DOOR COUNTY WALLEYES
2010/2013 Population Assessments and Sport Fishery

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Introduction

The status of the walleye fishery in the areas in and around Door County waters of Green Bay (hereafter referred to as Sturgeon Bay area) has varied considerably over time and stocking has often played a major role in the maintenance of a harvestable population (Figure 1). The focal area for walleye management in Door County has been the Sturgeon Bay area including Little Sturgeon Bay (Figure 2). The genetic strain of fish stocked in Door County waters has been mixed and most walleyes have been stocked at the fingerling stage though a small number of stockings at the fry stage have taken place. Sturgeon Bay was in fact the first, and for several years the only, site stocked with walleye in Wisconsin waters of Green Bay during a period of intensive stocking directed at restoring the overall Green Bay population beginning in the 1970s. Annual surveys in this area were conducted most years beginning in the 1970s and continuing into the 1990s. These surveys recorded periodic years of natural recruitment of walleye in this area. However, these events were not common and maintenance of the targeted minimum standing stock of four mature walleye per acre was at times difficult to achieve through natural recruitment. Loss of valuable walleye spawning and rearing habitat in Sturgeon Bay during the late-1980s resulted in a significant decrease in contribution of naturally produced walleyes and a stocking program was reinstated to maintain fishable populations. Stocking quotas and stocking years have varied over the last 20 years depending upon management plans and availability of hatchery fish; 2012 was the last year stocked. Surveys conducted periodically over the last 10-15 years suggested that most of the walleyes in the population were of stocked origin although it's important to note that there was no formal program for marking stocked fish making it impossible to discern wild from stocked during a stocked year. In recent years, however, Sturgeon Bay appears to be following the greater trend in Wisconsin waters of Green Bay of producing considerable numbers of naturally recruited walleyes. Herein we report the results from the last two spawning population surveys (2010 and 2013) as well as up to date results from periodic fall young-of-year recruitment surveys reinstated in 2008. Finally, we report information related to annual sport creel surveys for walleyes in Door County waters of Green Bay up to present.

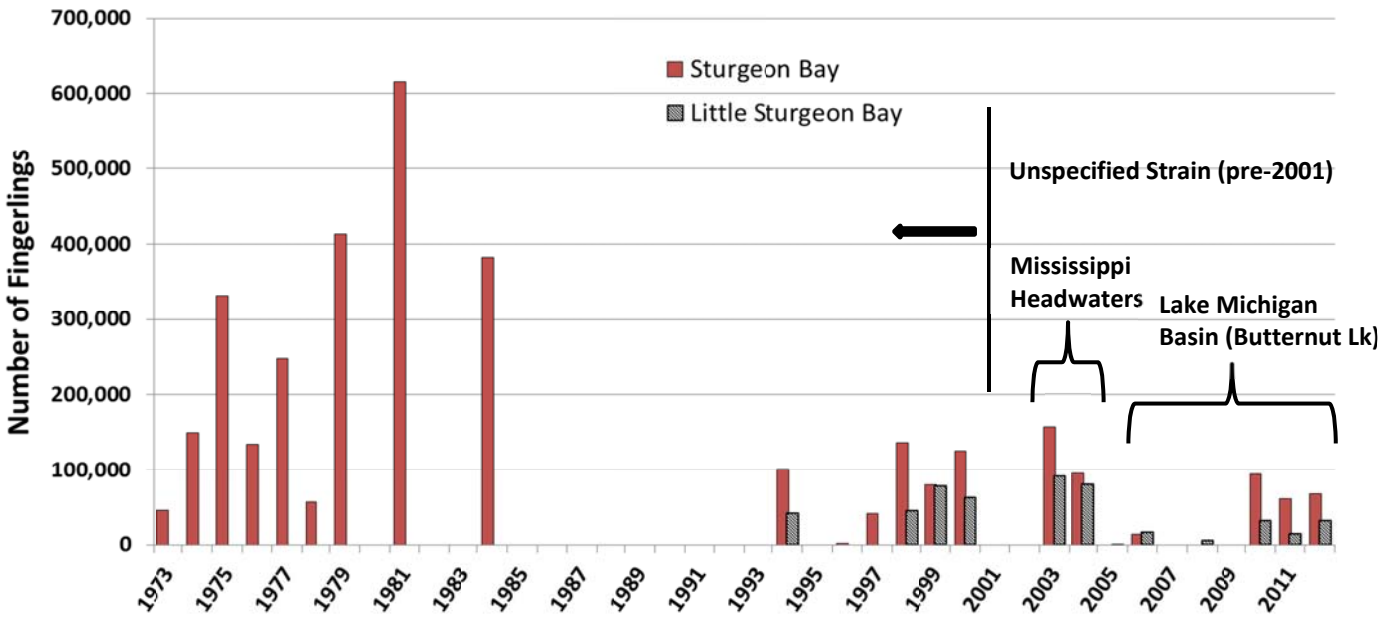

Figure 1. History and strain origin of walleye stocked in Green Bay waters of Sturgeon Bay and Little Sturgeon Bay. Stocking occurred in most years between 1973 and 1984 and then ceased until 1994 at which time fish were stocked when available.

Methods

Figure 2. Door County peninsula and surrounding areas of Green Bay and Lake Michigan. Red box indicates Sturgeon Bay/Little Sturgeon Bay study area.

2010 Assessment

Fyke nets were set in Sturgeon Bay beginning April 6 and Little Sturgeon Bay April 12 and were permanently removed after May1, 2010. (Nets were fished some weekend days but not all.) The walleye assessment was formally conducted until April 23. Any walleye data recorded after this date were incidentally caught and recorded during a Great Lakes Spotted Muskellunge assessment. The number of nets at each site ranged from 2 to 9 and fish were removed every 24 or 48 hours. Data collected from walleyes included total length measured to the nearest millimeter (converted to inches), gender, spawning condition and a subsample of dorsal spines used for ageing (10 fish per 10 mm increment by gender). Fish were given a caudal fin clip to indicate whether the fish had been captured previously. Fish health was also evaluated by examining for any external lesions. All other gamefish were measured and non-gamefish were identified to species, counted, and released.

2013 Assessment

Fyke nets were set in Sturgeon Bay beginning April 23 and were permanently removed after May 8. (Nets were fished some weekend days but not all.) Late ice conditions forced a delayed start to the sampling season and resulted in minimal sampling in Little Sturgeon Bay (began April 30) where much of the walleye spawning run was likely under-sampled due to this late start. The number of nets in each location ranged from 2 to 4 throughout the sampling period and fish were removed every 24 or 48 hours. Data collected from walleyes included total length measured to the nearest millimeter (converted to inches), gender, spawning condition and a subsample of dorsal spines used for ageing (10 fish per 10 mm increment by gender). Fish were given a caudal fin clip to indicate whether the fish had been captured previously. A total of 637 walleye were tagged along the left side, just below the dorsal fin with a green plastic tag (Floy Tag ®) which held a unique ID number and a WDNR fisheries office address. These fish were tagged in cooperation with an evaluation being conducted by the Green Bay fisheries office and the recapture results from those fish are reported in a separate report (Hogler et al. 2014). Fish health was also evaluated by examining for any external lesions. All other gamefish were measured and non-gamefish were identified to species, counted, and released.

Because so few fish were captured from Little Sturgeon Bay in 2013, and for consistency, the length, growth, and age comparison data between years will only be drawn from Sturgeon Bay samples, which had a very robust sample size for both survey years.

Young-of-year assessment

Gamefish, with an emphasis on the current year's walleye production (Age-0), were sampled during the fall using boomshocker capture methods. Index stations were developed in 2008 in parts of Sturgeon Bay and Little Sturgeon Bay and have been repeated most years. Sampling has also occurred on a less frequent basis in other locations including Riley's Bay and locations north of Sturgeon Bay. Sampling typically begins during the fall months once water temperatures have declined to 65° F or less. All gamefish are netted and measured to the nearest millimeter. Ageing structures are collected from small walleyes to determine size break between age-0 and age-1 fish. Catch-per-unit-effort for young-of-year walleyes is measured as the number of walleyes caught per

hour of electrofishing.

Creel Survey

The sport fishery for walleye has been assessed annually in the outlying Door County waters since the 1970s through the use of a randomized angler creel survey. The open water creel season in this area begins April 1 and typically runs thru the end of October. Survey sites include most popular access points along the Door County shoreline. Standard creel survey interview data are collected including effort, catch, harvest, biological data (length, weight, marks/tags) and angler demographics (Masterson and Eggold 2013).

Results

Catch

In 2010 fyke nets were fished a total of 146 net nights between the two sites though the last 15 nights fished were as a component of the muskellunge assessment. There were 87 net nights fished in Sturgeon Bay and 59 net nights in Little Sturgeon. A total of 2,226 walleyes were captured in total with 1,382 coming from Sturgeon Bay and 844 from Little Sturgeon. This resulted in a catch per unit effort of nearly 16 fish per net night for Sturgeon Bay, 14.3 fish per net night for Little Sturgeon and a combined 15.2 fish per net night between the sites.

Over 600 fish of other species were captured in the 2010 survey including northern pike (n=151), rock bass (n=73), smallmouth bass (n=61), white sucker (n=61), yellow perch (n=55), bullhead spp. (n=51), bowfin (n=41), pumpkinseed (n=32), common carp (n=19), largemouth bass (n=18), bluegill (n=13), redhorse spp. (n=10), black crappie (n=10), gizzard shad (n=5), brown trout (n=4), shiner spp. (n=4), white perch (n=3), freshwater drum (n=2), muskellunge (1), channel catfish (n=1), and longnose gar (n=1).

In 2013 fyke nets were fished a total of 65 net nights. Of this total, only 14 net nights were dedicated to Little Sturgeon, however. A total of 1,978 walleyes were captured of which 1918 were from Sturgeon Bay. This resulted in a catch per unit effort rate of 37.6 fish per net night for Sturgeon Bay and 4.3 walleyes per net night for Little Sturgeon.

Over 300 fish of other species were captured in the 2013 survey including northern pike (n=68), smallmouth bass (n=53), yellow perch (n=44), white sucker (n=38), rock bass (n=36), bullhead spp. (n=20), bowfin (n=12), largemouth bass (n=11), pumpkinseed (n=11), brook trout (n=8), black crappie (n=5), shiner spp. (n=4), muskellunge (3), channel catfish (n=3), common carp (n=2), white perch (n=2), freshwater drum (n=1), longnose sucker (n=1), bluegill (n=1), brown trout (n=1), and redhorse spp. (n=1).

Age Composition

The age composition of the walleye population during the 2010 spawning season in the area was very heavily skewed to age-7 fish (56%) from the 2003 year class (Figure 3). Previous to 2013, the 2003 year class was the largest year class of walleyes produced naturally in Wisconsin waters of Green Bay and its tributaries during the annual survey period of record beginning in 1987. A considerable number of walleyes were stocked in 2003 in the Sturgeon Bay area thus making it impossible to determine if any fish recruited naturally from this area that year. The next largest component of the age composition in 2010 came from the age-6 fish (12%), also a stocking year in Sturgeon Bay (2004). Together these two age classes accounted for over 65% of fish in the population. Naturally recruited age classes, ages 4, 5, 8, and 9 together made up approximately 17% of the sample. The remaining age classes were primarily from stocked years or older fish for which we have less confidence in determining accurate ages.

The age composition of the walleye population during the 2013 spawning season differed considerably from 2010 (Figure 3). The age classes were much more evenly distributed and naturally recruited fish (i.e. non-stock years) contributed substantially to the population. For example, age classes 4-8 made up nearly 60% of the spawning population. These year classes, produced during 2005 – 2009, were all non-stocked or minimally stocked years (Figure 1). Age 9 and 10 fish from the 2003 and 2004 (stocking years) year classes made up over 25% population. Ageing error becomes a greater factor for the older year classes though the data still suggest fairly strongly that the 2003 year class is still well-represented in the population, even at age 10. Age-3 fish, the first year walleyes

typically enter into maturity on Green Bay, are fairly well-represented in the population suggesting that survival from the 2010 stocking was good.

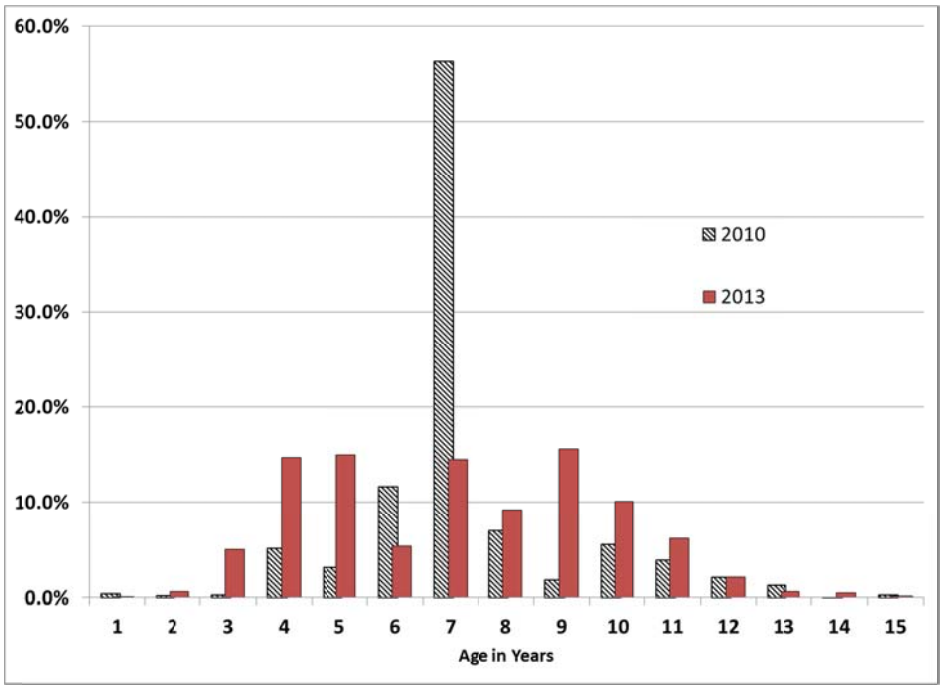

Figure 3. Age composition of walleye from 2010 and 2013 spawning surveys in Sturgeon Bay.

Length Composition and Growth

The length composition of walleyes captured between sampling years differed considerably as well (Figure 4a). Less than 5% of the walleyes sampled in Sturgeon Bay in 2010 were under 19 inches. Nearly 80% of the fish sampled fell between the 20 – 24 inch length bins (i.e. 20 – 24.9 inches). Fish 25 inches and greater made up approximately 9% of the sampled population. The size distribution of fish in Sturgeon Bay and Little Sturgeon Bay in 2010 were similar with some small differences in proportions in certain inch classes (Figure 4a).

The 2013 sampling, however, demonstrated a much broader range of lengths, similar to the age distribution (4b). While many fish were again within the 20-24 inch length groups (53%), there were nearly 3 times as many fish sampled that were less than 19 inches than in 2010. Furthermore, the percentage of fish 24 inches and greater (26.6%) was also about 3 times the amount sampled in 2010. These are likely representatives from the large 2003 year class.

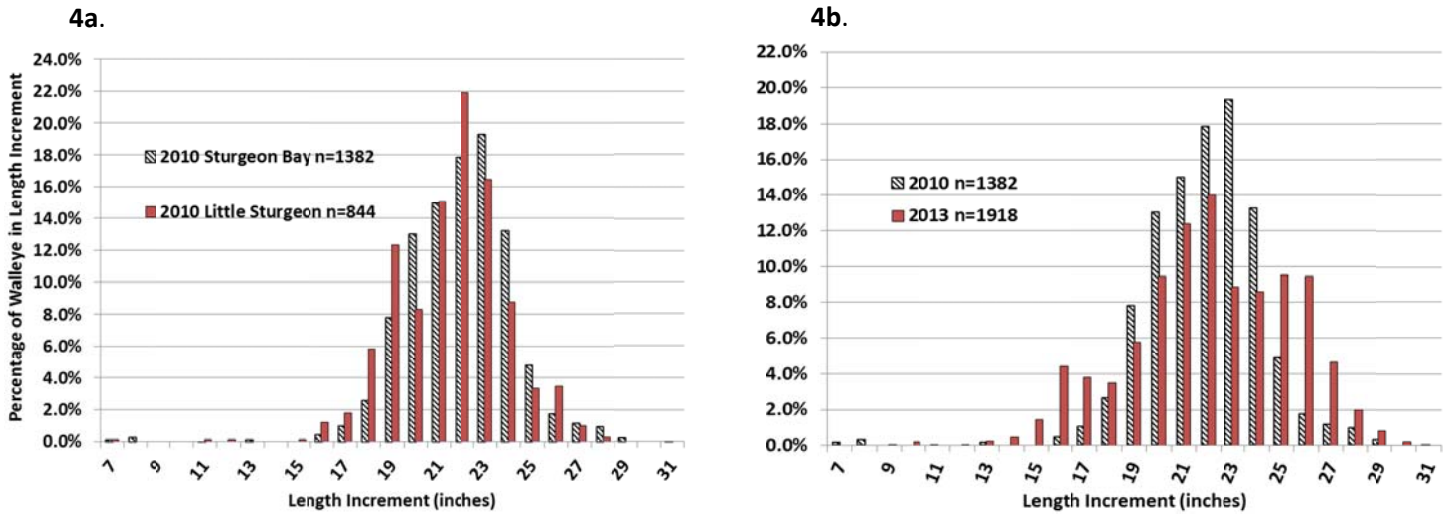

Figure 4a. Length composition comparison for walleye between **Sturgeon Bay and Little Sturgeon in 2010**. Length bins are delineated by any fish that fell within a particular inch group (e.g. a fish in the 16" bin could have been between 16-16.99 inches in length). **4b.** Length composition comparison for walleye in **Sturgeon Bay between 2010 and 2013 survey years**.

Size at age had not changed dramatically over the last few survey years (Figure 5). Generally there was some improvement in size at age for walleyes sampled between 2005 and 2013. However, for age classes where we have greater confidence in the age assignment (< age 8), and larger sample size, the difference in size between survey years varies and is minimal; and there is much overlap in size variation for a particular age. Size at age does appear to show more improvement for fish > 9 yrs. though, likewise, the confidence in age assignment diminishes along with sample size for these older fish. However, when comparing fish from this area of Green Bay to those from the rest of the state for a given year (2013), Sturgeon Bay fish are considerably larger on average for a particular age than the statewide values. This comparison should be used with caution as the statewide values can fluctuate annually to a certain extent depending on which lakes in the state were sampled in a given year. As an example, the 2010 statewide averages were very similar to 2013 statewide averages up to age-9. For older fish, however, they were approximately around 0.5-1 inch different on average which could be aging error or lakes with bigger fish that were sampled in a particular year.

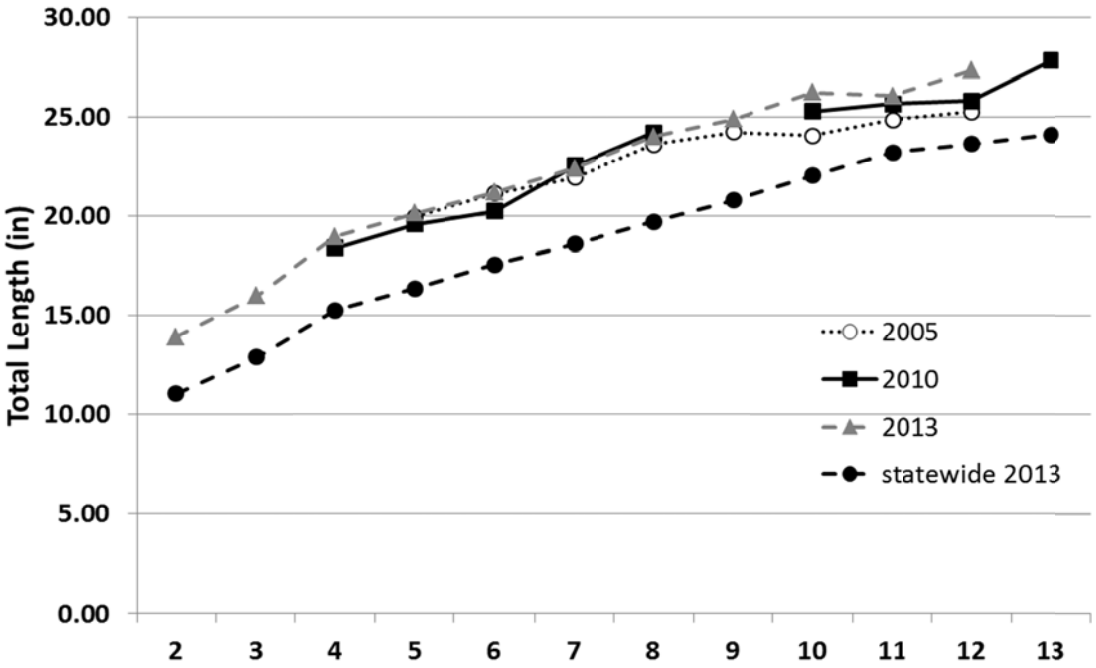

Figure 5. Mean length at age for walleye (min. sample n=9 per 10 mm length bin) up to age 13 measured from Sturgeon Bay for surveys during 2005, 2010, and 2013. Also shown (solid circles) is average size at age for walleyes sampled in inland Wisconsin lakes in 2013. Age classes without data points either had no samples or did not meet the minimum sample size.

Young of Year Walleye Surveys

Catch rates for age-0 (or young-of-year (YOY)) walleyes were relatively low in the Sturgeon Bay area until 2013 (Figure 6) when compared to other locations in Green Bay such as the Fox River and lower Green Bay (WDNR 2016). The catch rate of 30 age-0 walleyes per hour shocked in Sturgeon Bay in 2013 was by far the highest measured in the time series in this area. Catch rates in 2013 and 2014 are very similar to the catch rates recorded in shoreline transects sampled in southern Green Bay (WDNR data). Sturgeon Bay catch rates reported here are specific to Sawyer Harbor as this location has been consistently sampled annually and by far produces the most walleyes of any shoreline transects sampled in Sturgeon Bay. Catch rates for Little Sturgeon Bay have generally been low over time as have the catch rates for other areas in Sturgeon Bay. Years of high stocking (2010 and 2012) did not have correspondingly high catch rates of age-0 walleyes.

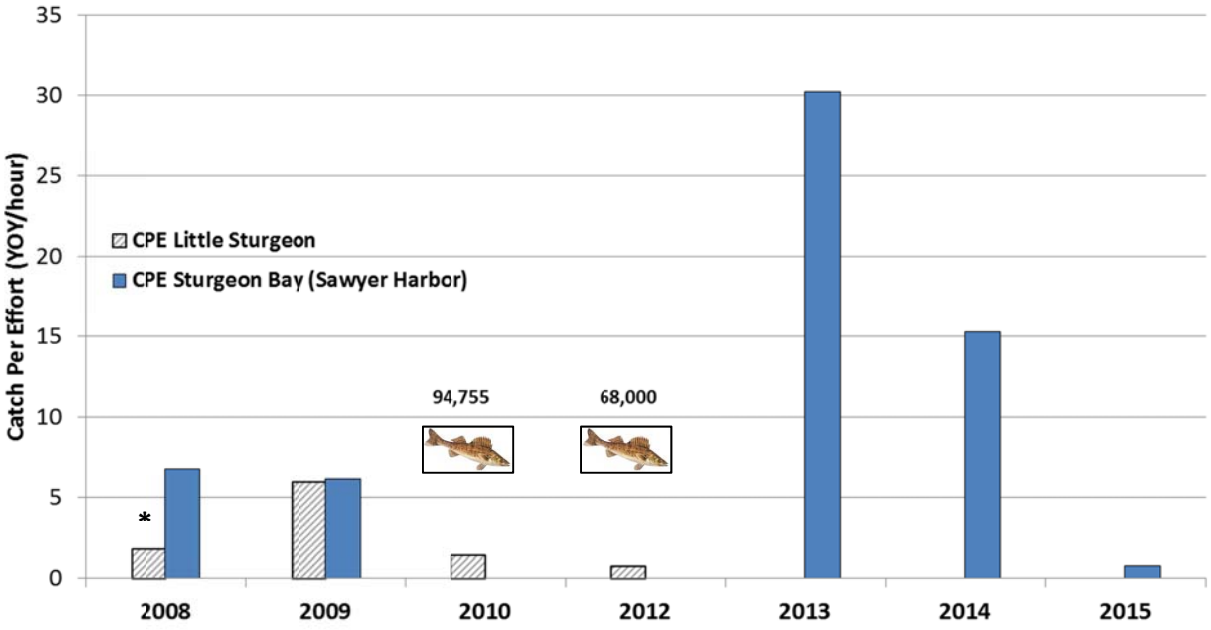

Figure 6. Shoreline electrofishing catch rates for young-of-year (YOY) walleyes in Little Sturgeon and Sturgeon Bays between 2008 and 2015. No sampling occurred in 2011. Graph also indicates number of fingerling walleyes stocked in 2010 and 2012 in Sturgeon Bay (denoted by walleye picture). With the exception of a small number of walleyes stocked into Little Sturgeon in 2008 (*5,365) no walleyes were stocked in either location for the other years illustrated.

Creel Surveys

Sport fishery catch rates for walleyes in Door County waters of Green Bay began a steadily increasing trend in 2001 eventually peaking in 2007 at close to 0.4 fish caught per hour fished (Figure 7). Since then catch rates for walleyes generally followed a declining trend although most of those years were still well above the average for the time series (0.12 fish caught per hour). Recently, in 2014 and 2015 catch rates rebounded with these years being the 3rd and 4th highest catch rates for walleyes in the time series.

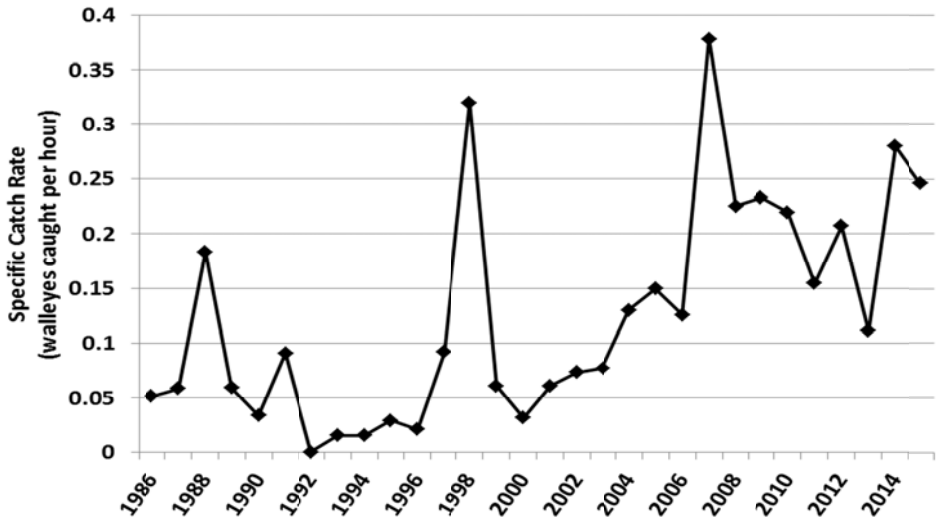

Figure 7. Historical angler catch per effort results for Door County waters of Green Bay during the open water season, 1986-2015. Catch rates are specific to anglers targeting walleyes.

Harvest of walleyes in Door County waters of Green Bay has typically been quite low but increased dramatically between 2006 and 2007 to over 7,000 fish (Figure 8). Since then the annual harvest has continued to grow and has been well above the time series annual harvest average of 3,064 fish. Furthermore, aside from the high harvest recorded in 1988, the last nine years have been the highest harvest years in the time series.

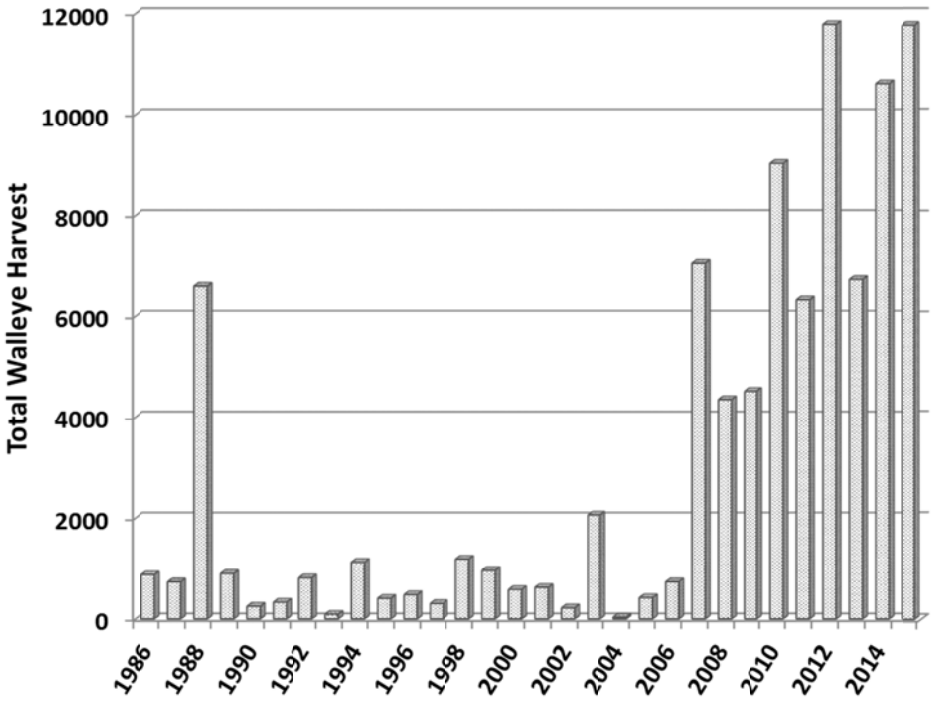

Figure 8. Walleye sport fishery harvest history in Door County waters of Green Bay during the open water season, 1986-2015.

Discussion

Although the number of walleyes caught per net night in fyke nets may not always be a highly reliable indicator of abundance, there was a substantial increase in the number of walleyes caught in Sturgeon Bay between 2010 (16/net night) and 2013 (37.6/net night). However, it is important to note that the 2010 survey began considerably earlier in the season than in 2013, and, depending on water temperatures there may have been fewer fish in the area early in the season. Although late ice conditions delayed our ability to begin the 2013 survey, it is likely that the walleyes had been well established in the spawning areas by the beginning of the survey. Nevertheless, 536 more walleyes were captured in Sturgeon Bay during the 2013 season than in 2010 even with 36 fewer net nights of effort. Furthermore, catch in Green Bay waters rose considerably between 2010 and 2013 suggesting an overall population increase (Wisconsin Department of Natural Resources 2015). There appears to be enough information to support the premise that walleye abundance increased to an extent in Sturgeon Bay between 2010 and 2013. Abiotic conditions can play a large role in the movement patterns and distribution of walleyes. The year 2013 proved to be a very strong year for walleye natural recruitment in Green Bay including Sturgeon Bay. It's conceivable that the conditions that provided for this large year class also resulted in a large number of walleyes being concentrated in our survey area as opposed to other years. However, production of large year classes is generally a reflection of ideal hatching and survival conditions for very small fish as opposed to a large number of spawning adults in an area. The immigration of walleyes (originating elsewhere) into the Sturgeon Bay area during the spawning season should also be considered a factor and the level of tagging in other parts of Green Bay should

provide some insight into this phenomenon in future Sturgeon Bay population assessments.

The age composition of walleyes changed dramatically between these two sample years. It is evident that the large 2003 year class dominated the population in 2010 given the large percentage of age-7 fish captured. Considering the substantial natural walleye recruitment in other parts of Green Bay in 2003, the same conditions may have provided for natural recruitment in the Sturgeon Bay area. However, given the number of walleyes stocked in 2003 in this area it is impossible to determine if there was a locally produced contribution. Although the composition of the 2010 population was largely dominated by age-7 fish, fish from other stocked years contributed substantially to the population as well. A walleye assessment conducted in 2005 demonstrated that fish from stocked years made up the vast majority of the population (WDNR unpublished data) as well with very little recruitment from non-stocked years. However, by 2013, the age composition of the population changed considerably. The age classes were then much more evenly distributed with nearly 75% of the fish between the ages of 4 – 9. Of these age classes, only the age-7 and age-9 fish could have come from stocking events as the other year classes represented non-stocked years in Sturgeon Bay. This strongly contrasts the 2010 year class distribution where the 6 – 8 year old age classes comprised 75% of the catch with the stocked year age-7 fish accounting for greater than 55%. Notably catches of age-0 fish in 2008 and 2009 (though low relative to other locations in Green Bay, correlated with improved catches of age-4 and age-5 fish in 2013 (from 2010 levels). Interestingly the 2003 year class was still well-represented in the 2013 population as 10-year olds (10%) again demonstrating the strength and survival characteristics of that year class. These fish also continue to produce the trophy fishery that is found today in Green Bay.

Although not all age classes are well represented in our sampling years, in general it appears that growth rate has not changed dramatically over the last 10 years. Between 4 and 8 years of age, size at age has been very similar over time. Once fish get to age-9 and older, length at age on average appears to have increased over time. However, studies from other Wisconsin walleye populations indicate that ageing accuracy declines considerably past around age-8 when using dorsal spines instead of otoliths (Isermann and Koenigs 2015). Therefore, a greater amount of ageing error should be assumed for these older fish bringing the precision of the size at age estimates somewhat into question. Given the increase in the number of walleyes in Green Bay, a decrease in size at age would be expected as a result of density-dependent competition for food resources. However, this does not seem to be the case. It's likely that even with the increased density of walleyes in Green Bay the amount of forage has not limited growth. Though no formal diet studies have been done in recent years, Green Bay is still productive in terms of forage including the explosion of the invasive round goby and the availability of alewives, smelt, and other species. Furthermore, there is evidence that walleyes are feeding upon juvenile lake whitefish which have become very productive in Green Bay recently. Given the general productivity of Green Bay and the aggressive feeding nature of walleyes, its likely Green Bay is providing enough food to sustain the increased population.

The walleye population in the Sturgeon Bay area has long been dependent upon stocking. However, the discovery of Viral Hemmorhagic Septicemia in Wisconsin temporarily halted our ability to raise walleye fingerlings in our hatcheries that could be stocked into the Sturgeon Bay area. Stocking resumed here during 2010-2012 albeit at lower levels than were carried out historically. The documentation of a robust number of age-0 walleyes in 2013 and 2014 in Sawyer Harbor suggests that local stocking may be unnecessary and possibly counter-productive if the stocked fish directly compete with a strong natural year class or impact adjacent year classes (Li et.al., 1994; Kampa and Jennings, 1998). Moreover, the high level of walleye production in Green Bay in general over the last 10-15 years provides further evidence that stocking should be unnecessary for the foreseeable future. Age-0 walleyes have not been found ubiquitously throughout Sturgeon Bay, however. Sawyer Harbor has been the focal area for these fish over the last two years; only limited numbers of walleyes been found in a patchy distribution in other portions of Sturgeon Bay and Little Sturgeon Bay. Reasons for the recent spike in productivity are not definitively known though the ideal environmental conditions that provided for the production of large naturally produced year classes in 2013 and 2014 in other parts of Green Bay may have done the same for Sturgeon Bay. Additionally, the increased spawning adult density in this area may be a possible explanation. As conditions for walleyes in Green Bay improved through the 2000s (for both wild and stocked fish), it's reasonable to think that Sturgeon Bay had more potential to produce substantial numbers of natural walleyes once a certain adult spawning density threshold was achieved. The fact that Little Sturgeon did not produce a large year class of walleyes in 2013 adds some support to this hypothesis as it is a smaller area and fewer walleyes have been stocked there than in

Sturgeon Bay over time. Although Little Sturgeon Bay appears to have suitable substrate conditions, spawning habitat and nursery conditions between these sites have not been formally assessed so it is difficult to determine the potential bottleneck that is occurring in Little Sturgeon Bay.

Creel Survey

Catch and harvest rates for walleyes in Door County waters of Green Bay demonstrated an impressive increase during the mid to late 2000s. Although walleye catch rates began a trend upward in the early 2000s, the actual harvest did not increase until 2007. This coincides with the amount of time it would have taken the large 2003 year class to achieve a harvestable size. Furthermore, a bag limit increase in 2007 from 3 to 5 walleyes during a certain period of the year likely influenced the number of harvested fish. Although the 2003 year class is largely responsible for kicking off this impressive fishery, strong recruitment events in Wisconsin waters of Green Bay have perpetuated these catch rates. The level of effort directed toward walleyes in Door County waters naturally has increased as well. In fact, while the specific catch rate between 2004 and 2015 approximately doubled, the amount of effort as measured in total hours fished annually increased by more than 10-fold during that time span (8,653 and 102,296 hrs. fished in 2004 and 2015, respectively) It is also noteworthy that although local recruitment can provide for a viable sport fishery in Door County, tags recovered in this area from fish that were tagged while spawning in other parts of Green Bay suggest during parts of the year Green Bay walleyes demonstrate some considerable movement.

Summary and future outlook

The results of our recent walleye surveys for the area of Sturgeon Bay indicate the walleye population is in relatively good condition compared to recent history though not likely as robust as other spawning populations in Green Bay. These other locations (e.g. Lower Green Bay, Lower Fox, Oconto River, Peshtigo River, Menominee River) host naturally recruited populations of walleyes that have not been stocked since the early 1980s. The areas around Sturgeon Bay, however, have received supplemental stocking during certain periods over the last several decades. Absolute abundance of walleyes spawning in Green Bay waters of Wisconsin is relatively unknown so it is difficult to determine the level of contribution of Sturgeon Bay walleyes to the meta-population. However, there is some indication they may be contributing at a substantial level, especially in recent years. There has historically been concern over local recruitment and evidence of non-stock year walleyes in our YOY and adult population surveys certainly indicates recruitment is occurring, to a certain extent. Although fish growth has not increased to any great extent recently, as it has with smallmouth bass for example, neither is the trend decreasing. Growth characteristics of walleyes in Green Bay are still considered to be well above the statewide average. With increasing numbers of fish, the potential for density dependent growth limitations exists; though forage is not likely a limiting factor in Green Bay. In fact, observational evidence indicates that Green Bay walleyes are in very good condition with ample levels of visceral fat (S Hansen personal observation).

Given past concerns over bottlenecks in local natural recruitment as related to habit limitations, there still remains a concern over whether this population can sustain itself without stocking. It appears most of the recent recruitment has been limited to Sawyer Harbor or adjacent areas given the distribution of age-0 fish in the fall. However, they may also be attracted to this area given it is a shallow, productive (i.e. forage) location. Further research investigating the specific areas where spawning is successful would be very beneficial, particularly from the standpoint of restoration efforts. Furthermore, further studies investigating the reasons for limited recruitment in the Little Sturgeon Bay area would be important. This area appears to have appropriate spawning habitat though other limitations may be precluding survival past early life history stages. Finally, it will be important to continue regularly scheduled adult walleye assessments to evaluate survival of age-0 fish to adulthood.

At this stage, it appears the current management practices have been effective at maintaining the Sturgeon Bay walleye population. Although stocking has contributed to the fishery in the past, it is not needed to supplement the current population, particularly given the abundance of walleyes in Green Bay which may be near historically high levels. Should the population in this area prove to not be self-sustaining and recede to low levels along with a decrease in the total Green Bay population, stocking could be once again considered an option. However, before reinstating a stocking program, it would be important to evaluate factors such as: 1) selecting a genetic stock of

walleyes with a higher level of predicted success 2) stocking fish at a size that substantially increases the chance of survival 3) marking stocked fish to estimate relative contribution to the overall population 4) taking steps to ensure spawning habitat is of appropriate quality and quantity. The population status of forage species in Green Bay and the impact of additional walleyes on that forage base would also need to be considered. Employing these management strategies would likely require additional resources as current staffing does not allow for this level of investment in Sturgeon Bay area walleye management.

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