ILLINOIS NATURAL HISTORY SURVEY
PRAIRIE RESEARCH INSTITUTE

Northern Riffleshell and Clubshell Translocation Effort and Post-Translocation Monitoring

Jeremy Tiemann

Illinois Natural History Survey
Prairie Research Institute, University of Illinois at Urbana-Champaign
1816 South Oak Street
Champaign, IL 61820
217-244-4594
jtiemann@illinois.edu

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Prairie Research Institute, University of Illinois at Urbana Champaign
Brian D. Anderson, Executive Director

Illinois Natural History Survey
Geoff Levin, Director
1816 South Oak Street
Champaign, IL 61820
217-333-6830

Executive Summary

Staff from the Illinois Natural History Survey participated in a joint project with the Illinois Department of Natural Resources and the U.S. Fish and Wildlife Service to collect two federally-endangered mussels species from the Allegheny River, Pennsylvania, and translocate them to the Vermilion River basin (Wabash River drainage), Vermilion County, Illinois. On 25 August 2014, 750 Northern Riffleshell (*Epioblasma rangiana*) and 808 Clubshell (*Pleurobema clava*) were collected at the U.S. Highway 62 bridge construction project in Allegheny River, Forest County, Pennsylvania. Animals were quarantined for four days at the INHS Aquatic Research Pond Facilities in Champaign-Urbana. While in quarantine, all individuals were affixed with a unique PIT tag and a plastic shellfish tag. After the quarantine period, the animals were divided and translocated to four sites in the Vermilion River basin, Vermilion County, Illinois, on 29-30 August 2014. These translocated animals were monitored in October 2014 to assess performance of translocations. The mean site results (58% detection and 100% "survivorship" for Northern Riffleshell and 79% detection and 100% "survivorship" for Clubshell) were comparable to previous years in Illinois. This relocation project is being funded, in part, by a natural resource damage assessment settlement (Hegeler Zinc—Lyondell Basell Companies) to the U.S. Fish and Wildlife Service and to the State of Illinois.

Project History

The Northern Riffleshell *Epioblasma rangiana* and Clubshell *Pleurobema clava* (Figure 1) were once widespread in the Ohio River basin but have experienced significant range reductions during the last century as a result of reduced habitat and water quality. Because of this range reduction, the U.S. Fish and Wildlife Service listed both species as federally-endangered. The joint recovery plan listed an objective of establishing viable populations of the species in ten separate river drainages throughout their respective ranges, and stated that population augmentations and reintroductions would be needed to achieve this objective. Beginning in 2005, natural resource agencies in Illinois partnered with the USFWS and natural resource agencies in Ohio, Pennsylvania, and West Virginia, and began implementing portions of the recovery plan. One of the recovery team's goal was to re-establish self-sustaining Northern Riffleshell and Clubshell populations in the Vermilion River basin (Wabash River drainage) in Illinois. A salvage project in Pennsylvania in the Allegheny River provided an

opportunity for the translocation of both species. Between 2010 and 2013, 1,349 Northern Riffleshell and 958 Clubshell have been translocated from the Allegheny River beneath the U.S. Highway 62 (=Hunter Station) Bridge, Tionesta Township, Forest County, Pennsylvania (Figure 2), to suitable habitat at eight sites in the Vermilion River basin in Champaign and Vermilion counties, Illinois, (Figure 3). The history of this project is summarized in Tiemann (2014).

2014 Project Tasks

The 2014 tasks of the project, as described by the grant agreement between IDNR and INHS, were the following:

1) Help coordinate with the 2014 translocations. Duties include, but were not limited to
    a. Collecting Northern Riffleshell and Clubshell from Pennsylvania,
    b. Quarantining the mussels to prevent the spread of aquatic species diseases,
    c. Tagging mussels for tracking, and
    d. Monitoring of the translocated populations.
2) Collect and analyze water samples for environmental DNA (eDNA) to try and determine the "detectability" of endangered species of known abundance and location.

2014 Project Activities

Task 1 – Five sites (four in the Middle Fork in the Middle Fork State Fish and Wildlife Area and one in the Salt Fork in Kickapoo State Park) were established in 2013 (Tiemann 2014). An attempt was made to monitor animals seasonally (Figure 4); however, conditions (e.g., weather and water levels) were not always favorable to allow seasonal monitoring (tables 1-4). Of these five sites, four were deemed suitable based upon high survivorship rates (tables 2 and 4), and therefore were selected to receive additional mussels in 2014. At the fifth site ("Beaver" in Figure 3), a beaver colony constructed a dam just downstream of our relocation area in the fall of 2013. Our monitoring efforts showed high mortality (tables 2 and 4) at this site and we determined the site to be unsuitable for stocking in 2014.

Staff from INHS, IDNR, and USFWS – Moline collected 750 Northern Riffleshell and 808 Clubshell from the Allegheny River at the U.S. Highway 62 bridge construction project, Forest County, Pennsylvania on 25 August 2014 (Figure 2). These animals were returned to the INHS Aquatic Research Pond Facilities in Champaign-Urbana (Figure 5) and quarantined for

four days. While in quarantine, all individuals were affixed with a unique passive integrated transponder (PIT) tag on the right valve and a unique plastic shellfish tag on the left valve (Figure 6). The data were entered into the existing Northern Riffleshell – Clubshell translocation database maintained by INHS. After the quarantine period ended, the animals were translocated to four sites in the Vermilion River basin (Figure 3; tables 1-4):

- "Ford" within Middle Fork State Fish and Wildlife Area (Figure 7) – 177 Northern Riffleshell and 175 Clubshell
- "Kennekuk" within Middle Fork State Fish and Wildlife Area (Figure 8) – 120 Northern Riffleshell and 174 Clubshell
- "Horse" within Middle Fork State Fish and Wildlife Area (Figure 9) – 167 Northern Riffleshell and 181 Clubshell
- "Donut" within Kickapoo State Park (Figure 10) – 286 Northern Riffleshell and 278 Clubshell

These four sites were monitored once (October 2014) post translocation. The mean site results (59% detection [Table 1] and 100% "survivorship" [Table 2] for Northern Riffleshell and 78% detection [Table 3] and 100% "survivorship" [Table 4] for Clubshell) were comparable to previous years in Illinois, and area similar to those reported in Ohio and West Virginia (Tiemann 2004).

Task 2 – The effective management of rare or endangered species requires the ability to detect populations at low densities. Detection of these species allows managers to identify and protect critical habitat that would enhance survival or measure reproductive success. Detection probabilities for rare species are typically low in all environments, but are particularly so in aquatic environments where organisms are hidden beneath the water's surface or buried in the substrate. One useful tool to help detect rare species is eDNA, which utilizes existing molecular genetic tools to detect the presence of genetic material (DNA) of species of interest in environmental samples. This technique has been successfully used in a variety of circumstances and applications range from presence/absence studies, long-term surveillance of areas, or the determination of the spatial extent of a species range. This technology is especially useful for organisms such as freshwater mussels, whose traditional sampling techniques (e.g., hand-picking or brailing) have difficulty detecting species in low abundance.

An agreement was made between INHS and Iowa State University to develop a detection protocol of endangered freshwater mussels using eDNA to determine the "detectability" of a federally endangered species of known abundance and location. However, given the nature of eDNA (e.g., breaks down quickly), the volume of water needed for detecting mussels, and other logistics, all parties determined it was not feasible to do the research as we originally planned.

Project Summary

Including the 2014 animals, a total of 2,099 Northern Riffleshell and 1,766 Clubshell have been translocated to eight sites in the Vermilion River basin since 2010. Detection rates have been highly variable by site, season, and species (tables 1 and 3) as was reported in Tiemann (2014). Since the inception of the monitoring program, the detection rate per survey per site has varied from 3% to 100% with a project mean of 42% for the Northern Riffleshell and from 37% to 100% for the Clubshell with a project mean of 70% (tables 1 and 3). Of the individuals encountered during the duration of the project, 58% of the Northern Riffleshell and 89% of the Clubshell have been alive (tables 2 and 4).

Future Plans

As discussed in Tiemann (2014), this project will assess performance of translocations, and is expected to provide benefits identified in the USFWS' recovery plan (USFWS 1994), including establishing viable populations, maintaining genetic variability and potentially reclassifying the species from endangered to threatened. Future plans include regular monitoring (= seasonally) of sites for several years. All sites, including those not stocked in 2014 (e.g., the Richter Tract and the Edgewood Farm Land and Water Reserve or "Smith Property"), will be monitored throughout 2015 and beyond. Animals will be documented via PIT tag readers and a small percentage will be excavated to assess survival. USFWS, IDNR, and INHS staff hope to collect more Northern Riffleshell and Clubshell in 2015 or 2016 to augment all the sites shortly before in-stream work begins on the Hunter's Station Bridge.

Also, data will be presented at meetings and conferences as time and budgets allow. For example, at the 2015 Freshwater Mollusk Conservation Society (22-26 March 2015, St. Charles, Missouri), Robert Anderson (USFWS – State College and project leader) is giving an oral presentation summarizing the result of the project. His talk will be titled "Cooperative recovery

on a landscape scale: the reintroduction of the Northern Riffleshell and Clubshell to sites in six states within their historical range" and will include the results of work done in Illinois.

Acknowledgements

This project is a collaborative effort among the U.S. Fish and Wildlife Service, Pennsylvania Fish and Boat Commission (PFBC), Pennsylvania Department of Transportation (Penn DOT), Illinois Department of Natural Resources ([IDNR], including the Illinois Nature Preserves Commission and the Illinois Endangered Species Protection Board), Illinois Natural History Survey (INHS), University of Illinois (U of I), Champaign County Forest Preserve District (CCFPD), Vermilion County Forest Preserve District, the Ohio State University (OSU), Columbus Zoo and Aquarium, West Virginia Department of Natural Resources (WV DNR), Kentucky Department of Fish and Wildlife, and BioMark, Inc. In 2014, the following people provided valuable assistance: Jordan Allison (PFBC), Robert Anderson (USFWS), Drew Becker (USFWS), Tara Beveroth (INHS), Angela Boyer (USFWS), Steve Buck (U of I), Janet Clayton (WV DNR), Kevin Cummings (INHS), Tyson Dallas (IDNR), Patty Dickerson (INHS), Sarah Douglass (INHS), Michael Dreslik (INHS), Jon Duyvejonck (USFWS), Terry Esker (IDNR), Sheldon Fairfield (IDNR), Nathan Grider (INHS), Kelly Hannan (U of I), Tom Heavisides (IDNR), Bridget Henning (IDNR), John Hott (IDNR), Andrew Kuhns (INHS), Rich Lewis (IDNR), Kristen Lundh (USFWS), Anne Mankowski (IDNR), Christine Mayer (INHS), Jean Mengelkoch (INHS), Patty Morrison (USFWS), Jen Mui (INHS), Kelly Neal (IDNR), Dan Olson (CCFPD), Jessica Riney (IDNR), Jason Robinson (INHS), Robert Schanzle (former IDNR), Jody Shimp (IDNR), the Smith Family, Mary Kay Solecki (IDNR), Jeff Stein (INHS), Alison Stodola (INHS), Kirk Stodola (U of I), Cory Suski (U of I), Robert Szafoni (IDNR), Matthew Van Der Bosch (U of I), Rachel Vinsel (INHS), Samantha Wassenhove (IDNR), Tom Watters (OSU), Nevin Welte (PFBC), Adam Wright (U of I), Sarah Wylie (INHS) and many other staff members from the INHS, IDNR, USWFS, CCFPD, PFBC, OSU, Columbus Zoo and Aquarium, WV DNR, Penn DOT, Prairie Rivers Network, and BioMark, Inc. Funding was provided in part by the U.S. Fish and Wildlife Service (through the IDNR's Office of Resource Conservation to the Illinois Natural History Survey - Grant #R70470002 and #RC09-13FWUIUC), the U.S. Fish and Wildlife Service's Ohio River Basin Fish Habitat Partnership (Award #F14AC00538), the Illinois Department of Natural Resources (through the Natural

Resource Damage Assessment settlement: Hegeler Zinc—Lyondell Basell Companies --- Reference Document #OREP1402 & #OREP1504), the Illinois Wildlife Preservation Fund (Grant #RC07L25W), and the Illinois Department of Transportation.

Literature Cited

Tiemann, J.S. 2014. Monitoring translocated Northern Riffleshell and Clubshell in Illinois. INHS Technical Report 2014(02). Final report submitted to the Illinois Department of Natural Resources, Natural Resources Damage Assessment, Restoration and Implementation. 27 pp.

Appendix 1 – Tables and Figures

Table 1. Detection rates for Northern Riffleshell by site (with stream name) per sampling period. Data are "number detected / maximum number of individuals in the stream at a site at that period." Site information can be found in Tiemann (2014). "NS" = not sampled and "-" = sites were not yet established. *Only half of the Richter site was sampled.

	Richter (Salt)	*Smith (Salt)*	*Donut (Salt)*	*MFNP (Middle)*	*Ford (Middle)*	*Horse (Middle)*	*Kennekuk (Middle)*	*Beaver (Middle)*	*Mean %*
Summer 2011	39/69	-	-	31/67	-	-	-	-	51%
Autumn 2011	12/66	-	-	28/67	-	-	-	-	30%
Spring 2012	38/66	-	-	NS	-	-	-	-	58%
Summer 2012	35/66	-	-	30/63	-	-	-	-	43%
Autumn 2012	321/555	302/472	-	NS	-	-	-	-	61%
Summer 2013	98/555	222/465	-	13/61	-	-	-	-	31%
Autumn 2013	37/550	235/464	50/50	NS	48/50	50/50	45/49	44/50	40%
Winter 2014	NS	NS	17/50	NS	35/50	NS	11/49	NS	43%
Spring 2014	NS	NS	NS	NS	29/50	19/50	11/49	9/50	34%
Summer 2014	20/546	116/446	20/50	NS	25/50	19/50	9/49	11/50	17%
Autumn 2014*	6/196	NS	275/336	NS	171/227	149/217	96/169	8/50	59%
Mean %	37%	47%	64%	39%	70%	61%	42%	36%	

Table 2. Survival of known fate individuals for Northern Riffleshell by site (with stream name) per sampling period. Data are "number alive / (number alive + number dead)." Site information can be found in Tiemann (2014). "NS" = not sampled, and "-" = sites were not yet established. *All individuals encountered during this time period were at surface and were left in stream, regardless of live or dead.

	Richter (Salt)	*Smith (Salt)*	*Donut (Salt)*	*MFNP (Middle)*	*Ford (Middle)*	*Horse (Middle)*	*Kennekuk (Middle)*	*Beaver (Middle)*	*Total*
Summer 2011	5/8	-	-	9/9	-	-	-	-	14/17
Autumn 2011	6/6	-	-	15/19	-	-	-	-	21/25
Spring 2012	2/2	-	-	NS	-	-	-	-	2/2
Summer 2012	0/0	-	-	4/6	-	-	-	-	4/6
Autumn 2012	3/3	0/7	-	NS	-	-	-	-	3/10
Summer 2013	17/22	8/9	-	6/7	-	-	-	-	31/38
Autumn 2013*	0/3	3/21	1/1	NS	0/7	2/2	0/3	1/11	7/48
Winter 2014	NS	NS	0/0	NS	0/0	NS	0/0	NS	0/0
Spring 2014	NS	NS	NS	NS	0/0	0/0	0/0	0/0	0/0
Summer 2014*	0/1	0/0	0/0	NS	0/0	0/0	0/0	1/3	1/4
Autumn 2014*	0/0	NS	0/0	NS	7/7	0/0	3/3	0/0	10/10
Total	33/45	11/37	1/1	34/41	7/14	2/2	3/6	2/14	93/160

Table 3. Detection rates for Clubshell by site (with stream name) per sampling period. Data are "number detected / maximum number of individuals in the stream at a site at that period." Site information can be found in Tiemann (2014). "NS" = not sampled and "-" = sites were not yet established (e.g., no Clubshell placed at MFNP). *Only half of the Richter site was sampled.

	Richter (Salt)	*Smith (Salt)*	*Donut (Salt)*	*MFNP (Middle)*	*Ford (Middle)*	*Horse (Middle)*	*Kennekuk (Middle)*	*Beaver (Middle)*	*Mean %*
Summer 2011	-	-	-	-	-	-	-	-	-
Autumn 2011	-	-	-	-	-	-	-	-	-
Spring 2012	-	-	-	-	-	-	-	-	-
Summer 2012	-	-	-	-	-	-	-	-	-
Autumn 2012	73/110	51/91	-	-	-	-	-	-	62%
Summer 2013	41/110	64/91	-	-	-	-	-	-	52%
Autumn 2013	301/368	271/340	50/50	-	46/50	50/50	48/50	49/50	85%
Winter 2014	NS	NS	41/50	-	44/50	NS	20/50	NS	70%
Spring 2014	NS	NS	NS	-	47/50	32/50	27/50	43/50	75%
Summer 2014	190/367	286/338	42/50	-	47/50	31/50	20/50	41/50	69%
Autumn 2014*	202/363	NS	296/328	-	194/225	197/231	173/224	41/50	78%
Mean %	59%	72%	92%	-	91%	78%	61%	87%	

Table 4. Survival of known fate individuals for Clubshell by site (with stream name) per sampling period. Data are "number alive / (number alive + number dead)." Site information can be found in figures Tiemann (2014). "NS" = not sampled and "-" = sites were not yet established (e.g., no Clubshell placed at MFNP). *All individuals encountered during this time period were at surface and were left in stream, regardless of live or dead.

	Richter (Salt)	*Smith (Salt)*	*Donut (Salt)*	*MFNP (Middle)*	*Ford (Middle)*	*Horse (Middle)*	*Kennekuk (Middle)*	*Beaver (Middle)*	*Total*
Summer 2011	-	-	-	-	-	-	-	-	-
Autumn 2011	-	-	-	-	-	-	-	-	-
Spring 2012	-	-	-	-	-	-	-	-	-
Summer 2012	-	-	-	-	-	-	-	-	-
Autumn 2012	0/0	0/0	-	-	-	-	-	-	0/0
Summer 2013	5/5	2/2	-	-	-	-	-	-	7/7
Autumn 2013	0/0	0/2	0/0	-	0/0	0/0	0/0	0/0	0/2
Winter 2014	NS	NS	0/0	-	0/0	NS	0/0	NS	0/0
Spring 2014	NS	NS	NS	-	0/0	0/0	0/0	0/0	0/0
Summer 2014*	1/2	2/2	4/4	-	13/13	3/3	3/3	4/7	30/34
Autumn 2014*	0/0	NS	0/0	-	0/0	0/0	1/1	0/0	1/1
Total	6/7	4/6	4/4	-	13/13	3/3	4/4	4/7	38/44

Figure 1. The Northern Riffleshell *Epioblasma rangiana* (lower left) and Clubshell *Pleurobema clava* (upper right).

Figure 2. Allegheny River at the U.S. Highway 62 (=Hunter Station) Bridge, Forest County, Pennsylvania, about 3 river miles downstream of the town of Tionesta (approximate coordinates of bridge 41.47235°N, 79.49992°W). Photo courtesy of Kevin Cummings (INHS).

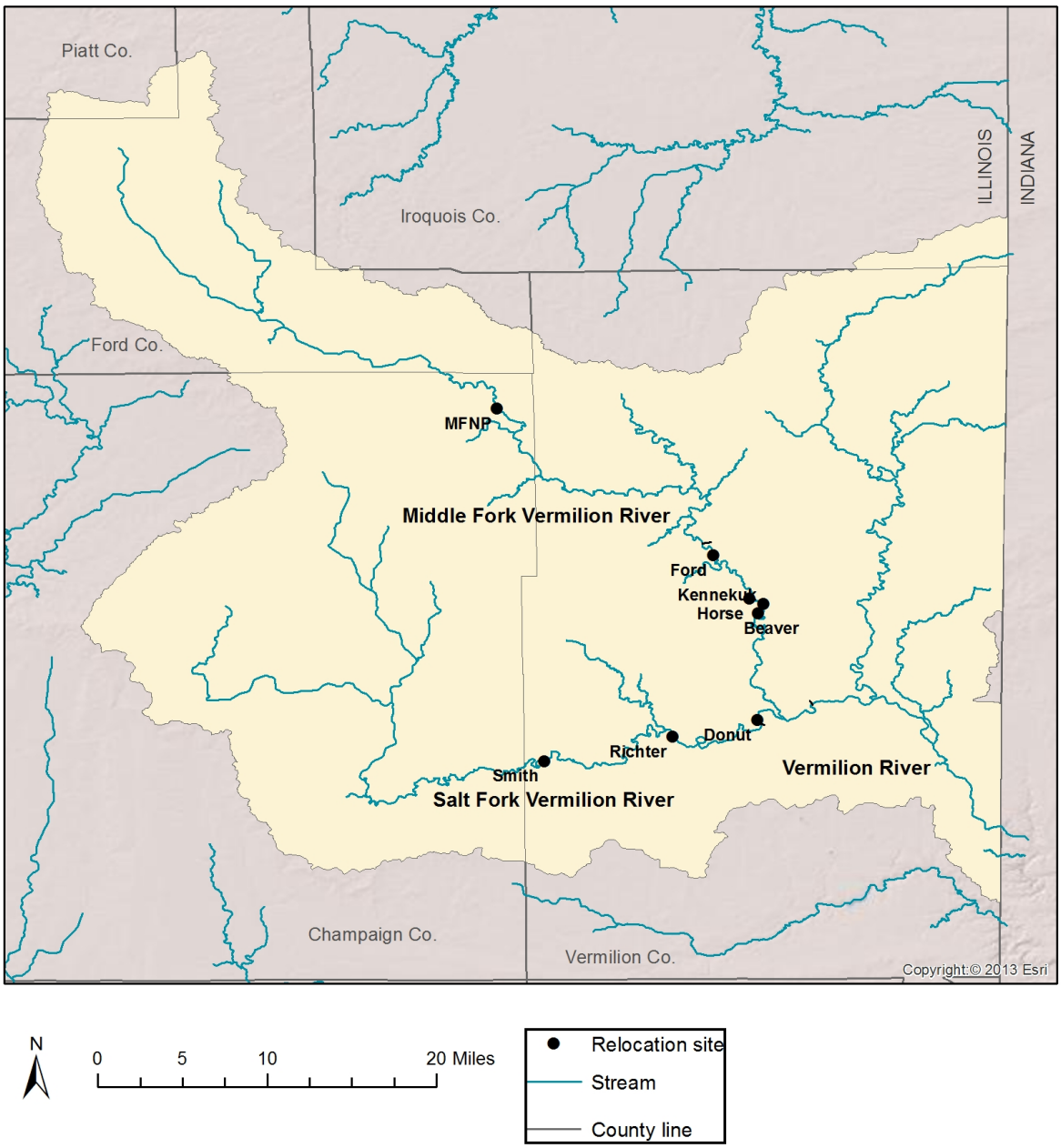

Figure 3. Vermilion River basin (Wabash River drainage) location and translocation sites from 2010-2014 for Northern Riffleshell and Clubshell. Map created by Alison Stodola (INHS).

Figure 4. When surveying for PIT-tagged freshwater mussels, a person carrying a PIT tag receiver wand slowly sweeps the streambed while walking the stream in a systematic manner. Detected tags are stored in the PIT reader, and data are later downloaded into a database after the sampling period ends. At least one additional sampler snorkels (or uses view buckets) if conditions are favorable and visually examines the streambed for tagged mussels. If an animal is seen, a note is made whether it was alive or dead. Photo courtesy of Rob Kanter (U of I).

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Figure 5. Quarantining of mussels in 2014 took place at the Illinois Natural History Survey Aquatic Research Facility in Champaign-Urbana, Illinois. Four circular tanks were provided with continuous ground water (temperature ranged from 68°F – 72°F throughout the day), and were aerated using air pumps. Effluent water spilled over the top and through an effluent pipe at the bottom; the water drained over the gravel bed and soaked into the ground. The quarantine period could be as little as four days (Tom Watters, the Ohio State University, personal communication). Photo courtesy of Mike Coffey (USFWS).

Figure 6. Northern Riffleshell with encased PIT tags (top two mussels) and plastic shellfish tags (bottom three mussels). Both tags were affixed with a "super glue" product and the PIT tags were later covered with marine grade epoxy. Each freshwater mussel had a PIT tag transponder on the right valve and a plastic shellfish tag on the left valve. Each PIT tag has a unique alphanumeric code (up to 13 digits), whereas each shellfish tag is unique when factoring in shape, color, and numeric code (up to four digits). All tags have been databased and contain the following information: PIT tag number and type, plastic shellfish tag number and type, species, sex, length at capture, collection year, origin of mussel, quarantine information, release date and site information, and detection history. Photo courtesy of Robert Szafoni (IDNR).

Figure 7. The Middle Fork re-introduction site "Ford" within Middle Fork State Fish and Wildlife Area. IDNR reviewed and approved the action. This site has the following stocking history: 2013 = 50 Northern Riffleshell and 50 Clubshell; 2014 = 177 Northern Riffleshell and 175 Clubshell. Photo courtesy of Alison Stodola (INHS).

Figure 8. The Middle Fork re-introduction site “Horse” within Middle Fork State Fish and Wildlife Area. IDNR reviewed and approved the action. This site has the following stocking history: 2013 = 50 Northern Riffleshell and 50 Clubshell; 2014 = 167 Northern Riffleshell and 181 Clubshell. Photo courtesy of Alison Stodola (INHS).

Figure 9. The Middle Fork re-introduction site “Kennekuk” within Middle Fork State Fish and Wildlife Area. IDNR reviewed and approved the action. This site has the following stocking history: 2013 = 50 Northern Riffleshell and 50 Clubshell; 2014 = 120 Northern Riffleshell and 174 Clubshell. Photo courtesy of Alison Stodola (INHS).

Figure 10. The Salt Fork re-introduction site “Donut” within Kickapoo State Park. IDNR reviewed and approved the action. This site has the following stocking history: 2013 = 50 Northern Riffleshell and 50 Clubshell; 2014 = 286 Northern Riffleshell and 278 Clubshell. Photo courtesy of Alison Stodola (INHS).