, K. Linde, J. Pfeiffer, K. Phillips, K., Weber, C. Weggler, S. Boyer, J. Eckstein, N. Juergen, and J. Ramirez. 2010. Suitable host fishes for the Wartyback mussel, *Quadrula nodulata*. Ellipsaria 12(3):19-20.

[62] [LT, NI]. Stern, E.M. and D.L. Felder. 1978. Identification of host fishes for four species of freshwater mussels (Bivalvia: Unionidae). American Midland Naturalist 100:233-236.

[63] [NI]. Suber, T. 1913. Notes on the natural hosts of fresh-water mussels. Bulletin of the Bureau of Fisheries 32(1912):103-116.

Strayer, D.L., J.A. Downing, W.R. Haag, T.L. King, J.B. Layzer, T.J. Newton, and S.J. Nichols. 2004. Changing perspectives on pearly mussels, North America's most imperiled animals. Bioscience 54:429–439.

Thomas, C., T.H. Bonner, and B.G. Whiteside. 2007. Freshwater fishes of Texas. Texas Department of Wildlife & Parks. 202 pp.

[64] [NS]. Tiemann, J.S., S.E. McMurray, C.M. Barnhart, and G.T. Watters. 2011. A review of the interactions between catfishes and freshwater mollusks in North America. Pages 733-743 *in* P.H. Michaletz and V.H. Travnichek, editors. Conservation, ecology, and management of catfish: the second international symposium. American Fisheries Society, Symposium 77, Bethesda, Maryland.

[65] [LT, NI]. Trdan, R.J. and W.R. Hoeh. 1982. Eurytopic host use by two congeneric species of freshwater mussel (Pelecypoda: Unionidae: *Anodonta*). American Midland Naturalist 108:381-388.

[66] [LT]. Tucker, M.E. 1927. Morphology of the glochidium and juvenile of the mussel *Anodonta imbecillis*. Transactions of the American Microscopical Society 46:286-293.

[67] [LT]. Tucker, M.E. 1928. Studies on the life cycles of two species of fresh-water mussels belonging to the genus *Anodonta*. Biological Bulletin 54:117-127.

U.S. Fish and Wildlife Service (USFWS). 2011a. Federal Status of the Texas Mussels Listed by the State of Texas. Available at http://www.fws.gov/southwest/es/Documents/R2ES/Status_Table_Texas_Mussels_Oct_2011.pdf (accessed July, 2014)

U.S. Fish and Wildlife Service (USFWS). 2011b. Frequently Asked Questions on the 12-month Finding for Five Central Texas Mussels. Available at http://www.fws.gov/southwest/es/Documents/R2ES/5_central_Texas_mussels_FAQs_2011.pdf (accesssed January, 2015).

Vaughn, C.C. and C.C. Hakenkamp. 2001. The functional role of burrowing bivalves in freshwater ecosystems. Freshwater Biology 46:1431-1446.

[68] [NI] Vaughn, C.C., M. Pyron, and D.L. Certain. 1993. Habitat use and reproductive biology of *Arkansia wheeleri* (Mollusca, Unionidae) in the Kiamichi River, Oklahoma. Final Report. Oklahoma Department of Wildlife Conservation. 118 pp.

[69] [LT]. Waller, D.L., L.E. Holland-Bartles, L.G. Mitchell, and T.W. Kammer. 1985. Artificial infestation of Largemouth Bass and Walleye with glochidia of *Lampsilis ventricosa* (Pelecypoda: Unionidae). Freshwater Invertebrate Biology 4:152-153.

[70] [LT]. Ward, N., B. Sietman, M.C. Hove, K. Baumann, A. Edgcumbe, and C. Weggler. 2011. Suitable host fishes for the Rock Pocketbook, *Arcidens confragosus*. Ellipsaria 13(1):27-28.

[71] [NS]. Watters, G.T. 1994. An annotated bibliography of the reproduction and propagation of the Unionoidea (primarily of North America). Ohio Biological Survey Miscellaneous Contributions. Ohio Division of Wildlife, Columbus, Ohio. 158 pp.

[72] [LT]. Watters, G.T. 1996. New hosts for *Lampsilis cardium.* Triannual Unionid Report 9:8.

[73] [LT]. Watters, G.T. 1997. Glochidial metamorphosis of the freshwater mussel *Lampsilis cardium* (Bivalvia: Unionidae) on larval Tiger Salamanders, *Ambystoma tigrinum* ssp. (Amphibia: Ambystomidae). Canadian Journal of Zoology 75:505-508.

[74] [LT]. Watters, G.T. and S.H. O'Dee. 1997. Identification of potential hosts: *Elliptio fisheriana* (Lea 1838), *Fusconaia masoni* (Conrad 1834), *Fusconaia flava* (Rafinesque 1820), and *Pleurobema clava* (Lamark 1819). Triannual Unionid Report 13:38-39.

[75] [LT]. Watters, G.T. and S.H. O'Dee. 1997. Surrogate hosts: transformation on exotic and non-piscine hosts. Triannual Unionid Report 11:35.

[76] [LT]. Watters, G.T. and S.H. O'Dee. 1998. Metamorphosis of freshwater mussel glochidia (Bivalvia: Unionidae) on amphibians and exotic fishes. American Midland Naturalist 139:49-57.

[77] [LT]. Watters, G.T. and S.H. O'Dee. 1998. Potential hosts for the washboard, *Megalonaias nervosa* (Rafinesque, 1820). Triannual Unionid Report 14:9.

[78] [LT]. Watters, G.T., S.W. Chordas, S.H. O'Dee, and J. Reiger. 1998. Host identification studies for six species of Unionidae (Abstract). *in* First Symposium of the Freshwater Mollusk Conservation Society, Chattanooga, TN.

[79] [LT]. Watters, G.T., S.H. O'Dee, and S. Chordas. 1998. New potential

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hosts for: *Strophitus undulatus* - Ohio River drainage; *Strophitus undulatus* - Susquehanna River drainage; *Alasmidonta undulata* - Susquehanna River drainage; *Actinonaias ligamentina* - Ohio River drainage; and *Lasmigona costata* - Ohio River drainage. Triannual Unionid Report 15:27-28.

[80] [LT]. Watters, G.T., S.H. O'Dee, S. Chordas, and J. Rieger. 1998. Potential hosts for *Lampsilis reeviana brevicula*, *Obliquaria reflexa*. Triannual Unionid Report 16:21-22.

[81] [LT]. Watters, G.T., T. Menker, S. Thomas, and K. Kuehnl. 2005. Host identifications or confirmations. Ellipsaria 7(2):11-12.

[82] [LT]. Watters, G.T., T. Menker, B. Smith, K. Harraman, and K. Kuehnl. 2006. Host identifications or confirmations. Ellipsaria 8(2):8.

[83] [LT]. Watters, G.T., T. Gibson, B. Smith, and K. Kuehnl. 2007. Host identifications or confirmations. Ellipsaria 9(2):2-3.

[84] [LT]. Watters, G.T., T. Gibson, and B. Kelly. 2009. Host identifications or confirmations. Ellipsaria 11(1):19.

[85] [NI]. Weiss, J.L. and J.B. Layzer. 1995. Infestations of glochidia on fishes in the Barren River, Kentucky. American Malacological Bulletin 11:153-159.

Williams, J.D., M.L. Warren, Jr., K.S. Cummings, J.L. Harris, and R.J. Neves. 1993. Conservation status of freshwater mussels of the United States and Canada. Fisheries 18:6-22.

[86] [NS]. Williams, J.D., A.E. Bogan, and J.T. Garner. 2008. Freshwater mussels of Alabama and the Mobile Basin in Georgia, Mississippi and Tennessee. University of Alabama Press, Tuscaloosa. 960 pp.

[87] [NI]. Wilson, C.B. 1916. Copepod parasites of fresh-water fishes and their economic relations to mussel glochidia. Bulletin of the Bureau of Fisheries 34:333-374.

[88] [LT]. Woody, C.A. and L. Holland-Bartels. 1993. Reproductive characteristics of a population of the Washboard mussel *Megalonaias nervosa* (Rafinesque 1820) in the Upper Mississippi River. Journal of Freshwater Biology 8:57-66.

[89] [LT]. Young, D. 1911. The implantation of the glochidium on the fish. University of Missouri Bulletin of Science Series 2:1-20.

Zale, A.V. and R.J. Neves. 1982. Fish hosts of four species of lampsiline mussels (Mollusca: Unionidae) in Big Moccasin Creek, Virginia. Canadian Journal of Zoology 60:2535-2542.

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