

ALL MUSSELS IN ALL HABITATS NARRATIVE

Problems affecting species and habitats

Species threats

Respondents ranked the following threats to all mussels in all habitats in Indiana:

Rank	Threats to all mussels in all habitats
1 (tie)	Habitat loss (breeding range)
1 (tie)	Habitat loss (feeding/foraging areas)
2	Specialized reproductive behavior or low reproductive rates
3	Viable reproductive population size or availability
4	High sensitivity to pollution
5	Unintentional take/ direct mortality (e.g., vehicle collisions, power line collisions, by-catch, harvesting equipment, land preparation machinery)
6	Dependence on other species (mutualism, pollinators)
7	Invasive/non-native species
8	Small native range (high endemism)
9	Predators (native or domesticated)
10	Genetic pollution (hybridization)

Respondents offered no additional threats to all mussels in all habitats in Indiana.

Respondents listed top threats to all mussels in all habitats in Indiana (not ranked):

- Instream dredging/habitat modifications
 - Dredging of headwater streams
 - From land use changes
 - Dredging/habitat loss of Kankakee drainage can result in large amounts of creek heelsplitters being lost
- Pollution/Runoff introducing streams, even if only temporary
 - Mostly agricultural
 - Pollution from Tippecanoe River system in Indiana
- Zebra mussels
- Unintentional take can result in large amounts of creek heelsplitters being lost
- Insuring that populations maintain critical larva-host connections
 - Dependence on other species: Requires fish host to reproduce; if fish populations decrease for any of a variety of reasons, then creek heelsplitter reproduction could decrease substantially
- Any factor that reduces reproductive population size

Appendix F-77: Mussels

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to all mussels in all habitats. Their responses included:

- While habitat loss is important, I would not necessarily rank it #1 threat. Suitable mussel habitats exist in many areas of IN but in these areas historic mussel populations continue to decline (EnviroScience, Inc. 2005 in prep). Reasons for declines are unknown but may be due to changes in river temperature and fish host assemblages from overall landscape level changes, but perhaps not necessarily water "quality".

I would rank non-point pollution from agriculture and development as the no 1 cause for declines. Also, loss of headwater streams to dredging and loss of wetlands or riverine buffers.

"unintentional take can result in loss of creek heelsplitters" is a vague statement and should be removed.

Habitat threats

Respondents ranked threats to mussel habitats in Indiana:

Rank	Threats to mussel habitats
1 (tie)	Habitat degradation
1 (tie)	Stream channelization
2	Nonpoint source pollution (sedimentation and nutrients)
3	Point source pollution (continuing)
4 (tie)	Drainage practices (stormwater runoff)
4 (tie)	Habitat fragmentation
5	Agricultural/forestry practices
6	Impoundment of water/flow regulation
7	Residual contamination (persistent toxins)
8	Commercial or residential development (sprawl)
9	Mining/acidification
10	Invasive/non-native species
11	Successional change

Respondents noted no other threats to mussel habitats in Indiana.

Respondents listed top threats to mussel habitats in Indiana (not ranked):

- Habitat degradation/instream modifications
 - There are large expanses of Wabash and East Fork – White River where relic valves once were common, but the living species is absent

Appendix F-77: Mussels

- Dredging (mining, ACOE)
- Channelization
 - Any that reduces the shallow (less than 1.5 feet) sand/gravel substrate can critically reduce or fragment habitat
 - Cause temporary loss of habitat and impact mussels directly by killing them or taking them out of their habitat
- Loss of riparian corridor
- Impoundments
- Any significant sedimentation into the stream can become a major threat
- Any toxins or pollutants are a major threat
 - Agricultural runoff

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the threats to all mussels habitats. Their responses included:

- Add dams and the regulation of dam discharges. Mussels downstream of the Norway Dam on the Tippecanoe will continue to decline from cold water discharges and uneven flow regime.

Additional research and survey efforts

Current body of research

Species research

Twenty percent of respondents stated that the current body of science is adequate, while eighty percent find it inadequate for all mussels in all habitats in Indiana.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of ALL mussels in ALL habitats in Indiana.

Title = Occurrence and distribution of freshwater mussels in the small streams of Tippecanoe County, Indiana;

Author = Myers-Kinzie, M., S. Wente, & A. Spacie;

Date = 2001;

Publisher = Proc. Ind. Acad. Sci.

Title = Federal Recovery Plan;

Author = USFWS;

Date = 1993;

Publisher = USFWS

Title = Field guide to freshwater mussels of Midwest;

Author = Cummings & Mayer;

Date = 1992;

Publisher = INHS

Title = Federal Recovery Plan;

Author = USFWS;

Date = 1991;

Publisher = USFWS

Title = Life history and propagation...;

Appendix F-77: Mussels

Author = Jones & Neves;
Date = 2002;
Publisher = JNABS

Title = Freshwater mussels of Tennessee;
Author = Parmalee & Bogan;
Date = 1998;
Publisher = U of Tennessee Press

Title = Freshwater mussels of the Midwest;
Author = Cummings & Mayer;
Date = 1992;
Publisher = INHS

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1919;
Publisher = WI Geol. Nat. Hist. Surv.

Title = 'Clubshell';
Author = USFW, Division of Endangered Species;
Publisher = Online

Title = (Numerous internet sites, including USF&W)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the body of science for all mussels in all habitats. Their responses included:

- Mussels of Alabama (P. Parmalee & A. Bogan) and Ohio (G.T. Watters) should be released w/ in the next 6 months and would be good to add in eventually.

Habitat research

Thirty percent respondents stated that the current body of science is adequate, while seventy percent find it inadequate for mussel habitats in Indiana.

Respondents identified the following citations (title, author, date, publisher) that would give the best overview of ALL mussel habitats in Indiana.

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1993;
Publisher = USFWS

Title = Naiades of Pennsylvania;
Author = Ortmann;
Date = 1919;
Publisher = Carnegie Museum

Appendix F-77: Mussels

Title = Federal Recovery Plan;
Author = USFWS;
Date = 1991;
Publisher = USFWS

Title = Freshwater Mollusca of WI;
Author = Baker;
Date = 1928;
Publisher = WI Geol. Nat. Hist. Surv.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the body of science for all mussel habitats. Their responses included:

- Yes, see comments above.

Research needs

Species research

Respondents ranked research needs for all mussels in all habitats in Indiana:

Rank	Research needs for all mussels in all habitats
1 (tie)	Limiting factors (food, shelter, water, breeding sites)
1 (tie)	Threats (predators/competition, contamination)
1 (tie)	Population health (genetic and physical)
2	Distribution and abundance
3 (tie)	Life cycle
3 (tie)	Relationship/dependence on specific habitats

Respondents noted additional research needs for all mussels in all habitats in Indiana (not ranked):

- Habitat needs are not completely understood. I have seen fresh dead cylindrical papershells in channelized agricultural ditches. Other small streams with good habitat have only weathered dead fragments
- To find out why the clubshell has depopulated most of its former distribution in Indiana. Developing some sort of timeline (late Pleistocene, Holocene (usually archaeological), or historic) for relic valve distribution might narrow the possibilities of critical limiting factors (post-settlement siltation, etc.)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the additional research needs for all mussels in all habitats. Their responses included:

- Population health, threats, enforcement, and dist & abundance are very important to understanding overall trends in IN. The other factors are being fairly thoroughly investigated in other states/institutions.

Appendix F-77: Mussels

Habitat research

Respondents ranked research needs for mussel habitats in Indiana:

Rank	Research needs for habitat
1	Threats (land use change/competition, contamination/global warming)
2	Distribution and abundance (fragmentation)
3	Relationship/dependence on specific site conditions
4	Growth and development of individual components of the habitat
5	Successional changes

Respondents noted no additional research need for mussel habitats in Indiana.

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the additional research needs for mussel habitats. Their responses included:

- Yes.

Conservation actions necessary

Species actions

Respondents ranked conservation efforts by how well they address threats to all mussels in all habitats in Indiana:

Rank	Conservation efforts for all mussels in all habitats
1 (tie)	Limiting contact with pollutants/contaminants
1 (tie)	Public education to reduce human disturbance
1 (tie)	Habitat protection (use below for details)
1 (tie)	Threats reduction
1 (tie)	Regulation of collecting
1 (tie)	Population management (hunting, trapping)

Respondents noted no additional conservation practices for all mussels in all habitats in Indiana.

Appendix F-77: Mussels

Respondents recommended these practices for more effective conservation of all mussels in all habitats in Indiana (not ranked):

- Educate anglers that it is illegal to use mussels as fishing bait. This applies to all mussel species
- Limit instream modification/strict enforcement of laws regulating instream modification
 - See Watters, 2000. Proc. 1st FMCS Symposium)
 - Including impoundment
- Incentives to farmers
- CREP/other incentives for BMPs
- Propagation
- Remove existing dams whenever possible (See Watters, 2000. Proc. 1st FMCS Symposium)
- Restore free-flowing systems (See Watters, 2000. Proc. 1st FMCS Symposium)
- Intensive quantitative sampling of known populations. Need to understand demography of Clubshells(See Strayer and Smith, 2003. AFS Monogram 8)
- Less intensive qualitative sampling of new or not recently surveyed areas. Need to determine distribution and status of Clubshells (See Strayer and Smith, 2003. AFS Monogram 8)
- Restore riparian corridor (See Watters, 2000. Proc. 1st FMCS Symposium)
- Protect shallow sand/gravel habitat from siltation and channelization
- Protect habitat against pollution and toxins

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the more effective conservation of all mussels in all habitats. Their responses included:

- Yes, propagation should be highly ranked. Prop. should really be done with IN mussel species soon before further declines & loss of genetic diversity.

Habitat actions

Respondents ranked conservation efforts by how well they address threats to all mussel habitats in Indiana:

Rank	Conservation efforts for mussel habitats
1	Cooperative land management agreements (conservation easements)
2 (tie)	Pollution reduction
2 (tie)	Protection of adjacent buffer zone
2 (tie)	Corridor development/protection
2 (tie)	Habitat protection on public lands
2 (tie)	Habitat protection incentives (financial)
2 (tie)	Habitat restoration through regulation
2 (tie)	Habitat restoration on public lands
2 (tie)	Habitat restoration incentives (financial)
2 (tie)	Land use planning
2 (tie)	Technical assistance
2 (tie)	Habitat protection through regulation

Appendix F-77: Mussels

- 2 (tie) Managing water regimes
- 2 (tie) Restrict public access and disturbance

Respondents listed no other current conservation practices for mussel habitats in Indiana.

Respondents recommended the following conservation practices for more effective conservation of mussel habitats in Indiana (not ranked):

- Increase and maintain habitat using/considering:
 - Incentives/CREP and other incentives for BMPs
 - Regulation
 - Restrict instream modifications (channelization, instream dredging, etc.) (See Watters, 2000. Proc. 1st FMCS Symposium)
 - Treat small streams as biological resources and not just drainage ditches. At the least require that a mussel survey be done before dredging
 - Protect adjacent buffer zones
 - Limiting runoff through incentives or other means (See Watters, 2000. Proc. 1st FMCS Symposium)
 - Assessing and promote riparian corridors
 - Restoring free-flowing systems
- Manage pollutants and toxins
 - Water quality monitoring (See Watters, 2000. Proc. 1st FMCS Symposium)

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the conservation practices for mussel habitats in Indiana. Their responses included:

- Yes, actually.

Proposed plans for monitoring

Current monitoring

Species monitoring

Respondents were aware of the following monitoring efforts by state agencies for all mussels in all habitats in Indiana (not ranked):

- Occasional statewide (less than once a year and not regularly scheduled) monitoring
- Occasional regional or local (less than once a year and not regularly scheduled) monitoring

Respondents were aware of the following monitoring efforts by other organizations for all mussels in all habitats in Indiana (not ranked):

- Statewide once-a-year monitoring
- Regional or local once-a-year monitoring
- Occasional regional or local (less than once a year and not regularly scheduled) monitoring

Respondents ranked monitoring efforts by state agencies based on their importance for conservation of all mussels in all habitats in Indiana:

Rank	Monitoring efforts by state agencies for
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Appendix F-77: Mussels

	conservation of all mussels in all habitats
1	Periodic statewide (less than once a year but still regularly scheduled) monitoring
2 (tie)	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
2 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
3 (tie)	Statewide once-a-year monitoring
3 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring
4	Regional or local once-a-year monitoring
5	Regional or local year-round monitoring
6	Statewide year-round monitoring

Respondents ranked monitoring efforts by other organizations based on their importance for conservation of all mussels in all habitats in Indiana:

Rank	Monitoring efforts by other organizations for conservation of all mussels in all habitats
1	Occasional regional or local (less than once a year and not regularly scheduled) monitoring
2	Periodic regional or local (less than once a year but still regularly scheduled) monitoring
3 (tie)	Regional or local once-a-year monitoring
3 (tie)	Statewide once-a-year monitoring
4 (tie)	Occasional statewide (less than once a year and not regularly scheduled) monitoring
4 (tie)	Periodic statewide (less than once a year but still regularly scheduled) monitoring
5 (tie)	Regional or local year-round monitoring
5 (tie)	Statewide year-round monitoring

Respondents listed regional or local monitoring by state agencies for all mussels in all habitats in Indiana (not ranked):

- IDNR nongame biologist does mussel surveys
 - He is only one person, and there are thousands of miles of streams in the state
- IDNR nongame biologist monitors yellow sandshell habitat: Two surveys have been done 10 years apart, completed by biologists for the Wabash, Tippecanoe and East Fork – White rivers; results are pending. This is prime yellow sandshell habitat
- Tippecanoe River (periodic – usually annual – monitoring by IDNR
- Maumee River
- Ohio River
- Wabash River

Appendix F-77: Mussels

- Kankakee drainage (random locations)

Respondents listed regional or local monitoring by other organizations for all mussels in all habitats in Indiana (not ranked):

- Commonwealth Biomonitoring: Frequently does habitat evaluations in small streams as part of watershed studies. If I happen to see a shell, I make a note in field notes. These are not official mussel surveys
- Tippecanoe River
- Maumee System
- Ohio River
- Wabash System

Respondents listed organizations that monitor all mussels in all habitats in Indiana (not ranked):

- TNC
- USFWS
- Consultants

Respondents considered monitoring techniques for all mussels in all habitats in Indiana:

Monitoring techniques for all mussels in all habitats	Used	Not used but possible with existing technology and data	Not economically feasible
Radio telemetry and tracking	--	--	X
Modeling	X	X	--
Spot mapping	X	--	--
Driving a survey route	X	--	--
Reporting from harvest, depredation, or unintentional take (road kill, by-catch)	--	--	X
Mark and recapture	X	--	--
Professional survey/census	X	--	--
Volunteer survey/census	X	X	--
Representative sites	X	--	--
Probabilistic sites	X	X	--

Respondents noted no other monitoring techniques for all mussels in all habitats in Indiana.

Appendix F-77: Mussels

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for all mussels in all habitats in Indiana. Their responses included:

- No. IDNR biologists are working on a statewide mussel atlas. EnviroScience (Stow, OH) is working w/ IDNR on final results of Wabash, Tippecanoe, and East Fork White R. Surveys (2003-2004).

Habitat inventory and assessment

Respondents were aware of the following inventory and assessment efforts by state agencies for mussel habitats in Indiana:

- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

Respondents were aware of the following inventory and assessment efforts by other organizations for mussel habitats in Indiana:

- Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment

Respondents ranked inventory and assessment efforts by state agencies based on their importance for conservation of mussel habitats in Indiana:

Rank	Inventory and assessment for conservation of mussel habitats
1 (tie)	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
1 (tie)	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
4	Statewide once-a-year inventory and assessment
5	Regional or local once-a-year inventory and assessment
6	Regional or local year-round inventory and assessment
7	Statewide annual inventory and assessment

Appendix F-77: Mussels

Respondents ranked inventory and assessment efforts by other organizations based on their importance for conservation of mussel habitats in Indiana:

Rank	Inventory and assessment for conservation of mussel habitats
1	Occasional regional or local (less than once a year and not regularly scheduled) inventory and assessment
2	Periodic regional or local (less than once a year but still regularly scheduled) inventory and assessment
3	Periodic statewide (less than once a year but still regularly scheduled) inventory and assessment
4	Regional or local once-a-year inventory and assessment
5 (tie)	Statewide once-a-year inventory and assessment
5 (tie)	Occasional statewide (less than once a year and not regularly scheduled) inventory and assessment
6 (tie)	Regional or local year-round inventory and assessment
6 (tie)	Statewide annual inventory and assessment

Respondents listed regional or local inventory and assessment by state agencies for mussel habitats in Indiana (not ranked):

- Tippecanoe River
- Maumee System
- Ohio River
- Wabash System
- Usually species inventories are made with relevant habitat information
- IDNR primarily monitors mussel species, making habitat notations. No real habitat monitors are made
- IDEM and IDNR – Division of Water do monitor water quality as a component of habitat

Respondents listed regional or local inventory and assessment by other organizations agencies for mussel habitats in Indiana (not ranked):

- Tippecanoe River
- Maumee System
- Ohio River
- Wabash System
- Commonwealth Biomonitoring do habitat evaluations on small streams as part of watershed studies. These evaluations are not specific to mussels, but are Ohio EPA QHEI methods

Respondents listed organizations that monitor mussel habitats in Indiana (not ranked):

- TNC
- USFFWS

Appendix F-77: Mussels

- Consultants

Respondents considered inventory and assessment techniques for mussel habitats in Indiana:

Inventory and assessment techniques for	Used	Not used but possible with existing technology and data	Not economically feasible
GIS mapping	X	X	--
Aerial photography and analysis	--	--	X
Systematic sampling	X	--	--
Property tax estimates	--	--	X
State revenue data	--	--	X
Participation in land use programs	X	X	--
Modeling	X	X	--
Voluntary landowner reporting	X	--	X

Respondents listed additional inventory and assessment techniques for mussel habitats in Indiana:

- Water quality monitoring

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for all mussel habitats in Indiana. There were no responses.

Recommended monitoring

Species monitoring

Respondents recommended the following monitoring techniques for effective conservation of all mussels in all habitats in Indiana:

- Intensive quantitative sampling of known populations. (Need to understand demography of species. See Strayer & Smith, 2003. AFS Monogram 8)
- Less intensive qualitative sampling of new or not recently surveyed areas. (Need to determine distribution and status of species. See same for protocols)
- Systematic monitoring of probabilistic sites (professional)
 - Professional surveys using timed searches and systematic sampling (Strayer and Smith 2003)-A guide to sampling freshwater mussel populations. American Fisheries Society Monograph 8. American Fisheries Society. Bethesda, Maryland. 103 pp.)
- Use of volunteer census/monitoring:

Appendix F-77: Mussels

- Development of trained, select volunteer core to undertake surveys at probabilistic sites, particularly where the species should, or could occur and has not been documented in recent years

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the monitoring techniques for effective conservation of all mussels in all habitats in Indiana. Their responses included:

- Yes, we used some of these techniques in EnviroScience/IDNR surveys.

Habitat inventory and assessment

Respondents recommended the following inventory and assessment techniques for effective conservation of mussel habitats in Indiana (not ranked):

- CREP/farmer incentives for no-till, riparian corridors, etc.
- Strictly control instream modifications: mining, snagging, etc.
- Assess zebra mussel infestations. Contact P. Morrison, USFWS, Parkersburg, WV
- Assess riparian corridor presence
- Water quality monitoring
- More extensive use of GIS-modeled habitat probabilities
 - To look at saturation of potential habitat. With GIS construction of existing potential habitat (based upon known factors) and overlaying the current distribution of the yellow sandshell

Technical experts and conservation organizations reviewed the above results and were asked if these were a reasonable representation of the inventory and assessment techniques for effective conservation of mussel habitats in Indiana. Their responses included:

- Yes. Focus on watershed and landuse-based approaches like CREP, etc. Use GIS models to identify and manage mussel pops.