Final Report to the National Fish and Wildlife Foundation - Milwaukee River Fish Spawning Habitat Rehabilitation Project

Will Wawrzyn, WDNR Senior Fisheries Biologist
Milwaukee River Basin

Project Name: Fish Spawning Habitat Rehabilitation (WI)
Project Number: 2004-0005-224
Organization: Wisconsin Department of Natural Resources (WDNR)
Reporting Period: June 30, 2007 through December 31, 2007

1.0 SUMMARY

We used the spawning life-requisites of Walleye for designing and constructing a spawning reef in the Milwaukee River Estuary, Milwaukee County, Wisconsin. Walleye life-requisites were selected because of their historical importance to Lake Michigan potamodromous and river and estuary fluvial fish stocks. Furthermore, the project objectives support the WDNR's on-going Walleye restoration program for the Milwaukee River Estuary and recommendations contained in the Milwaukee Estuary Area of Concern Remedial action Plan (WDNR, 2005a and 2005b). Walleye also have overlapping life-requisites with those of other simple lithophilic spawning fishes in the watershed, including the state Special Concern listed Lake sturgeon and Threatened Greater rehorse. Critical Walleye life-requisites for the reef design included their optimum range of preferred spawning substrate size, water velocity, water quality and water depth (McMahon et al., 1984; Aadland and Kuitunen, 2006).

We initially identified five potential reef construction areas ranging in size from 3,000 SF to 28,000 SF and evaluated them for construction feasibility according to access constraints, water depth, sediment bearing strength and other hydrologic and hydraulic characteristics including river velocities, shear stress and potential for increasing local and state regulatory flood elevations. Following the feasibility analysis, a single large reef totaling 26,050 SF (0.6 acre) was constructed using 1,675 T of 3-in to 10-in alluvial stone placed at an average thickness of 1-ft. Contracted time and materials unit costs for the project were $3.16 per SF.

We assessed the reef's utility for producing Walleye 1-year post-construction using a variety of gears selective for larvae and young-of-year. No Walleye production was found. We will continue to assess the biological use of the constructed reef during the spring and summer of 2008. This effort may include a combination of methods for identifying Walleye use and production for life stages ranging from egg deposition through young-of-the year. This effort will continue through 2010.

2.0 BACKGROUND

Water quality along the lower Milwaukee River and Milwaukee River Estuary has steadily improved since 1997. Two of the most notable and visible water resource

management projects responsible for these improvements include the Milwaukee Metropolitan Sewerage Districts (MMSD) multi-billion dollar Combined Sewer Overflow Abatement Program and other facility improvements, and the City of Milwaukee's $4.5 million project resulting in the abandonment of the 150-year old North Avenue Dam. The later project was funded by the City of Milwaukee, WDNR, Great Lakes Protection Fund and the US Environmental Protection Agency. Although water quality is now capable of supporting a more diverse fish and aquatic life community, critical fish spawning habitat in the estuary is limited. Beginning in the early 1900's, river and corridor fish and other aquatic life habitat was severely modified by dredging and filling to accommodate commercial shipping. Prior to dredging, a large riffle complex was located at the upstream limits of the estuary and coincidentally, the location of the former North Avenue Dam (Figure 1). The goal of the project was to re-create a portion of the Milwaukee River Estuary's historic native potadromous fish spawning habitat.

3.0 RESULTS

3.1 Planning, Design and Permitting

- Year 2001 pre-construction and year 2007 post-construction GIS based bathymetric & hydrological surveys.

- Encumbered grants and gifts.

- Secured temporary access and construction agreement with private landowner for upland and in-water work; and permanent easement to place structure onto bed of the river.

- Submitted multiple iterations of bathymetric reef design plans to Southeastern Wisconsin Regional Planning Commission (SEWRPC) and completed hydrologic & hydraulic impact analysis for 100-yr floodplain and affected property owners.

- Prepared and published construction proposal and bid documents.

- Submitted materials and obtained federal, state and local permits;
  - Natural Heritage Review (NHI)
  - State Historic Preservation Office (SHPO) review
  - Wisconsin Wetland Inventory review
  - NR 216 Stormwater Discharge Permit review
  - Project plans and drawings
  - Safety plan
  - FEMA floodplain boundary map, and hydrologic and hydraulic analysis.
  - US Army Corps of Engineers (ACOE) authorization under Sec. 10 of the Rivers & Harbors Act of 1899 and provisions under Sec. 404 of the Clean Water Act.
  - Completed informational meeting with City of Milwaukee representatives including alderman, Port Authority, Department of Public Works; and other

local groups including the Milwaukee River Revitalization Foundation, and Friends of Milwaukee's Rivers.
    - Published Class 1 30-day Public Notice and provided copies to interested parties via certified mail.
    - Initiated on-site visits with contractors (5) as pre-condition for submitting project construction bid.

The project originally proposed to construct up to five reef areas ranging in size from 3,000 SF and 28,000 SF, and totaling between 40,000 SF (1-acre) and 60,000 SF (1.4-acres); using approximately 3,000 T of clean, 3-in to 5-in diameter alluvial stone; placed at a thickness ranging from 1-ft to 2-ft (Figure 2).

A variety of factors caused the project to be reduced to one large reef totaling approximately 26,050 SF (0.6 acre); using 1,675 T of 3-in to 10-in alluvial stone; placed at an average thickness of 1-ft. Factors that limited the original design of potential reef construction areas included;

- The recent construction of a permanent pedestrian bridge spanning the former North Avenue Dam weir prevented equipment access to construct 5,220 SF of reef in the northeast quadrant of the project area (Area 3).

- A continuing decline in Lake Michigan water elevation since the project was proposed in year-2000 prevented the use of a barge and boat to transport and construct between 10,000 SF and 30,000 SF of reef downstream and including Area 5. According to a local marine contractor, a construction barge would require a minimum draft of 6-ft. Water depths along the thalweg adjoining these areas are less than 4-ft.

- Approximately 1,300 SF of deeper water reef ($\geq$ 4-ft) originally proposed to be constructed by barge access along Areas 1 & 4 could not be constructed.

- In order to construct the majority of the 5,220 SF reef in Area 2, large trees (black willow and box elder) would need to be removed. The landowner who did provide an easement and access to construct the reef did not want to remove trees along his shoreline. As a result, 5,000 SF of the proposed 5,220 SF for this area was not constructed.

- Following the reductions in reef size above, the hydraulic analysis for the remaining 40,000 SF by 2-ft thick reef would have caused an increase in the 100-year recurring flood interval, typically less than 0.2-ft over existing flood elevations. An increase in the 100-yr flood elevation $\geq$ 0.01-ft would have required flood easements from over 12 different riparians landowners. To mitigate this impact, the extent and volume of stone for the proposed reef was reduced until no net increase in flood elevations was noted in the final hydraulic analysis, or 26,050 SF (Figures 3a through 3c). The analysis also indicated that the reduction in stone thickness would not reduce the stability of the reef.

- The hydraulic model also described shear stresses and velocities along one of the boundaries planned reef that exceeded the 3-in to 5-in (D_{50} 4-in) limits for the proposed reef stone. To minimize or eliminate the potential scour and potential loss of reef material during the design 100-year discharge event, the proposed stone along the erosive boundary was increased to 6-in to 12-in stone (D_{50} 9-in).

3.2 Construction

- In-stream construction commenced on October 9, 2006 and was completed on October 19, 2006. No significant or costly construction problems were encountered. All permit conditions were met.

- We observed Lake Michigan/Milwaukee River Estuary seiche to vary up to 1.8-ft in as little as 20-minute intervals. This required placement of the temporary stone causeway at higher elevations in order to avoid equipment from operating in the water consistent with State permit requirements.

- Short-term Lake Michigan seiche events do result in portions (typically less than 20% of the constructed reef) undergoing short-term (hourly and daily) periods of water loss and reef exposure to the air. In recognition of these hydrologic variations, we decided early on in the planning stages to construct the reef to accommodate as near to possible the long-term "average" lake and estuary water elevations as opposed to short-term variations.

- Long-term Lake Michigan/Huron water elevations continue to decline since completing the pre-construction bathymetric survey in October 2001. While continued lake level declines may cause additional exposure and desiccation of the constructed reef substrate, reductions in lake water levels may enable access to potential reef construction areas that meet the original reef design and location criteria (e.g., water depth).

3.3 Funding and Costs

- Funding sources and budget sources included USEPA 319 Grant $30,000; USEPA GLNPO Grant via National Fish and Wildlife Foundation $60,000; USFWS Grant $15,000; Walleyes for Tomorrow (gift) $15,000 or Total of $114,460 (Appendix 1).

- Alby Stone, Inc. delivered 181 T of 6-in to 12-in stone and 1,494 T of 3-in to 5-in stone at $37,900.

- Dakota Intertek contractor construction costs (mobilization, stone placement, clean up) at $42,643.

- SEWRPC, Reinder's and Veiola for hydrologic and hydraulic analysis, landscaping/erosion control materials and debris disposal totaling $1,872.

- Total project costs $82,415 or $3.16 per SF of constructed reef (excluding WDNR in-kind related costs as time, mileage, and equipment use).
- Project balance approximately $32,000.

3.4 Information & Education

- Completed Project Fact Sheet describing the project for public distribution and poster boards for public presentations.

- Prepared project MS Power Point presentation and presented to Milwaukee River Basin Chapter of Walleyes for Tomorrow.

- Digital photographs were obtained throughout the construction phase of the project (Appendix 2).

3.5 Monitoring

- We began pre-reef construction spring fish larvae plankton tows in 2004 following initiation of the WDNR's Milwaukee River Estuary Walleye stocking and restoration program (WDNR 2005). Fish larvae were captured but did not include Walleye.

- Two late-summer and day-light electrofishing assessments did not result in the collection of any Walleye young-of-the-year (YOY) (Appendix 3). Adult Walleye, young-of-the-year and adult smallmouth bass, five species of sucker including the state threatened greater redhorse, gizzard shad, common shiner, grass carp, logperch and rock bass were effectively sampled by electrofishing. Similarly, a fall 2007 Walleye YOY sampling effort using mini-fyke nets also did not result in the collection of any Walleye YOY. Monitoring will continue through 2010.

- We will continue to assess the biological use of the constructed reef during the spring and summer of 2008. This effort may include a combination of methods including post-spawn plankton/larvae tows; fish egg and fry traps; semi-qualitative fish egg sampling using benthic "kick" nets; and spring and summer tow boat electrofishing along the reef and adjoining shorelines. Viable egg samples may be taken to laboratory aquaria for development to an identifiable life-stage.

- Historic and future reef biological use assessment results will be reported through the on-going Milwaukee River Estuary Walleye Restoration Program. Field sample results will be managed in the WDNR's Fish and Habitat database.

4.0 RECOMMENDATIONS

- Additional spawning reef habitat could be constructed in the original project boundary. Continuing decreases in Lake Michigan water elevations may allow for the construction of spawning reef material closer to or within the thalweg of the Milwaukee River consistent with spawning depths preferred by Walleye. The construction of additional reefs will require revised points of access, access agreements, permits, hydrologic and hydraulic analysis, and placement techniques (e.g. long-boom crane or by barge). These revised means and methods may result in an increase in the original unit cost for reef construction.

- Before proceeding with additional reef construction, the above factors should be weighed against the constructed reef's ability to meet the goal of providing suitable habitat for spawning fish and other aquatic life.

- Extensive reaches of the Milwaukee River Estuary are not conducive to reef construction. As a drowned river mouth, the Milwaukee River Estuary is aggrading sediment. With the formal cessation of dredging for commercial navigation and continued shoaling, water depths will continue to decrease. In aggrading or shoaling areas, re-creating fish and aquatic habitat with submerged and emergent aquatic vegetation should be explored. Additional reef or other structural habitat features would need to be located in areas where river or lake currents would limit embedding sediment.

- Continue to explore the purchase of easements or land acquisition through fee title of additional flowed lands and floodplain to enable future habitat projects described above. NGO partnerships would be the most expedient.

5.0 REFERENCES

McMahon, T.E., J.W. Terrell, P.C. Nelson. 1984. Habitat suitability information: Walleye. U.S. Fish and Wildlife Service. FWS/OBS-82/10.56. 43 pp.

Wisconsin Department of Natural Resources. 2005a. Milwaukee River Estuary Walleye Management Plan, Bureau of Fisheries Management and Habitat Protection, Madison, WI. PUB FH-512-05.

Wisconsin Department of Natural Resources. 2005b. Milwaukee River Estuary Remedial Action Plan – A Plan to Cleanup Milwaukee's Rivers. Madison, Wisconsin.

Aadland, L.P. and A. Kuitunen. 2006. Habitat suitability criteria for stream fishes and mussels of Minnesota. Minnesota Department of Natural Resources.

FIGURES

Figure 1. Newly reconstructed North Avenue Dam prior to dredging for commercial navigation (circa. 1876). Note riffle and coarse bed material forming the dated upstream limits of the Milwaukee River Estuary.

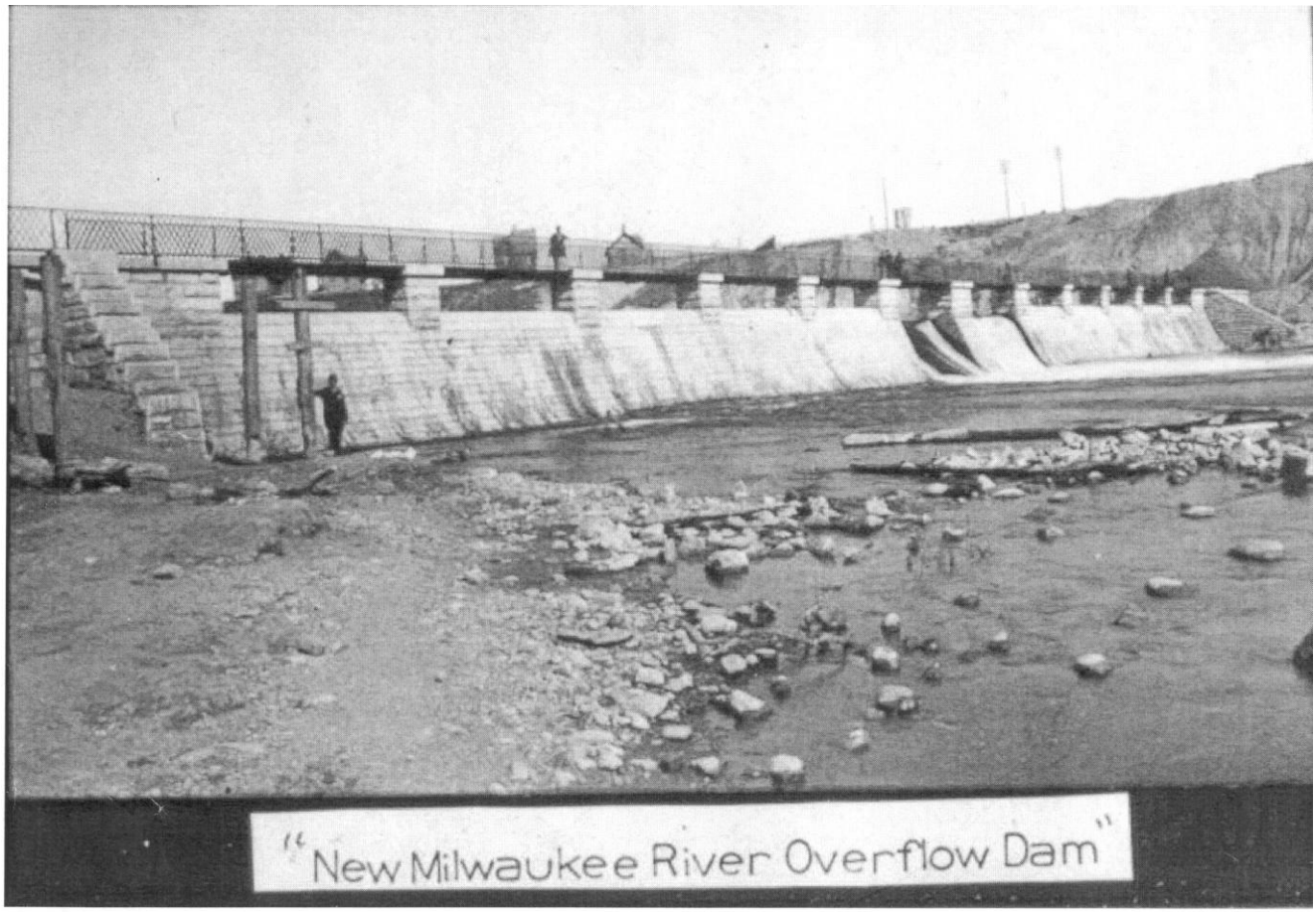


Figure 2. Potential and as-built reef areas (Wawrzyn, 2005).

Potential Reef Area No.	SF	Acres
1	8,265	0.19
2	5,220	0.12
3	5,220	0.12
4	13,920	0.32
5	10,875	0.25
Total	43,500	1.00

As- Built Reef Area	SF	Acres
1	26,050	0.60

Figure 3a. Milwaukee River reach and transects for HEC-RAS hydraulic analysis (Wawrzyn, 2005).

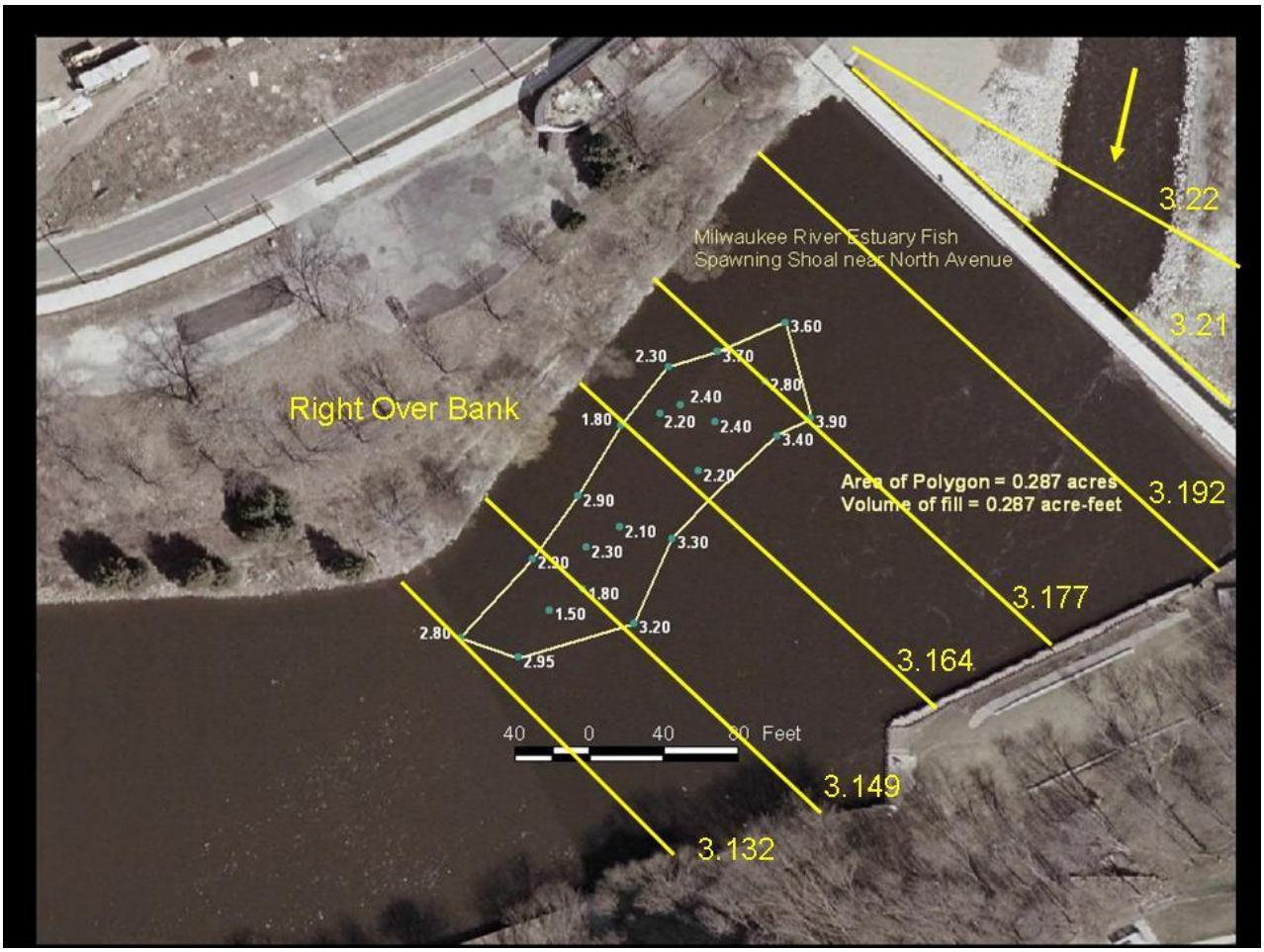


Figure 3b. Milwaukee River HEC-RAS hydraulic analysis for surface water elevations with and without spawning reef at selected discharges (Wawrzyn, 2005).

			Water Surface Elev. (ft)		
River Mile (Location)	**Profile**	**Total (ft3/s)**	**WITH REEF**	**WITHOUT REEF**	**NET CHANGE**
3.192 (between former dam & reef)	2-Yr Q	5200	581.12	581.11	
3.192	5-Yr Q	7300	582.15	582.14	
3.192	10-Yr Q	8790	582.89	582.88	
3.192	50-Yr Q	12900	584.88	584.88	
3.192	100-Yr Q	14800	**585.96**	**585.96**	**0.00**
Maximum					
3.177 (top of reef)	2-Yr Q	5200	581.15	581.15	
3.177	5-Yr Q	7300	582.21	582.20	
3.177	10-Yr Q	8790	582.97	582.96	
3.177	50-Yr Q	12900	585.00	585.00	
3.177	100-Yr Q	14800	**586.09**	**586.09**	**0.00**
Maximum					
3.164 (upper 1/3 of reef)	2-Yr Q	5200	581.13	581.13	
3.164	5-Yr Q	7300	582.18	582.17	
3.164	10-Yr Q	8790	582.93	582.93	
3.164	50-Yr Q	12900	584.95	584.95	
3.164	100-Yr Q	14800	**586.04**	**586.05**	**-0.01**
Maximum					
3.149 (lower 1/3 of reef)	2-Yr Q	5200	580.82	580.85	
3.149	5-Yr Q	7300	581.78	581.81	
3.149	10-Yr Q	8790	582.49	582.53	
3.149	50-Yr Q	12900	584.49	584.53	
3.149	100-Yr Q	14800	**585.62**	**585.66**	**-0.04**
Maximum					
3.132 (bottom of reef)	2-Yr Q	5200	580.69	580.69	
3.132	5-Yr Q	7300	581.63	581.63	
3.132	10-Yr Q	8790	582.35	582.35	
3.132	50-Yr Q	12900	584.38	584.38	
3.132	100-Yr Q	14800	**585.53**	**585.53**	**0.00**
Maximum					

Figure 3c. Milwaukee River HEC-RAS hydraulic analysis for shear stress and velocities with and without spawning reef at selected discharges (Wawrzyn, 2005).

	Vel. Chnl. (ft/s)		Flow Area (sq ft)		Shear Chan (lb/sqft)		Shear Right Over Bank (ROB) (lb/sqft)	
Transect (Location)	**WITH REEF**	**WITHOUT REEF**	**WITH REEF**	**WITHOUT REEF**	**WITH REEF**	**WITHOUT REEF**	**WITH REEF**	**WITHOUT REEF**
3.192 (between dam & former reef)	3.04	3.05	1708.22	1705.99	0.11	0.12		
3.192	3.82	3.83	1909.41	1907.44	0.17	0.18		
3.192	4.28	4.28	2053.93	2052.37	0.21	0.21		
3.192	5.28	5.29	2441.66	2440.86	0.31	0.31		
3.192	5.58	5.58	2652.39	2651.89	0.33	0.33		
Maximum	**5.58**				**0.33**			
3.177 (top of reef	2.24	2.20	2348.51	2391.97	0.06	0.06	0.02	0.02
3.177	2.82	2.77	2615.10	2659.16	0.09	0.09	0.04	0.04
3.177	3.16	3.11	2806.59	2851.32	0.11	0.11	0.05	0.05
3.177	3.92	3.87	3320.28	3366.29	0.16	0.16	0.07	0.07
3.177	4.16	4.10	3597.43	3643.86	0.18	0.18	0.07	0.08
Maximum	**4.16**				**0.18**		**0.07**	
3.164 (upper 1/3 of reef	2.42	2.37	2179.75	2225.75	0.07	0.07	0.03	0.03
3.164	3.04	2.98	2440.87	2487.59	0.10	0.10	0.04	0.05
3.164	3.40	3.33	2628.77	2676.21	0.13	0.13	0.06	0.06
3.164	4.18	4.11	3133.53	3182.35	0.18	0.18	0.08	0.09
3.164	4.41	4.35	3406.98	3456.20	0.20	0.20	0.09	0.10
Maximum	**4.41**				**0.20**		**0.09**	
3.149 (lower 1/3 of reef	4.77	4.53	1090.39	1147.37	0.35	0.31		
3.149	5.56	5.32	1313.40	1372.64	0.45	0.41		
3.149	5.91	5.68	1487.17	1547.39	0.50	0.45		
3.149	6.47	6.28	1994.11	2054.88	0.55	0.51		
3.149	6.45	6.29	2293.46	2353.06	0.52	0.49		
Maximum	**6.47**				**0.55**			
3.132 (bottom of reef	4.88	4.88	1064.57	1064.57	0.37	0.37		
3.132	5.67	5.67	1288.38	1288.38	0.47	0.47		
3.132	5.99	5.99	1466.93	1466.93	0.51	0.51		
3.132	6.51	6.51	1982.77	1982.77	0.55	0.55		
3.132	6.47	6.47	2287.88	2287.88	0.53	0.53		
Maximum	**6.51**				**0.55**			

Riprap d_{50} (inches)	(lbs/sf)	V_{min} (ft/s)	V_{max} (ft/s)	Reference
24-in d50	10.10	14.0	18.0	Norman, J.N. (1975)
18-in d50	7.60	12.0	16.0	Norman, J.N. (1975)
12-in d50	5.10	10.0	13.0	Norman, J.N. (1975)
9-in d50	3.80	7.0	11.0	Norman, J.N. (1975)
6-in d50	2.50	5.0	10.0	Norman, J.N. (1975)
12-in uniform	4.00	5.5	12.0	Chang, H.H. (1988)
6-in uniform	2.00	4.0	7.5	Chang, H.H. (1988)
2-in uniform	0.67	3.0	6.0	Chang, H.H. (1988)
1-in uniform	0.33	2.5	5.0	Chang, H.H. (1988)

Chang, H.H. 1988. Fluvial Processes in River Engineering, John Wiley & Sons, NY

$t_o = {}_yDS_f$
where,
t_o = average boundary shear stress
${}_y$ = specific weight of water
D = the flow depth (~ hydraulic radius)
S_f = friction slope

Appendix 1

Completed National Fish and Wildlife Foundation Annual Financial and Programmatic Reporting Form

National Fish and Wildlife Foundation
Annual Financial and Programmatic Reporting Form

Project Name: Fish Spawning Habitat Rehabilitation (WI)
Project Number: **2004-0005-224**
Organization: **Wisconsin Department of Natural Resources**
Reporting Period: **October 1, 2006 through June 30, 2007**

No activity to date, no funds received

Expenditures of NFWF Funds for the reporting period:

Category	Actual Expenses NFWF Funds
Salaries & Benefits	**$0**
Equipment	**$0**
Other	$32,246.44
Total	$32,246.44

Expenditures of Matching Contributions for the reporting period: $44,978.25

Describe All Expenses: *(Use additional space if necessary.)*

FINAL MILWAUKEE RIVER HABITAT PROJECT CONTRACTS November 13, 2006

(Project costs and balances are for contracts only and do not include other non-contract project costs)

FUNDING SOURCE	ORIGINAL FUNDING SOURCE BALANCE	ALBY MATERIALS, INC Stone purchase & delivery Project No. QGEFT Contract No. 479 Quote No. 1216	DAKOTA INTERTEK Stone placement Project No. FHSB Contract No. 478 Proposal 09/13/2006	DAKOTA INTERTEK Site prep & clean up Project No. FHIW Contract No. 477 Proposal 09/13/2006
EPA GRANT 319	$ 30,000.00			$20,518.25
EPA GLNPO (NFWF)	$ 60,000.00	$10,121.44	$22,125.00	
Walleyes for tomorrow (gift)	$15,000.00	$15,000.00		
USFWS *	$ 9,460.00	$9,460.00		
TOTAL	**$114,460.00**	**$34,581.44**	**$22,125.00**	**$20,518.25**

* ORIGINAL USFWS AWARD WAS $10,000 LESS $540 FOR FRINGE, ETC.

For more information see the detailed financial information.

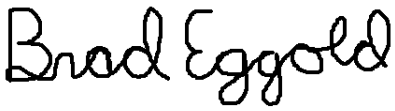
Project Accomplishments: *(Briefly describe the accomplishments of the Project for the reporting period – use additional space if necessary.)*

- Funds for the project were secured
- Construction easement from a property owner was secured
- Design plans were finalized
- All local, state and federal permits or approvals were obtained
- Advertisement and selection of contractor and materials were completed
- Site preparation was completed
- Construction of habitat was completed
- Site was prepared for winter including seeding and erosion control measures

The main portions of this project have been completed. The only items left post construction biological monitoring. Post construction monitoring was to have taken place in April 2007 in conjunction with our Walleye spawning survey on the Milwaukee River. However, due to high spring water levels we could not survey for egg deposition of targeted species on the newly created reef. We will be conducting a survey for young-of-the-year Walleye in and around the reef in September 2007 as well as ongoing monitoring during our spring Walleye spawning survey.

I hereby certify that the accomplishments and expenses described above have been completed and that the above information is accurate and complete.

Department of Natural Resources

Approved:  Date: September 15, 2007

Signature

Bradley T. Eggold – Fisheries Supervisory
Print name and title

E-mail: Bradley.Eggold@dnr.state.wi.us Telephone: 414-382-7921

Note: Forms sent by e-mail must come from an e-mail address authorized in the Grant Agreement or an amendment to the Grant Agreement.

Appendix 2
Select Construction Photographs

Photo 1. Construction of haul road to waters edge and future temporary causeway.

Photo 2. Looking northeast along haul road and initial leg of temporary causeway.

Photo 3. Looking southwest toward haul road and initial leg of temporary causeway.

Photo 4. Looking northeast along haul road and temporary causeway. Note quality of stone generally clear of fines and the increase in thickness of stone for causeway to avoid equipment contact with river.

Photo 5. Approaching the limits of the causeway construction. "Rust" line along the former North Avenue Dam spillway is the 1997 high water mark of Lake Michigan approximately 3.5-ft above current lake elevation.

Photo 6. Excavator backing off the temporary causeway following redistributing the causeway as reef material. Orange flag tape and rebar outline the limits of the former causeway.

Photo 7. Exposed as built reef during out flow of Milwaukee River.

Photo 8. As built reef entirely submerged during ebb flow from Lake Michigan. Water elevation change of approximately 1.8-ft over 20-30 minutes from previous photograph.

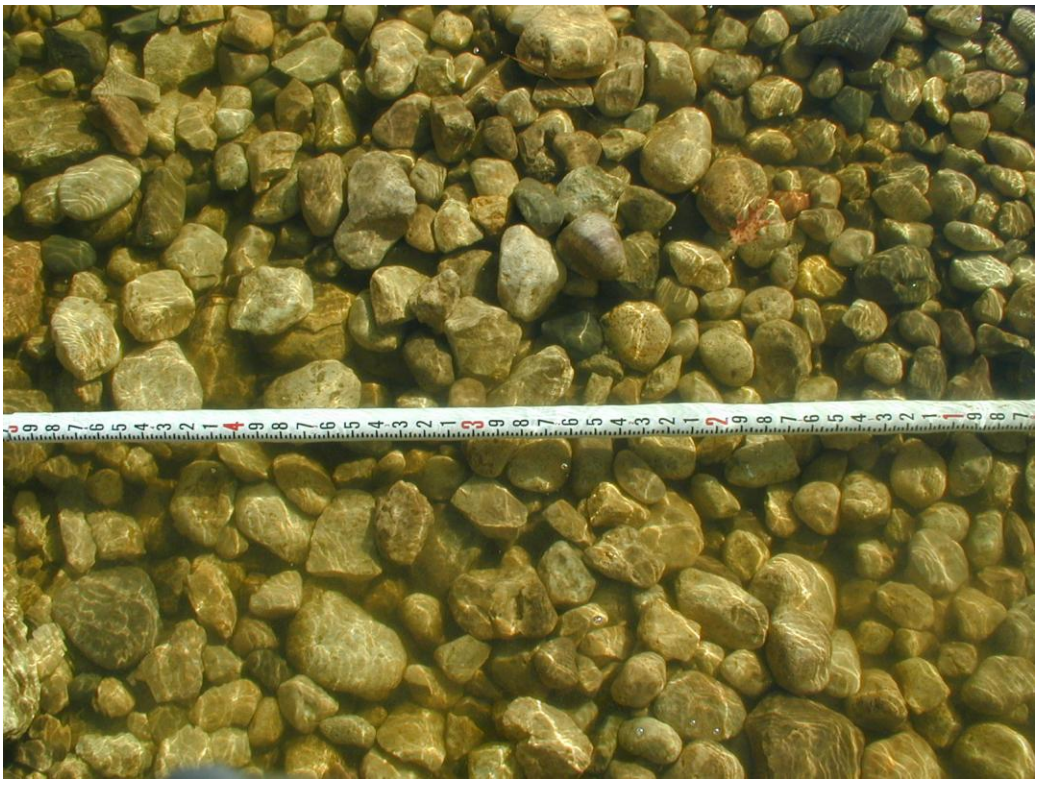


Photo 9. Typical reef substrate (2-in to 5-in dia. alluvial stone) constructed in low-shear stress and velocity areas. Approximately 80% of shoal area (0.50 acre).

Photo 10. Typical reef substrate mixture of (2-in to 5-in and 6-in to 12-in dia. alluvial stone) constructed in moderate-shear stress and velocity areas. Approximately 20% of shoal area (0.10 acre).

Appendix 3

Summary of the 2007 Young-of-the-Year (YOY) Walleye Survey for the Milwaukee River Estuary and Outer Harbor

Wisconsin Department of Natural Resources Lake Michigan Work Unit

Summary of the 2007 YOY Walleye Survey
for the Milwaukee River and Outer Harbor

Objective: To survey and document if natural reproduction of Walleye is occurring along the Milwaukee River Estuary and Outer Harbor study area.

Electrofishing (9/12 and 9/13):

Day time electrofishing was conducted on 9/12/2007 and 9/13/2007 in the Lower Milwaukee River between the Pleasant Street Bridge and the abandoned North Avenue Dam, a distance of approximately 1-mile (Figure 1). Fishing times were similar at 49 and 50 minutes, respectively. Neither survey captured juvenile Walleye.

On 9/12, 26 adult Walleye were captured. All Walleye specimens were previously fin clipped or marked with a colored elastomer tag. The remainder of the sample included young-of-the-year (YOY) and multiple year classes of smallmouth bass; five species of sucker including the common white sucker, shorthead redhorse, silver redhorse, golden redhorse and the state Threatened greater redhorse; logperch, chinook salmon, rainbow trout, gizzard shad, rock bass and common shiner (Table 1).

On 9/13, five adult Walleye (all fin clipped) and two grass carp were captured. The sampling crew also observed schools of gizzard shad, white sucker, chinook salmon, a few adult smallmouth bass and many juvenile smallmouth bass.

Both sample dates were conducted under bright sunny conditions. Boomshocking works more effectively at night or on a cloudy day. It is possible that the condition of the day of sampling was not conducive for effective sampling.

Fyke net (9/17 – 9/20):

Two mini-fyke nets were set up in the river on 9/17/2007, one on the newly build spawning shoal downstream of the former North Avenue Dam, and the other further downstream near the Van Buren Bridge (Figures 2-3). The nets were allowed to fish over night. The nets were checked on 9/18/07. Three smallmouth bass and one rock bass were recorded between two nets. The nets were reset for fishing, and checked on the following day. On 9/19/2007, we found six smallmouth bass, two rock bass, one round goby, one pumpkinseed and one black bullhead. Once again the nets were reset, and checked on the following day. On 9/20/2007, we had five smallmouth bass, five rock bass, one bluegill sunfish and one black bullhead. No YOY Walleye were found in the fyke nets. Overall, very small number of fish was caught in these nets. It is possible that the low flows in the river during the time of sampling limited movement of fish and as a result, fewer fish in the fyke nets. Only seven fish were captured in electroshocking effort conducted on 9/13/2007 in the area. Water temperature in the area was in low 60s ^{0}F.

Gillnet (9/19 – 9/20):

Two boxes of 200 ft each gillnet were set in the Milwaukee harbor off Veterans Park (Figure 4). Each box consisted of 100 ft of 1 inch stretch mesh and 100 ft of 1.25 inch stretch mesh. The nets were set as bottom set gillnets at 15 ft of water, with proper buoy marking, and allowed to fish overnight. The nets were lifted the following day and data were collected. Unfortunately, one of the nets got entangled into a sail boat and was dragged to McKinley Marina. Therefore, this net was not fishing for the full duration. There were two yellow perch caught in this net. Total length (mm) and spine samples were collected from these two fish.

The second net had alewife (744), brown trout (1), lake trout (1), yellow perch (32), spottail shiner (19), white sucker (1), rainbow smelt (1), trout perch (1) and chinook salmon (1). The majority of the yellow perch were caught in the 1 inch mesh with a size range of 109 mm and 130 mm. This suggests that the mesh size selected would be appropriate to capture YOY or yearling Walleye. A few spine samples (4) were collected from the yellow perch to determine their age. No YOY or yearling Walleye was found in the gillnet sample. Based on the catch the net seemed to be fishing well. The harbor water temperature was 57 ^{0}F.

Figure 1. Map showing the electrofishing sampling area, depicted by the yellow polygon, in the Lower Milwaukee River downstream of the former North Avenue Dam.

Figure 2. Sampling location and the direction mini-fyke nets set near the newly built spawning shoal. Based on spawning shoal as-built GIS topographic survey (Wawrzyn, 2007).

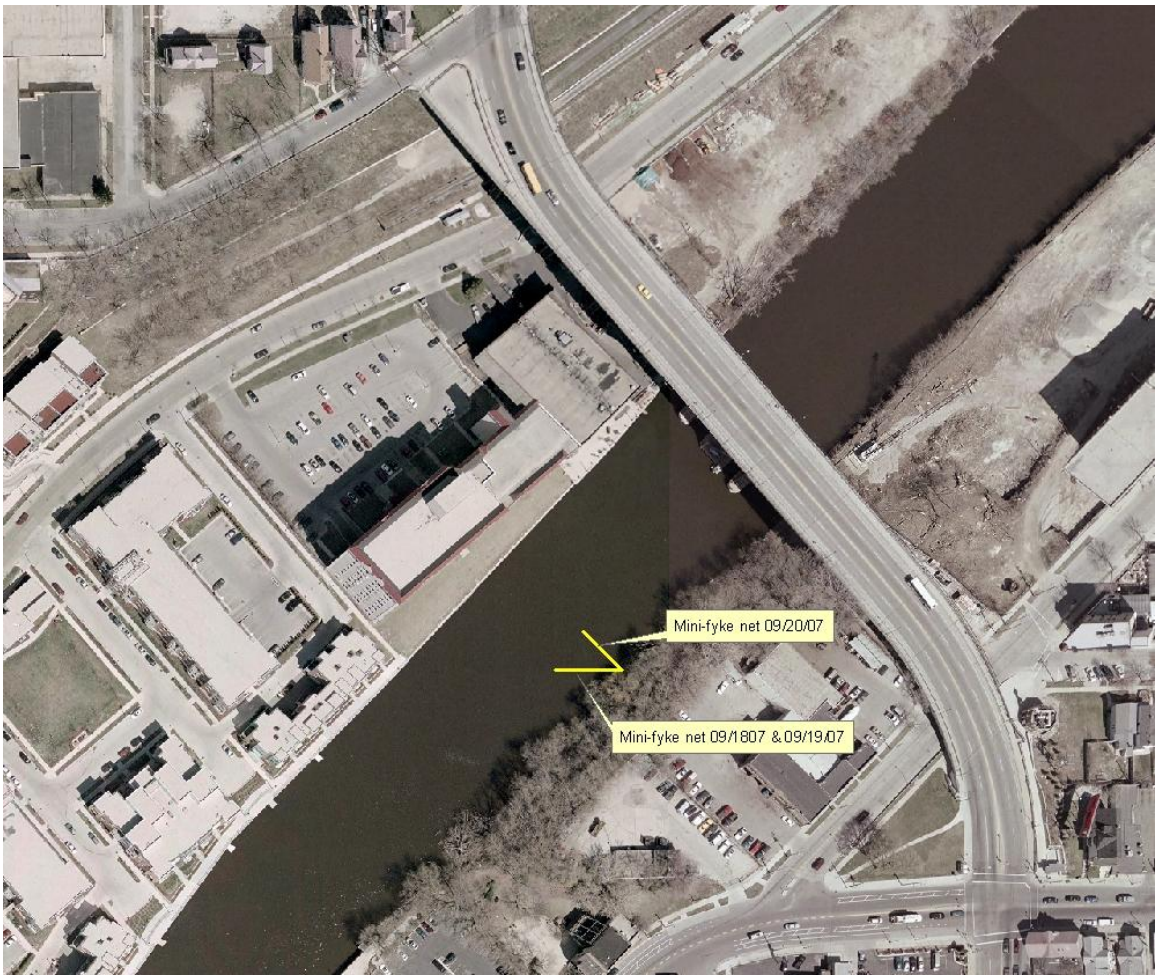


Figure 3. Sampling location and the direction of mini-fyke nets set below Van Buren St. Bridge.

Figure 4. Sampling location using gill net set in the Milwaukee River Estuary Outer Harbor off Veterans Park.

Table 1. Non-Wadable Streams Fish Community Summer Electrofishing Results for the Milwaukee River Estuary, September 12, 2007.

County MILWAUKEE
Name (WIBC) MILWAUKEE RIVER (15000)
MILWAUKEE RIVER (MILWAUKEE RIVER ESTUARY)
Start Latitude 43.0516417
Start Longitude -87.9073371
End Latitude 43.0572327
End Longitude -87.8979148
Lat/Long Method: GIS ARCVIEW
1991 ADJUSTMENT OF NAD 83
Survey Date 09/12/2007
Stream Order 5
Primary Survey Purpose NON-WADABLE BASELINE. WAWRZYN, WILL

Parameter Description	Value
WATER TEMPERATURE (CELCIUS)	16.81
CLOUD COVER (PERCENT)	0
DISCHARGE (CUBIC FEET PER SECOND)	333
TURBIDITY (NTU)	9.5
CONDUCTIVITY (UMHOS PER CM AT 25 CELCIUS)	745.7
DISSOLVED OXYGEN PROBE % SATURATION)	99.8
DISSOLVED OXYGEN (MG/L)	9.59
PH - FIELD (SU)	8.09

MINI-BOOM
1 UNIT
1 DIPPER
NET 0.1250 BAR
IBI RUN 49 MINUTES
GET RUN 67 MINUTES
IBI RUN DISTANCE 1609 METER
GET RUN DISTANCE 1609 METER
CPE
PDC 220 V 18 AMPS @ 60 PULSE 60 DUTY CYCLE

INDEX OF BIOTIC INTEGRITY (IBI) RUN

Common Name	Total Count	DELT #	Mortality #
CHINOOK SALMON	10	0	0
GIZZARD SHAD	140	0	0
COMMON CARP	11	0	11
COMMON SHINER	1	0	0
LOGPERCH	8	0	0

Common Name	Count	Length (mm)	Weight (g)	Mark Found
GOLDEN REDHORSE	1	315		
GREATER REDHORSE	1	525		
ROCK BASS	1	110		
ROCK BASS	1	160		
ROCK BASS	1	170		
ROCK BASS	1	175		
SHORTHEAD REDHORSE	1	335		
SMALLMOUTH BASS	1	85	57	
SMALLMOUTH BASS	1	104	15	
SMALLMOUTH BASS	1	147	46	
SMALLMOUTH BASS	1	147	37	
SMALLMOUTH BASS	1	147	46	
SMALLMOUTH BASS	1	156	45	
SMALLMOUTH BASS	1	160	49	
SMALLMOUTH BASS	1	160	48	
SMALLMOUTH BASS	1	163	60	
SMALLMOUTH BASS	1	167	55	
SMALLMOUTH BASS	1	170	70	
SMALLMOUTH BASS	1	170	63	
SMALLMOUTH BASS	1	170	70	
SMALLMOUTH BASS	1	171	70	
SMALLMOUTH BASS	1	173	70	
SMALLMOUTH BASS	1	181	60	
SMALLMOUTH BASS	1	185	83	
SMALLMOUTH BASS	1	185	70	
SMALLMOUTH BASS	1	185	83	
SMALLMOUTH BASS	1	206	110	
SMALLMOUTH BASS	1	211	98	
SMALLMOUTH BASS	1	217	145	
SMALLMOUTH BASS	1	223	150	
SMALLMOUTH BASS	1	242	210	
SMALLMOUTH BASS	1	260	275	
SMALLMOUTH BASS	1	275	295	
SMALLMOUTH BASS	1	277	320	
WALLEYE	1	360	390	LP
WALLEYE	1	410	640	LP
WALLEYE	1	422	575	LP
WALLEYE	1	435	870	LP
WALLEYE	1	500	1230	RV
WALLEYE	1	512	1380	RV
WALLEYE	1	532	1530	VIE
WHITE SUCKER	1	450		
WHITE SUCKER	1	540		
GAMEFISH RUN (EXTENDED)				
CHINOOK SALMON	20			
RAINBOW TROUT	1	390		RV
SMALLMOUTH BASS	1	250		
SMALLMOUTH BASS	1	143		

Common Name	Count	Length (mm)	Weight (g)	Mark Found
SMALLMOUTH BASS	1	184		
SMALLMOUTH BASS	1	378		
SMALLMOUTH BASS	1	157		
SMALLMOUTH BASS	1	250		
SMALLMOUTH BASS	1	243		
SMALLMOUTH BASS	1	158		
SMALLMOUTH BASS	1	183		
SMALLMOUTH BASS	1	242		
SMALLMOUTH BASS	1	240		
SMALLMOUTH BASS	1	157		
SMALLMOUTH BASS	1	164		
SMALLMOUTH BASS	1	117		
SMALLMOUTH BASS	1	185		
SMALLMOUTH BASS	1	164		
SMALLMOUTH BASS	1	164		
SMALLMOUTH BASS	1	227		
SMALLMOUTH BASS	1	173		
SMALLMOUTH BASS	1	147		
WALLEYE	1	422		LP
WALLEYE	1	432		LP
WALLEYE	1	480		LP
WALLEYE	1	352		LP
WALLEYE	1	422		LP
WALLEYE	1	498		RV
WALLEYE	1	457		LP
WALLEYE	1	498		LP
WALLEYE	1	444		RP
WALLEYE	1	480		LP
WALLEYE	1	420		LP
WALLEYE	1	485		RV
WALLEYE	1	530		LP
WALLEYE	1	362		LP