# 2012 Pool 8 State of the Ecosystem Report

**Long Term Resource Monitoring Program**

**An element of the**

## Upper Mississippi River Restoration

**Environmental Management Program**

**Wisconsin Department of Natural Resources**

**Mississippi River Monitoring Field Station**

## Introduction

Fish, water quality and vegetation data are collected each year through the Upper Mississippi River Restoration- Environmental Management Program- Long Term Resource Monitoring Program (LTRMP). A complete description of the program can be found at: http://www.umesc.usgs.gov/ltrmp.html. Personnel from the Wisconsin Department of Natural Resources collect data in Navigation Pool 8, one of 6 study reaches included in the program. Data have been collected under a stratified random framework for fish and water quality since 1993 and for vegetation since 1998. This report summarizes the 2012 dataset.

## 2012 Hydrograph

*Methods*

Discharge data were obtained from the U.S. Geological Survey gauge in Pool 6 at Winona, MN. A historical hydrograph was constructed by computing the mean daily values from the years 1930-2012. The daily discharge for 2012 was then compared to the long term daily mean to observe departure from typical conditions (Figure 1a). Additional analyses examined annual, growing season, and spring flood discharge characteristics. Mean annual discharge was calculated from daily values and plotted for years 1993-2012 and overlaid on a plot containing the grand mean, $10^{th}$, and $90^{th}$ percentiles for all years (1930 to 2012; Figure 1b). Mean growing season (May – September) discharge was calculated and plotted similarly to the mean annual discharge (Figure 1c). The spring flood pulse was characterized according to timing, duration, and magnitude. The timing of the spring flood was ascribed to the month (March, April, or May) containing the preponderance of the dates in which the ten highest discharge values were observed each spring. Duration of the spring flood was characterized by the number of days each spring in which the discharge exceeded the $75^{th}$ percentile discharge value from March through May. Magnitude was reported as the maximum spring discharge value for each year (Table 1).

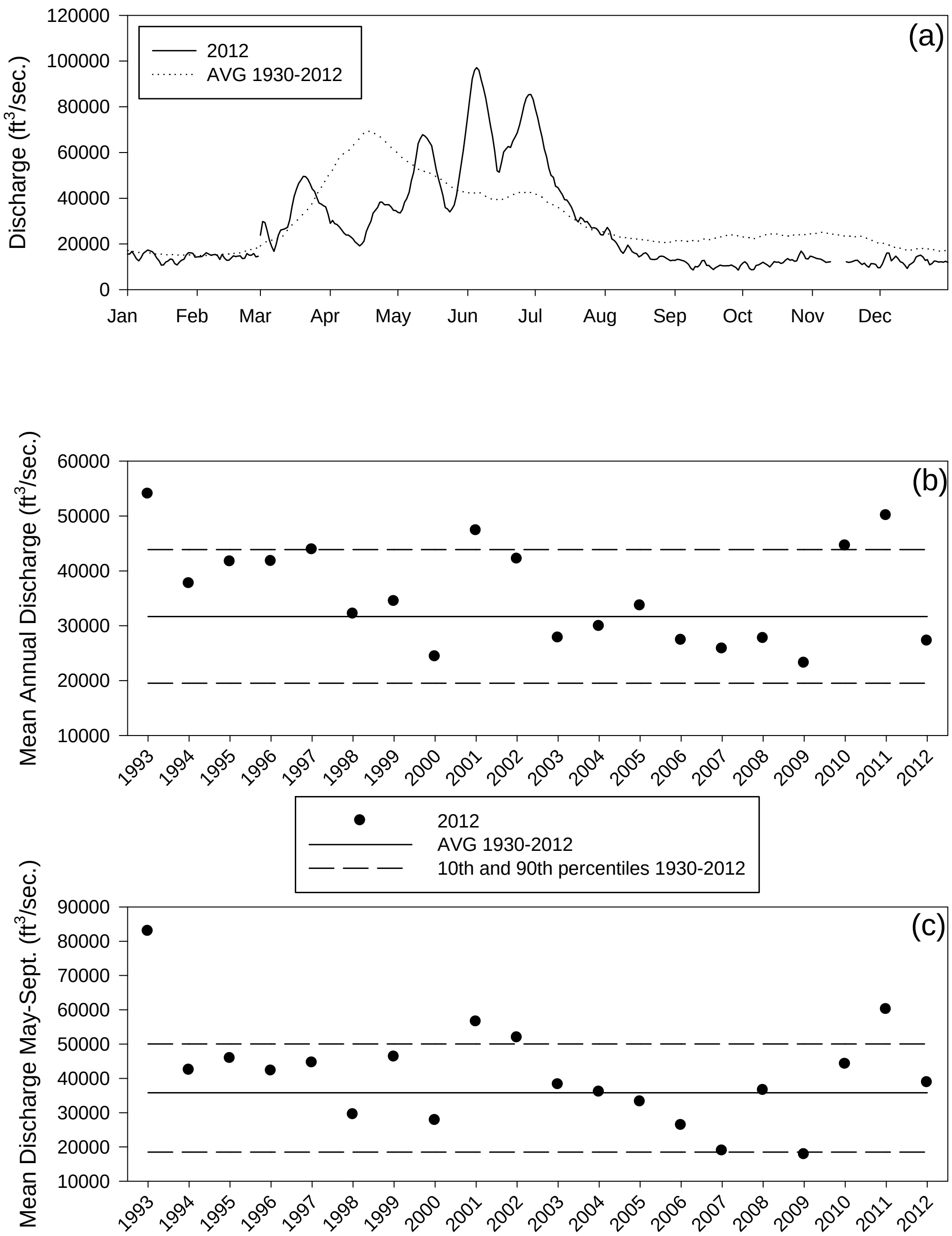



Figure 1. (a) Daily discharge for 2012 is represented by the solid line. Mean daily discharge by day of the year for 1930-2012 is represented by the dotted line. (b) Mean annual discharge by year is represented by the black dots. The solid line represents mean annual discharge for 1930-2012. The dashed lines represent the 10th and 90th percentiles for 1930-2012 annual discharge. (c) Mean growing season (May-Sept.) discharge by year is represented by the black dots. The solid line represents mean growing season discharge for 1930-2012. The dashed lines represent the 10th and 90th percentiles for 1930-2012 growing seasons.

Table 1. Spring flood pulse statistics by year during the LTRMP period of record (1993-2012). Duration represents the number of days each spring when discharge was above the 75th percentile from the long term record (1930-2012). Timing represents the month when the preponderance of the ten highest discharge days were observed each spring. Magnitude represents the maximum discharge observed each spring.

| Year | Duration | Timing | Magnitude | Year | Duration | Timing | Magnitude |
|---|---|---|---|---|---|---|---|
| 1993 | 60 | April | 109000 | 2003 | 28 | May | 119000 |
| 1994 | 27 | May | 106000 | 2004 | 4 | April | 76500 |
| 1995 | 50 | April | 83700 | 2005 | 23 | April | 91600 |
| 1996 | 45 | April | 143000 | 2006 | 31 | April | 95400 |
| 1997 | 41 | April | 194000 | 2007 | 17 | April | 86300 |
| 1998 | 26 | April | 117000 | 2008 | 38 | May | 99000 |
| 1999 | 35 | May | 109000 | 2009 | 13 | April | 81700 |
| 2000 | 0 | March | 50100 | 2010 | 25 | March | 116000 |
| 2001 | 54 | April | 236000 | 2011 | 70 | April | 167000 |
| 2002 | 25 | April | 124000 | 2012 | 3 | May | 68400 |

*Results*

The 2012 hydrograph indicated that the typical spring flood pulse was largely absent due to reduced snow cover throughout the majority of the winter and record-setting warm weather in March. The highest discharge occurred in May, June, and July, due to runoff from widespread precipitation events in the northern portion of the watershed. These events resulted in elevated and unstable discharge during the first half of the summer. Prolonged hot and dry weather persisted throughout the remainder of the summer, and into fall, resulting in below normal discharge for the remainder of the year (Figure 1).

**2012 Water Quality**

*Methods*

The focus of the water quality component of the Long Term Resource Monitoring Program (LTMRP) is to collect limnological information relevant to the suitability of aquatic habitat for biota and transport of material within the system. The LTRMP water quality sampling design since 1993 incorporates biweekly fixed-site sampling (FSS) and quarterly stratified random sampling (SRS). The mixed-model design provides information at both broad spatial scales with low temporal resolution (i.e., SRS), and at small spatial scales with higher temporal resolution (i.e., FSS). SRS tracks conditions at spatial scales corresponding to sampling strata or larger (i.e., whole pool or sampling reach) and at seasonal to annual time scales or longer. In contrast, FSS provides information at more frequent intervals (i.e., within

season) at specific points of interest such as tributaries, tailwaters, and backwaters with high habitat value. The data used for this report were collected from the main channel during SRS sampling. Dissolved oxygen (DO) concentrations used were surface measurements taken at 0.20m. Water was collected near the surface (0.20m) to quantify total suspended solids (TSS), chlorophyll a, total phosphorus (TP), and total nitrogen (TN). More detail on LTRMP water quality sampling methods can be found in Soballe and Fischer (2004) at:
http://www.umesc.usgs.gov/documents/reports/2004/04t00201.pdf. More in-depth graphical display of data pertaining to water quality metrics by season, reach and sampling stratum can be found by utilizing the LTRMP Water Quality Graphical Data Browser at:
http://www.umesc.usgs.gov/data_library/water_quality/water_quality_page.html.

*Results*

River discharge is the key variable influencing limnological variables and biota. Changes in discharge result in variable rates of delivery of sediment, nitrogen and phosphorus (Balogh et al., 1997; Goolsby et al., 2000; Likens, 2010). Discharge in 2012 was below the long-term median for the LTRMP period of record (1993-2012) during winter, spring, and fall (Figure 2a). Discharge was slightly above the long-term median during summer sampling.

Excessive TSS concentration can limit primary productivity by blocking light, negatively affects macroinvertebrate respiration and behavior, results in habitat loss, and affects fish by reducing feeding efficiency and smothering spawning habitat (Walters, 1995). Mean TSS values were below the long-term median during spring and summer and above the long-term median in fall (Figure 2b). TSS concentration was well below the criterion (<30 mg/L) required to sustain submersed aquatic vegetation (SAV) in the Upper Mississippi River (UMR) during all seasons (Giblin et al., 2010).

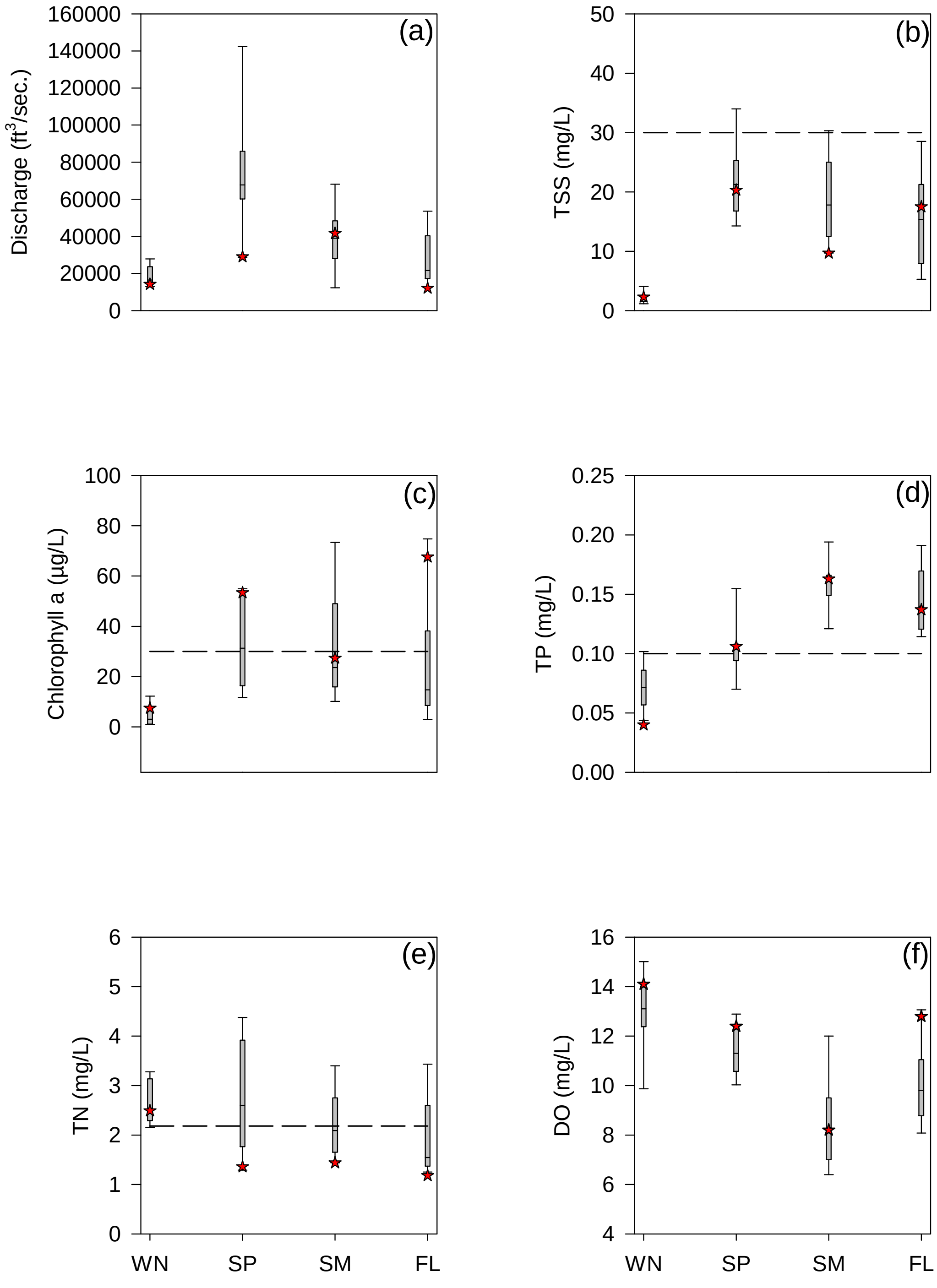



Figure 2. Box plots represent the 10th, 25th, 50th, 75th, and 90th percentiles by stratified random sampling season for the Long Term Resource Monitoring Program period of record (1993-2012). The star represents the mean for each parameter by season for 2012. (b) The dashed line represents the upper limit to sustain submersed aquatic vegetation in the Upper Mississippi River as defined by Giblin et al., 2010. (c) The dashed line represents the lower limit of the eutrophic range as defined by Dodds et al. 1998. (d) The dashed line represents the total phosphorus criterion for non-wadeable rivers in Wisconsin. (e) The dashed line represents upper limit of the range suggested for total nitrogen as defined by the USEPA (2000).

Chlorophyll a is an indicator of phytoplankton biomass in the water column. As in lakes, light, nutrients, and hydraulic retention time are the primary factors determining phytoplankton biomass and growth (Likens, 2010). Chlorophyll a was above the long-term median during all seasons in 2012 (Figure 2c). Mean chlorophyll a was in the eutrophic range (>30 µg/L) during the spring and fall of 2012 (Dodds et al., 1998). The eutrophic chlorophyll a values observed in the spring and fall of 2012 coincided with discharge values well below the long-term median. Increased hydraulic retention time as a result of decreased discharge likely allowed for the accumulation of algal biomass due to decreased washout during these seasons (Baker and Baker, 1979).

Phosphorus is an essential plant nutrient that can limit the biomass of phytoplankton and aquatic macrophytes in aquatic ecosystems. Excessive phosphorus loading can result in increased biomass of phytoplankton and rooted vegetation, increased incidence of fish kills, reduction in species diversity, and reduction in perceived value of a water body. TP was below the long-term median during winter and near the long-term median in spring, summer, and fall (Figure 2d). Mean TP was above the Wisconsin TP criterion (>0.10 mg/L) for non-wadeable rivers during spring, summer, and fall.

Nitrogen is also an essential plant nutrient that can limit the biomass of phytoplankton and aquatic macrophytes in aquatic ecosystems. Nitrogen concentration tends to increase with increasing discharge as non-point input from agriculturally dominated tributary watersheds is delivered to the UMR (Goolsby et al., 2000). TN was near the long-term median during winter and below the long-term median in spring, summer, and fall. Mean TN was above the upper concentration recommended by the USEPA for ecosystem health (0.6-2 .18 mg/L) during winter (Figure 2e; USEPA, 2000).

Adequate DO is critical to sustain aquatic life. DO concentration can be reduced through decomposition of organic material from point and non-point sources, plant and animal respiration, and demand from the sediments. Mean DO was near the long-term median during summer and above the long-term median during winter, spring, and fall (Figure 2f). Elevated DO values tended to coincide with seasons when algal biomass and photosynthetic activity was highest.

Ice and snow thickness can affect the concentration of DO in the underlying water column by reducing available light and thereby photosynthetic activity. Ice thickness was below the long-term median and snow thickness was near the long-term median during the winter of 2012 (Figure 3). It’s likely that the reduced ice thickness improved light penetration and photosynthetic activity which contributed to DO concentrations above the long-term median during winter.

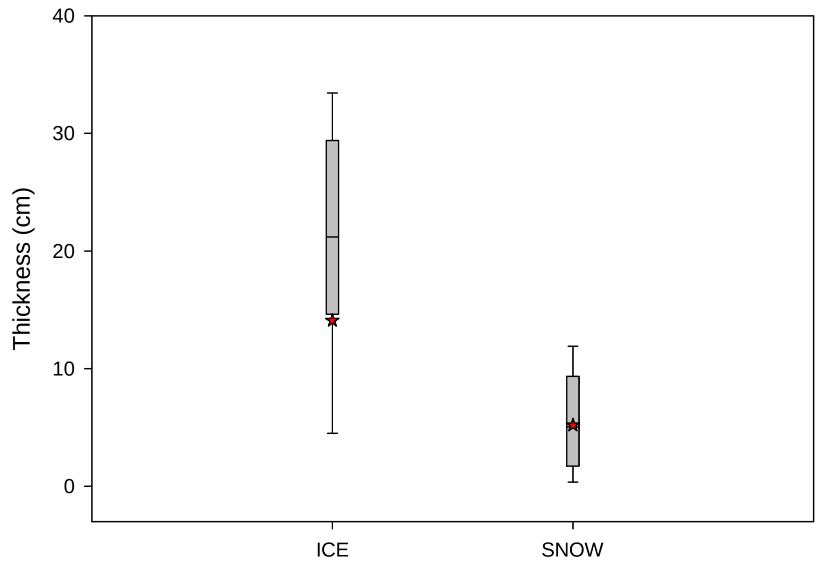



Figure 3. Box plot represents the 10th, 25th, 50th, 75th, and 90th percentiles for winter ice and snow thickness on top of the ice during winter for the Long Term Resource Monitoring Program period of record (1993-2012). The star represents the mean for each parameter for the winter of 2012.

**2012 Aquatic Macrophytes**

*Methods*

Aquatic macrophytes are an important habitat component in the Upper Mississippi River. They provide food and shelter for birds, fish and aquatic invertebrates. Aquatic macrophyte data were collected from June 16 to August 2, 2012. The sampling area (a 2-m area around the boat) was searched visually. Six subsampling locations were sampled within the 2-m area with rake grabs. All species on the rake and observed during the visual search were identified and recorded. Each submersed species on the rake was also given a rake score (1-5) based on how much of the rake teeth were filled. More detail on LTRMP vegetation sampling protocol can be found in Yin et al., 2000 at: http://www.umesc.usgs.gov/documents/reports/1995/95p00207.pdf

*Results*

We sampled 450 sites within 5 different strata (isolated and contiguous backwaters, impounded, secondary channel, and main channel border). In Pool 8, submersed aquatic macrophytes (SAV) were found at 73% of the sites, rooted floating macrophytes (RF) at 21% and emergent macrophytes (EM) at 23% (Figure 4). Submersed macrophytes and RF decreased in frequency from 2011 to 2012, whereas EM showed a slight increase. The highest percentage of SAV was found in the impounded strata, the highest percentage of RF was found in the contiguous backwaters and the highest percentage of EM was found in the isolated backwaters (Figure 5).

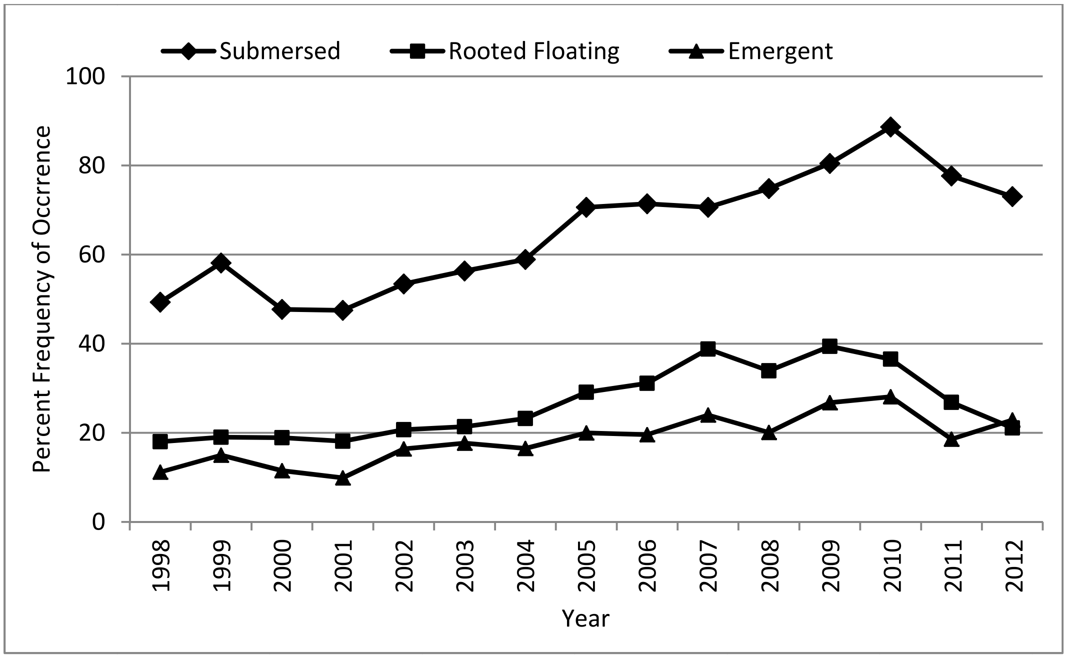



Figure 4. Percent frequency of occurrence of submersed, rooted floating and emergent macrophytes within Pool 8.

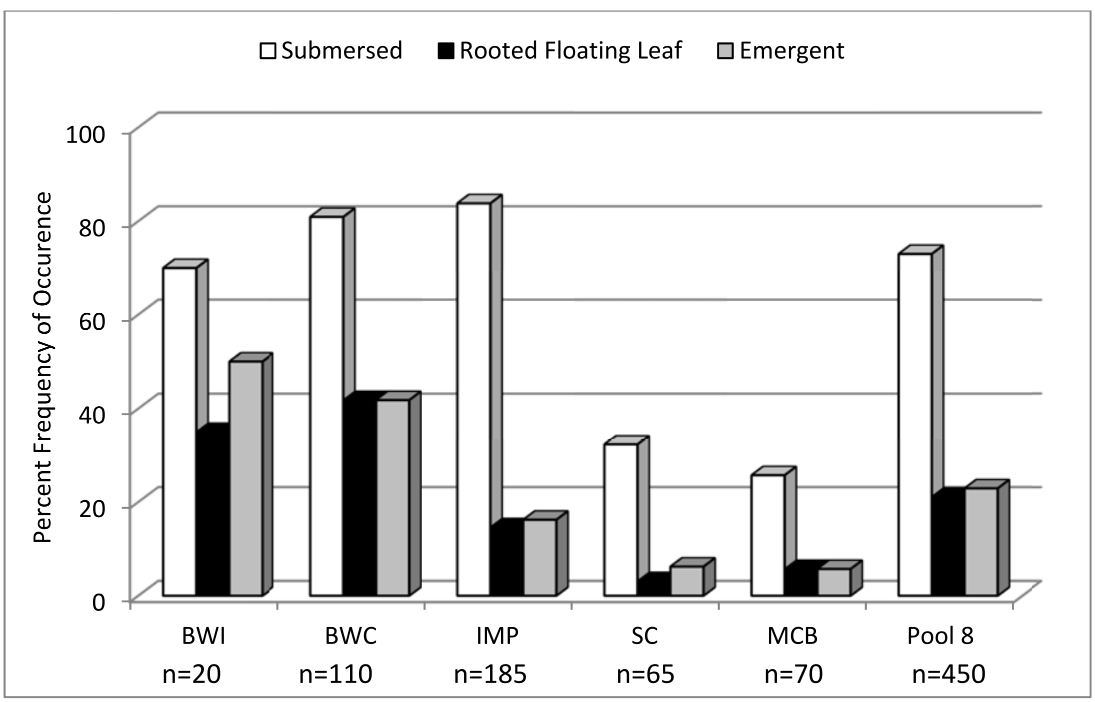


Figure 5. Percent frequency of occurrence of lifeform by sampling strata. (BWI=isolated backwater, BWC=contiguous backwater, IMP= impounded, SC=secondary channel, MCB=main channel border)

Pool-wide, the most frequent EM species included stiff arrowhead (7%; *Sagittaria rigida*), wild rice (7%; *Zizania aquatic*), and broadleaf arrowhead (5%; *Sagittaria latifolia*). White waterlily (15%; *Nymphaea odorata*) was the most common RF species and coontail (49%; *Ceratophyllum demersum*) and Canadian waterweed (48%; *Elodea canadensis*) were the most common SAV species. Mean number of species per site with all strata combined was 3.3, down from 3.6 in 2011.

The Pool 8 impounded strata has showed a marked increase in SAV and EM since 1998. Submersed macrophytes increased from a low of 34% in 1998 to a peak of 97% in 2010 followed by a decrease to 84% in 2012. In 2011, water elevations were unusually high throughout the sampling period most likely lowering the amount of light available to SAV. Discharge in 2012 was also high in June, July and August most likely contributing to the continued decrease in SAV. Emergent macrophytes have increased from a low of 0% in 1998 to a high of 16% in 2012. In particular, wild celery (*Vallisneria americana*) and wild rice have increased in the impounded strata (Figure 6). A visualization of the change in lower Pool 8 can be found on the vegetation graphical browser under surface maps at:
http://www.umesc.usgs.gov/data_library/vegetation/graphical/surface_distribution_maps.shtml

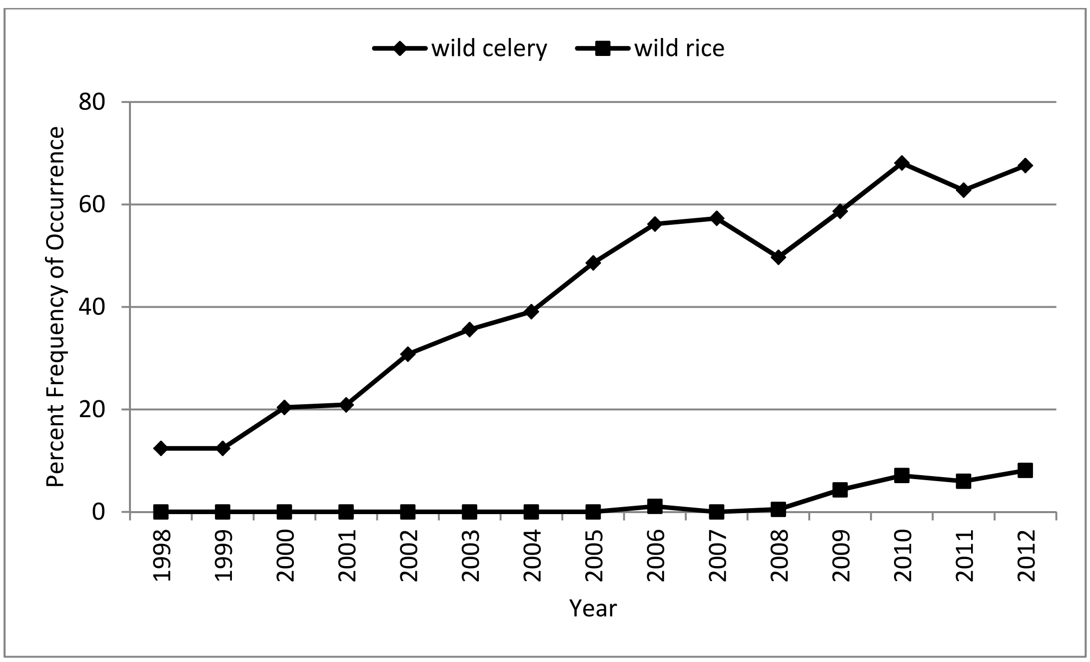



Figure 6. Percent frequency of occurrence of wild celery (*Vallisneria americana*) and wild rice (*Zizania aquatic*) in the impounded strata of Pool 8.

**2012 Fisheries**

*Methods*

The LTRMP fish component uses six standardized gear types, including daytime electrofishing, fyke nets, mini fyke nets, large and small hoop nets, and otter trawls, within a randomized sampling scheme and stratification based on broad habitat features. Fish sampling is conducted within three consecutive six-week episodes, from June 15 to October 31, to ensure both temporal, as well as spatial, interspersion of the sampling gear deployments (Figure 1). More detail on LTRMP fish sampling can be found in Gutreuter et al., 1995 at: http://www.umesc.usgs.gov/documents/reports/1995/95p00201.pdf

Routine data analyses for overall fish community data include species richness, total catch by species, and community composition (presence/absence). Catch per unit effort (CPUE) and frequency of occurrence are calculated for all species, and proportional stock density (PSD) is calculated for species of interest. The LTRMP Fish Graphical Data Browser automates many of these analyses and provides on-demand analytical products for end users. This information can be accessed at: http://www.umesc.usgs.gov/data_library/fisheries/graphical/fish_front.html

This report summarizes sampling effort, overall catch rates and species richness, as well as the five most abundant species sampled and data on species of special concern. CPUE and PSD trends from day electrofishing data are provided for ten species of interest to anglers and fish managers. Data were omitted for 2003 in all cases because of reduced sampling that year.

*Results*

The fisheries component made 270 fish collections in 2012, completing the full planned allocation. High and unstable water levels during the first time period likely influenced catches, but did not preclude any sampling activities. Dense and expansive aquatic vegetation stands have made it challenging to determine when some sites can be sampled and when alternate sites must be chosen.

Sampling effort was highest for daytime electrofishing (84 collections), followed by mini fyke nets (66 collections), and fyke nets (48 collections). Effort was greatest in the contiguous backwater stratum (84 collections), with side channel (60 collections) and main channel border (48 collections) also receiving considerable effort.

Overall catch rates in 2012 were the highest observed since 2007 and ranked fourth highest over the 20-year period of SRS sampling (Figure 7), when compared with historic catches using the currently deployed gears. Total catch was 30,389 fish, representing 64 species. The species total increased from 2011 when 59 species were observed, and was the highest since 2004. The species total in 2012 was bolstered by single specimens of American brook lamprey, bigmouth buffalo, brown bullhead, central mudminnow, fathead minnow, Iowa darter, northern hog sucker, sand shiner, stonecat, and white sucker.

The top 5 species, in order of catch, were weed shiner – 12,712, bluegill – 6874, largemouth bass – 2110, emerald shiner – 1026, and black crappie – 679. Yellow perch numbers were lower (620) compared to recent years, but ranked sixth in total catch. The majority of emerald shiners reported were caught in a single electrofishing run on the last day of the season.

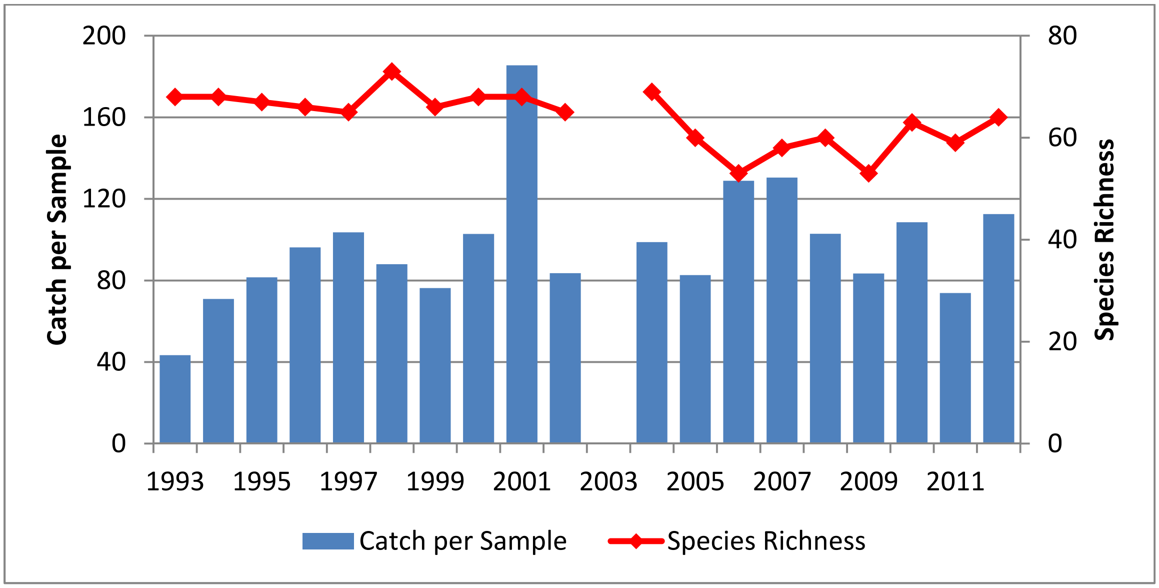



Figure 7. Catch per sample and species richness, annually, for Upper Mississippi River Restoration – EMP-LTRMP fish collections in Pool 8 of the Upper Mississippi River. Data represent samples collected with daytime electrofishing, fyke nets, mini fyke nets, large and small hoop nets, and otter trawls. Data are omitted for 2003 due to limited sampling that year.

In addition to the 12,712 weed shiners, 7 mud darters and 40 western sand darters (listed as special concern in Wisconsin), 26 river redhorse, 2 blue suckers, and 33 speckled chubs (listed as threatened in Wisconsin) were also caught.

Total catch of yellow bullheads (74) increased and seven species of ictalurids were collected in 2012.

Zero asian carp were collected, and the total catch of common carp was only 184, representing one of the lowest catch rates for this species over the past 20 years.

Again, in 2012, the major change to the fish community in Pool 8 over the past decade was evident. Catch of riverine species which were previously abundant, such as white bass (77), quillback (3), river carpsucker (2), river shiner (9), and smallmouth buffalo (8) were reduced, while catches of lentic species increased.

Black crappie

The catch rate for black crappie rebounded in 2012 after reduced catch in 2011 (Figure 8). The 2012 CPUE was within the $10^{th}$-$90^{th}$ percentile range, but above the long-term average. The PSD score for black crappie in 2012 was 69, indicating a healthy mixture of large and small fish in the population. The PSD trend for black crappie appears stable over time.

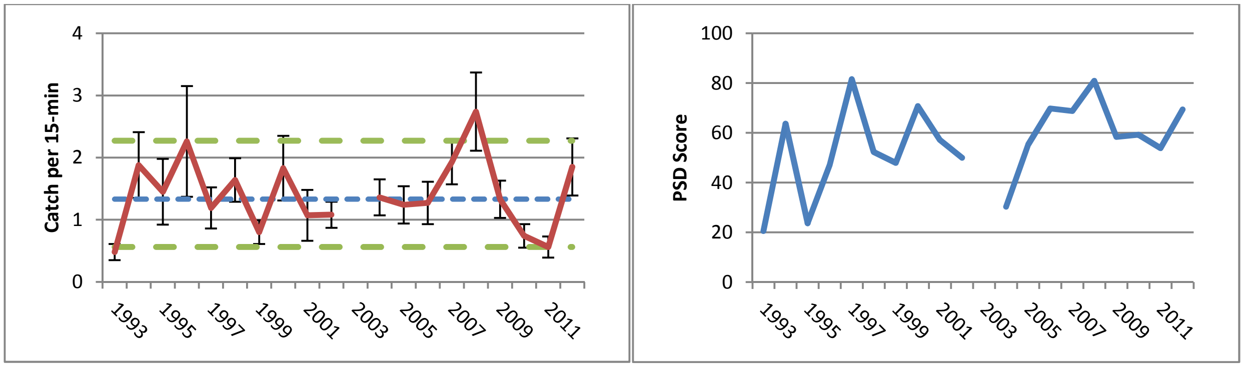



Figure 8. Catch per unit effort and proportional stock-density of black crappie collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP. The long dashed lines represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

Bluegill

Bluegill CPUE showed a slight reduction in 2012 from 2011, but was still above the long-term average (Figure 9). A steady increase in CPUE was observed through 2008, with catch rates plummeting in 2009. The 20-yr trend for bluegill PSD has been remarkably stable, but low, reflecting many small fish in the population.

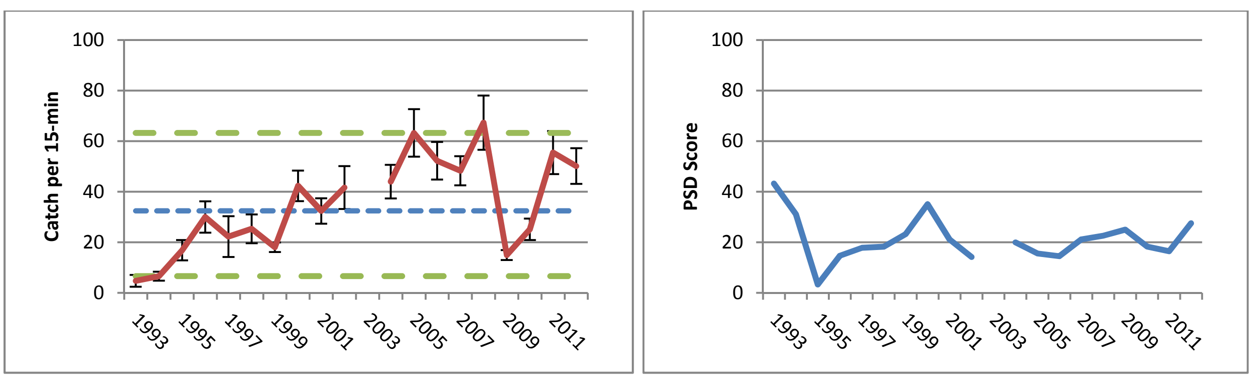



Figure 9. Catch per unit effort and proportional stock-density of bluegill collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP. The long dashed lines represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

Channel catfish

Catch rates for channel catfish with day electrofishing have been generally low, but stable, over time (Figure 10). The 2012 CPUE was near the 90th percentile for the 20-yr period of record. The PSD value for channel catfish in both 2012 and 2011 was 100, suggesting poor recruitment in both years. PSD values for channel catfish from 1993-2012 were most often in the 80-100 range, suggesting a very mature population with infrequent and small year classes entering the fishery.

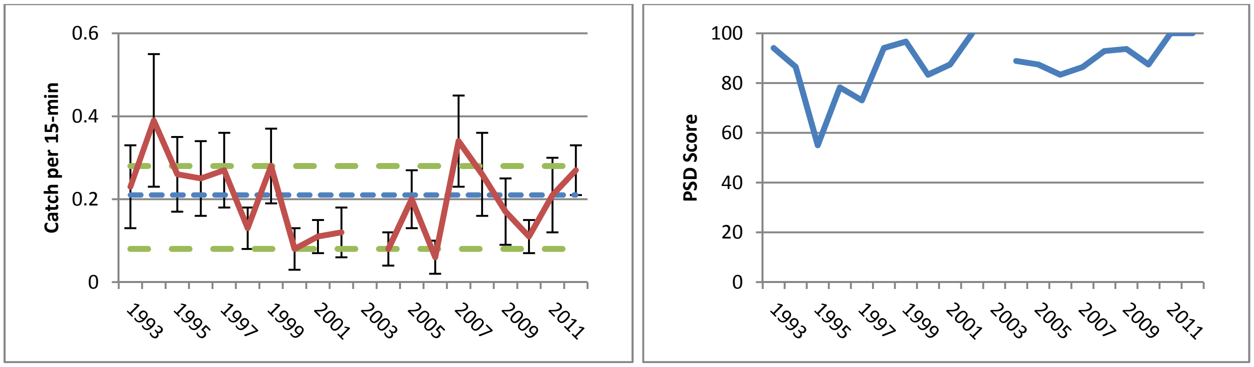



Figure 10. Catch per unit effort and proportional stock-density of channel catfish collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP. The long dashed lines represent the $10^{th}$ and $90^{th}$ percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

## Flathead catfish

The 2012 CPUE for flathead catfish was near the $90^{th}$ percentile for the 20-yr period at 0.24 fish per 15-minute electrofishing run (Figure 11), a substantial increase from 2011. However, the long-term trend for flathead catfish CPUE was stable. As with channel catfish, PSD values for flathead catfish were high, ranging from about 60 to 100, over the period of record, with values of 100 for both 2011 and 2012.

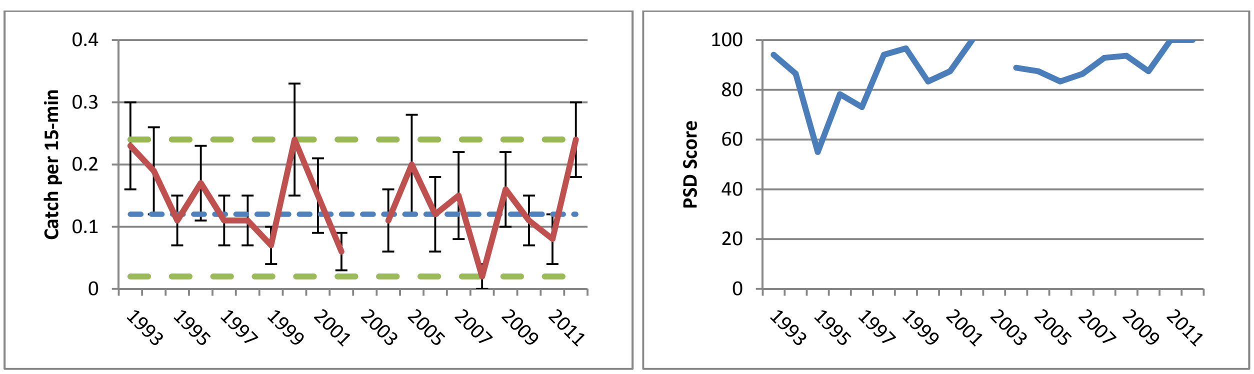
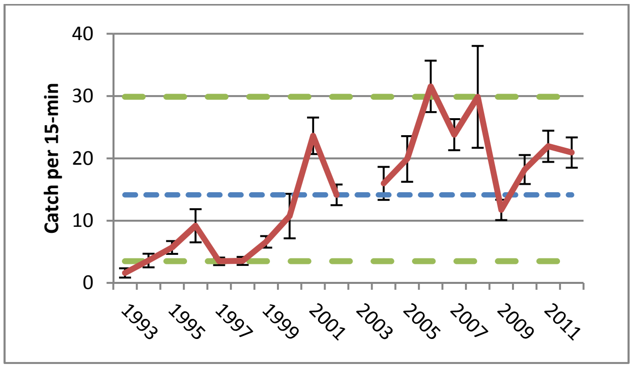



Figure 11. Catch per unit effort and proportional stock-density of flathead catfish collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP. The long dashed lines represent the $10^{th}$ and $90^{th}$ percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

## Largemouth bass

Largemouth bass CPUE declined slightly from 2011 to 2012, but was still above the 20-yr average for Pool 8 (Figure 12). Similar to bluegill, largemouth CPUE decreased precipitously in 2009, after what had been a long-term increase. Catch rates quickly rebounded to above the mean value since 2009. The PSD value for largemouth bass in 2012 was 80, suggesting a mature population. Recent years have shown evidence of strong year classes in 2007 and 2011.



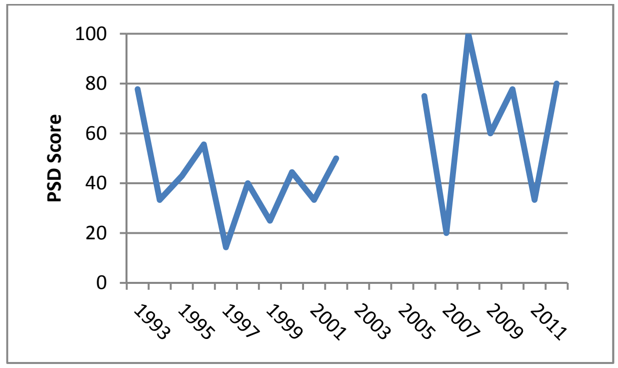
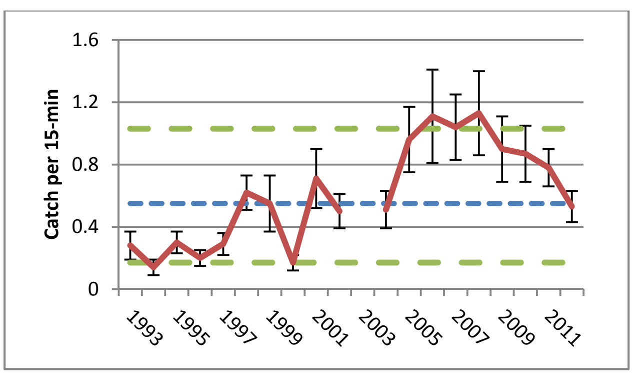




Figure 12. Catch per unit effort and proportional stock-density of largemouth bass collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP. The long dashed lines represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

Northern pike

After a steady increase from 1994 to 2008, northern pike CPUE has shown a reduction in recent years (Figure 13). The 2012 CPUE for pike was near the 20-yr mean value of 0.53 per 15-minute day electrofishing run. The 2012 PSD score for northern pike was at the lower end of the long-term spectrum (42), indicating mainly smaller fish. However, no clear downward trend was evident in pike PSD over time.



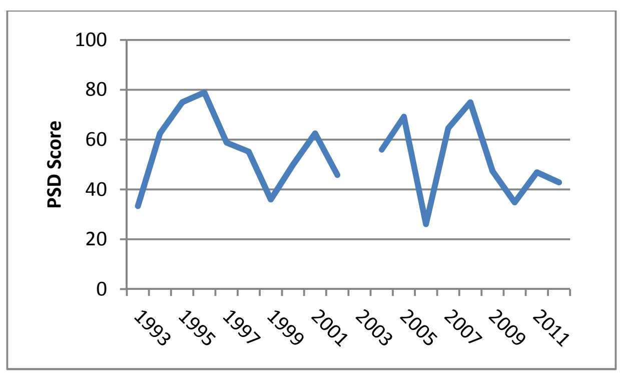




Figure 13. Catch per unit effort and proportional stock-density of northern pike collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP. The long dashed lines represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

Sauger

Sauger CPUE indicates a declining catch rate, after a peak in 1998 (Figure 14). The 2012 CPUE low and represents a string of five consecutive years below the 20-yr mean. Sauger PSD has fluctuated widely over the past decade, with a general increase observed. The 2012 PSD value was 67, tied for the third highest value in the last 20 years. This would suggest that one or more older year classes are present in the fishery, along with poor recruitment in recent years.

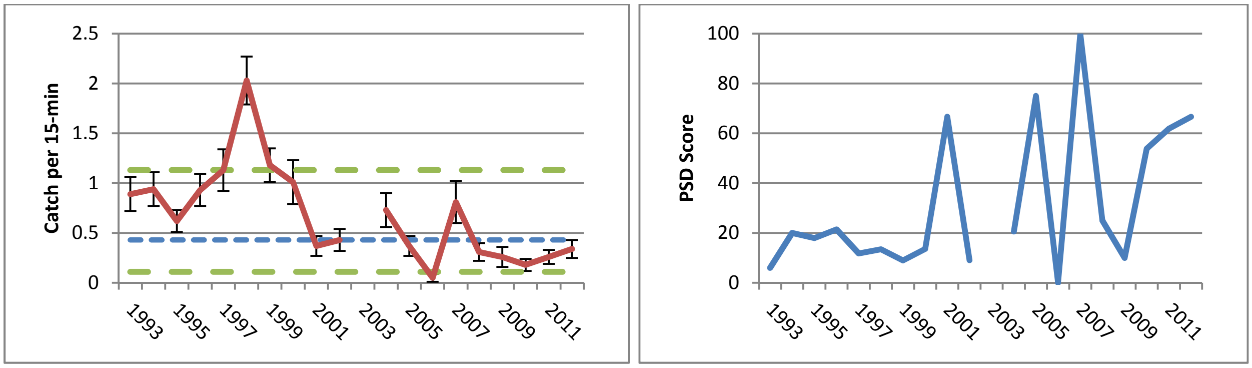



Figure 14. Catch per unit effort and proportional stock-density of sauger collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP. The long dashed lines represent the 10$^{th}$ and 90$^{th}$ percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

Smallmouth bass

Catch rates for smallmouth bass were near the long-term average in 2011 and 2012 (Figure 15). High catch rates were observed in the late 1990's, but catch has declined in recent years. The PSD trend indicates a slight increase over time. However, 2011 and 2012 were substantially lower than the 20-yr peak that occurred in 2009. A healthy mix of large and small fish is evidenced by the 2012 value (52).

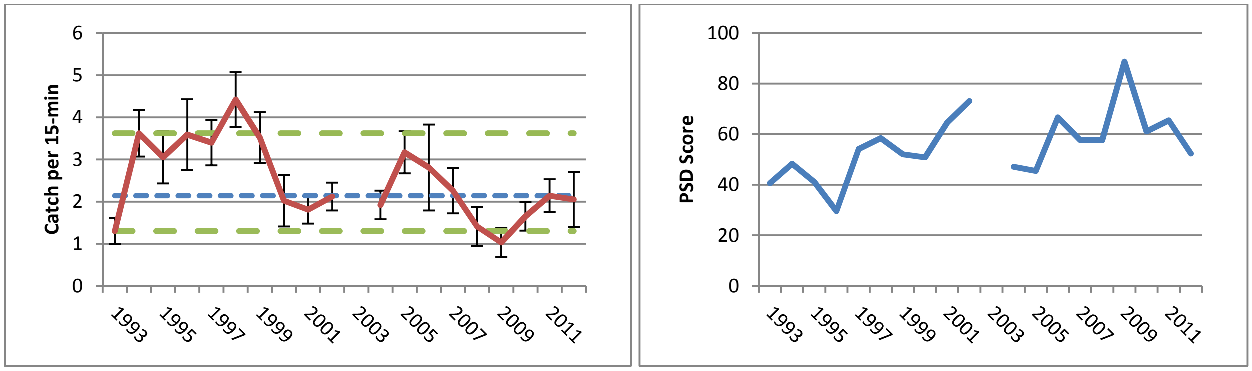



Figure 15. Catch per unit effort and proportional stock-density of smallmouth bass collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP. The long dashed lines represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

Walleye

Walleye CPUE has remained stable and low for the past dozen years of LTRMP sampling (Figure 16). High CPUE was observed in 1994, 1997 and 1998, and again in 2007. Catch rates in 2011 and 2012 were rebounding from the all-time low in 2010, and were near the long-term average in 2012. Walleye PSD values depict a stable pattern over time, with scores ranging from about 40 to 80. The 2012 value of 86 was very high, suggesting the presence of at least one mature year class in the population.

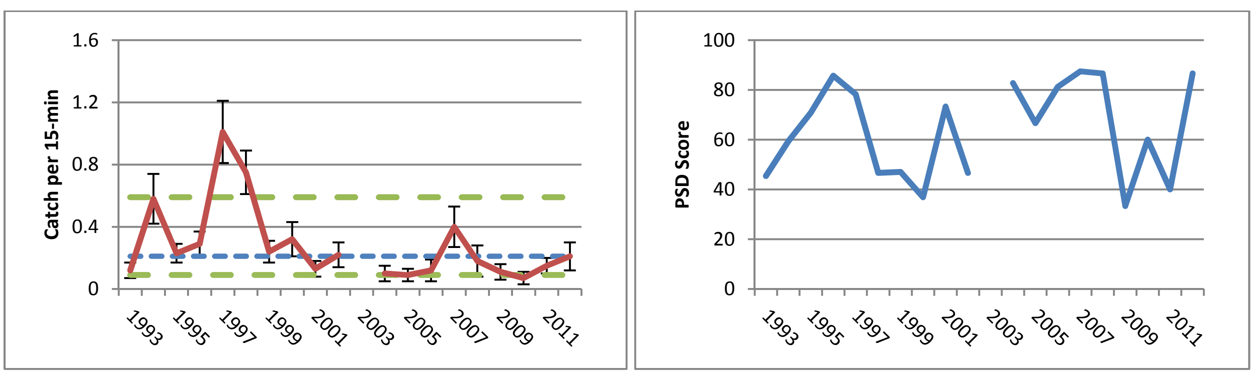



Figure 16. Catch per unit effort and proportional stock-density of walleye collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP. The long dashed lines represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

Yellow perch

The 2012 CPUE for yellow perch exhibited a steep decline from the previous four years of high catch (Figure 17), but was still above the long-term average. The dramatic increase in the yellow perch population may be over, as catch rates are trending back to the mean.  PSD values from 1993 to 2012 appear to fluctuate in a cyclic pattern of 2-3 years of high values, followed by 3-4 years of low values. This pattern suggests sporadic and variable year class strength.

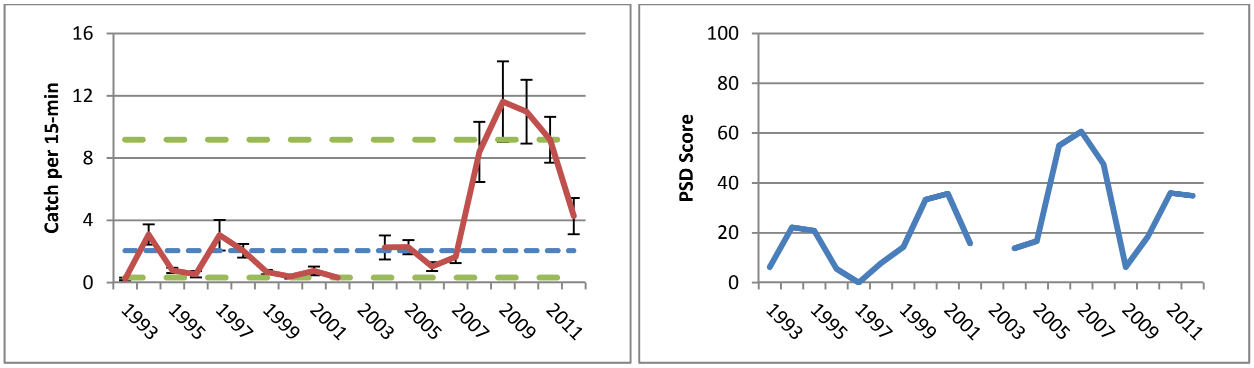



Figure 17.  Catch per unit effort and proportional stock-density of yellow perch collected by day electrofishing in Navigation Pool 8, Upper Mississippi River, by the Upper Mississippi River Restoration – EMP-LTRMP.  The long dashed lines represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2012).

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