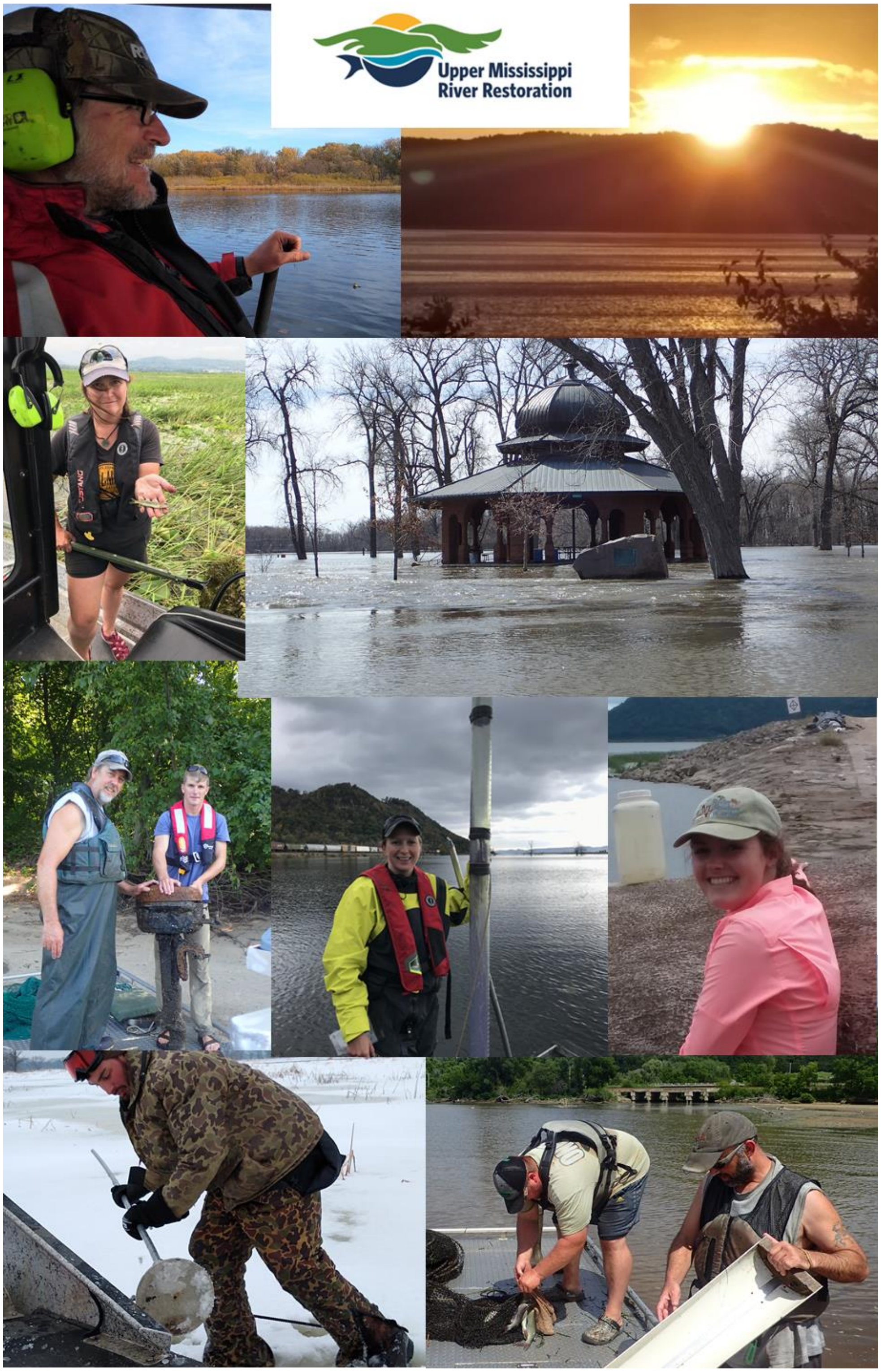
Upper Mississippi River Pool 8
2019 Status Report - Long Term Resource Monitoring



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This report describes work conducted by the WI DNR as part of the US Army Corps of Engineer's Upper Mississippi River Restoration Program Long Term Resource Monitoring element. The element is implemented by the U.S. Geological Survey, Upper Midwest Environment Sciences Center (UMESC), in cooperation with the five Upper Mississippi River System states of Illinois, Iowa, Minnesota, Missouri, and Wisconsin. The USACE provides guidance and has overall Program responsibility.

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Executive Summary 2019

This report summarizes the annual increment of monitoring accomplished in 2019 by the Wisconsin Department of Natural Resources' La Crosse Field Station for the Long Term Resource Monitoring Element (LTRM) of the Upper Mississippi River Restoration Program (UMRR). Here, we report data and observations for hydrology, water quality, aquatic vegetation, and fish in Navigation Pool 8 of the Mississippi River, emphasizing the 2019 sampling year in the context of historic trends.

High water dominated Upper Mississippi River conditions in 2019. As a result of both significant winter snowfall and persistent heavy rains, the 2019 hydrograph set numerous all-time records including three monthly, three yearly, and four consecutive-day records. Total 2019 discharge was approximately double the historic summed annual discharge, and daily discharge was higher than the historic daily mean every day between mid-March and 31 December. The high water in 2019 will be remembered more for its duration than its magnitude, although the third highest daily discharge during the LTRM period of record occurred in late March.

Most 2019 water quality observations fell within the normal range of values for Pool 8 LTRM sampling. Water temperatures were near long-term median values in winter and summer, but somewhat below median values in spring and fall. Total suspended solids (TSS) concentrations were near the long-term median values in all seasons, but this marked a change from recent years which have been characterized by very low TSS and clear water. Chlorophyll *a* concentrations were above the long-term median in winter, and below the long-term median in spring, summer and fall. Total phosphorous concentrations were near the long-term median in winter, well above the long-term median in spring and below the long-term median in summer and fall, and exceeded 0.10 mg/L in spring, summer and fall which is consistent with the Mississippi River being listed as TP-impaired by WDNR (2020). Total nitrogen and nitrate-N concentrations were close to median values in spring and summer, but notably high in winter and fall. Total nitrogen was at or above the U.S. Environmental Protection Agency "healthy ecosystem" levels in all four seasons. Dissolved oxygen (DO) values were above the long-term median in winter and somewhat lower than the spring, summer and fall long-term medians. Median DO concentrations in 2019 were adequate for fish and invertebrates in all seasons. Ice was substantially thinner than usual during the three-week sampling period in January, and snow depth was near long-term median values.

The overall prevalence (percent frequency occurrence) of aquatic vegetation in 2019 remained high despite high discharge over the last 4 years, and especially in 2019. Sampling crews in all three LTRM pools where vegetation is monitored (Pools 4, 8 and 13) however, noted a 3-4 week delay in growth and maturation of aquatic vegetation which we attributed to exceptionally high water and higher-than-normal turbidity in the early growing season. Additionally, rooted floating-leaf vegetation prevalence decreased from 40.2% in 2016 to 25.1 % in 2019 and frequently appeared to be damaged and inundated by high water in 2018 and 2019. Prevalence of duckweeds and filamentous algae were relatively low in 2019. Prevalence of submersed vegetation remained high and similar to 2016-2018 values, and emergent vegetation prevalence has remained relatively high since ~2014. Wild celery and wild rice are important native species that support migratory waterfowl and other wildlife, and both have increased considerably in prevalence over the period of LTRM monitoring. Wild celery prevalence increased dramatically between 2000 and 2010 and remains abundant, especially in the impounded area. Pool-wide detection of wild rice was ~2% prior to 2005, but has steadily increased since then, reaching a maximum prevalence of 28% in 2019.

Total catch in 2019 was 18,832 fish - the lowest total catch in Pool 8 LTRM sampling since sampling in all three periods were restored in 2010. Persistent high water limited fisheries sampling substantially in 2019 and prevented tailwater trawling and wing dam electrofishing in periods 1 and 3. In period 3, all hoop netting was forgone due to dense loads of drifting aquatic vegetation and high current velocities. All scheduled sampling was accomplished in period 2. In total, 234 of 270 planned samples were collected in 2019. High water almost certainly also reduced gear efficiency during much of the season. Species richness remained about average, at 66 species. Weed Shiner (4,589) and Bluegill (4,231) dominated the catch numerically, and Common Carp was the dominant species by weight. Fish community diversity (Shannon-Weiner Index) increased in 2019 to the highest level since the mid-1990's. We caught two Wisconsin-listed threatened species, Blue Sucker (3) and River Redhorse (7), in 2019 Pool 8 LTRM sampling season. We also caught 19 Mud Darters, a species of special concern. Most sport fishes appear to be maintaining stable populations. Flathead Catfish, Northern Pike and Smallmouth Bass catch rates have increased in recent years; however, the 2019 catch of Largemouth Bass was the lowest since the turn of the century, and Sauger catch remains low and of concern. In summary, monitoring results suggest that the Pool 8 fish community remained healthy in 2019.

Contents

1. Hydrograph

Methods

Pre-1988 discharge data were previously obtained from the U.S. Army Corps of Engineers' (Corps) web site for water information on the Mississippi River, which is no longer available. For 1988-2018, we requested a dataset of daily discharge data directly from St. Paul district Corps water personnel. For 2019, data were obtained at the Corps Access to Water website.

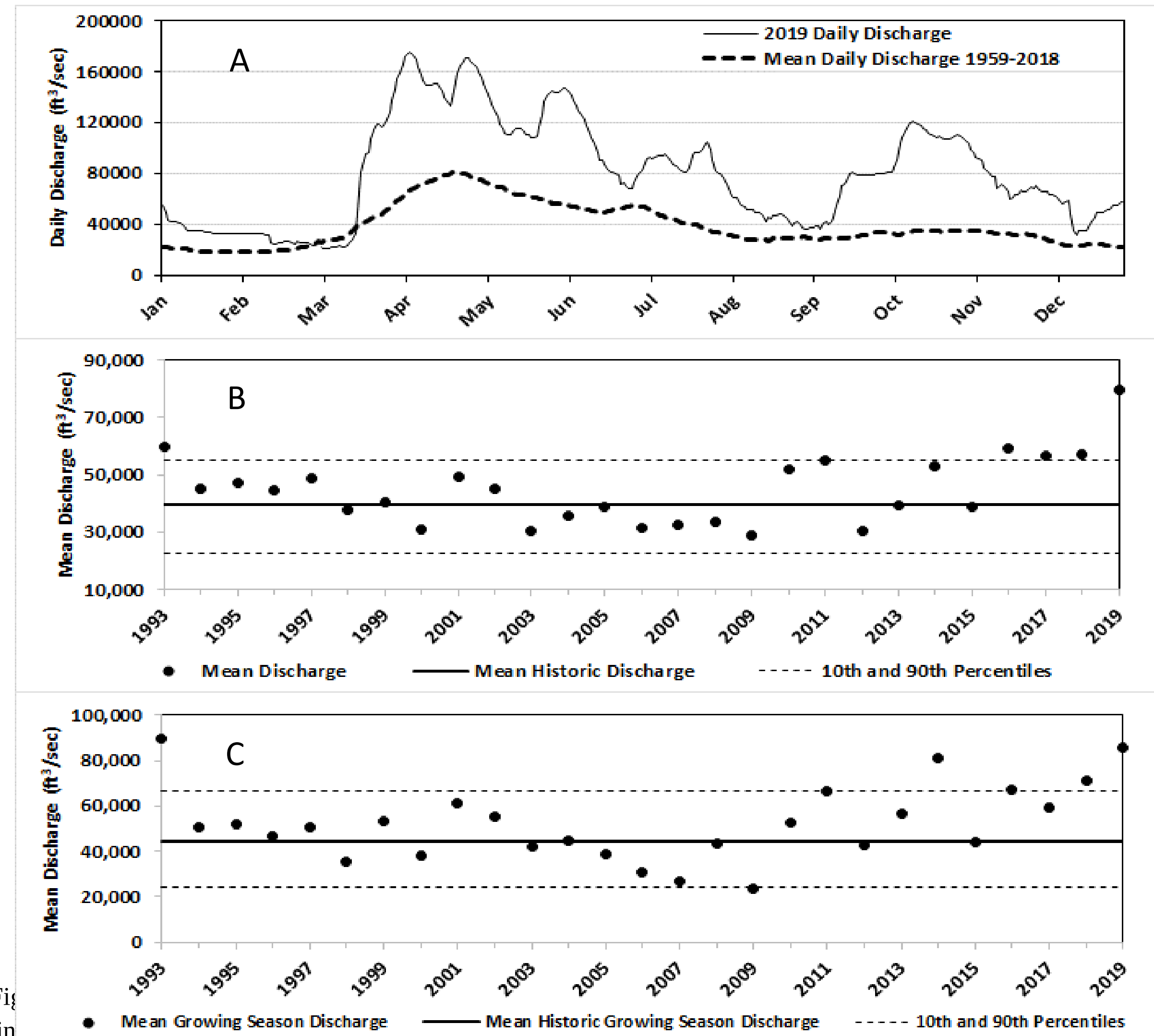
Herein, we used discharge estimates from Lock and Dam 8 at Genoa, WI, as they reflect important local tributary flow inputs. We report daily discharge values, using values recorded at 0800 hrs from 1959-1987, and calculated mean daily values for multiple daily observations reported in recent years. All discharge data reported are in cubic feet per second (cfs).

A historical hydrograph was constructed by computing the mean daily discharge values from the years 1959-2018. The daily discharge for 2019 was then overlain on the long-term daily mean to observe departure from typical conditions (Figure 1.1A). Additional analyses examined annual, growing season (May–September) and spring flood discharge characteristics. Mean annual discharge was calculated from daily values, plotted for years 1993-2019 (i.e. LTRM period of record for stratified random sampling), and overlain on a plot containing the historic mean, 10th, and 90th percentiles for all years (1959 to 2019; Figure 1.1B). Mean growing season discharge was calculated and plotted similarly to the mean annual discharge (Figure 1.1C). 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 dates on 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 historic 75th percentile discharge value from March through May. Magnitude was reported as the maximum spring discharge value for each year (Table 1.1).

Results

2019 was slightly cooler and much wetter than normal in La Crosse (National Weather Service, http://www.weather.gov/arx/lse2019). The months of February (-6.5° F), March (-4.3° F) and November (-3.5° F) were much cooler than normal, while July (+3.4° F), September (+6.3° F) and December (+5.6° F) were warmer than usual. Snowfall for the entire winter season was 12th highest on record, with nearly 58" falling from January through April. In addition, precipitation was an inch or more above normal during each of the following months: May, June, July, September and October; while August was the only month during 2019 where precipitation was significantly below normal.

As a result of both the significant winter snowfall and persistent heavy rains throughout the entire year, the 2019 hydrograph (Figure 1.1A) set numerous all-time records, including three monthly, three yearly and four consecutive days records. The daily discharge was above the historic discharge every day from mid-March onward. The National Weather Service (NWS) details many of the records at this web site: https://www.weather.gov/arx/2019Flooding_LaCrosse. The high discharge in October was not considered in the NWS analysis, and added to the all-time yearly records. Thus, the 2019 UMR hydrology will be remembered more for its duration than its magnitude, although it also had the third highest daily peak discharge during the LTRM period of record (Table 1.1). As a point of context, most islands in Pool 8 become submerged at about 90,000 cfs which was exceeded for four months in 2019. Under those conditions, dry land within the floodplain is limited to a few high islands, most terrestrial vegetation is inundated and currents flow through nearly all backwater areas. This inundation likely impacted not only terrestrial and aquatic vegetation, but also aquatic and terrestrial animals, and birds.



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year is represented by the black dots. The solid line represents mean historic discharge for 1959-2019. The dashed lines represent the 10th and 90th percentiles for 1959-2019 discharge. C. Mean growing season discharge (May-Sept.) by year is represented by the black dots. The solid line represents mean historic growing season discharge for 1959-2019. The dashed lines represent the 10th and 90th percentiles for 1959-2019 growing seasons.

Figure 1.1 illustrates the magnitude of the sustained high discharges throughout 2019. Mean daily discharge for the year was nearly 80,000 cfs, more than double the historic mean and 33% higher than the next closest year, 1993. The mean daily discharge has now been near or above the 90th percentile for seven of the last ten years. It is noteworthy that the mean daily discharge for 2019 (Figure 1.1B) was as high as the peak spring flood discharge for the historic hydrograph (Figure 1.1A).

Table 1.1 Spring flood pulse statistics by year during the LTRMP period of record (1993-2019) for discharge at Lock and Dam 8 of the Upper Mississippi River. Duration represents the number of days each spring when discharge was above the 75th percentile from the long-term record (1959-2019). 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
1993	56	April	116200
1994	20	May	107100
1995	27	May	86000
1996	29	April	140200
1997	40	April	188300
1998	22	April	122500
1999	32	May	110400
2000	0	March	66500
2001	54	April	225100
2002	18	April	121100
2003	23	May	116900
2004	3	April	80300
2005	19	April	96300
2006	24	April	104000
2007	18	April	87400
2008	40	May	101000
2009	11	April	83300
2010	26	March	114100
2011	67	April	168800
2012	0	May	76200
2013	50	May	116900
2014	49	May	133500
2015	1	May	79600
2016	14	March	106200
2017	50	May	129200
2018	25	May	135100
2019	77	April	175404

While mean growing season discharge was slightly less than 1993's all-time high (Figure 1.1C), it was the second-highest value during the LTRM era, and likely influenced, or will influence, biotic productivity during 2019 and future years. The year after the great summer flood of 1993 produced some of the highest catch rates of fish for many species in LTRM. A major difference between 1993 and 2019, however, is that aquatic vegetation is currently abundant but was greatly reduced between approximately 1989 and 1995. The abundance and persistence of aquatic vegetation may prove to moderate increases or decreases in fish year-class strength, depending upon the species and their life history strategies.

Bimodal and polymodal hydrographs have also become more common in the last decade, including winter (2015) and fall (2016, 2017, 2018 and 2019) floods. The impact of these out-of-season floods is uncertain, but could have significant ecological effects, including plant maturation and dispersal patterns, young fish fitness, fish overwintering concentrations and waterfowl feeding efficiency.

The 2019 spring flood analysis (Table 1.1) depicts a typical flood timing in April, although the first discharge peak in early April was caused by snowmelt and the second peak late in the month was caused by rainfall. Water levels were elevated for 77 of a possible 92 days during the spring, and the peak discharge was 175,404 cfs. This was the first time since 2011 that the spring flood occurred at the usual time in April (Table 1.1); however, it continued through the rest of the year.

2. Water Quality

Methods

The focus of the LTRM water-quality component is to collect limnological information relevant to the suitability of aquatic habitat for biota and transport of materials within the system. Since 1993, the LTRM water-quality sampling design has incorporated year-round fixed-site sampling (FSS) and quarterly stratified random sampling (SRS). This combined sampling approach provides information at both broad spatial scales, with low temporal resolution (i.e., SRS quarterly), and at small spatial scales, with higher temporal resolution (i.e., FSS bi-monthly April-August and monthly September to March). 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, impounded and backwaters with high habitat value. The data used for this report are weighted pool-wide median values from Pool 8 SRS sampling. Water temperature and dissolved oxygen (DO) concentrations used in this report were surface measurements taken at 0.20m depth. Water samples were collected near the surface (0.20m depth) to quantify total suspended solids (TSS), chlorophyll *a*, total phosphorus (TP) and total nitrogen (TN). More details on LTRM 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 and summary data pertaining to water quality metrics by season, reach and sampling stratum can be found by utilizing the LTRM Water Quality Graphical Data Browser at: http://www.umesc.usgs.gov/data_library/water_quality/water_quality_page.html.

Results

Temperature

Water quality in 2019 was strongly influenced by high discharge throughout the year with the highest annual and 2nd highest growing season discharge for the LTRM period of record (POR), (Figure 1.1). This was the fourth consecutive year of very high discharge. Open-river conditions (high flow where dams do not regulate flow) were reached during spring, summer and fall. Impacts of high flow on water quality variables are discussed below in the summaries of the major water quality variables.

Water temperatures were near the long-term medians for winter and summer, but below average for spring and fall (near the 25th and 10th percentile respectively, Figure 2.1A). Water temperature can have direct and indirect effects on large river ecology. Warm water temperatures can result in higher respiration rates, leading to lower oxygen saturation concentrations, which can increase the frequency of hypoxic conditions (Houser et al., 2015; Likens 2010). Water temperature also influences the rate of photosynthetic production in aquatic ecosystems (with lower rates of photosynthetic productivity at very low and very high water temperatures, and higher rates of productivity at intermediate temperatures). The LTRM SRS data browser does not show any strong trends for pool-scale temperature over the period of record (1993-2019), although winter and summer have weak increasing trends, while spring and fall show a weak decreasing trend.

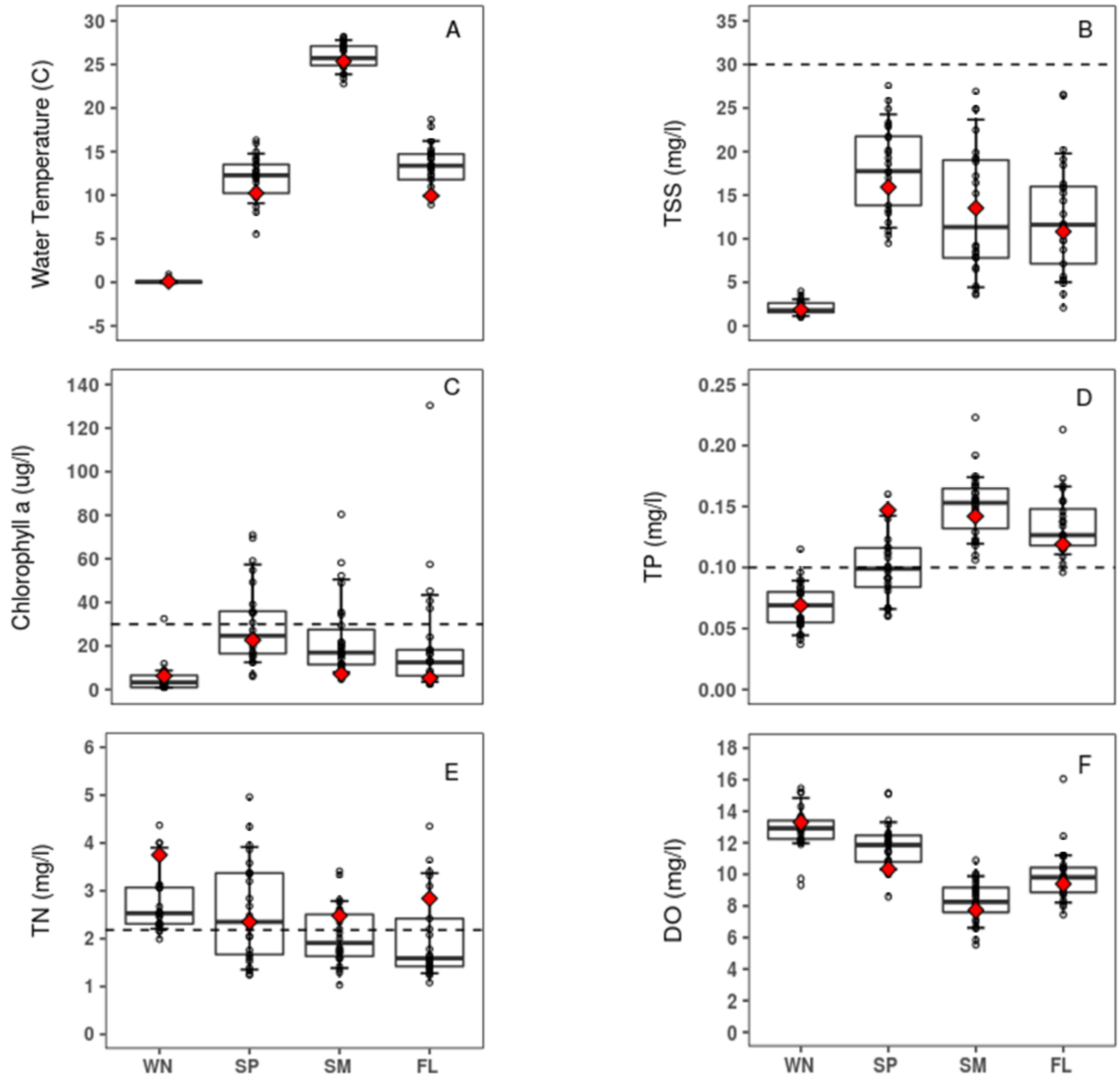

Figure 2.1A-F Box plots represent the 10th, 25th, 50th, 75th, and 90th percentiles of the pool-wide medians by stratified random sampling season for the Long Term Resource Monitoring period of record (1993-2019). The diamonds represent the weighted pool-wide median for each parameter by season for 2019. The dashed line represents: (B) the upper limit to sustain submersed aquatic vegetation in the Upper Mississippi River from Giblin et al., 2010; (C) the lower limit of the eutrophic range as defined by Dodds et al. 1998; (D) the total phosphorus criterion for non-wadeable rivers in Wisconsin as defined by NR 102.06; (E) the upper limit of the range suggested for total nitrogen as defined by the USEPA, 2000.

Constituents

Total suspended solids (TSS) concentrations were near the long-term median values in all seasons (Figure 2.1B). The LTRM SRS data browser shows a strong decreasing trend in pool-wide TSS for spring, summer and fall, and a weak decreasing trend for winter (Pool 8, 1993-2019). Pool-wide median TSS concentrations are rarely above 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). Aquatic vegetation stabilizes substrates and slows local water velocity, allowing sediment to settle out of the water column. The physical influence that aquatic vegetation has on the river hydrology can create positive feedbacks (e.g. lowering current velocity and attenuating waves), which can allow vegetation beds to expand into nearby areas that were previously unsuitable, which further lowers TSS (Scheffer 1993). However, aquatic vegetation prevalence has been similarly high for over a decade, yet TSS has been steadily decreasing and exactly what is driving the decreasing TSS trend is still unclear.

Chlorophyll *a* concentrations were above long-term median (~75th percentile) for winter, and below the long-term median for spring, summer and fall (~ 40th, 10th and 25th percentile respectively; Figure 2.1C). The lower concentrations in spring, summer and fall were likely a function of dilution, mixing and flushing, caused by the high and erratic discharge during 2019. Chlorophyll *a* is an indicator of phytoplankton biomass in the water column. Light, temperature, nutrients and hydraulic retention time are the primary factors determining phytoplankton biomass and growth in the UMR, as in lakes (Houser et al. 2015; Likens 2010, Soballe and Kimmel 1987). Median chlorophyll *a* concentrations during 2019 were well below the eutrophic range (>30 µg/L, Dodds et al., 1998). Eutrophication is still a major water quality issue in the UMRS, and, while chlorophyll *a* concentrations in Pool 8 were consistently below the eutrophic range in 2019, collections made during high water may not reflect long-term conditions. The LTRM SRS data browser (1993-2019) showed no trend for pool-wide chlorophyll *a* in winter, a weak decreasing trend in spring, and moderate decreasing trends in summer and fall.

Total phosphorous concentrations (TP) in 2019 were near the long-term median for winter, well above the long-term median for spring (~90th percentile) and below the long-term median for summer and fall (~35th and 25th percentile, Figure 2.1D). The LTRM SRS data browser shows a weak decreasing trend in TP for spring, a fairly strong decreasing trend in winter and fall and a moderate decreasing trend in summer seasons (pool-wide medians, 1993-2019).

The Wisconsin criterion for TP impairment of non-wadeable rivers is when summer average TP (from six samples monthly from May to October) exceeds 0.10 mg/L (WDNR 2020). TP concentrations were below the 0.10 mg/L winter and were above this level during spring, summer and fall in 2019. While the WI criterion was not strictly met due to the lower sampling frequency in LTRM SRS monitoring, the Mississippi River is listed as impaired for TP by the Wisconsin DNR (WDNR 2019), and the SRS data are consistent with this.

Heavy rain events can cause increased erosion/runoff in the watershed, therefore, increased sediment delivery to the river. A significant fraction of TP input is adsorbed to the TSS load; hence the concentration of TP tends to covary with TSS (if one is running high the other usually is too, Figure 2.1B and 2.1D). However, this did not hold true in 2019, especially in spring. It was surprising to see the higher TP levels in spring, given the lower TSS concentrations. The rate that snow cover melted, as well as the magnitude of rain events, may have resulted in a less erosive spring runoff (evidenced by lower TSS).

Elevated phosphorous concentrations are often attributed to inputs from point and non-point source pollution (e.g. municipal treatment plants and agriculture runoff). Significant phosphorous inputs can arise from sediment microbial activity, especially in backwaters experiencing anoxic conditions in warmer months. This is referred to as anoxic sediment release of phosphorous. High discharge in 2019, and, therefore, more water exchange between the well oxygenated channel water and backwater areas, may have limited anoxic conditions and reduced the rate of anoxic sediment release of phosphorous. Only 4 sites had anoxic (DO below 0.5 mg/l) conditions in 2019 (the average number we see is ~15 sites with some years having more than 30 sites with DO < 0.5 mg/l).

Excessive delivery of nitrogen (mainly from agriculture), in the form of nitrate to groundwater and surface waters, has been associated with several negative consequences for human and ecosystem health (Wolfe and Patz, 2002). 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). Total nitrogen (TN) was above the long-term median in winter, summer and fall, and near the long-term median for spring (Figure 2.1E). In 2019, TN was above the upper concentration recommended by the USEPA for ecosystem health (0.6-2.18 mg/L) during all seasons (USEPA, 2000). Trends for TN are mixed, the LTRM SRS data browser shows a strong increasing trend in winter, a weak decreasing trend in spring and summer, and a weak increasing trend in fall (pool-wide 1993-2019).

Despite efforts to reduce nitrate-nitrogen delivery to groundwater, rivers and ultimately the Gulf of Mexico, nitrogen export has continued to increase in Wisconsin and regionally (e.g. see https://fmr.org/minnesota-nitrate-study-highlights-farm-runoff-pollution). Further investigation into the high variation observed between years as well as the increasing winter and fall trend is needed.

Dissolved Oxygen

Adequate dissolved oxygen (DO) is critical to sustain aquatic life. The concentration of DO in water reflects the balance of consumption (through decomposition of organic material, plant and animal respiration and sediment demand), production (by photosynthesis), mixing with the atmosphere though diffusion and turbulence, and water movements depending on discharge and currents. Long-term, pool-wide trends in served LTRM SRS data (https://www.umesc.usgs.gov/data_library/water_quality/graphical/wq_browser.html) suggest a weak increasing trend in winter DO, no trend in summer and a weak decreasing trend in spring and fall.

In 2019 DO measured during SRS episodes was slightly higher than the long-term median in winter, but slightly lower than long-term medians in all other seasons. Spring DO was relatively low, at the ~20th percentile (Figure 2.1F). Pool-wide spring, summer and fall concentrations were all higher than the level of concern for fish and invertebrates (~5 mg/L). High discharge in 2019 likely contributed to the stable and overall good DO levels (presumably from thorough mixing of main-channel water with backwaters). DO was often at or near 100% saturation, with less than 4% of sites having hypoxic/anoxic conditions. Low DO occurred mainly in backwater sites in winter or bottom readings in backwaters during summer.

In winter, ice and snow cover can affect the concentration of DO in the underlying water column by regulating light transmission (and photosynthesis) and preventing gas exchange with the atmosphere. High under-ice DO suggests photosynthetic activity (O_2 evolution) by phytoplankton or overwintering aquatic macrophytes. Median ice thickness in 2019 was thin, near the 10th percentile, while snow depth was near the long-term median (Figure 2.2). Few sites in winter 2019 exhibited low DO (< 5 mg/l). Pool-wide median DO during winter was close to saturation and slightly higher than long-term median values (Figure 2.1F). Most of the low DO measurements occurred in Blue Lake, a shallow, productive, isolated backwater (previously a sewage outfall for the City of La Crescent, MN) that is often hypoxic in winter.

Oxygen supersaturation under conditions of ice cover limiting diffusion of oxygen from water into the atmosphere along with high rates of photosynthesis has been implicated in past years as the cause of under-ice fish kills (from gas-bubble disease) in Pool 8, as well as other pools. Even though the ice was relatively thin and snow depth was at about the 50th percentile (Figure 2.2), very few sites had supersaturated DO, the highest level being only ~125% (values can range to >300% in similar field settings). Discharge during winter SRS was relatively high compared to the long-term average and may have kept water exchange rates high enough to buffer high DO concentrations.

The LTRM SRS pool-wide browser data show a weak increasing ice thickness trend and a weak decreasing snow thickness trend between 1993 and 2019.

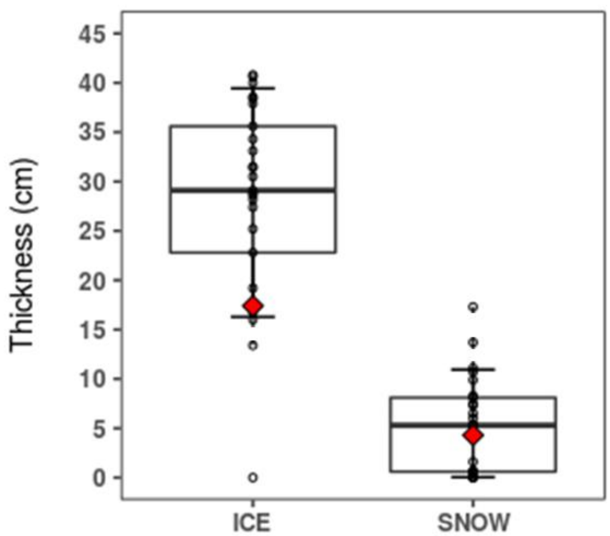

Figure 2.2 Box plots represent the 10th, 25th, 50th, 75th, and 90th percentiles of the medians by stratified random sampling during winter for the Long Term Resource Monitoring period of record (1993-2019). The diamonds represent the weighted pool-wide median for each parameter for winter SRS 2019.

3. Aquatic Vegetation

Methods

Aquatic vegetation surveys are conducted at 450 sites in Pool 8 annually, and sites are visited between 15 June and 15 August to target the period of peak biomass. Methods are described briefly here, but more detail on LTRM vegetation sampling protocol can be found in Yin et al., 2000. Sites are randomly selected at established stratum-specific densities to reflect relative coverage in the Pool 8 ecosystem, based on LTRM probabilistic design (https://www.umesc.usgs.gov/ltrmp/stats/statistics.html). The boat is anchored within 10 m of site coordinates. Emergent species, rooted floating-leaf species and nonrooted floating-leaf species are assigned ordinal-scale cover scores based on their abundance in a 2-meter ring around the boat. At each site, SAV is sampled in six subplots by pulling a modified garden rake over the sediment surface for a distance of ~1.5 m and SAV caught in the rake teeth is examined for species identification and abundance scoring. Vegetation caught on the rake is scored as "plant density" using a six-level ordinal scoring scheme. Increasing plant density values represent increasing levels of stem density on the rake; score = 0 when no plants are on the rake, and scores of 1-5 are assigned to increasing number of plant stems (irrespective of length or branching density) caught on the rake. Rake teeth are marked in 20% intervals and plant density is scored as 1 if SAV fills rake teeth up to the first mark, scored as 2 if plant stems fall between the first and second intervals, etc.

Specific features of the Pool 8 aquatic vegetation are based on data spanning 1998 – 2019, and data were downloaded from the LTRM graphical data browser at:
https://www.umesc.usgs.gov/data_library/vegetation/graphical/veg_front.html

Results

We conducted surveys at all 450 scheduled sites between 15 June and 8 August in 2019. Pool 8 was at or above 10 feet at the NOAA LACW3 gage beginning in March and extending through most of the 2019 growing season and all but the last week of vegetation SRS sampling. High water (Figure 1.1) which occurred during most of the 2019 field season may have affected aquatic vegetation sampling to some extent; mean depths measured during sampling were, on average, ~20-30 cm deeper than other years. Extended high water had several implications for 2019 data:

Approximately 15 sites were too deep to sample (> 2.8 m) when they were first visited but were also <3.8 m, suggesting that they might be sampleable under more "normal" conditions. Because the water level remained high through the sampling season, we were unable to return to many of them during lower water conditions. These were judged as likely not able to support aquatic vegetation and recorded as "no aquatic vegetation" sites.

Vegetation field crews in Pool 8 (and also in LTRM Pools 4 and 13) observed a 3-4 week delay in growth and maturation of aquatic vegetation, which we attributed to high water and associated reduced light conditions. For example, curly pondweed (*Potamogeton crispus* L.) started flowering on ~10 June, approximately 3 weeks later than usual. Also notable was delayed growth and flowering of wild celery *(Vallisneria americana* Michx.) which was small and underdeveloped during the first month of sampling. On 7 August we resampled 10, Pool 8 impounded area sites that had first been sampled during the first week of July. Wild celery was detected at the same 7 of 10 sites in both July and August, but August plant density scores were approximately double the July values. This suggested that while detect/non-detect data (percent frequency occurrence) for wild celery in the 2019 data were relatively stable through the growing season, measures based on plant density (rake score) were likely underestimated relative to other years. An unquantified, but potentially useful observation, is that by the end of the 2019 vegetation SRS sampling season (mid-August), vegetation in Pool 8 appeared to be about what we would expect for mid-July in terms of plant biomass and development. Additionally, the epiphytic snails (especially *Bithynia tentaculata* L.) that are usually very abundant on aquatic vegetation in the impounded area appeared 3-4 weeks later than usual.

Long-term patterns in vegetation abundance

Since LTRM probabilistic monitoring was initiated in 1998, the prevalence of all three major vegetation life forms (submersed, rooted floating-leaf and emergent) in Pool 8 has increased (Figure 3.1), as has "total aquatic plant index", the sum of percent frequency occurrence of the three life forms (Figure 3.2). Because all three life forms can overlap in distribution, this index can exceed 100%. This overall abundance index increased considerably between 1998 and 2010 and has varied between 120 and 160 since 2011. The prevalence of non-rooted floating species (duckweeds and water fern) and filamentous algae have varied considerably over time and likely reflect short term changes in discharge/ water residence time.

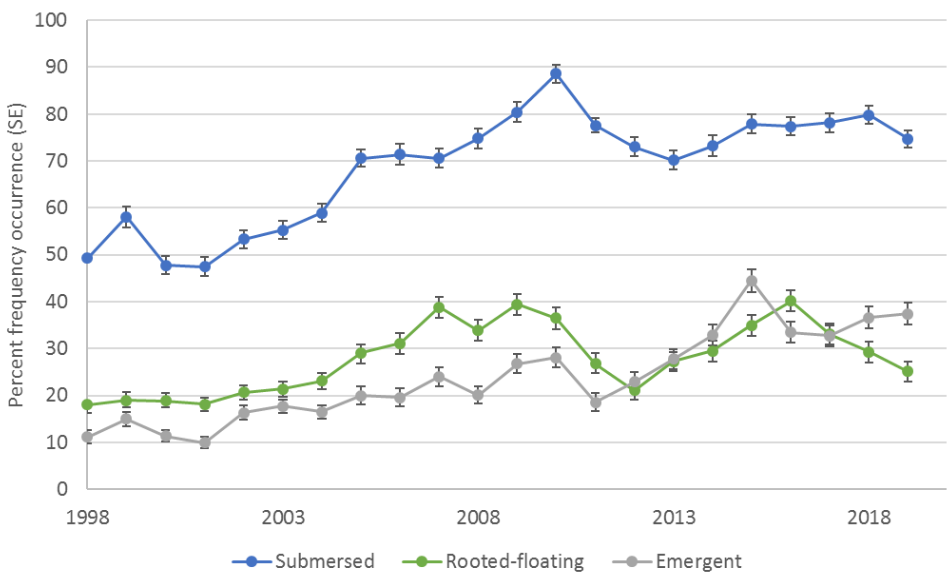

Figure 3.1. Pool-wide prevalence of the three vegetation life forms over 22 years of probabilistic monitoring (±SE).

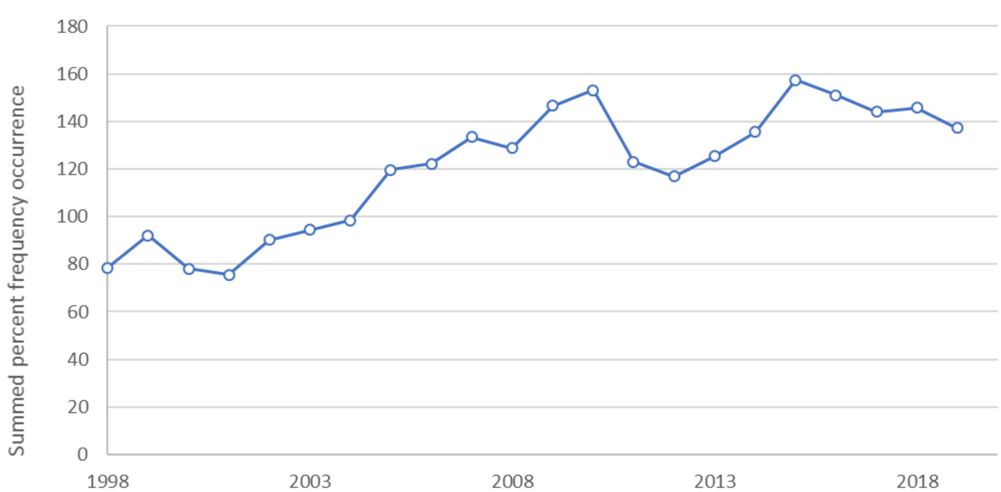

Figure 3.2. Pool-wide total aquatic plant index over time is annual, summed percent frequency occurrence of the submersed, rooted floating-leaf, and emergent life forms. Because more than one life form can occur at the same site, the index can exceed 100%.

While the overall prevalence of aquatic macrophytes has remained relatively high, the percent frequency occurrence of submersed species decreased slightly to 74.7% in 2019 from77.4 -79.8% in the preceding 4 years (Figure 3.1). Notably, the prevalence of rooted-floating leaf species has decreased by almost half, from ~40% to ~25% since 2016, which is likely associated with sustained, high water conditions. We have observed that pond lilies and American lotus are frequently small and yellowed with many damaged and submerged leaves during field surveys in recent years. The prevalence of emergent species has generally increased over the period of monitoring, although the species driving this increase have shifted from the *Sagittarias* which increased between 1998 and ~2010 to wild rice (*Zizania aquatica* L.) which expanded considerably beginning in the mid-2000s (details below).

Patterns in aquatic vegetation by LTRM stratum

Vegetation abundance varied considerably between strata, with slow-moving and still waters (the backwater isolated, backwater contiguous, and impounded strata) generally supporting more aquatic vegetation than swift waters (side channels and the main channel borders) (Table 3.1, Figure 3.3). Stratum-specific average depths at the time of sampling in 2019 were, on average, ~20 cm deeper than previous years (excluding 2018).

Table 3.1 Summary of site distribution among strata for aquatic vegetation sampling in 2019. The column "% Vegetated" was calculated by subtracting the number of unvegetated sites from the total number of sites in each stratum and dividing by the number of sites sampled in that stratum. Depths were measured at time of sampling and are not corrected for river stage – reported depths provide only a general indication of differences.

Stratum	Number of sites	2019 mean depth m (SD)	2019 % Vegetated
Backwater connected (BWC)	110	1.07 (0.70)	85.5%
Backwater isolated (BWI)	20	0.44 (0.24)	95.0%
Impounded (IMP)	185	1.34 (0.55)	83.8%
Main channel border (MCB)	70	2.55 (1.62)	28.6%
Side channel (SC)	65	2.04 (1.56)	41.5%

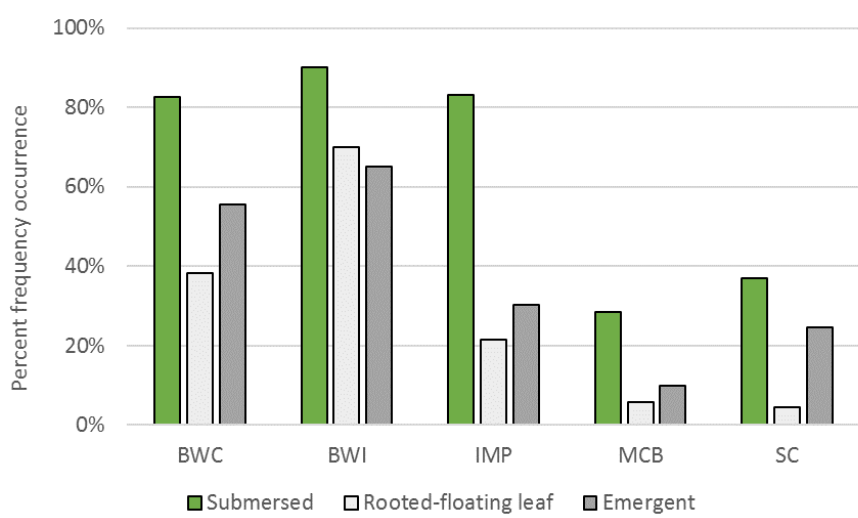

Figure 3.3 Prevalence of life forms by stratum.

Aquatic vegetation species of interest

A total of 34 aquatic plant species plus filamentous algae have been identified in Pool 8 over the course of LTRM monitoring. Between 4 and 8 species are usually detected at vegetated sites. The maximum number of species found at a single site in 2019 was 18. The highest diversity sites usually span a range of depths and include the transition from submersed species to emergent species (i.e. are near the edge of water). A portion of the increase in aquatic vegetation over the LTRM monitoring period is attributable to the expansion of two native species of special interest – wild celery and wild rice. Wild celery is a predominantly clonal, perennial plant, and has high specific value as forage for canvasback (*Aythya valisineria* Wilson) and other migrating waterfowl. Wild rice, an annual aquatic grass, can also be an important source of food and cover for wildlife. Long-term data show considerable increases in the prevalence of both species since 1998 (Figure 3.4). Wild celery has remained at a relatively high prevalence (~40% pool-wide percent frequency occurrence) since 2010, and does not appear to be negatively affected by the recent high-water conditions. Prior to 2008, wild rice was only detected at 1-3% of sites annually, but it started expanding in the mid-2000s and in 2019 was detected at 28% of sites. We note that it has rapidly expanded into the impounded area despite increased depths and water velocity. Wild rice is now the most frequently detected emergent species in Pool 8 LTRM surveys and is a substantial contributor to the total vegetation index (Figure 3.2).

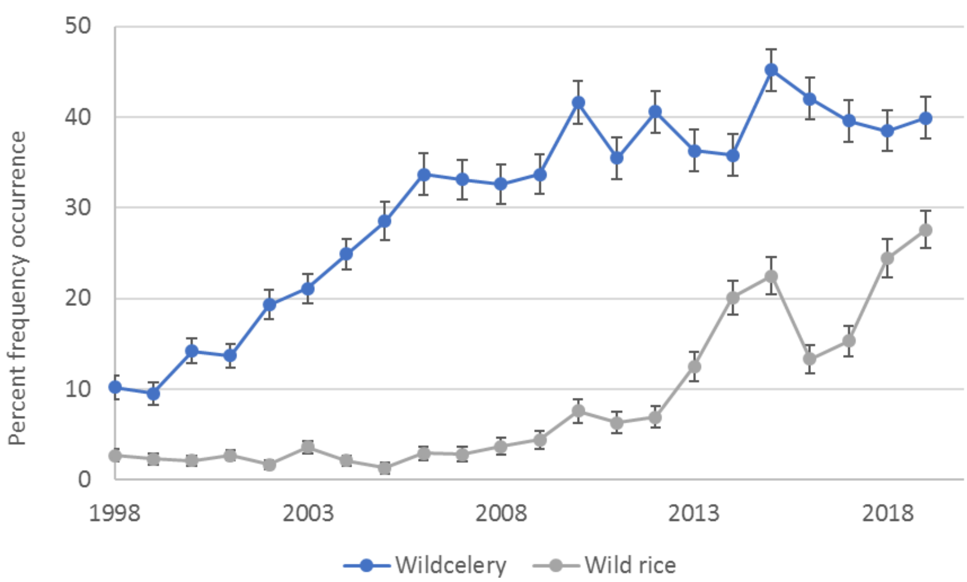

Figure 3.4 Positive trends in the pool-wide detection of wild celery and wild rice in Pool 8 over the period of LTRM vegetation SRS monitoring.

The Pool 8 aquatic vegetation community is composed primarily of native species, with only two, locally abundant invasive species: Eurasian watermilfoil (*Myriophyllum spicatum* L.) and curly pondweed (Figure 3.5). These species have been detected at ~10-30% of Pool 8 sites annually, but have not increased as dramatically as the native species described above, or as much as the total vegetation index. Prevalence of the Eurasian watermilfoil in 2019 was the lowest on record, while curly pondweed prevalence was not strikingly different from recent years. Although sometimes locally abundant, the invasive species rarely appear to exclude native vegetation at the site level, and are virtually never the only species detected at a site. In most years, the maximum biomass of curly pondweed occurs in early- to mid-May, and it senesces considerably by the time summer surveys are conducted. However, delayed development in 2019 attributed to high water likely meant that the 2019 estimate is more representative of curly pondweed peak biomass.

The prevalence of native Northern watermilfoil (*M. sibiricum* Kom.) (Figure 3.5) increased substantially and suddenly in 2015 and has remained at levels comparable to the Eurasian watermilfoil since then. This pattern was also observed in Pools 4 and 13 in the same year. Although we most frequently encounter individuals that are clearly either the native (most leaves are "open" with 4-11 leaflets) or the invasive (most leaves are "folded" with >16 leaflets), we also find hybrids with intermediate numbers of leaflets and other morphological features. In cases where plants appear to be hybrids, those with > 11 leaflets are categorized as *M. spicatum*, and those with 11 or fewer are categorized as *M. sibiricum*.

The profusion of algae in freshwater systems is associated with eutrophication, a major concern for managers of the greater Upper Mississippi River. Filamentous algae are often found in dense mats or clinging to vegetation, and late each summer blue-green algae appear as patchy films. The prevalence of filamentous algae has varied considerably over time in LTRM surveys (Figure 3.6). Abundance of filamentous algae in 2019 was low compared to most of the LTRM record, and its abundance was likely limited by the higher discharge and thus higher water velocity throughout the 2019 sampling season.

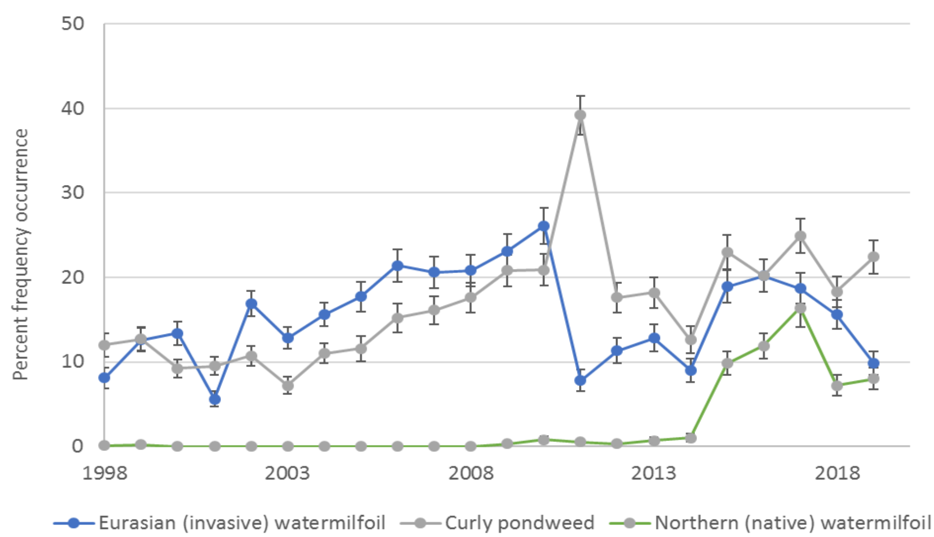

Figure 3.5 Prevalence of the two common invasive species, curly pondweed and Eurasian watermilfoil, and the native Northern watermilfoil in Pool 8 over LTRM monitoring.

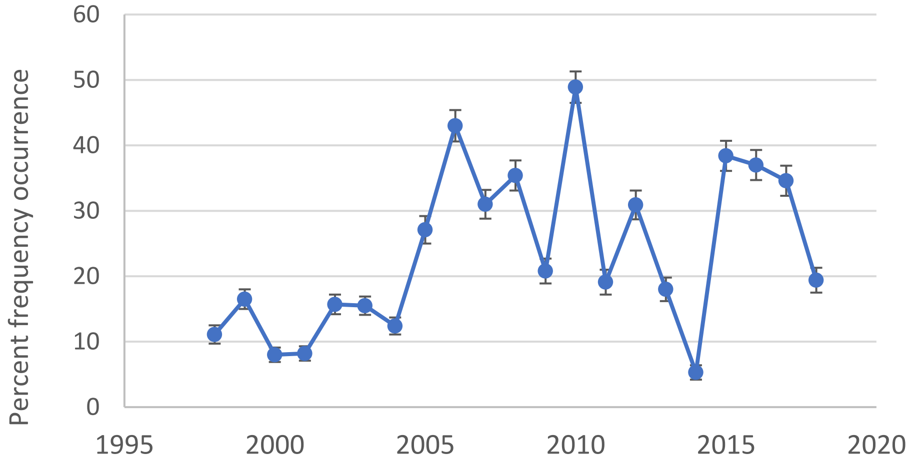

Figure 3.6. Prevalence of filamentous algae over the period of LTRM monitoring.

4. Fisheries

Methods

The LTRM 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 stratified random sampling scheme (SRS) and stratification based on broad habitat features. Fish sampling is conducted within three consecutive six-week episodes (periods 1 – 3), from June 15 to October 31, to ensure both temporal and spatial interspersion of the sampling gear deployments. The same number of gear-habitat combinations are fished each time period, but sites are independently selected for each episode. More detail on LTRM fish sampling procedures can be found in Ratcliff et al., 2014 at: https://pubs.usgs.gov/mis/ltrmp2014-p001/. A companion document (Ickes et al., 2014) describes the monitoring rationale, strategy, issues and methods, and can be found at: https://pubs.usgs.gov/mis/ltrmp2014-p001a/.

The LTRM Fish Graphical Data Browser automates many routine analyses and provides on-demand analytical products for end users. This information can be accessed at: https://umesc.usgs.gov/data_library/fisheries/graphical/fish_front.html. Routine data analyses for overall fish community data include sample allocation, species richness, total catch by species and community composition (presence/absence). Stock size designations defined in published manuscripts are among many useful descriptive parameters that can be found in the LTRM Fish Life History Database, available for download at https://umesc.usgs.gov/data_library/fisheries/fish_page.html. The life history database also contains a table with allometric growth information that allows conversion of length data to mass, which yields additional insight into fish community characteristics.

This report summarizes sampling effort, total catches, species richness and dominant species in the catch, by number and weight. Detection frequencies of common and rare fishes are discussed, and data on species of special concern are also presented. Any collections of bigheaded carps will be reported, as well as Common Carp status, and other anecdotal observations on the fish community. Shannon-Wiener Diversity Index (Zar 1984) scores are computed from day electrofishing collections to indicate fish community diversity relative to previous years.

Catch-per-unit-effort (CPUE) data are provided for ten common sport fish of interest to anglers and fish managers. CPUE is reported as estimates of gear-specific pool-wide means and standard errors, weighted for effort expended within each of the sampling strata. Herein, we present CPUE data for one or two effective gear types, as suggested by total catches from each gear. More detailed descriptions of CPUE calculations can be found at the Fish Monitoring Rationale and Fish Procedures web pages, listed above.

A stock-size analysis for these ten common sport fish of interest displays the catch of fish in each stock category, annually, in stacked bar graphs, with substock catches in separate figures due to their generally higher numbers. Stock categories are based upon those listed in the Life History Database, referenced above. The stock-size analysis includes catches from all gear types and sampling sites.

Data were omitted for 2003 in all cases because of reduced sampling that year. Also, catches of fish from randomly selected wingdam and fixed tailwater sites are reported in total catch, species richness and the stock analyses, but are excluded from CPUE calculations because these strata were considered too small and unique for proper stratification of sampling effort. However, CPUE values for the individual strata, including wingdam sites, are available on the Fish Graphical Data Browser at the link provided above.

Results

Effort by gear type and period

LTRM Pool 8 fish sampling in 2019 was affected by the persistent high water levels during periods 1 and 3. No tailwater trawling or wingdam electrofishing was accomplished in either of these time periods. In period 3, all hoop netting was forgone, as well, because dense loads of drifting aquatic vegetation, which would have coated and clogged the nets, were present along with the high current velocities. In contrast to periods 1 and 3, water levels were lower and all scheduled sampling was accomplished in period 2, a welcome change from many recent time periods. In total, 234 samples were collected, of 270 planned (87%). High water almost certainly reduced gear efficiency during much of the season.

The LTRM fish sampling allocation among gear types has remained stable for many years. Sampling effort in 2019 was highest for daytime electrofishing (76 collections), followed by mini fyke nets (66 collections) and fyke nets (48 collections). Effort in 2019 was greatest in the contiguous backwater stratum (84 collections), with side channel (52 collections) and main channel border (40 collections) also receiving considerable effort. The missed hoop net samples in period 3 were split evenly among the side channel border and main channel border strata, 4 large- and small-hoop net sites in each. The impounded shoreline stratum received the least effort. Please note that although the strata names imply habitat features, a wide variety of habitat conditions exist within each stratum.

Catch and species richness

Total catch in 2019 was 18,832 fish, which is the lowest total catch in Pool 8 LTRM sampling since all three periods were restored in 2010. As mentioned previously, this is likely due to missed samples, as well as reduced gear efficiency in the high water. The catch per sample value was higher than 2018 (Figure 4.1), but still one of the lowest values since SRS began in 1993. Mini fyke nets (8,221) and day electrofishing (7,979) had the highest catches, yielding 86% of the total catch, combined. Species richness was 66 in 2019, the second highest value in the last 15 years.

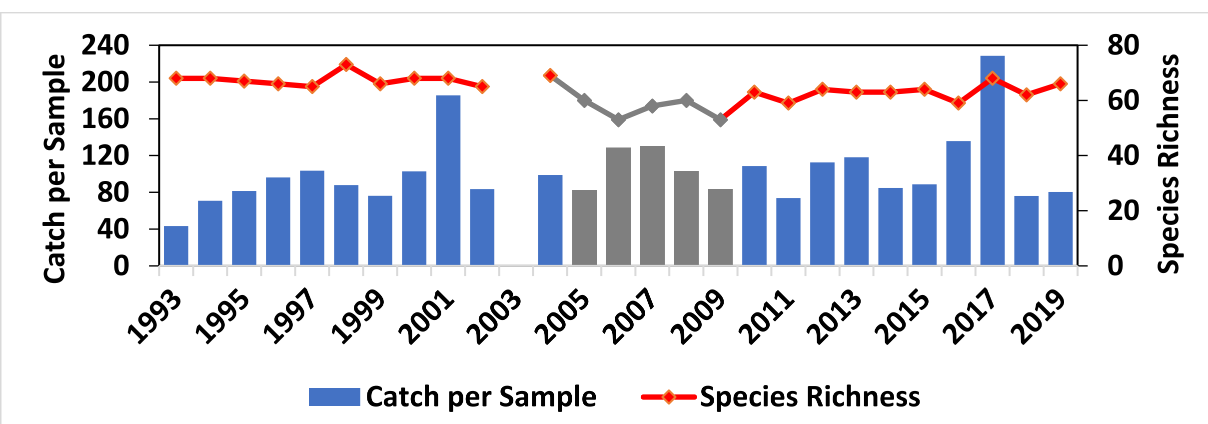

Figure 4.1. Catch per sample and annual species richness for Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Pool 8 of the Upper Mississippi River. Data represent samples collected with daytime electrofishing, fyke nets, mini fyke nets, large and small hoop nets, and otter trawls. Data are omitted for 2003 due to limited sampling that year. Period 1 (June 15 – July 31) was not sampled from 2005-2009 (gray shaded bars).

Weed Shiner (4,589), Bluegill (4,231), Spotfin Shiner (1,286), Largemouth Bass (1,067) and Yellow Perch (800) were the top 5 species, in order of catch, in 2019 (Figure 4.2a). These top five species comprised 64% of the catch. No other species surpassed 500 individuals for the year, but the next most abundant were Emerald Shiner, Shorthead Redhorse and Smallmouth Bass.

By weight (Figure 4.2b), Common Carp (631 kg) ranked first in the catch, followed by Bowfin (270 kg), Shorthead Redhorse (255 kg), Channel Catfish (236 kg) and Flathead Catfish (204 kg). The top five species accounted for about 54% of the total weight. Other species yielding over 100 kg included Freshwater Drum, Largemouth Bass, Golden Redhorse, Bluegill, Silver Redhorse and Northern Pike.

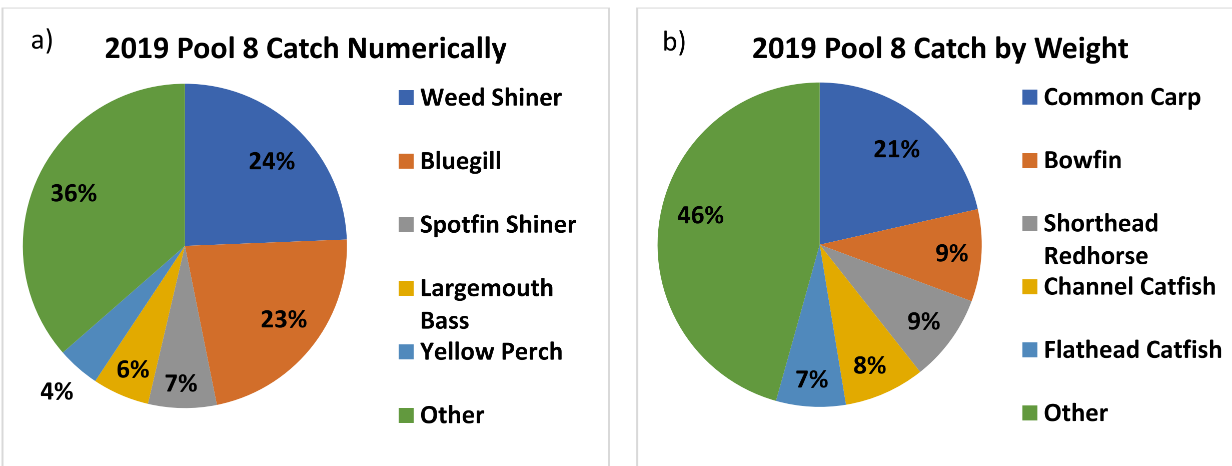

Figure 4.2 Top species for a) catch and b) weight in samples from Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Pool 8 of the Upper Mississippi River during 2019. Data represent samples collected with daytime electrofishing, fyke nets, mini fyke nets, large and small hoop nets, and otter trawls.

Fish community structure

Shannon-Wiener Diversity Index (SWDI) scores (which reflect diversity, abundance and evenness of species present) for day electrofishing in Pool 8 LTRM samples (Figure 4.3) increased again in 2019, to the highest score in twenty years. Because fish species richness (diversity) in Pool 8 has remained essentially stable (Figure 4.1), changes in SWDI scores are likely due to changes in community evenness. The most abundant fish species in Pool 8 have varied in total catches considerably over that time, and these catch variations match up with some of the larger changes in SWDI scores. For example, total catch was very high in 2017, yet the SWDI score was relatively low. Years 2007 and 2011 also exhibited relatively low SWDI. However, in 2007 only three species comprised 74% of the total catch, and in 2011, five species comprised 73% of the total catch. In 2019, the top four species only constituted about 51% of the total catch. Interestingly, 2007 was a year with relatively low mean annual discharge, 2011 had high mean annual discharge, and 2019 had the highest (Figure 1.1B); thus, any relationship between fish community diversity and discharge seems inconsistent. It is also important to remember that from 2005-2009, fish sampling was done only in time periods 2 and 3. Attempting to link fish community attributes with driving forces, such as hydrology, illustrates the necessity of consistent monitoring over long time frames, as there are many short-term perturbations that do not necessarily indicate real trends.

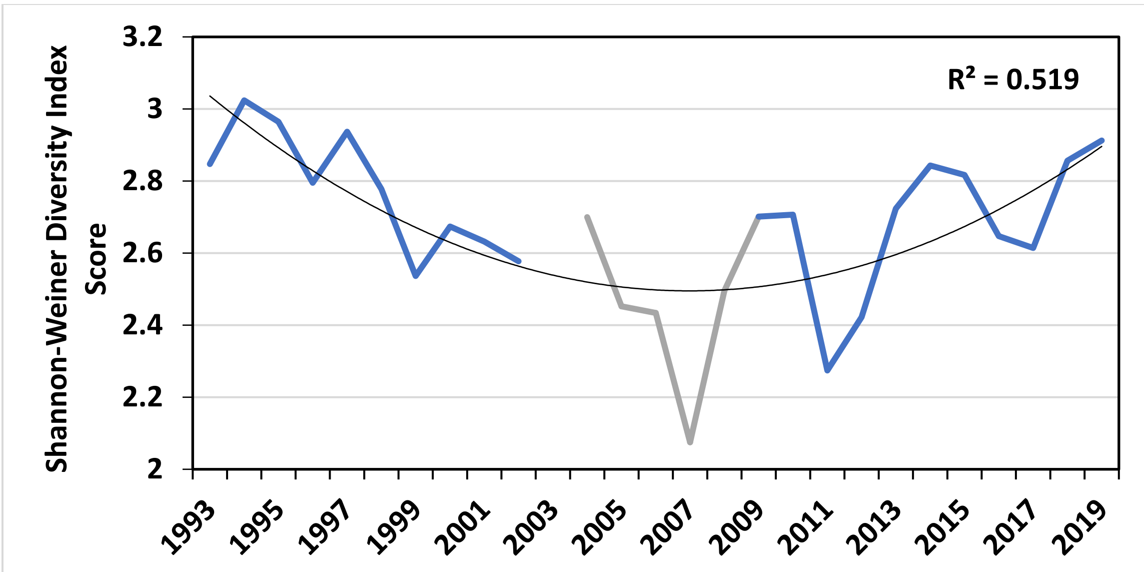

Figure 4.3 Shannon-Wiener Diversity Index Scores calculated from LTRM daytime electrofishing samples from 1993-2019 in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. Data for 2005-2009 are shaded in gray because period 1 samples were not collected those years. Trend line is a second-order polynomial representation of the data.

Species representation in 2019

Appendix A lists all fish species collected in LTRM Pool 8 samples, and number of years collected. Historically, 37 species have been detected in Pool 8 LTRM samples every year since SRS began in 1993, and each of them were again collected in 2019. An additional 26 species have been detected in at least half of the years. However, of those, Orangespotted Sunfish has not been collected since 2014. Sand Shiner had not been collected since 2013, but was collected in 2019.

Twenty-eight species have been detected in fewer than half of sampling years. Of that group of relatively rare species, we sampled the following in 2019 (most recent previous detection in parentheses): Troutperch (2018), Northern Hog Sucker (2017), Pirate Perch (2018), Burbot (2018), Mississippi Silvery Minnow (2018) and Brook Stickleback (2010). Pirate Perch has now been caught in six of the last seven years, despite only being reported in ten years overall. None of the 13 rarest species (captured in only one or two years) were sampled, nor were any new species collected, in 2019. Thus, the LTRM fish species total in Pool 8 remains 91.

We caught two Wisconsin-listed threatened species, Blue Sucker (3) and River Redhorse (7), in the 2109 Pool 8 LTRM sampling season. We also caught 19 Mud Darters, a species of special concern.

Through 2019, the Pool 8 LTRM sampling efforts have not detected any Asian carp (Bighead, Silver or Black). This year we caught 252 Common Carp, currently the only non-native fish species of significance in Pool 8. Common Carp are thought to be in systemic decline in the UMR. However, they continue to dominate the catch, by weight, of all species in Pool 8 – more than double any other species. CPUE graphs of several gear types provide a somewhat mixed picture. Day electrofishing CPUE for Common Carp (Figure 4.4 top) does suggest a long-term decline; whereas, fyke net CPUE (Figure 4.4 bottom) shows a stable long-term pattern, with a recent increase. Shifting habitat utilization or a change in gear efficiency could be contributing factors to these data trends, although population decline still seems likely, given the trends in other LTRM study reaches.

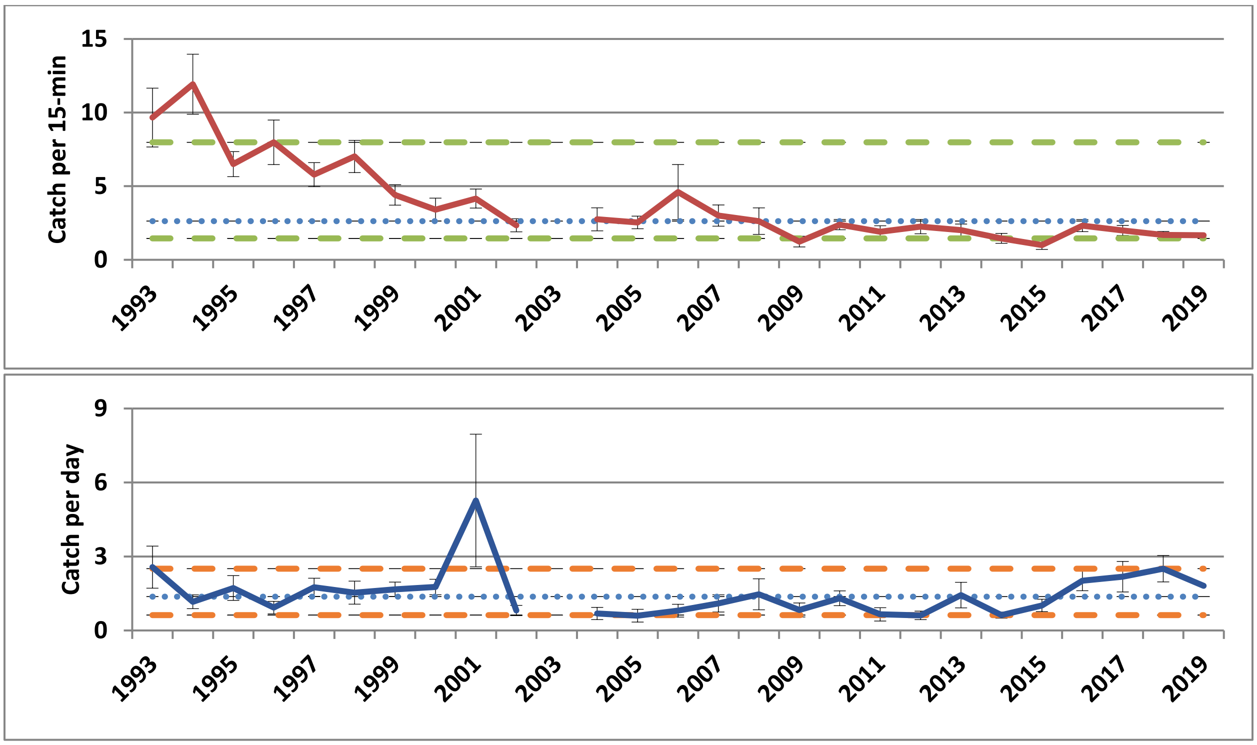

Figure 4.4 Catch per unit effort (± 1SE) of Common Carp by daytime electrofishing (top graph) and fyke netting (bottom graph) samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10^{th} and 90^{th} percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

In summary, monitoring results suggest that the Pool 8 fish community remained healthy again in 2019, with good species richness and high diversity. Though Common Carp still dominate the biomass, they are the only invasive species of consequence represented in monitoring, and their abundance seems much reduced from historic levels. Historically high discharge throughout most of the sampling season in 2019, made sampling difficult and inefficient, and seemingly led to reduced catches. High discharge, strong currents and elevated water levels seem to have become the norm over the past decade.

However, the robust habitat and species diversity in Pool 8 seems to have allowed the fish community to withstand these perturbations.

Species of Interest Data are presented on the following pages.

Black Crappie (*Pomoxis nigromaculatus)*

Total catches of Black Crappie from all standard LTRM gear types combined have ranged from 269 in 2009 to 1,693 in 1994. We caught 307 Black Crappies in 2019. Black Crappie CPUE decreased slightly in 2019 for both daytime electrofishing and fyke nets (Figure 4.5). Both gear types yielded catch rates near the 10th percentile for the LTRM period. There are more years below the long-term average in recent times than there were in the past.

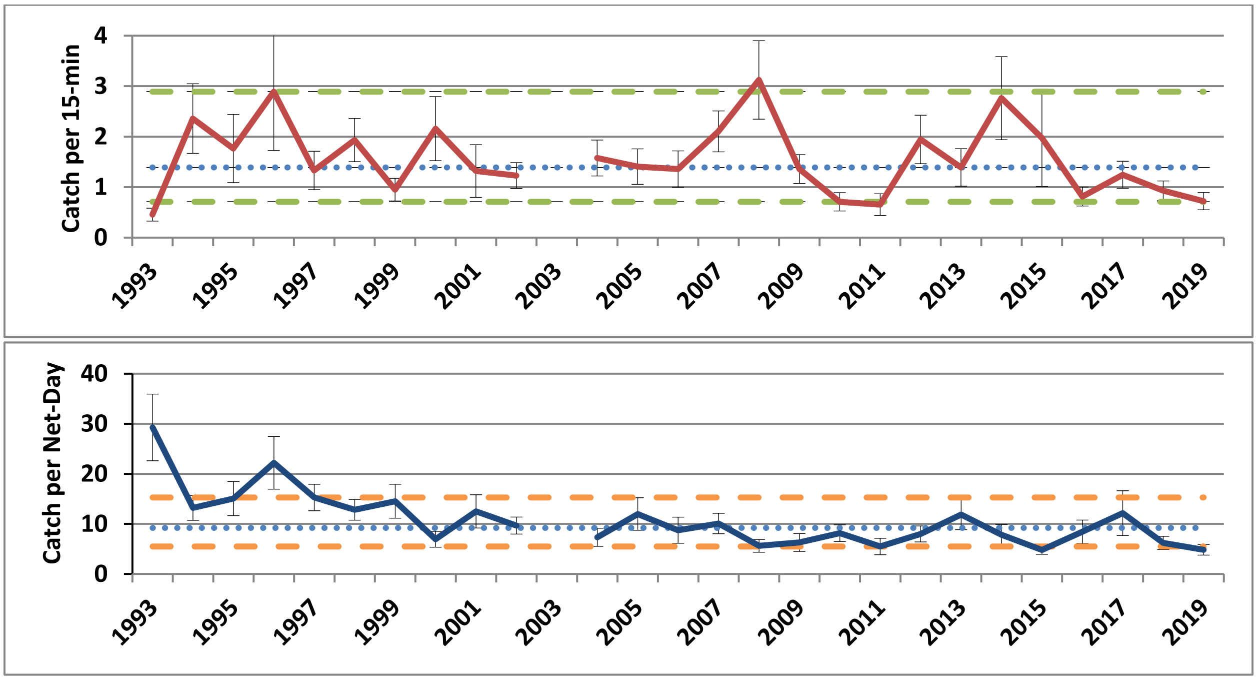

Figure 4.5 Catch per unit effort (± 1SE) of Black Crappie by daytime electrofishing (top graph) and fyke netting (bottom graph) samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

Catch of substock-size (<130 mm total length (TL)) Black Crappie (Figure 4.6) was far below the long-term average in 2019, and one of the lowest catches of the LTRM era. The substock graph suggests Black Crappie reproductive success is sporadic and infrequent, a surprising occurrence for a nest-building equilibrium species.

A small, but stable, proportion of the Black Crappie population reaches preferred- (250-299 mm TL) or memorable-size (>300 mm TL) each year (Figure 4.7), indicating stability in the harvestable fishery. However, fewer fish have been present in the stock-size category since about 2000. CPUE for daytime electrofishing (Figure 4.5 top) and fyke net (Figure 4.5 bottom) depict a small declining trend like that of the stock- (130-199 mm TL) and quality-size (200-249 mm TL) categories shown in Figure 4.7. Reasons for a decline of these intermediate sizes of Black Crappie are unknown, but, could be related to 1) fewer substock fish in the population (as discussed above), 2) the rebound in submersed aquatic vegetation that occurred after a nearly complete crash in the early 1990's, or 3) significant sampling reductions that also occurred in 2000, and may have resulted in fewer sites being located in prime Black Crappie habitats.

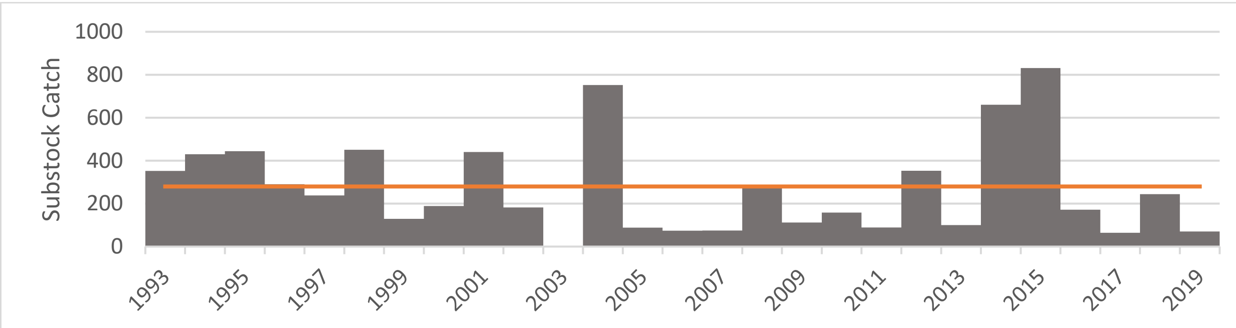

Figure 4.6 Catch of substock-sized Black Crappie annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

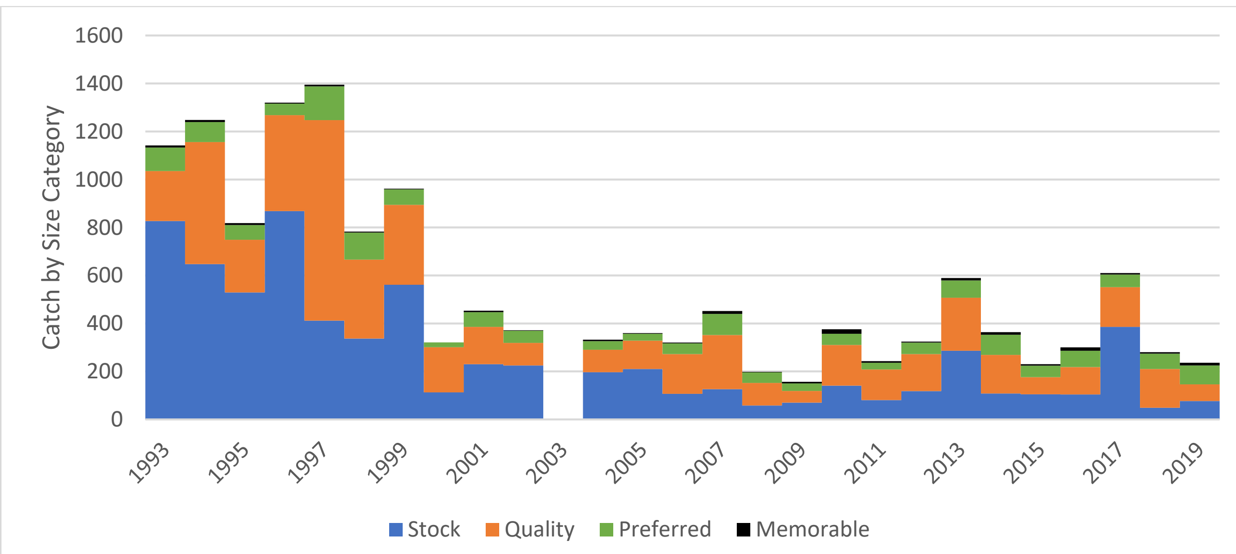

Figure 4.7. Catch of stock- through memorable-sized Black Crappie annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

Bluegill *(Lepomis macrochirus)*

Total catches of Bluegill from all standard LTRM gear types combined have ranged from 1,685 in 1994 to 12,005 in 2010. We caught 4,230 Bluegill in 2019. Bluegill daytime electrofishing CPUE remained stable in 2019 compared to 2018, maintaining a six-year period of below normal catch rates (Figure 4.8 top). Fyke net CPUE (Figure 4.8 bottom) has shown a long-term pattern similar to that of electrofishing and remained in 2019 near the tenth percentile for the period. Low Bluegill catch rates in the early 1990's were attributed to the system-wide crash of submersed aquatic vegetation; however, aquatic vegetation in Pool 8 has been abundant since ~2010, and catch rates have become low again. A possible explanation for the recent decline may be hydrology, specifically high summer flows (see Figure 1.1 bottom) that may be having deleterious effects upon survival or condition. An alternative explanation could also be increased predation by Yellow Perch. Research by the Minnesota Department of Natural Resources LTRM staff indicates that perch seem to be targeting age-0 Bluegills in winter (Steve Delain, MNDNR, personal communication). Yellow Perch have become abundant in Pool 8 in recent years.

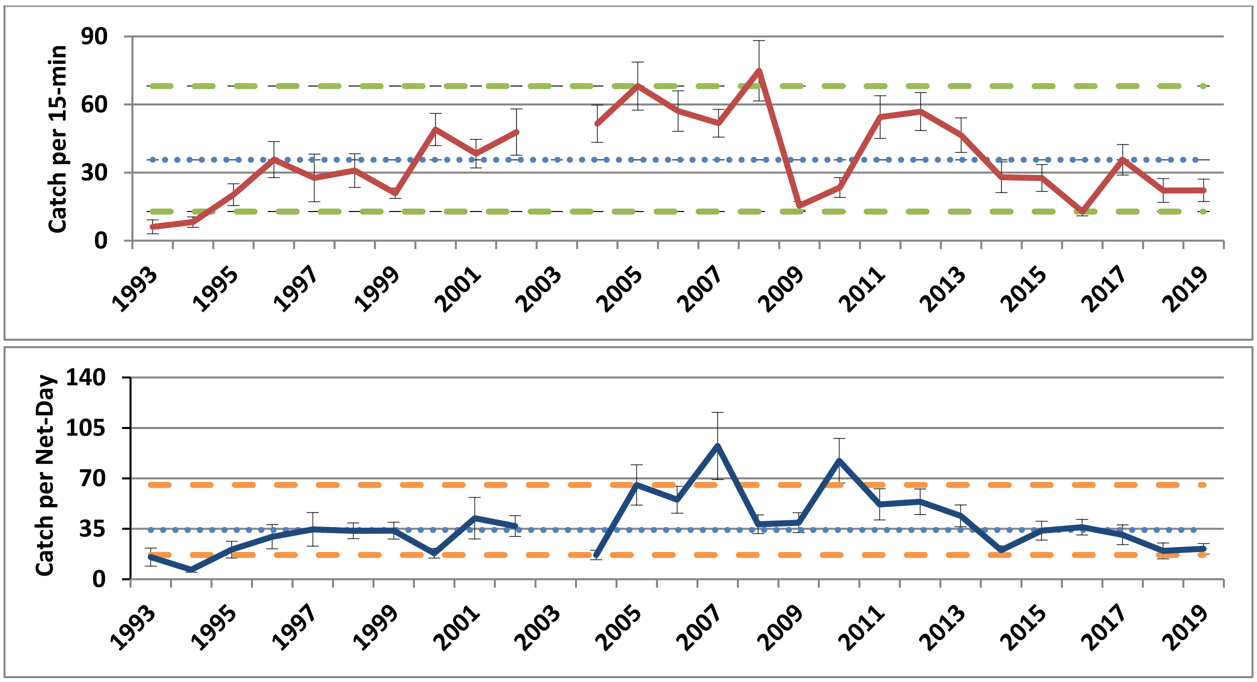

Figure 4.8 Catch per unit effort (± 1SE) of Bluegill by daytime electrofishing (top graph) and fyke netting (bottom graph) samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

Catches of substock-sized (<80 mm TL) Bluegill (Figure 4.9) were below the long-term average again in 2019, for the eighth time in the last eleven years. However, no severe decline seems evident. Like Black Crappie, Bluegill seem to produce strong year classes every few years.

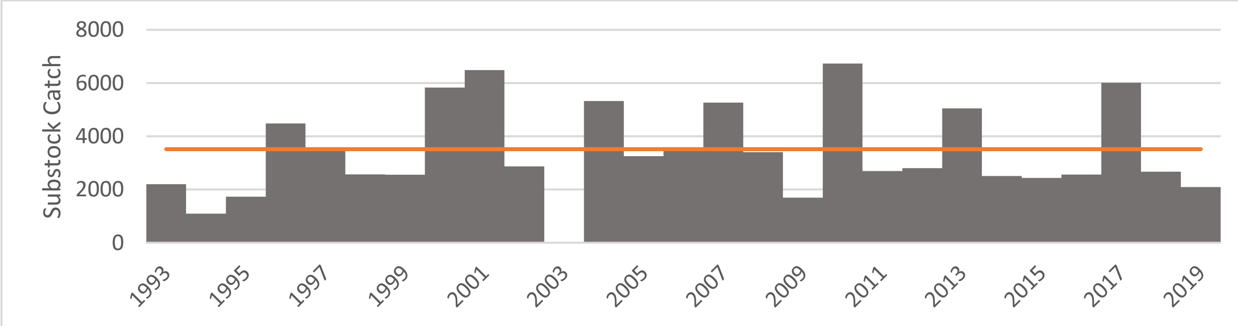

Figure 4.9. Catch of substock-sized Bluegill annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

Preferred- (200-249 mm TL) and memorable-size (>250 mm TL) Bluegill comprise a very small proportion of the overall catch (Figure 4.10), but have been slightly more prevalent since 2010, including 2019. The number of quality-sized (150-199 mm TL) Bluegill seems stable, relative to the high variability in the number of stock-sized fish. The number of substock-sized Bluegill does not seem to translate into stock-sized fish the next year or following. This would suggest that external forces are acting to shape the number of Bluegills that survive to larger sizes and would support the presumption that hydrology may be a factor. If Yellow Perch predation was having a population-level impact, we would expect to see a declining trend in substock Bluegills, which is not evident.

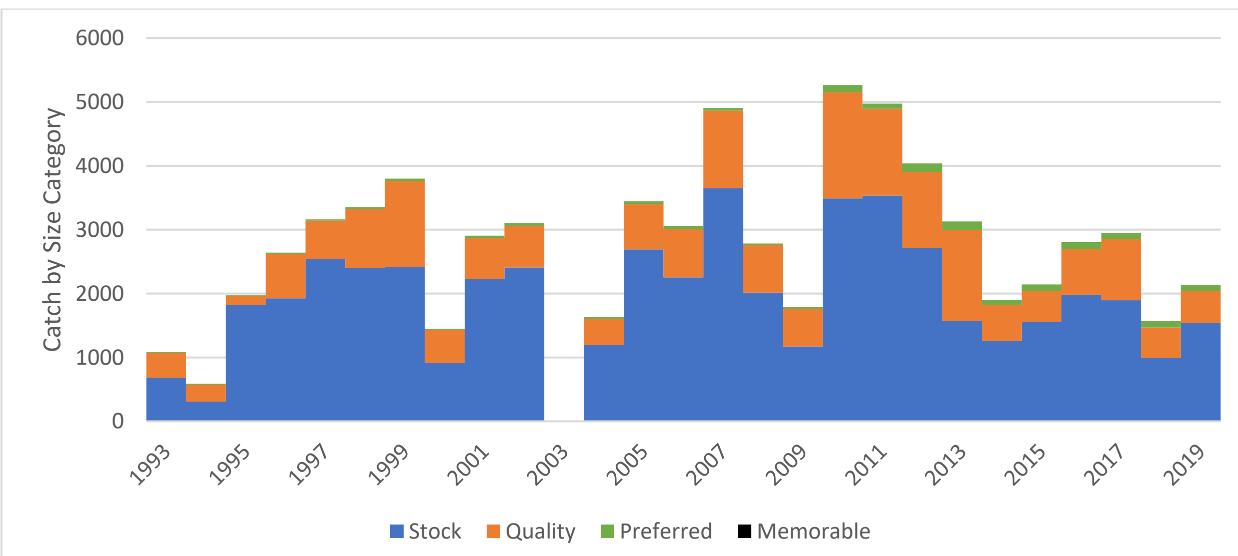

Figure 4.10 Catch of stock- through memorable-sized Bluegill annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

Channel Catfish *(Ictalurus punctatus)*

Total catches of Channel Catfish from all standard LTRM gear types combined have ranged from 85 in 2009 to 785 in 1994. We caught 197 Channel Catfish in 2019, despite not fishing the period 3 hoop nets. Channel Catfish CPUE increased in 2019 for large-hoop nets (Figure 4.11 top) beyond the 90th percentile for LTRM SRS years. Small-hoop netting CPUE (Figure 4.11 bottom) declined to below the long-term average, continuing a persistent pattern of modest catch rates. The overall CPUE trends suggest stability, with perhaps a shift from small hoop nets being more effective earlier to large hoop nets being better in recent years.

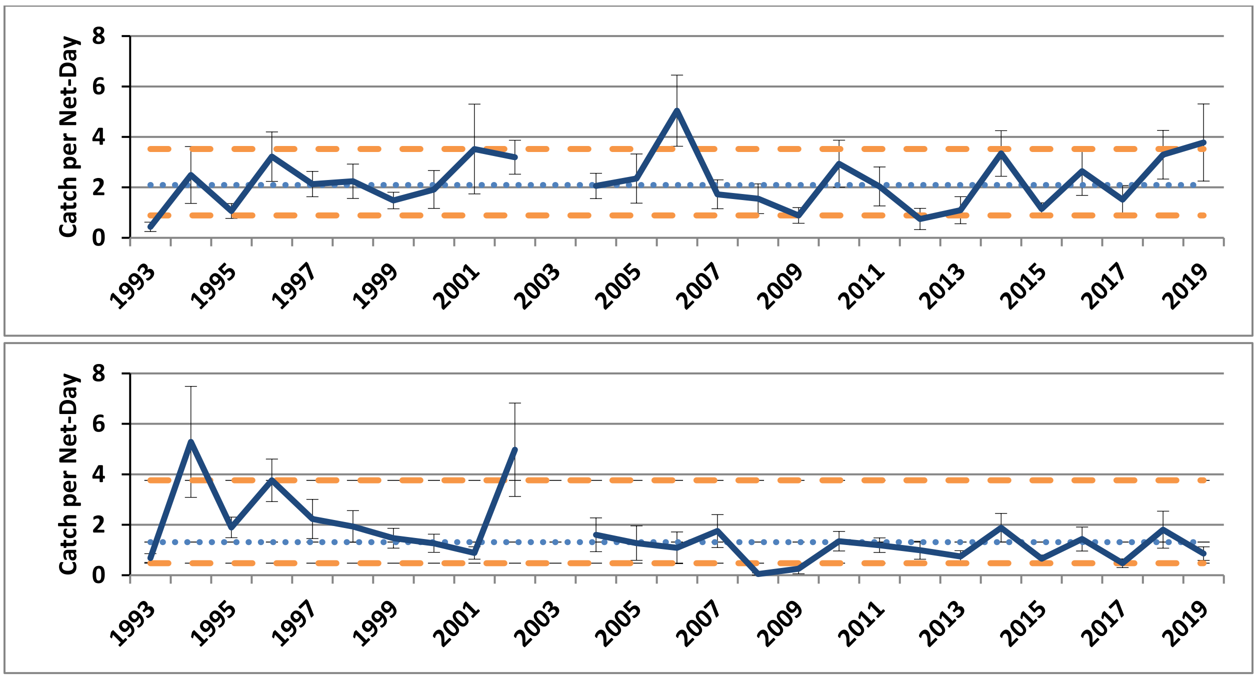

Figure 4.11 Catch per unit effort (± 1SE) of Channel Catfish by large-hoop netting (top graph) and small-hoop netting (bottom graph) samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

Substock-sized (<280 mm TL) Channel Catfish were far more abundant in the Pool 8 catch during the first decade of SRS fish sampling than since 2004 (Figure 4.12). Many of these were probably caught by trawling, although the CPUE for small-hoop nets does show a decline, as well. Catch of substock-sized Channel Catfish bears watching, as even a long-lived species must generate a strong year class occasionally to thrive. Only 13 substock-sized Channel Catfish were caught in 2019. We note, however, that substock-sized catch was underestimated relative to other years by the lack of sampling during two-thirds of the trawl hauls and all of period 3 hoop nets in 2019.

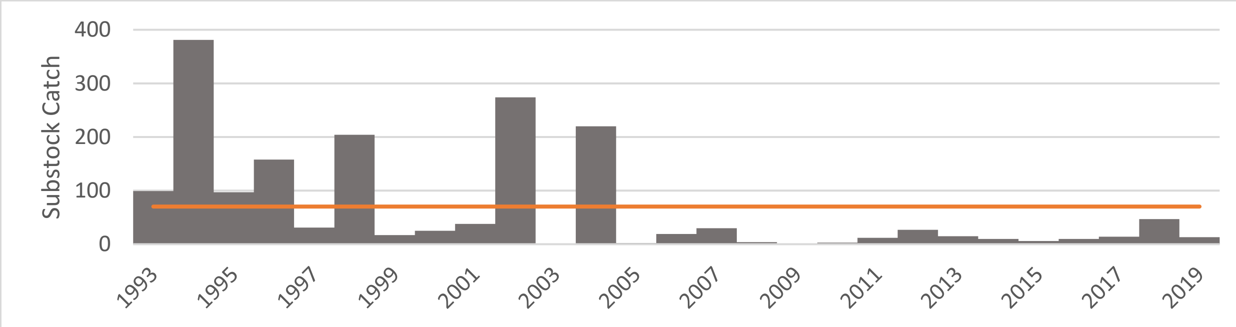

Figure 4.12 Catch of substock-sized Channel Catfish annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

Stock- (280-409 mm TL) and quality-sized (410-609 mm TL) Channel Catfish dominated the LTRM Pool 8 catch through 2000 (Figure 4.13), but preferred- (610-709 mm TL) and memorable-sized (>710 mm TL) fish have been relatively more common since then. Interestingly, stock- and larger sized Channel Catfish numbers seem to be holding their own, even without contributions from the substock-size group. This would suggest that the population may be aging and mortality rates could be low.

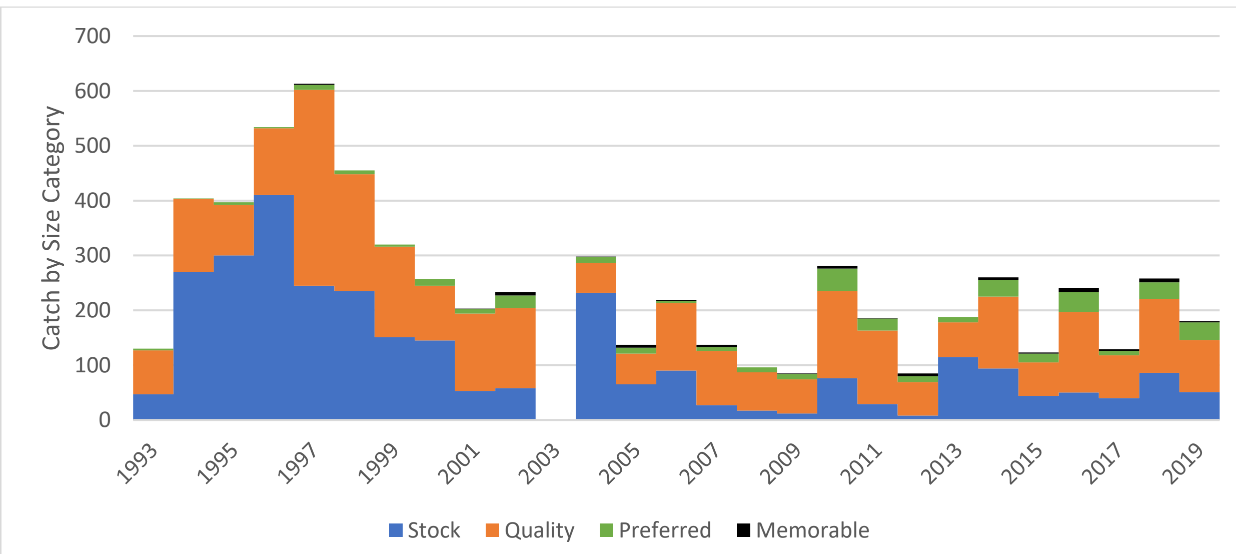

Figure 4.13. Catch of stock- through memorable-sized Channel Catfish annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

Flathead Catfish *(Pylodictis olivaris)*

Total catches of Flathead Catfish from all standard LTRM gear types combined have ranged from 8 in 2006 to 100 in 1998. We caught 68 Flathead Catfish in 2019. Daytime electrofishing CPUE for Flathead Catfish declined in 2019 but remained at the 90th percentile for the LTRM period of record (Figure 4.14 top). CPUE from large hoop nets (Figure 4.14 bottom) increased above the 90th again, continuing a three-year run of excellent catch rates. The fact that catch rates have remained high in both gear types over this recent period suggests that Flathead Catfish are thriving in Pool 8.

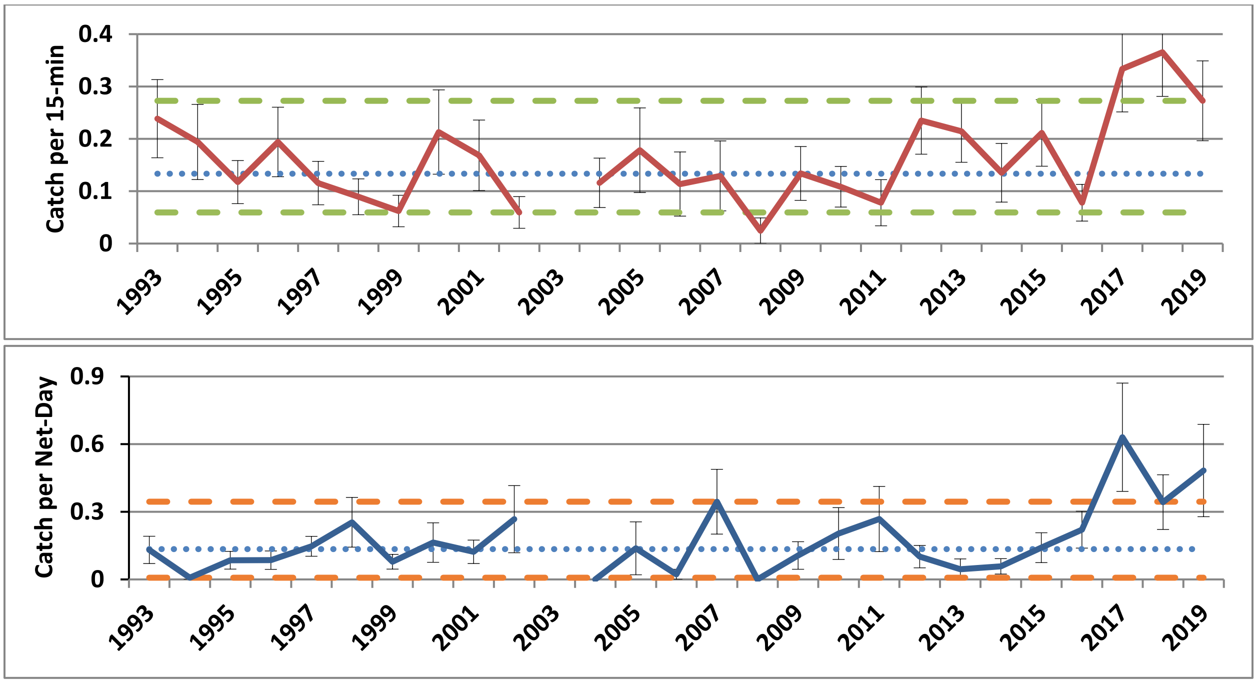

Figure 4.14. Catch per unit effort (± 1SE) of Flathead Catfish by daytime electrofishing (top graph) and large-hoop netting (bottom graph) samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

Catches of substock-sized (<350 mm TL) Flathead Catfish (Figure 4.15) were higher in the 1990's, then dipped, and have rebounded since 2011. The ten substock-sized Flathead Catfish we caught in 2019 was tied with 2013 for the most in a single season since 1999. Judging from the flat or increasing trends of the CPUE graphs, higher overall sampling effort in the 1990's may have been the cause for those early numbers of young fish.

Perhaps the most striking feature of the adult-size graph for Flathead Catfish (Figure 4.16) is the number of memorable-sized (>860 mm TL) fish present in the catch. A few very large fish have always been caught, but these have become a larger component of catch in recent years. The stock- (350-509 mm TL) and quality-size (510-709 mm TL) categories reflect the substock graph well, showing the decline during the middle decade of LTRM fish sampling. Variability in catch, reflected in the adult stock-size graph as well as the wide CPUE error bars, is expected in a species that grows large and has lower populations than smaller fishes.

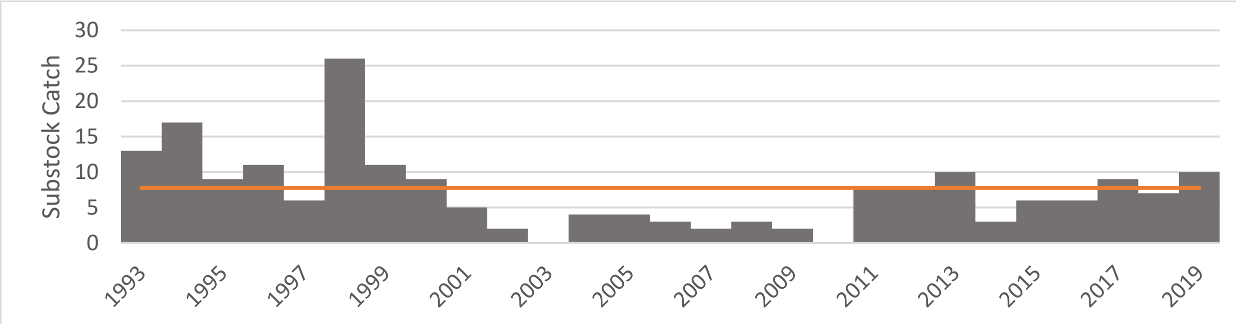

Figure 4.15 Catch of substock-sized Flathead Catfish annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

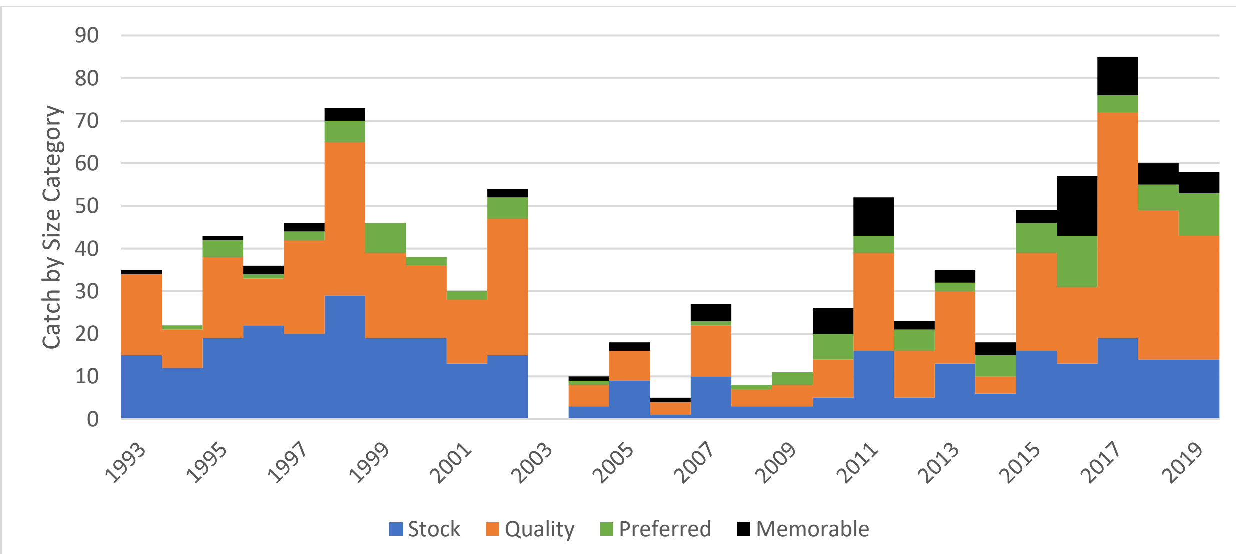

Figure 4.16 Catch of stock- through memorable-sized Flathead Catfish annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

Largemouth Bass *(Micropterus salmoides)*

Total catches of Largemouth Bass from all standard LTRM gear types combined have ranged from 292 in 1993 to 7,714 in 2016. We caught 1,067 Largemouth Bass in 2019. Largemouth Bass CPUE for daytime electrofishing plummeted well below the long-term average in 2019 (Figure 4.17), resulting in the lowest catch rate since the turn of the century. No other LTRM gear type provides significant numbers of adult Largemouth Bass.

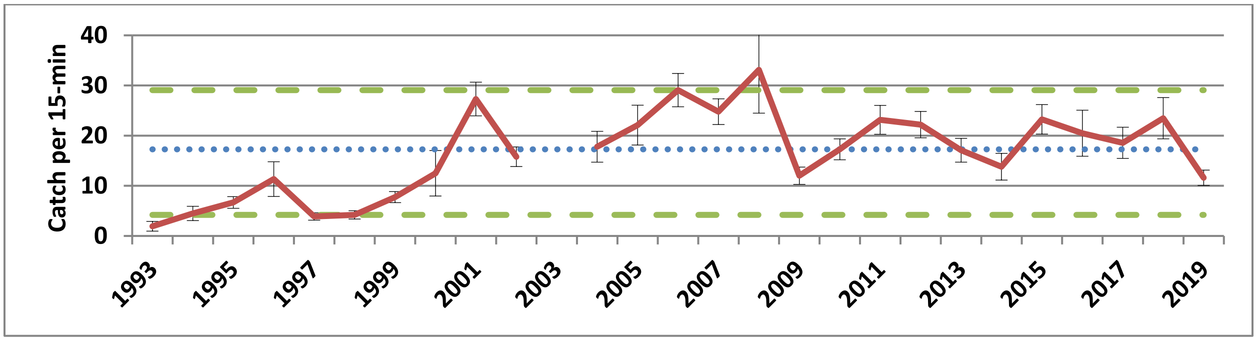

Figure 4.17 Catch per unit effort (± 1SE) of Largemouth Bass by daytime electrofishing samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

The catch of substock-sized (<200 mm TL) Largemouth Bass (Figure 4.18) was below the long-term average, more closely resembling that of the 1990's than recent years. This could reflect poor spawning success, but could just as easily be due to reduced gear efficiency in high water.

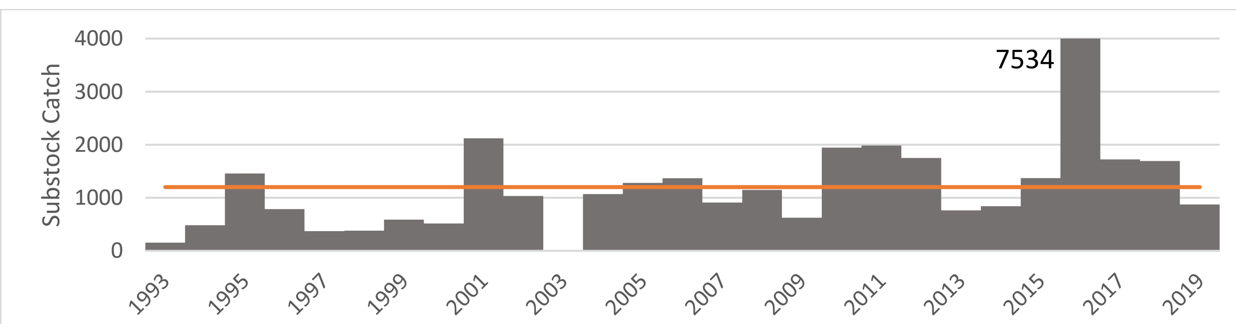

Figure 4.18 Catch of substock-sized Largemouth Bass annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

The graph of stock- (200-299 mm TL) through memorable-sized (> 510 mm TL) Largemouth Bass (Figure 4.19) shows consistency among the quality- (300-379 mm TL) and preferred-size (400-509 mm TL) groups, with seldom any fish reaching memorable status. Tournament anglers routinely comment that Largemouth Bass fishing is easy in Pool 8 and surrounding waters, but that big fish are few and far between. The LTRM data bear them out.

Stock-sized Largemouth Bass have been the most volatile size range in catch statistics and was quite low in both 2018 and 2019. Recruitment, as suggested by the numbers of stock-sized fish in the catch compared to substock-sized catches from previous years, appears to be variable. The relationship seems to hold better in recent years but was poor from about 1999 through 2009.

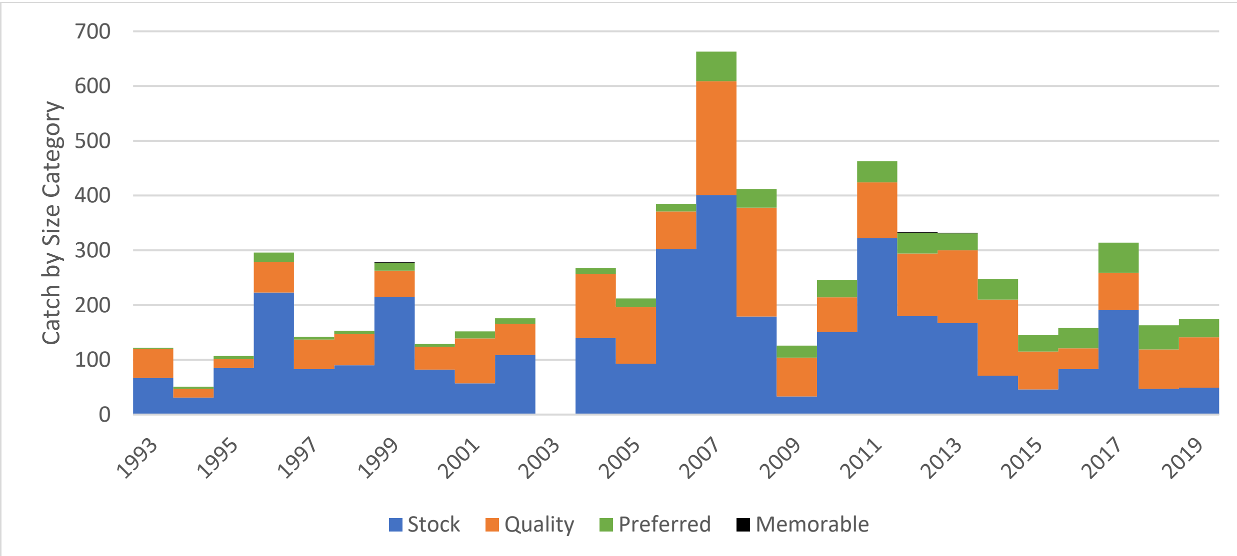

Figure 4.19 Catch of stock- through memorable-sized Largemouth Bass annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

Northern Pike *(Esox lucius)*

Total catches of Northern Pike from all standard LTRM gear types combined have ranged from 51 in 2000 to 199 in 2019, a new record. Northern Pike daytime electrofishing CPUE has been up and down for the last 15 years, but has only dipped below the long-term average twice (Figure 4.20 top). The current three-year increase in daytime electrofishing CPUE has resulted in an all-time high value, considerably above the 90th percentile. Fyke netting CPUE (Figure 4.20 bottom) declined in 2019 back to levels similar to those prior to 2018. The wide error bar for 2018 indicates many of those fish were caught in just a few nets.

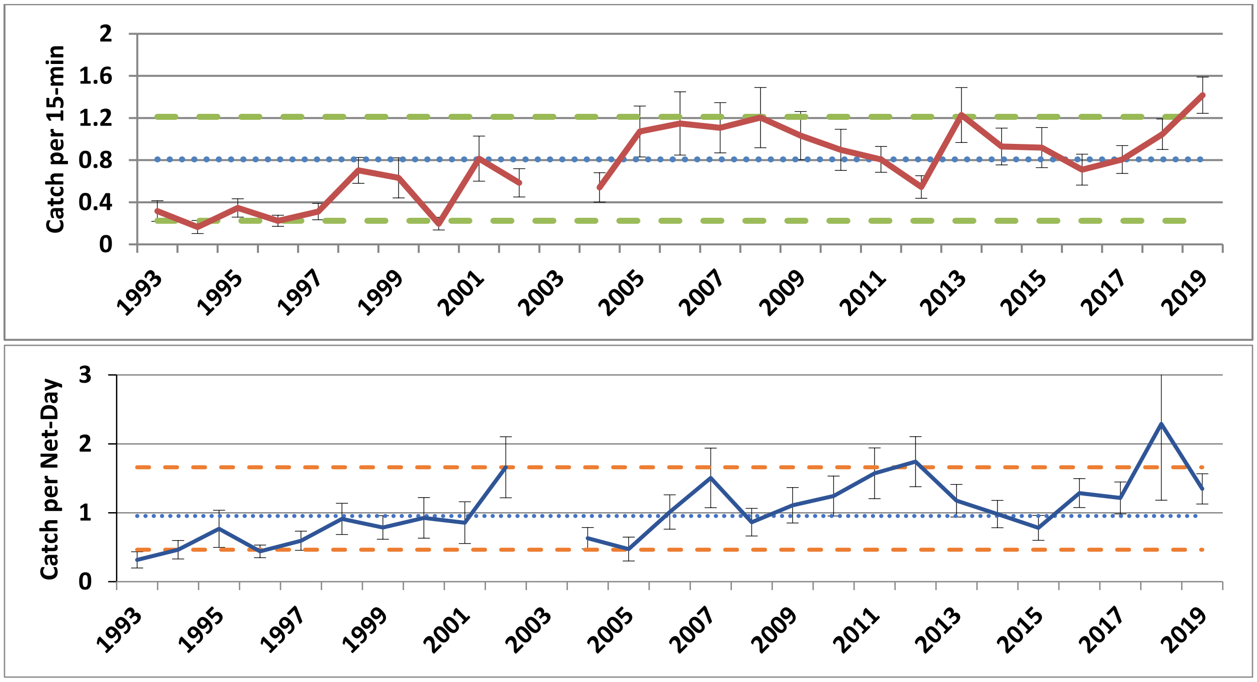

Figure 4.20. Catch per unit effort (± 1SE) of Northern Pike by daytime electrofishing (top graph) and fyke netting (bottom graph) samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

The catch of substock-sized (<350 mm TL) Northern Pike (Figure 4.21) has been consistent, with the exception of a few years where few or no small fish were caught. In most of those years, the spring flood was either very late, very early, of short duration or small in scale, which would tend to limit spawning success. The catch of substock-sized Northern Pike in 2019 was the highest on record, besting that of 2001, which had the second largest spring flood on record for Pool 8. Thus, it seems evident that the abundance of small Northern Pike is linked with spring floods of appropriate timing, magnitude and duration.

Catches of stock-sized (350-529 mm TL) Northern Pike (Figure 4.22) also seem linked to substock catches from the previous year; whereas quality- (530-709 mm TL) and preferred- (710-859 mm TL) sizes of pike are remarkably consistent. Thus, it would seem that recruitment and adult mortality are likely stable, and the driving factor for northern pike populations is spawning success. Memorable-sized (>860 mm TL) Northern Pike were slightly more prevalent in the first few years of SRS but are still present in most years. Two consecutive years of record catches and large numbers of all smaller stock sizes should translate into some very large Northern Pike in coming years.

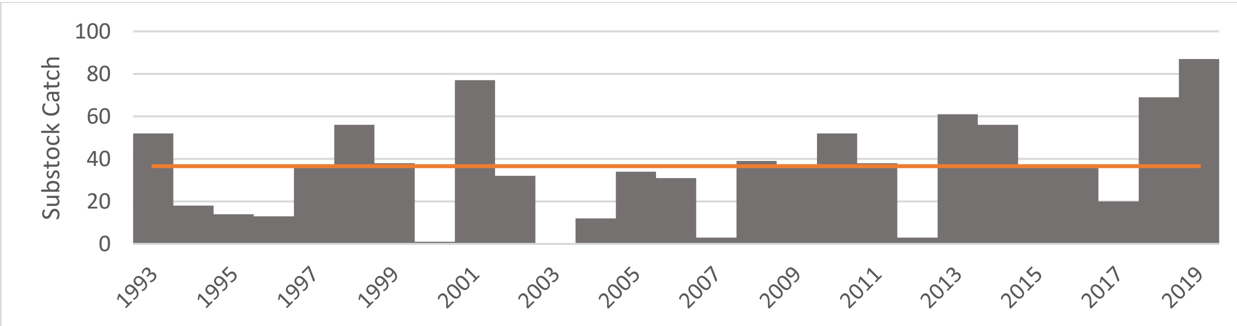

Figure 4.21 Catch of substock-sized Northern Pike annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

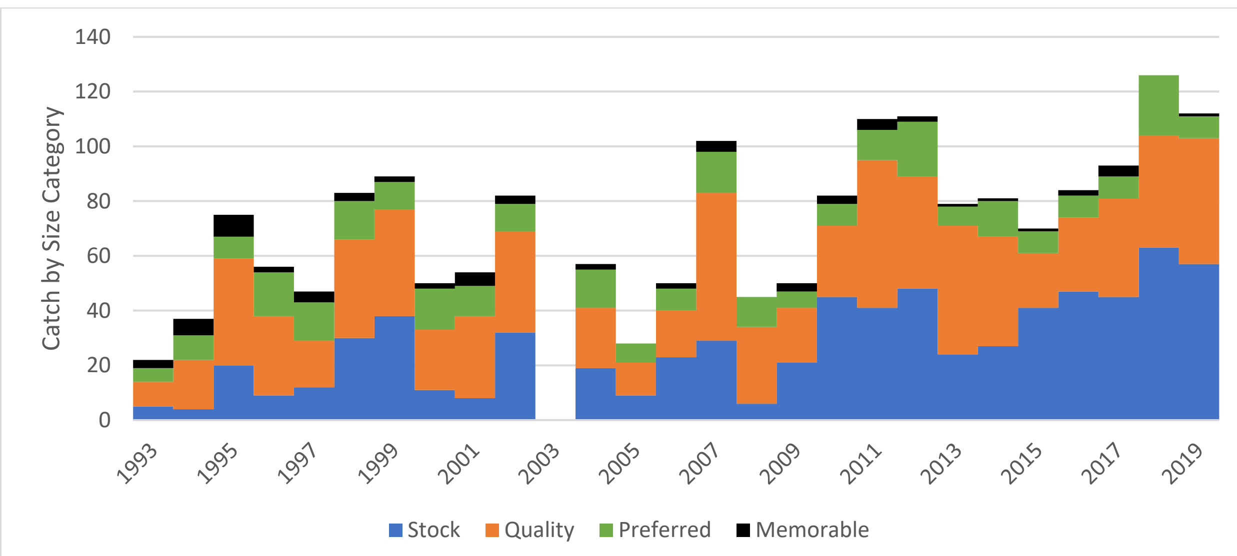

Figure 4.22 Catch of stock- through memorable-sized Northern Pike annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

Sauger *(Sander canadensis)*

Total catches of Sauger from all standard LTRM gear types combined have ranged from 4 in 2006 to 311 in 1998. We caught 17 Sauger in 2019. Sauger CPUE for daytime electrofishing has, for many years, been below that of the 1990's (Figure 4.23) and has remained below the historic LTRM mean since 2008. While the current LTRM gear/stratum combinations do not achieve high catch rates or large sample sizes for Sauger, they do likely reflect the Sauger population. Low variability in catch rates, as indicated by the consistently small standard errors, supports the notion that the sampling effort is not simply "missing" fish that are there to be captured. While it is possible that the 1990's catch rates were inflated by several successful year classes, and were thus, unusually high, the consistently low catch rates over the past twenty years suggests the need for some type of management action. New bag limits that take effect in 2020 and reduce the Sauger daily bag from 6 to 4 may help.

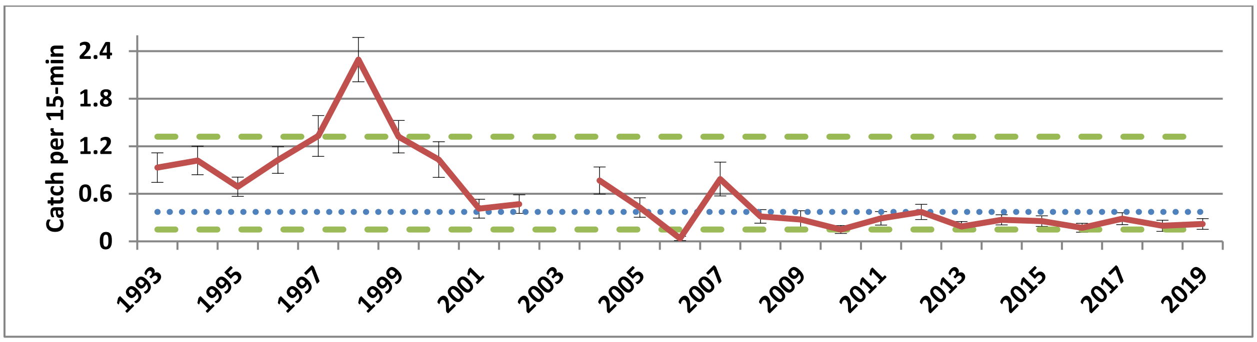

Figure 4.23 Catch per unit effort (± 1SE) of Sauger by daytime electrofishing samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

The graph of substock-sized (<200 mm TL) Sauger catch (Figure 4.24) illustrates why Sauger CPUE has been in decline in Pool 8. Since 2000, catch of immature Sauger has been largely non-existent. Only twice in 19 years did the catch reach the average value, and not at all since 2007. For some reason, reproductive failure seems evident.

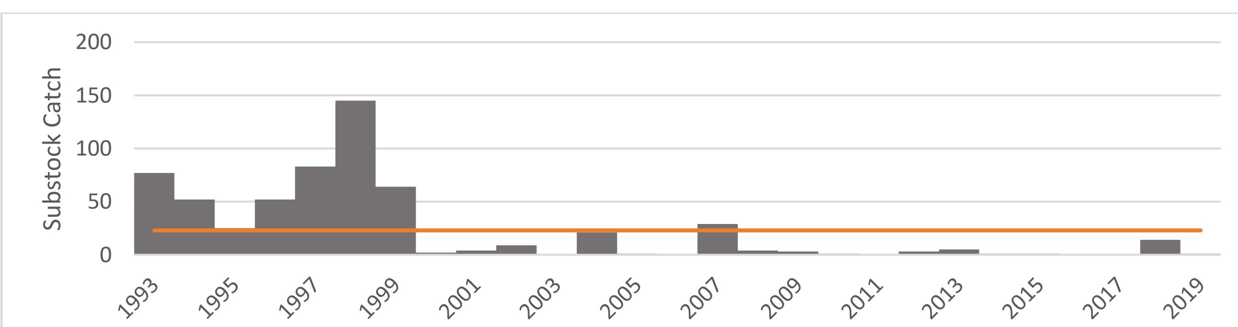

Figure 4.24 Catch of substock-sized Sauger annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

The graph of stock- (200-299 mm TL) through memorable-sized (>510 mm TL) Sauger catch (Figure 4.25) also shows that prior to the turn of the century, stock-sized Sauger constituted a large proportion of the catch. Since that time, stock-sized fish have been a far lesser constituent of the catch, often fewer in number than the quality-sized (300-379 mm TL) fish. Figure 4.25 also shows, however, that preferred- (380-509 mm TL) and larger-sized Sauger have been few in the catch since the onset of LTRM sampling, which may indicate high mortality. Given the popularity of this fish among anglers, and paucity of recruits to the population, fishing overharvest is a plausible explanation.

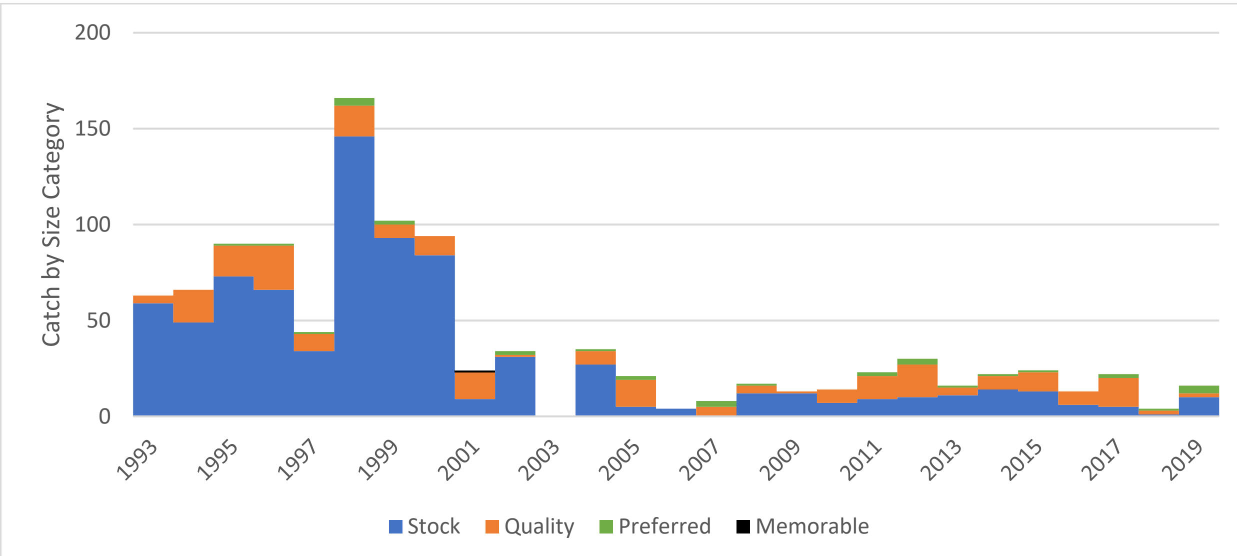

Figure 4.25 Catch of stock- through memorable-sized Sauger annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

Smallmouth Bass *(Micropterus dolomieu)*

Total catches of Smallmouth Bass from all standard LTRM gear types combined have ranged from 80 in 2009 to 550 in 1998. We caught 424 Smallmouth Bass in 2019. Smallmouth Bass daytime electrofishing CPUE has generally been on the increase since low points in 2009 and 2013 (Figure 4.26). The 2019 CPUE declined from 2018's record catch rate, but was still considerably above the 90th percentile. Wider error bars the last two years suggest that a few sites are producing many of the Smallmouth Bass caught.

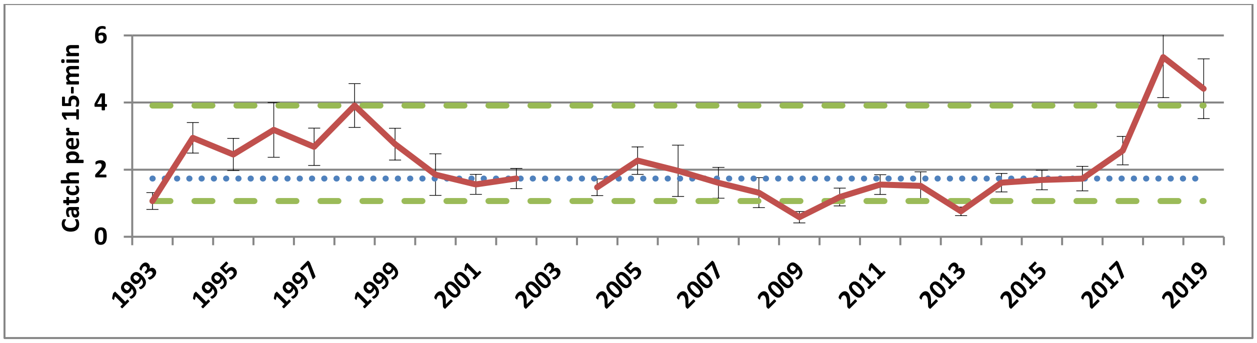

Figure 4.26 Catch per unit effort (± 1SE) of Smallmouth Bass by daytime electrofishing samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

Substock-sized (<180 mm TL) Smallmouth Bass catch in 2019 (Figure 4.27) was the third highest on record in Pool 8 LTRM samples. This marks a third consecutive year above the long-term average, with catches not recorded in these numbers since the 1990's.

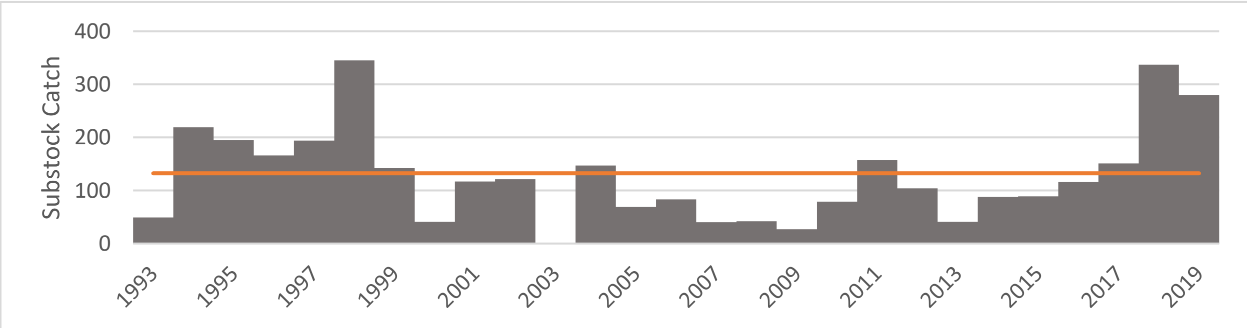

Figure 4.27 Catch of substock-sized Smallmouth Bass annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

The catch of stock-sized (180-279 mm TL) and longer Smallmouth Bass (Figure 4.28) has been quite stable over time, despite some low numbers from 2008-2010 and 2013-2014. The greatest variation seems to be in the stock-size category, which reached a low point in 2009, rebounded, and dropped again five years later. Conversely, the preferred- (350-429 mm TL) and memorable-sized (> 430 mm TL)

Smallmouth Bass catches have been very consistent, offering anglers good opportunities to catch large fish year after year.

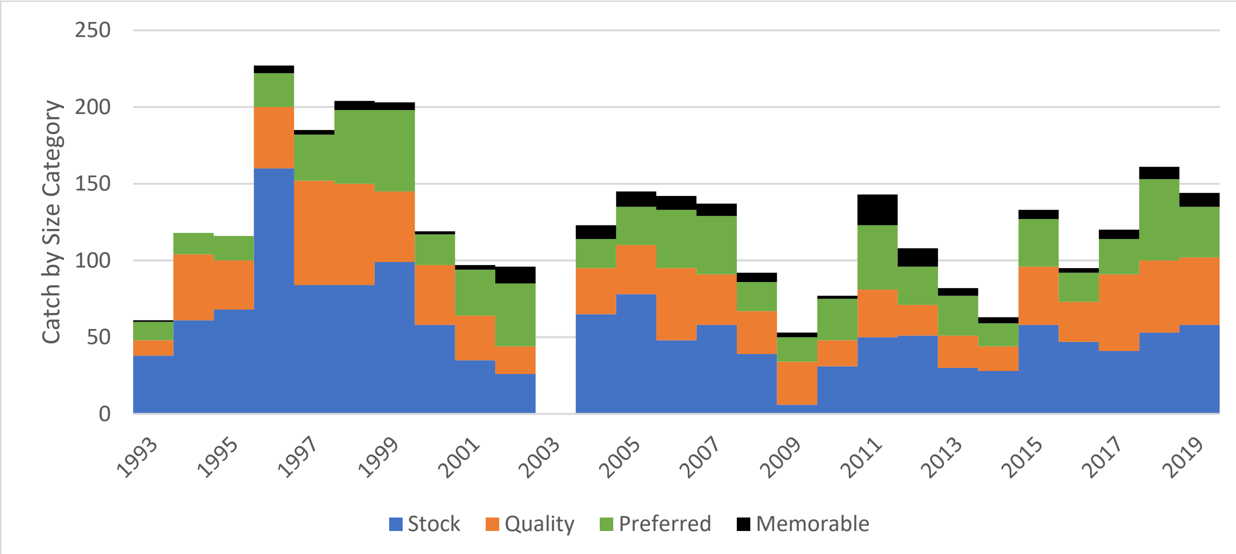

Figure 4.28 Catch of stock- through memorable-sized Smallmouth Bass annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

Walleye *(Sander vitreus)*

Total catches of Walleye from all standard LTRM gear types combined have ranged from 10 in 2009 to 137 in 1997. We caught 33 Walleyes in 2019. Walleye daytime electrofishing CPUE decreased in 2019 from the very high 2018 catch rate (Figure 4.29 top). However, the 2019 CPUE still exceeded the long-term mean and does seem to indicate a larger Walleye population than that of a decade ago. The fyke net CPUE (Figure 4.29 bottom) declined slightly in 2019 but remained near the long-term mean. Because fyke nets tend to catch only larger Walleyes, and because many of the Walleyes caught in 2018 were young of the year, it will be interesting to see if fyke net CPUE increases in a year or two, as hopefully, the year class from 2018 is recruited into that gear type. LTRM CPUE's may be useful in evaluating Walleye responses to daily bag limit changes (reduction from 6 to 4) being implemented in 2020.

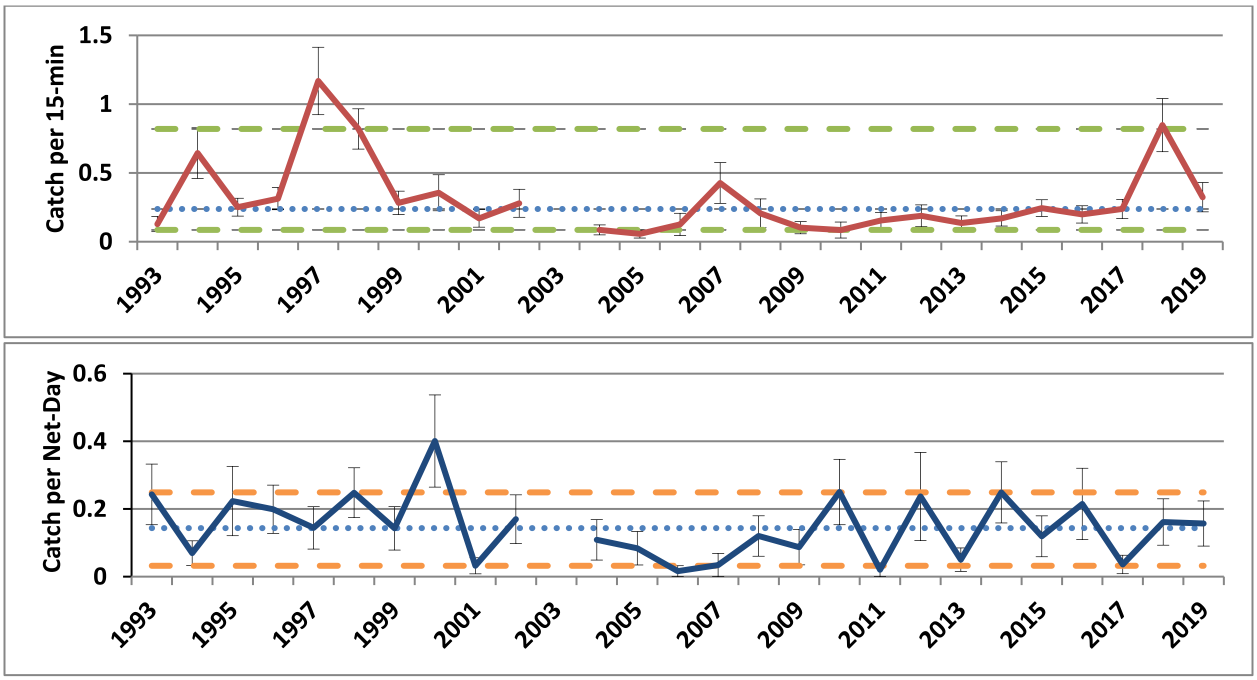

Figure 4.29 Catch per unit effort (± 1SE) of Walleye by daytime electrofishing (top graph) and fyke netting (bottom graph) samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10^{th} and 90^{th} percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

2019 was a slightly above-average year for substock-sized (<250 mm TL) Walleyes in Pool 8, the first time in over 20 years with successive above-average hatches (Figure 4.30). As noted in the hydrograph section, the 2019 spring flood had the discharge ingredients for a good hatch: high and sustained with an April peak.

The stock-size (250-379 mm TL) and larger graph (Figure 4.31) for Pool 8 Walleyes is somewhat similar to the same analysis for Sauger, in that the catch of stock-sized fish was greater in the 1990's than since. However, stock and quality-sized (380-509 mm TL) Walleyes still constitute a significant proportion of the catch in many years; whereas, the catch of preferred- (510-629 mm TL) and memorable-sized (>630 mm TL) Walleyes has begun to constitute a smaller share of the catch since 2012. Thus, both Sauger and Walleye populations appear to be affected by weak year classes, Walleyes more so since 2012. A good possibility, though, is that missing wingdam samples in recent years are negatively affecting the catch, and providing the illusion that larger Walleyes (usually caught on wingdams) are absent.

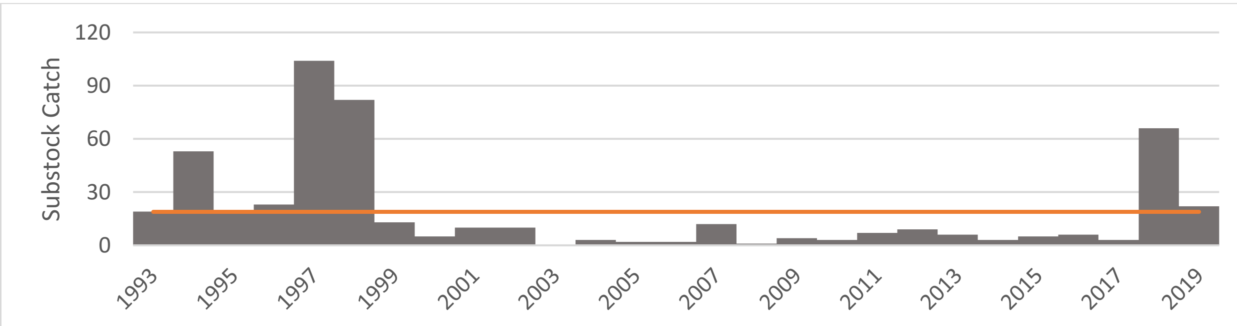

Figure 4.30 Catch of substock-sized Walleye annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

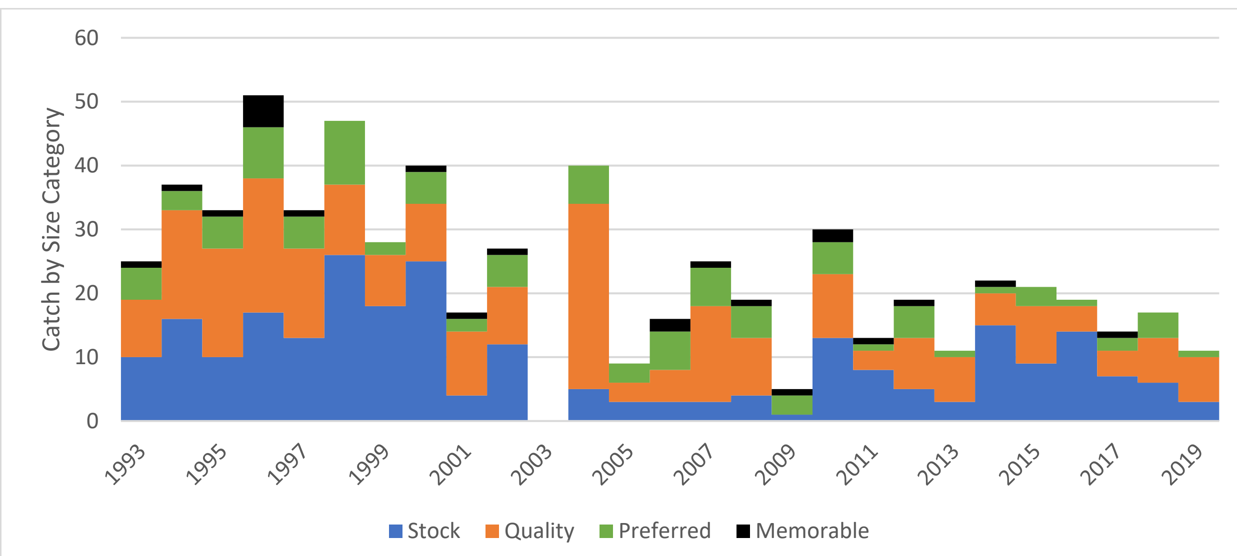

Figure 4.31 Catch of stock- through memorable-sized Walleye annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

Yellow Perch *(Perca flavescens)*

Total catches of Yellow Perch from all standard LTRM gear types combined have ranged from 53 in 2000 to 1,579 in 2015. We caught 800 Yellow Perch in 2019. Daytime electrofishing CPUE in 2019 (Figure 4.32 top) remained essentially the same as 2018, in the upper quartile of long-term values. Fyke net CPUE for Yellow Perch (Figure 4.32 bottom) remained slightly above the long-term mean, where it has remained for the past eight years.

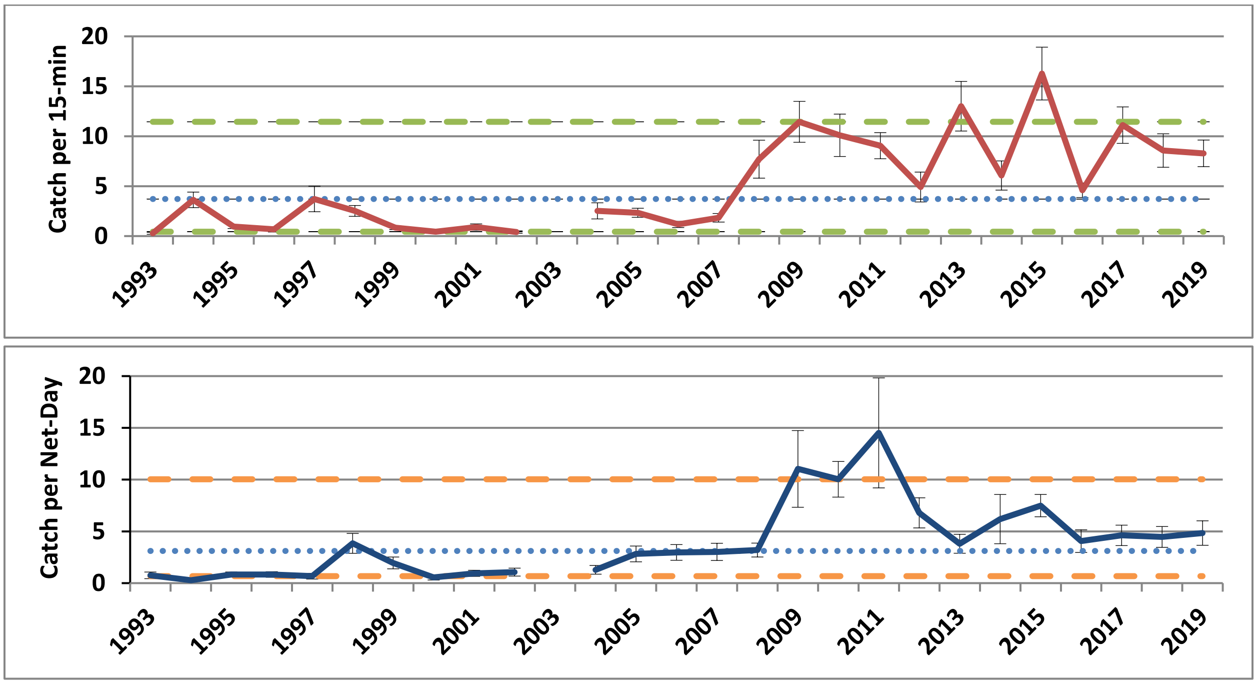

Figure 4.32 Catch per unit effort (± 1SE) of Yellow Perch by daytime electrofishing (top graph) and fyke netting (bottom graph) samples from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element fish collections in Navigation Pool 8 of the Upper Mississippi River. Data are omitted for 2003 due to limited sampling that year. The long-dashed lines on the CPUE graphs represent the 10th and 90th percentiles and the dotted line represents the long-term average for the period of record (1993-2019).

Numbers of substock-sized (<130 mm TL) Yellow Perch (Figure 4.33) were down from 2018, and below the long-term mean. Four of the past eight years had below-average catches of substocked-size Yellow Perch and four were above average. The historically large 2013 and 2015 year classes are likely reaching the end of their lifespans and will need to be replaced soon if populations are to remain at current levels.

Recruitment from substock-sized Yellow Perch to adults is usually evident in Pool 8. For example, substock-sized perch in 1997 and 1998 were evident as stock-sized (130-199 mm TL) fish in 1998 and 1999 (Figure 4.34). This pattern repeated in 2008-2010 and 2009-2011. Again, the pattern repeated from 2013 to 2014. However, the largest catch of substock-sized Yellow Perch from 2015 were not evident as stock-sized fish in 2016 and following, nor, apparently, was the third highest substock-sized catch from 2017 recruited in 2018. The 2019 stock-sized Yellow Perch catch was the fourth highest during the LTRM era, so at least some of the fish from 2017 and 2018 recruited to the stock category. There seems to be a disconnect between the substock-sized population and adult Yellow Perch, suggesting that year class strength is only one of several likely population drivers. Finally, although preferred-size (250-299 mm TL) Yellow Perch have remained a considerable part of the catch in the past decade, few Yellow Perch attain memorable-size (>300 mm TL). This may indicate high mortality among larger adults.

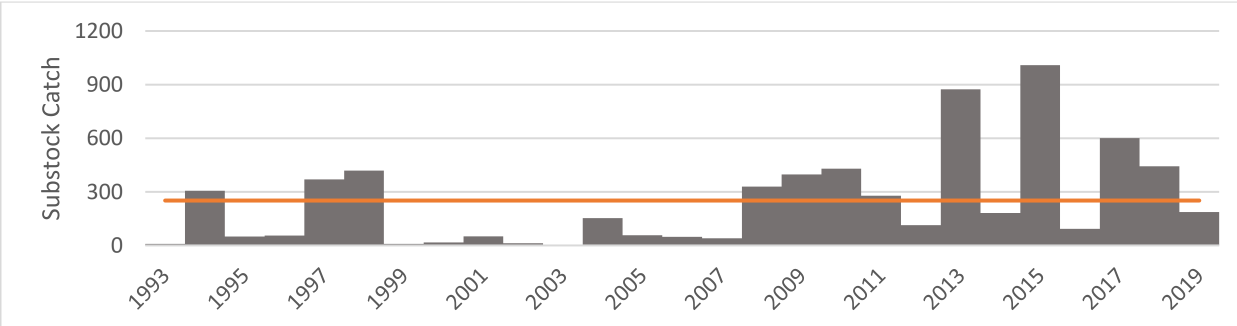

Figure 4.33 Catch of substock-sized Yellow Perch annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. The horizontal line indicates long-term average catch of substock-sized fish. Data are omitted for 2003 due to limited sampling that year.

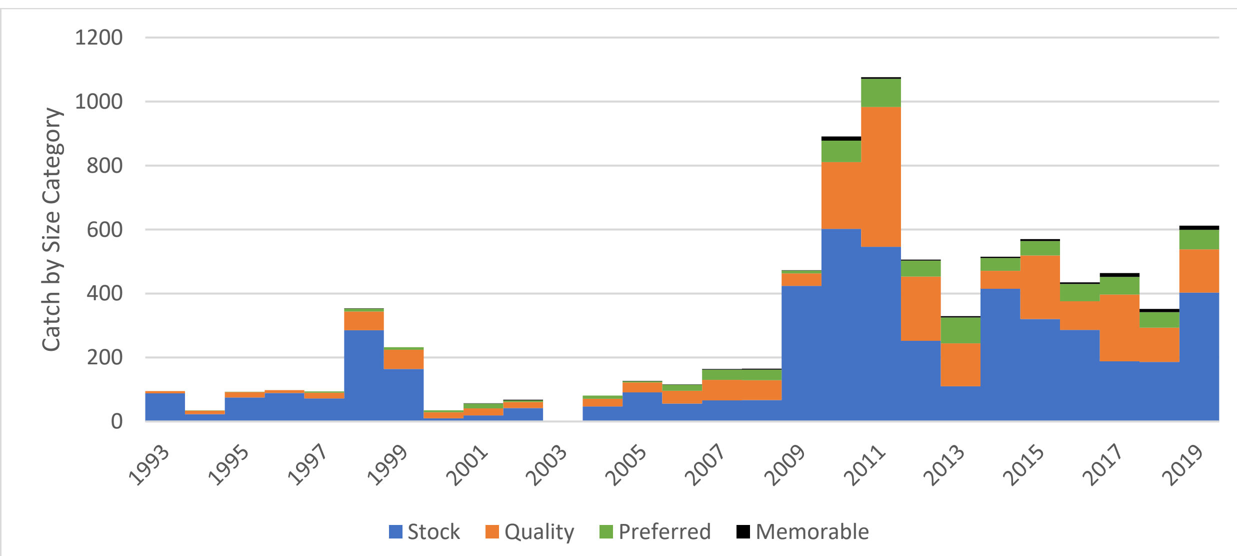

Figure 4.34 Catch of stock- through memorable-sized Yellow Perch annually in Navigation Pool 8 of the Upper Mississippi River by all gears combined from the Upper Mississippi River Restoration Program - Long Term Resource Monitoring Element. Data are omitted for 2003 due to limited sampling that year.

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Appendix A

Species list and years detected in LTRM Pool 8 samples. Species in green rows have been detected every year, those in blue have been detected in half or more of years, those in orange less than half of years, and those in gray only single years.

Black Crappie	27	Shovelnose Sturgeon	24
Bluegill	27	Slenderhead Darter	24
Bowfin	27	Fathead Minnow	23
Brook Silverside	27	Mooneye	23
Bullhead Minnow	27	Central Mudminnow	22
Channel Catfish	27	Western Sand Darter	22
Common Carp	27	White Crappie	22
Emerald Shiner	27	White Sucker	22
Freshwater Drum	27	Bigmouth Buffalo	21
Gizzard Shad	27	River Darter	21
Golden Redhorse	27	Black Bullhead	20
Golden Shiner	27	Silver Lamprey	20
Green Sunfish	27	Blue Sucker	17
Johnny Darter	27	Highfin Carpsucker	16
Largemouth Bass	27	Orangespotted Sunfish	16
Logperch	27	Sand Shiner	16
Longnose Gar	27	Silver Chub	16
Mimic Shiner	27	Banded Darter	14
Northern Pike	27	Brown Bullhead	13
Pumpkinseed	27	Trout Perch	13
Quillback	27	Northern Hog Sucker	10
River Redhorse	27	Pirate Perch	10
River Shiner	27	Bluntnose Minnow	9
Rock Bass	27	Burbot	9
Sauger	27	Iowa Darter	9
Shorthead Redhorse	27	Speckled Chub	9
Silver Redhorse	27	Lake Sturgeon	8
Smallmouth Bass	27	Blackside Darter	7
Smallmouth Buffalo	27	Mississippi Silvery Minnow	7
Spotfin Shiner	27	Stonecat	7
Spottail Shiner	27	Yellow Bass	7
Spotted Sucker	27	Brook Stickleback	6
Tadpole Madtom	27	American Brook Lamprey	5
Walleye	27	Black Buffalo	2
Weed Shiner	27	Brassy Minnow	2
White Bass	27	Brown Trout	2
Yellow Perch	27	Crystal Darter	2
Flathead Catfish	26	Fantail Darter	2
Mud Darter	26	Pallid Shiner	2
Shortnose Gar	26	American Eel	1
Warmouth	26	Central Stoneroller	1
Pugnose Minnow	25	Creek Chub	1
Yellow Bullhead	25	Goldeye	1
Chestnut Lamprey	24	Largescale Stoneroller	1
River Carpsucker	24	Rainbow Smelt	1
		Skipjack Herring	1