Appendix G:

Mussel Relocation Plan and Mussel Survey Results

I. Introduction

The Corps of Engineers, St. Paul District, proposes to construct two channel training structures in Lower Pool 2 of the Upper Mississippi River to improve navigability and safety, and to reduce channel maintenance requirements.

Freshwater mussel surveys conducted in the proposed project footprint were used to estimate that project construction would kill approximately 85,000 ± 25,750 individual mussels, including individuals representing four species of conservation concern in the State of Minnesota. Freshwater mussels fill important ecological roles including nutrient cycling, substrate stabilization, and as a food source for fish and mammals. In accordance with Corps' planning guidance and CMMP guidance, the Corps has incorporated mitigation measures that would ensure that the project does not have more than a negligible adverse effect on this ecological resource. Project effects were first minimized by selecting narrow rock mounds for the channel training structures to reduce the project footprint. Unavoidable impacts of the selected TSP would be offset by relocating the mussels currently within the footprint of the proposed structures prior to project construction. This would involve divers collecting as many mussels from the footprints as possible, and moving the mussels to a location or locations that would augment nearby existing populations.

II. Objectives

Objectives are identified below, with major associated tasks identified for each objective. Tasks and methodologies are detailed further in Chapter III.

(1) Collect and remove unionids within the impacted footprint.

  a. Finalize structure footprint locations and delineate for relocation. (USACE)
  b. Divers to search and remove all unionids encountered. Following established methodology, it is anticipated that the relocation would result in >%90 of all mussels being successfully removed. (Contract)
  c. The USFWS will be consulted with for any federally listed species collected and a plan for T&E relocation will be finalized prior to relocation efforts. (USACE)

(2) Verify nearby stable, suitable areas for relocation.

  a. Use previous mussel surveys, bathymetry, aerial imagery, etc. to delineate at least 10 acres of potentially suitable habitat in Lower Pool 2. (USACE)
  b. Verify site suitability by diver reconnaissance exploration prior to placement. (Contract)

(3) Augment existing unionid populations in Lower Pool 2.

  a. Mark relocated mussels via rotary tool or other identifiable marker and document release location (Contract)

b. Mussels may be relocated by scattering from the surface by relocation crew. Federally listed species if encountered will be uniquely marked and hand placed in the substrate at relocation sites. (Contract)
c. Conduct two surveys to assess the relocation: (1) survey a subset of relocation sites immediately after the relocation, and (2) survey all relocation sites one-year following relocation to assess survival. (USACE)

III. Relocation Description

Collection

Relocation would be scheduled to occur as close prior to construction as feasible, no more than one year prior to proposed construction. Relocation activities would only take place when the water temperature exceeds 40°F and air temperature exceeds 32°F but is below 95°F.

Relocation efforts will follow established guidelines provided by Dunn, et al. (1997, attached). Divers will thoroughly search each of the impact areas, removing all unionids encountered. . Divers will place two parallel collecting lines (i.e., weighted rope) along the edge of the footprint spaced approximately 1m apart and will crawl along the line and collect unionids within an arms-reach within the lines (approximately 1m), disturbing all substrate and debris and placing unionids in a mesh collecting bag. Divers will traverse the line a second time to ensure double coverage and that the majority of unionids have been collected. One line will then be moved another one-meter and parallel to one line, and the process alternated (lines leap frogging each other) and repeated until the entire area is thoroughly searched twice. (Due to the large area and varying orientation of the proposed structure to the river flow, alternate strategies such as grids may be proposed to better ensure that the entire area is searched with double coverage.)

All collected unionids will be placed into mesh bags and retrieved by the surface dive tenders. Bags will be labeled with the area, time searched, date, and diver. A relocation team (malacologist and technician) will retrieve bags of unionids from the dive team. Unionids will be sorted into species and zebra mussels removed. All common species will be counted, recorded, and marked with a slash hitting the edge of the periostracum on the anterior, ventral side. Threatened and endangered species (T&E species) will each be marked with a unique number using a dremel tool to etch the periostracum. These individuals will also be measured and aged.

Unionids will be transported between the collection and relocation areas by boat in a flow through live well containing river water. Animals will only be exposed to air briefly (<5min) during processing.

If Federally-listed species are found during relocation efforts, the Corps and USFWS should be immediately notified. The Corps would conduct the necessary Endangered Species Act

Coordination with the U.S. Fish and Wildlife Service prior to and during relocation efforts with a plan agreed upon as to the treatment of T&E species.

Relocation Site Selection

Potential relocation sites will be delineated by Corps biologists. Ideally, the areas will have stable substrate, be free of threats such as future development, and have species-rich and reproducing unionid communities. Corps biologists will use recent and historic surveys conducted near the project area to identify likely existing mussel beds. Areas that have been surveyed multiple times and have demonstrated a stable mussel community will be given the highest priority.

The proposed site locations will be provided to the contractor. The contractor will perform spot dives at each of the sites to verify suitability prior to placement of new mussels. Factors considered should include substrate composition, substrate consolidation, flow, and presence of unionids, preferably represented by both older specimens and recent recruits. Areas should have sufficient current velocity to prevent deposition of fine material, but low enough to allow substrate stability (Vaughn 1997). Areas should be avoided that may require future channel maintenance activities or impose regulatory constraints to industry or governmental agencies.

Relocation

After divers have verified the suitability of the relocation area(s), the areas will be marked at the surface in 100m intervals to assist the relocation crew with unionid distribution. Animals will be spread from the boat as it is driven slowly through the area, with the goal of scattering them evenly throughout the site(s). An area (or areas) may be designated for rare species, so as to aggregate them within the most suitable habitat available, and to assist in monitoring their survival.

Relocated mussels would be spread over an area such that the density in the relocation areas would be increased by approximately 10 mussels/m2. Density in high-quality mussel beds in the Upper Mississippi River has been recorded as exceeding 100 mussels/m2 (e.g. Prairie du Chien, WI) as recently as the mid-1980s. Existing mussel densities within Lower Pool 2 range from 0 to approximately 10/m2.

If federally listed species are relocated, a specific area delineated by divers within the general relocation prior to relocation will be identified for hand placement of T&E individuals. Federally listed individuals will be uniquely marked, measured for length, aged, sex and gravidity determined, and hand placed in the substrate by divers in either a grid marked by blocks, PVC, or a similar fashion. The General Relocation Area will be marked at 100m intervals and the T&E relocation grid marked to assist the relocation crew with unionid distribution and future monitoring.

Federally T&E species will be hand placed in their natural position in the grid cells, with two unionids placed per cell. A diver will dig a small hole, and bury approximately 2/3 of the unionid.

A malacologist/diver will place all unionids, such that they are properly positioned. Once all four cells of each grid are filled, the PVC frames will be flipped downstream to create a new row of cells. Habitat will be inspected to insure its suitability for unionids. If habitat is unsuitable, a new grid will be established within the T&E area. For each grid row, cells will be marked with pins and a reference cell sampled as above.

During and after all collected unionids are relocated, the position of lines and weights delineating the areas will be recorded with GPS and the lines and weights will be removed. Similarly, the position of T&E grids will be recorded with GPS.

Monitoring – Relocation Sites

The Corps will conduct monitoring with qualified malacologists of relocation areas immediately post relocation (at a subset of relocation sites), and one year following relocation. The first monitoring effort will focus on ensuring that mussels generally survived relocation and were able to burrow into the substrate at the relocation sites. The second monitoring effort will focus on verifying survival through the first year. Results would be incorporated into the overall relocation report. Details for each event follow:

In Year 0 (the same calendar year the relocation is completed), 2 of the approximately 10 relocation sites will be inspected to assess the acclimation to the site. Divers would perform a visual inspection to the extent possible to qualitatively assess whether it appears that the majority of relocated mussels have burrowed into the substrate. 100 relocated (marked) mussels will be collected from the substrate, taken to the water surface, and assessed for mortality.

In Year 1 (the calendar year directly following the relocation), each relocation site would be inspected to assess mortality. At each relocation site, a diver would perform a qualitative search until 100 relocated (marked) mussels have been collected. All mussels collected would be identified and determined to be living or dead. The relocation would be determined to be successful if the overall average mortality of all relocation sites is below 15 percent. If relocation failure is revealed by the Year 1 relocation site survey, the Corps will investigate potential measures for remedying the failure and loss of ecological function, in coordination with the Minnesota Department of Natural Resources.

Monitoring – Potential Project Indirect Impacts

The Corps will conduct monitoring with qualified malacologists of pre-project, and five years post-project in an area where some indirect project impacts could occur, but are not expected to occur (See Exhibit 4). Each monitoring effort would consist of (1) A minimum of 40 0.25 m2 quadrat samples randomly placed within the area identified on Exhibit 2 to estimate density, and (2) One five minute spot dive at each of 10 (or more) of the 0.25 m2 quadrat sample sites will be sampled, plus an additional ten (or more) 5-minute spot dives in areas that are high-probability areas for unionids, as determined by the malacologist in the field. A report describing the results would be prepared and shared with interested parties.

References

Dunn, H. L., B. E. Sietman, and D. E. Kelner. 2000. Evaluation of recent unionid (Bivalvia) relocations and suggestions for future relocations and reintroductions, p. 169–183. In: R. A. Tankersley, D. I. Warmolts, G. T. Watters, B. J. Armitage, D. Johnson and R. S. Butler (eds.). Freshwater Mollusk Symposia Proceedings. Ohio Biological Survey, Columbus.

Dunn, H.L., and B.E. Seitman. 1997. Guidelines used in four geographically diverse unionid relocations. Pp. 176-183 in: K.S. Cummings, 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, October 1995, St. Louis, Missouri. Upper Mississippi River Conservation Committee, Rock Island, Illinois.

Exhibit 1:
List of Minnesota State Endangered, Threatened and Special Concern Unionid Species

***Species in Red are also Federally-Endangered.**

Endangered
Arcidens confragosus .... rock pocketbook
Cumberlandia monodonta .... spectaclecase
Cyclonaias tuberculata .... purple wartyback
Elliptio crassidens .... elephant-ear
Epioblasma triquetra .... snuffbox
Fusconaia ebena .... ebonyshell
Lampsilis higginsii .... Higgins eye
Lampsilis teres .... yellow sandshell
Megalonaias nervosa .... washboard
Plethobasus cyphyus .... sheepnose
Quadrula fragosa .... winged mapleleaf
Simpsonaias ambigua .... salamander mussel
Tritogonia verrucosa .... pistolgrip

Threatened
Actinonaias ligamentina .... mucket
Alasmidonta marginata .... elktoe
Ellipsaria lineolata ....butterfly
Elliptio dilatata ....spike
Lasmigona costata ....fluted-shell
Ligumia subrostrata ....pondmussel
Quadrula metanevra ....monkeyface
Quadrula nodulata .... wartyback
Truncilla donaciformis ....fawnsfoot
Venustaconcha ellipsiformis ....ellipse

Special Concern
Anodonta suborbiculata ....flat floater
Elliptio complanata ....eastern elliptio
Lasmigona compressa .... creek heelsplitter
Ligumia recta .... black sandshell
Pleurobema sintoxia .... round pigtoe

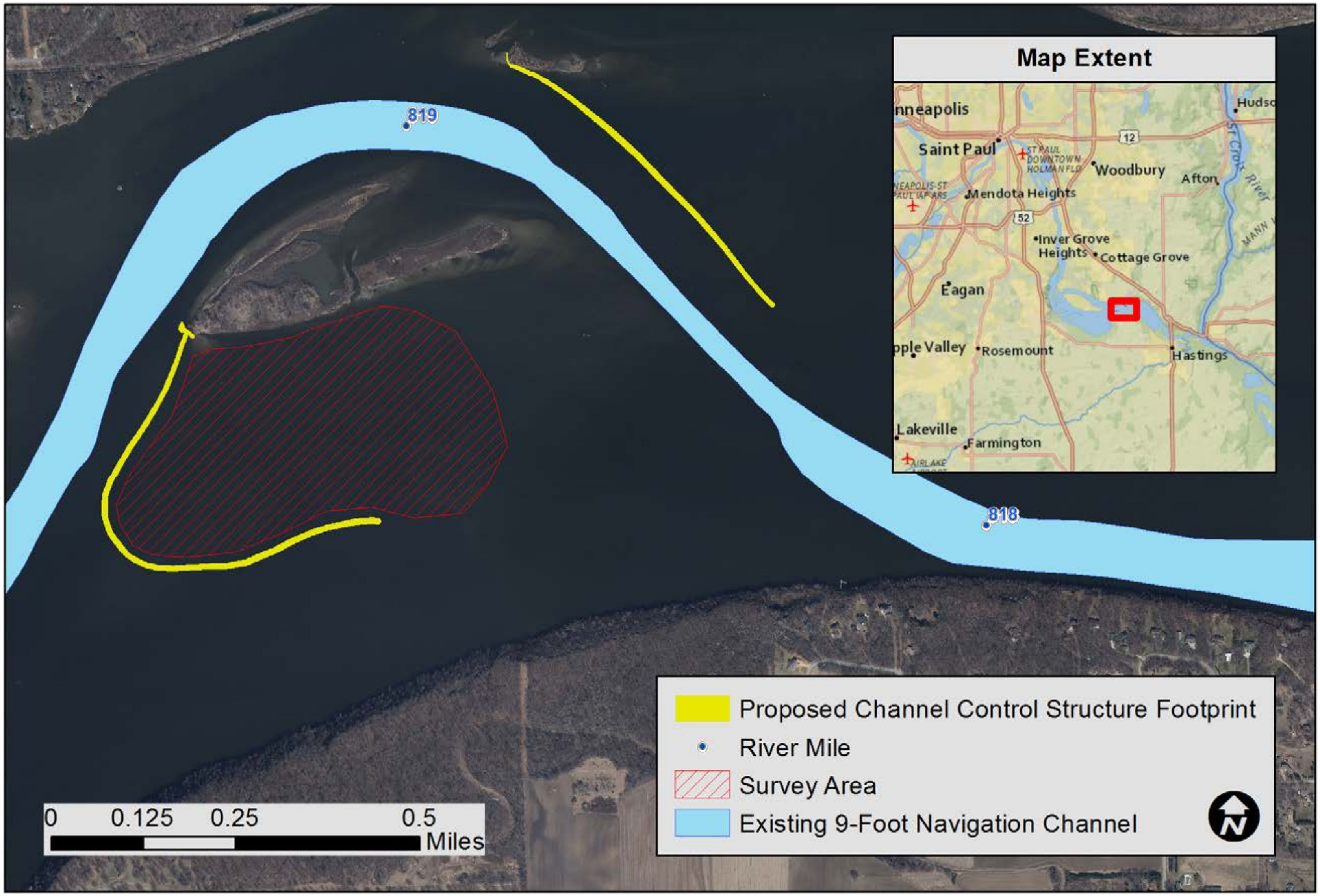

Exhibit 2. Project location, showing proposed channel training structure footprints.

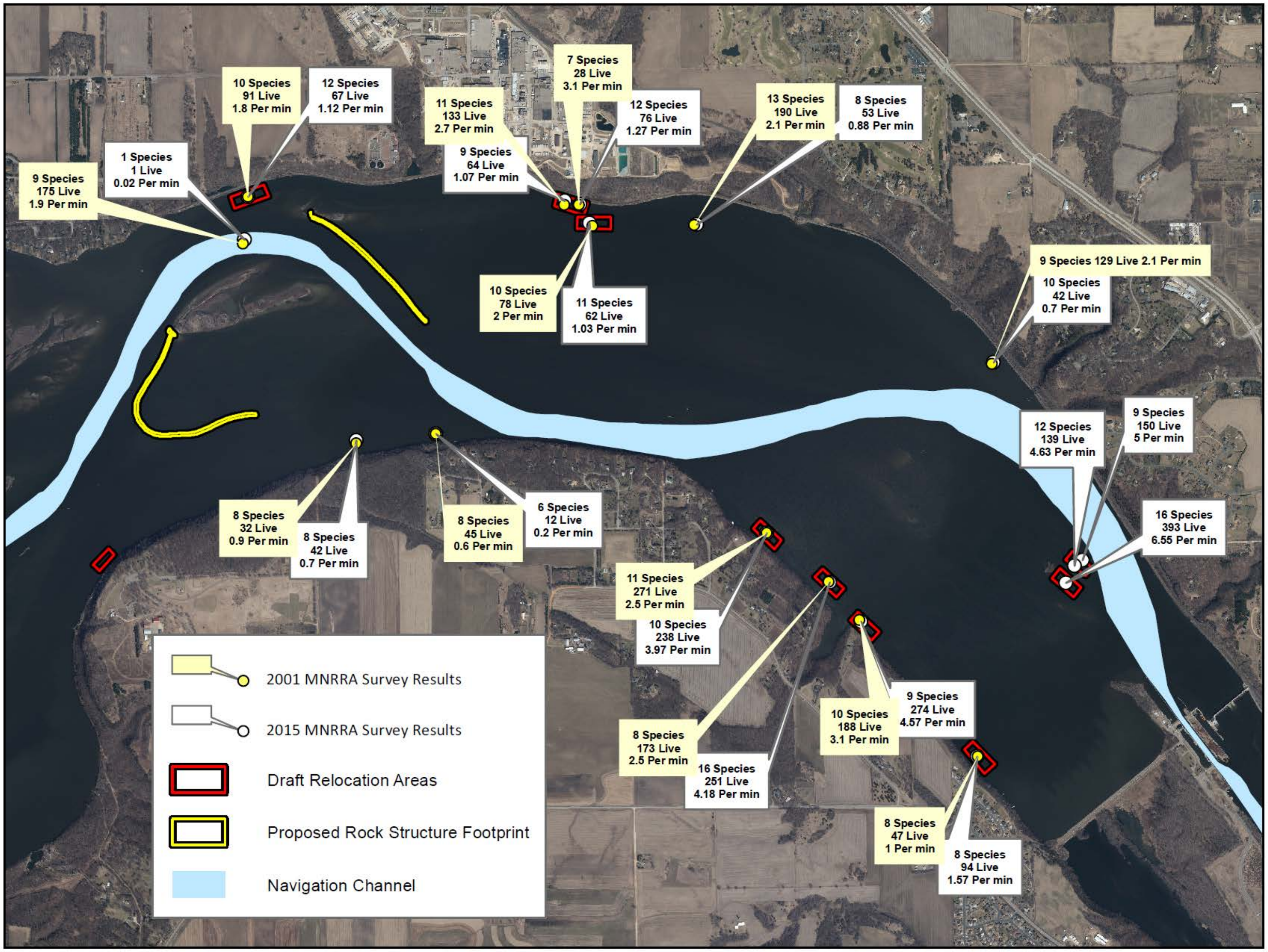

Exhibit 3. Corps-identified potential unionid relocation areas

Exhibit 4. Project Mussel Surveys, Effects, and Relocation Areas, shown with existing bathymetry

Final Report

Mussel Survey
Lower Pool 2 Channel Management Study
Boulanger Bend to Lock and Dam 2
Upper Mississippi River, Dakota and Washington Counties, Minnesota

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Introduction

The St. Paul District, Army Corps of Engineers (Corps) is authorized to maintain a 9-Foot Navigation Channel Project on the Upper Mississippi River. The ongoing program is funded through the Corps' annual operation and maintenance (O&M) appropriation. Boulanger Bend is a two-mile main navigation channel reach in lower Pool 2 of the Upper Mississippi River, approximately four miles upstream of Lock and Dam 2. Between river miles 818 and 820, the navigation channel switches from one bank of the river to the other and back again creating a near 90-degree bend in the river at mile 819. The congressionally authorized channel width in Pools 1 & 2 is 200 feet, compared to 300 feet for areas downstream from Lock and Dam 2 and 150 feet for areas upstream of the Saint Anthony Falls Locks and Dams.

The navigable width of the channel in this area has been gradually narrowing due to increased sedimentation over recent years primarily due to higher than normal flow events and increased bank erosion. The high rate of sediment deposition throughout the navigation season makes it very difficult to consistently maintain an acceptable channel width. Under low-flow conditions, portions of the proposed cut area would be less than 8 feet deep, which could cause navigational vessels to have a grounding accident. Therefore, dredging is needed to allow tow operators and boaters have enough space to maneuver through this section of river and to maintain the safety of the channel in this area. In addition, The United States Coast Guard has expressed their concern for how difficult and expensive it is to maintain the Aids to Navigation (buoys and day marks) in this stretch of Pool 2. The Commercial Navigation Industry has expressed difficulty in navigating the channel in this reach. This has resulted in reduced tow sizes and increased transport costs.

The Corps has evaluated alternatives to alleviate these maintenance difficulties. The tentatively selected plan (TSP) is a combination of (1) constructing two channel control structures to concentrate flows within the channel, thereby reducing sediment deposition in this reach and (2) dredging and maintaining the existing navigation channel to the congressionally-authorized width (features shown on Figure 1).

Due to concerns of adverse impacts to mussels from constructing the channel control structures, a mussel survey was conducted. This report presents results of a mussel survey conducted by the Corps in and around the footprints of the proposed channel control structures. The survey was conducted by Corps Biologists and the Corps Dive Team. Other mussel surveys have been conducted as a part of this project and include a report by Davis (2012) which discusses mussels in and around the main navigation channel, and a report by Kelner (2012), which evaluates mussels in a side channel to the south of Boulanger Bend. Both of these reports are included as attachments at the end of this appendix.

Methods

The survey was conducted July 27-30, 2015. The U.S. Army Corps of Engineers, St. Paul District divers were used for sample collection.

Two methods, quantitative and qualitative, were used to evaluate the mussel community and collect specimens. Quantitative sampling was necessary to accurately estimate density, age structure, and relative abundance. Quadrat samples of 0.25 square meters (m^2) were collected from 121 randomly placed and pre-determined points generated by the Corps (Figure 1). At each sampling point, a diver hand placed the quadrat on the river bottom and excavated all the material to an approximate depth of 10 centimeters (cm). The excavated material was placed into a mesh collection bag attached to the quadrat frame and sent to the surface for processing. The contents of the mesh bag were evaluated for mussel and substrate composition (Wentworth scale; Wentworth, 1922). Sample substrate was additionally described by the diver, and water depth was recorded to the nearest 0.3 meter using a pneumatic pressure gauge attached to the diver. Mussels were identified and enumerated, aged (external annuli count), and measured for length in millimeters (mm); shells were recorded as fresh dead (FD), weathered dead (WD), or sub-fossil (SF). Zebra mussel infestation on native live mussels was also recorded, using the following ranges: 0, 1-10, 11-50, >50. Native mussels were replaced near their collection point after processing.

Qualitative sampling (visual and tactual searching by diver) was used to estimate the species composition within the footprint of the proposed channel control structures. A total of nine timed searches were performed (Figure 2). Searches were conducted in areas thought to contain higher densities of mussels based on quadrat sampling. Mussels collected in qualitative samples were identified, enumerated, and classified as young (≤5 years, ≤30mm) or mature (>5 years, >30mm) based on age and length. The presence and quantity of zebra mussels was also recorded.

Density was calculated for each species using quantitative data. The number of live specimens for each species was divided by the area of the quadrat ($0.25m^2$) to convert the calculation into live specimens per meter squared (No. live/m^2). Two standard errors (2SE) were then calculated to quantify the variability of the data. From density data and estimated footprint size of the proposed channel control structures, a total population estimate was made by multiplying the area of the proposed structures (25,495 m^2) by total mussel density (no.m^2 ± 2SE), and converting to mussels per acre.

Relative abundance was calculated for both quantitative and qualitative data to show the composition of each mussel species within the mussel community. To find relative abundance, the number of individuals for each species (No. live) was divided by the total number of individuals found in that particular sampling method. This number was then multiplied by 100 to convert the units into a percentage (%). Total relative abundance was also calculated. This was calculated by adding the number of individuals for each species, regardless of sampling method, and dividing by the total number of individuals for all species. The numbers were then converted to percentage (%) as described above.

Another measure of abundance or density of mussels was calculated using catch per unit effort (CPUE) (number of live mussels collected per hour) for the qualitative samples. CPUE was calculated by dividing the number of mussels collected during the timed searches by the amount of time spent.

Size and age were also analyzed for the quantitative data to assess recent recruitment and age/size class demography in the mussel community. Mussel length (mm) and age (number of annuli) were recorded for each specimen. The mean, minimum, and maximum were calculated for each species as well as the mussel community as a whole. Data were summarized in three categories; % individuals less than 30 mm and having three and five or less external annuli.

Results

Substrate within the footprints of the proposed channel control structures varied considerably, with most areas consisting of a loose, 'mucky' mixture of silt, clay, and sand, but with pockets of homogenous sand and hardpan clay. Some areas also contained significant amounts of woody detritus. Water depths through the study area ranged from 0.15m to 3.4m. Zebra mussels (*Dreissena polymorpha*) were uncommon and were found attached only to three live unionids. Asiatic clams (*Corbicula fluminea*) were ubiquitous and were noted in nearly every quadrat.

Overall, 631 live native mussels representing 16 species were collected in the study area (Table 1). An additional nine species were represented by empty shells only. The community was dominated by *Obliquaria reflexa* (threehorn wartyback) (38.5%) and *Quadrula quadrula* (mapleleaf) (18.5%) (Table 1). Other common species include *Amblema plicata* (threeridge) (12.5%), *Fusconaia flava* (Wabash pigtoe) (11.6%), the Minnesota State Threatened *Quadrula nodulata* (wartyback) (8.7%), and *Quadrula pustulosa* (pimpleback) (3.8%). The remaining species were rare (< 2.0%) but included other species listed for protection in Minnesota: *Ellipsaria lineolata* (butterfly), *Ligumia recta* (black sandshell), and *Tritogonia verrucosa* (pistolgrip), for a total of four state-protected species collected in the survey. No federally listed or candidate species were collected live during the survey, but one weathered-dead, federally endangered *Lampsilis higginsii* (Higgins eye) shell was found.

For quantitative samples, 101 live mussels representing 12 species were collected and total density was 3.34±1.01 mussels/m^2 (see Table 1). Density of native mussels throughout the footprints of the proposed control structures varied and the number of mussel collected per 0.25m^2 quadrat varied from 0 to 7 mussels (Figure 3). Mean native mussel density at the eastern control structure (2.5 mussels/m^2) appeared lower than at the western control structure (4.2 mussels/m^2); however, these results were not statistically significant based on a one-way ANOVA test (P=0.09), and therefore, quantitative data for both control structures were pooled and analyzed together.

Based on the density estimate, the total mussel population size within the estimated 6.3-acre footprint of the proposed channel control structures was 85,200 ± 25,800 mussels. *Obliquaria reflexa* was most the most abundant species with a density of $1.02/m^2$ and comprising 30.7% of the collection. Overall average age for all species was 7.7 years old and recent recruitment was moderate, with 30.7% and 19.8% of individuals collected ≤ 5 and 3 years old, respectively, and 9 of the 12 species were represented with juveniles (≤ 5) (see Table 1).

For qualitative collections, a total of 530 live native mussels representing 16 species were collected (see Table 1). Most species collected in quantitative searches were also represented in the qualitative collections, with the exception of two species, *Potamilus ohiensis* (pink papershell) and *Pyganodon grandis* (giant floater). Four locally-rare species (<2%) that were only collected live in qualitative collections were *Ellipsaria lineolata* (butterfly), *Ligumia recta* (black sandshell), *Strophitus undulatus* (strange floater), and *Tritogonia verrucosa* (pistolgrip). A total of 190 minutes were spent in 9 locations, and total CPUE was 167.4 native mussels/hr. (see Table 1).

Discussion

Relative to the mussel fauna within Pool 2 and other UMR pools, the study area supports a moderate mussel community. Historically, as many as 41 species have occurred in Pool 2. Presently there are 29 known species living, ten of which are now either federally or state protected. In this study, only about half (16) the live species in the pool were present in this survey, four were listed for state protection, and no federally listed species were present. Density was relatively low ($3.34/m^2 \pm 1.01$) compared to high-quality areas within Pool 2. Davis (2007) reported native mussel density nearly three times greater, $9.02/m^2 \pm 1.29$ in upper Pool 2 at Hidden Falls County Park. Similarly, across the navigation channel from the study area adjacent to Lower Grey Cloud Island in Pool 2 (river mile 822 to 820), Kelner and Davis (2002) reported average mussel density of $9.8/m^2 \pm 0.8$. Conversely, the current study area supports a more abundant mussel community than the other areas surveyed as a part of the Lower Pool 2 Channel Management Study: Kelner (2012) reported native mussel densities of 2.41 ± 0.6 mussels/m^2 in a survey of the nearby Boulanger Slough area, and Davis (2012) reported native mussel density three times lower (1.03 mussels/m^2) in quantitative samples focused on nearby areas of the main channel, main channel border, and Nininger Slough.

There would be no anticipated impacts to federally listed mussel species from the proposed channel control structures. Although a single live individual of the federally endangered Higgins eye (*Lampsilis higginsii*) was collected in 2010 within a mile of the study area near Spring Lake (Bernard Sietman, MNDNR, pers. comm., 2010), it's unlikely it occurs within the proposed project area given the habitat conditions and the lack of mussel species diversity and low abundance, areas where Higgins eye are typically not found.

Four species listed for protection in Minnesota were present in the study area and would be impacted by the proposed control structures. The wartyback (*Quadrula nodulata*) is listed as Threatened by the state of Minnesota, and was found during quantitative sampling throughout the two structure footprints at a relative abundance of nearly 9%. Based on the sampled density, it is estimated that approximately 1,300 ± 890 wartyback are present per acre within the project area, and therefore approximately 8,200 ± 5,600 would be affected by the construction of the proposed channel control structures. Although the wartyback is rare throughout the state including other locations within the UMR, the species has healthy populations in Pool 2. Studies of the mussel community in Pool 2 reflect the good health of the wartyback species in the area. In 2002, Kelner and Davis performed a study of the mussel community within the Mississippi National River and Recreation Area (MNRRA) Corridor, which encompassed the entirety of Pool 2. During the study, they collected wartyback with relative abundances ranging from 2.3% in the lower portion of the pool to 2.6% in the upper reach of the pool, and represented by young and medium to older individuals, which is indicative of recent and ongoing recruitment. In 2015, the Corps, Minnesota DNR, National Park Service, and U.S. Fish and Wildlife Service began re-surveying the sites from the 2002 study, including nearly all of the sites in Lower Pool 2. Sampling methods were replicated, and the same personnel – Kelner and Davis – led the study. In the 2015 survey, the relative abundance of wartyback in Lower Pool 2 rose to 9.7%, had the fifth-highest relative abundance out of twenty-two species collected, and again included both young, medium aged, and mature individuals. The catch per-unit-effort of wartyback also rose from 2.3 ± 0.5 individuals per hour to 9.2 ± 3.0 individuals per hour (results based on an unpublished preliminary data analysis). These results suggest that the wartyback population in Lower Pool 2 is improving. Further, the relative abundance of wartyback throughout Lower Pool 2 in the 2015 MNRRA survey is nearly identical to the relative abundance found within the proposed project footprint, suggesting that the suitability of the habitat for wartyback is not unique to the approximately five acres of the project footprint, and is likely similar in much of the approximately 1,900 acres of impounded habitat in Lower Pool 2 (see Figure 4 depicting habitat types in Lower Pool 2 for existing conditions and under project conditions).

Two individuals of the state-endangered pistolgrip (*Tritogonia verrucosa*), and one individual of the state-threatened butterfly (*Ellipsaria lineolata*) were found in qualitative timed-searches. A population estimate cannot be calculated based on survey data for these two species because they were only found in qualitative searches. It is reasonable to assume that a small number of individuals of these species exist within the project area, and would be impacted by project construction.

One other listed species, the black sandshell (*Ligumia recta*), is a Species of Special Concern for the state and although rare in Pool 2, the species is widespread and common in other areas of the state and other areas of the Mississippi River (thus the reduced status listing), and therefore, no adverse impacts to their population would occur through the construction of the proposed channel control structures.

Summary of Effects and Mitigation Recommendation

The proposed project would impact an estimated 85,200 ± 25,800 native freshwater mussels, and would impact individuals representing four species of conservation concern in the State of Minnesota. Given that native freshwater mussels are one of the most imperiled groups of animals in North America, mitigating project impacts to this valuable resource is an important part of meeting the Federal objective of protecting the Nation’s natural environment. Compared to other alternatives considered during this study, effects to freshwater mussels were minimized significantly by selecting this plan. The Boulanger Slough channel realignment alternative would have impacted 52 acres of aquatic habitat and an estimated 529,400 ± 131,800 mussels, over six times as many as the selected plan. During design of the Tentatively Selected Plan, a number of potential structure designs were identified, ranging from wide island-style structures to narrow rock mounds. The narrow Rock mounds were selected in order to minimize the footprint and thereby minimize the adverse effects to freshwater mussels. The only alternative identified that would further reduce impacts would be the No Action alternative, which does not meet study goals.

Due to the unavoidable impacts to freshwater mussels, relocation of the affected mussels is proposed to mitigate for the adverse effects of the selected plan. Mussel relocation consists of divers physically hand collecting mussels that would be impacted by a project and moving them to a nearby location. Often mussels are moved to areas that are known to have historically supported good mussel communities. This has been shown to be an effective method for mitigating in-stream impacts and is frequently used when Federally-listed species occur in an area of impact, and studies suggest divers can reliably collect 90-95% of mussels.

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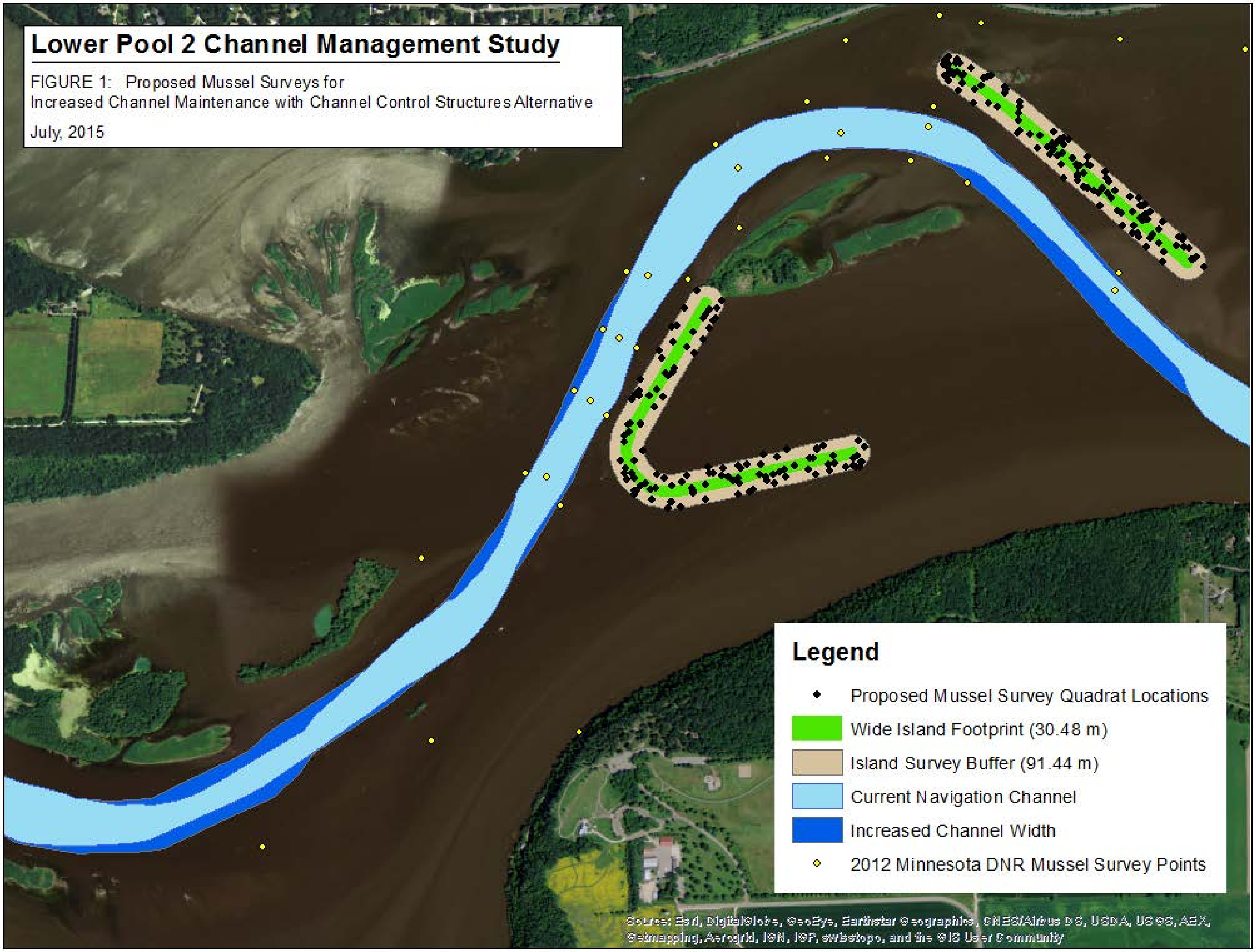
Kelner, D.E. 2012. Final Report: Mussel Survey – Lower Pool 2 Channel Management Study, Boulanger Bend to Lock and Dam 2, Upper Mississippi River, Dakota and Washington Counties, Minnesota. 13pp.

Figure 1



Lower Pool 2 Channel Management Study
FIGURE 1: Proposed Mussel Surveys for
Increased Channel Maintenance with Channel Control Structures Alternative
July, 2015
Legend
Proposed Mussel Survey Quadrat Locations
Wide Island Footprint (30.48 m)
Island Survey Buffer (91.44 m)
Current Navigation Channel
Increased Channel Width
2012 Minnesota DNR Mussel Survey Points
Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AEX, Getmapping, Aerogrid, IGN, IGP, swisstopo, and the GIS User Community

Figure 2

Lower Pool 2 Channel Management Study
Quantitative Mussel Survey Results
Increased Channel Maintenance with Channel Control Structures Alternative
July 27-30, 2015
Legend
Wide Structure Footprint (30.48 m)
Survey Buffer (91.44 m)
Current Navigation Channel
Increased Channel Width
Quadrat Locations (# Live Mussels)
No Live Mussels
1
2
3
4 - 5
6 - 7
Quadrula nodulata

Figure 3

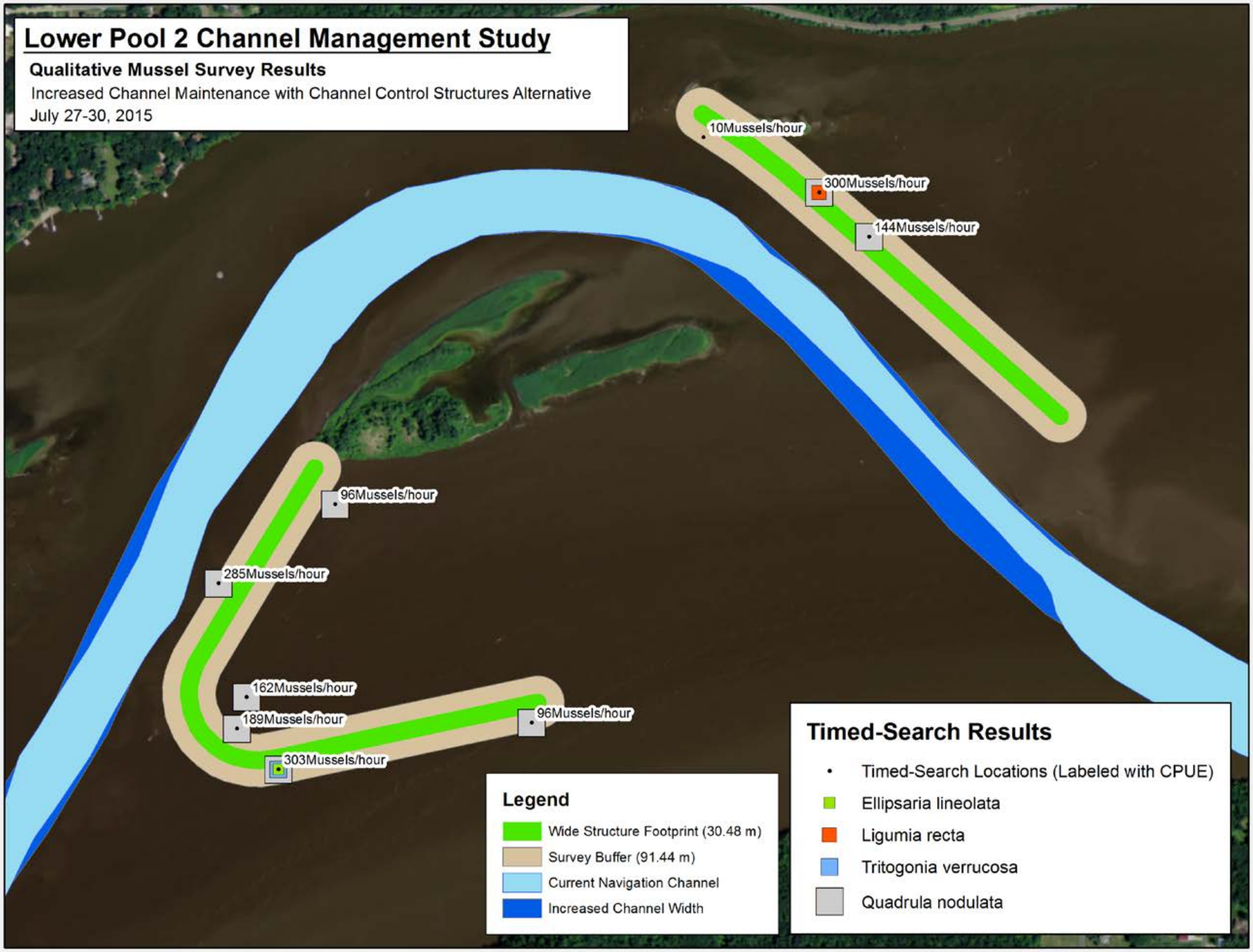
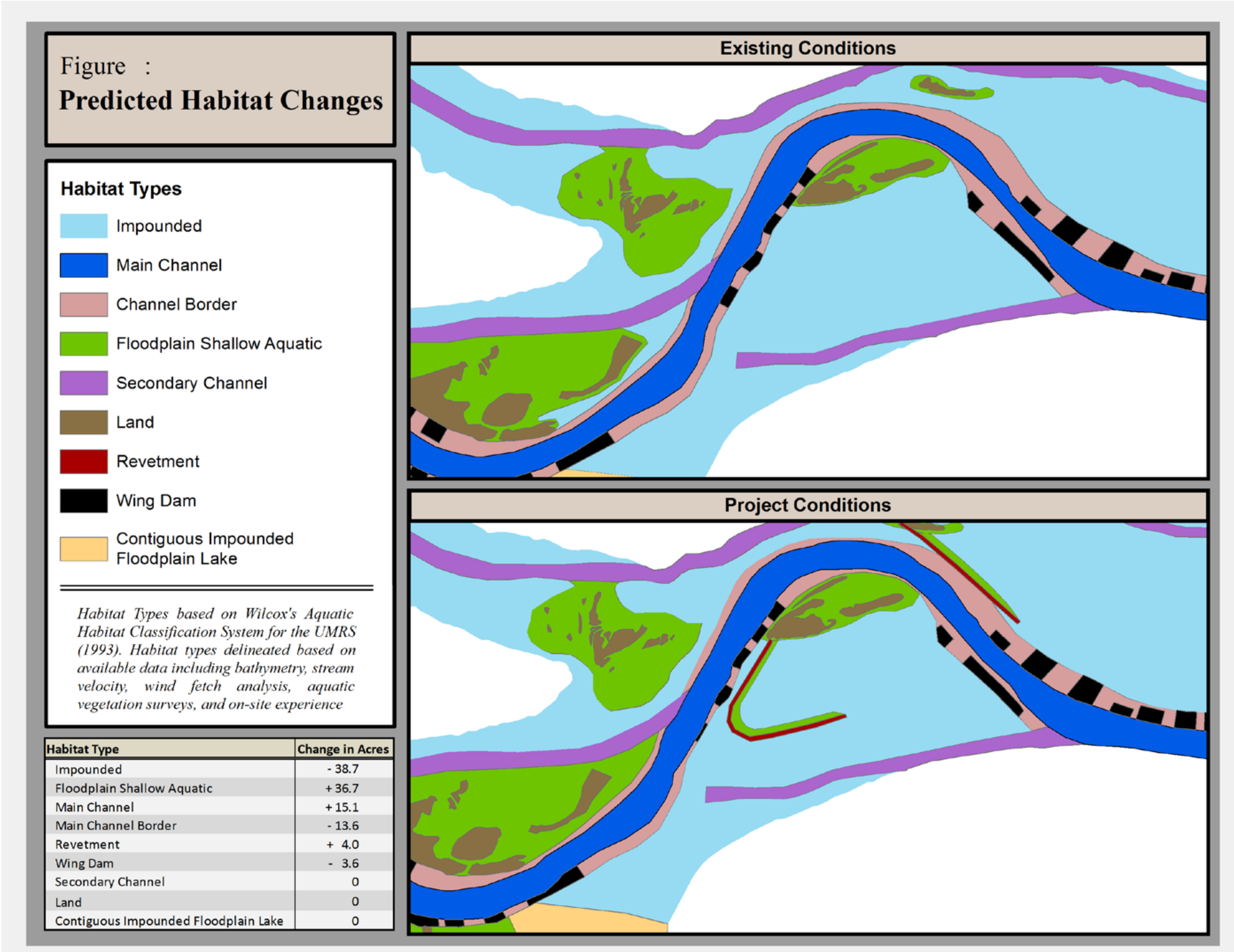

Lower Pool 2 Channel Management Study
Qualitative Mussel Survey Results
Increased Channel Maintenance with Channel Control Structures Alternative
July 27-30, 2015
10Mussels/hour
300Mussels/hour
144Mussels/hour
96Mussels/hour
285Mussels/hour
162Mussels/hour
189Mussels/hour
303Mussels/hour
96Mussels/hour
Legend
Wide Structure Footprint (30.48 m)
Survey Buffer (91.44 m)
Current Navigation Channel
Increased Channel Width
Timed-Search Results
Timed-Search Locations (Labeled with CPUE)
Ellipsaria lineolata
Ligumia recta
Tritogonia verrucosa
Quadrula nodulata

Figure 4



Habitat Type	Change in Acres
Impounded	- 38.7
Floodplain Shallow Aquatic	+ 36.7
Main Channel	+ 15.1
Main Channel Border	- 13.6
Revetment	+ 4.0
Wing Dam	- 3.6
Secondary Channel	0
Land	0
Contiguous Impounded Floodplain Lake	0

Table 1. Mussel species richness, relative abundance, and density in the proposed channel control structure footprint, UMR Pool 2 , July 2015

	Quantitative										Qualitative		Total	
	Abundance				Age			Length						
Species	No. Live	%	No./m2	2SE	Ave	Min.	Max	Ave	Min.	Max	No. Live	%	No. Live	%
Amblema plicata	14	13.9	0.46	0.25	8.4	0	16	66.1	7	115	65	12.3	79	12.5
Arcidens confragosus[E]	D	-	-	-	-	-	-	-	-	-	D	-	-	-
Ellipsaria lineolata[T]	-	-	-	-	-	-	-	-	-	-	1	0.2	1	0.2
Elliptio crassidens[E]	D	-	-	-	-	-	-	-	-	-	-	-	-	-
Fusconaia flava	8	7.9	0.26	0.20	10.4	6	16	64.9	42	131	65	12.3	73	11.6
Lampsilis cardium	D	-	-	-	-	-	-	-	-	-	D	-	-	-
Lampsilis higginsii[E]	-	-	-	-	-	-	-	-	-	-	D	-	-	-
Lasmigona complanata	1	1.0	0.03	0.07	7.0	-	-	131.0	-	-	8	1.5	9	1.4
Leptodea fragilis	1	1.0	0.03	0.07	2.0	-	-	44.0	-	-	3	0.6	4	0.6
Ligumia recta[SC]	-	-	-	-	-	-	-	-	-	-	8	1.5	8	1.3
Obliquaria reflexa	31	30.7	1.02	0.49	7.1	1	13	49.0	7	73	212	40.0	243	38.5
Obovaria olivaria	D	-	-	-	-	-	-	-	-	-	-	-	-	-
Pleurobema sintoxia[SC]	D	-	-	-	-	-	-	-	-	-	-	-	-	-
Potamilus alatus	1	1.0	0.03	0.07	9.0	-	-	123.0	-	-	2	0.4	3	0.5
Potamilus ohiensis	1	1.0	0.03	0.07	5.0	-	-	100.0	-	-	D	-	1	0.2
Pyganodon grandis	1	1.0	0.03	0.07	4.0	-	-	152.0	-	-	D	-	1	0.2
Quadrula nodulata[T]	10	9.9	0.33	0.22	6.9	3	12	49.4	21	80	45	8.5	55	8.7
Quadrula pustulosa	6	5.9	0.20	0.16	7.8	1	12	51.0	11	74	18	3.4	24	3.8
Quadrula quadrula	21	20.8	0.69	0.32	9.3	1	15	65.1	10	87	96	18.1	117	18.5
Strophitus undulatus	-	-	-	-	-	-	-	-	-	-	1	0.2	1	0.2
Toxolasma parvus	D	-	-	-	-	-	-	-	-	-	-	-	-	-
Tritogonia verrucosa[E]	-	-	-	-	-	-	-	-	-	-	2	0.4	2	0.3
Truncilla donaciformis[T]	D	-	-	-	-	-	-	-	-	-	-	-	-	-
Truncilla truncata	6	5.9	0.20	0.16	3.0	2	4	24.7	20	32	4	0.8	10	1.6
Utterbackia imbecillis	D	-	-	-	-	-	-	-	-	-	-	-	-	-
Total No. Live	101	-	3.34	1.01	7.7	-	-	57.7	-	-	530	-	631	-
Live Species	12	-	-	-	-	-	-	-	-	-	16	-	16	-
Total Species	20	-	-	-	-	-	-	-	-	-	18	-	25	-
(n)	121	-	-	-	-	-	-	-	-	-	9	-	-	-
% ≤ 3 years old	-	-	-	-	9.9	-	-	-	-	-		-	-	-
% ≤ 5 years old	-	-	-	-	30.7	-	-	-	-	-		-		-
% ≤ 30 mm	-	-	-	-	19.8	-	-	-	-	-		-	-	-
Effort (min.)	-	-	-	-	-	-	-	-	-	-	190.0	-	-	-
CPUE (no./hour)	-	-	-	-	-	-	-	-	-	-	167.4	-	-	-

E, T, SC = Species listed in Minnesota as Endangered, Threatened, or Special Concern, respectively.

D=empty shell only collected

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