Mark-recapture and catch per unit effort measures of walleye (*Sander vitreus*) abundance in Otsego Lake, NY

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Abstract: In this study, the adult population of Otsego Lake walleye was estimated in order to evaluate the success of the walleye stocking program. Spawning walleye were trap netted at five locations in April 2008, marked with a dorsal fin punch and visible implant elastomer, and recaptured in May using boat electro-fishing and in September by NYSDEC experimental gill net survey. Catch per unit effort as measured by spring boat electro-fishing (24.6 fish/hr) and gill netting (11 fish/net) following the standard percid sampling manual, indicate that Otsego Lake's walleye population density was average compared to other New York State lakes. However, a Petersen population estimate (6,428 walleye with a 95% confidence interval of ± 987) produced by the combination of electro-fishing and gillnet recapture data indicated a low density of 3.76 walleye per hectare. These findings indicate that estimates of walleye abundance utilized by fisheries researchers and managers to measure ecological interactions and stocking success are more reliable if based on data derived from mark and recapture studies rather than catch per unit effort.

INTRODUCTION

Walleye were once an important component of Otsego Lake's fishery, but were extirpated by the 1970's presumably due to fry predation by the accidentally-stocked cisco (*Coregonus artedii,* Lehman et al. 1991). Since 2000, an extensive stocking program has been undertaken to re-introduce walleye to Otsego Lake (Cornwell 2005). The primary goal was to re-establish an historical walleye fishery, with a secondary goal of installing a partial bio-control of the alewife (*Alosa pseudoharengus,* Cornwell and McBride 2007). Since their illegal introduction in 1986 (Foster 1989), alewives have caused substantial detrimental impacts to the ecology of Otsego Lake, including the decline of many fish populations as well as decreased mean secchi disc readings and zooplankton abundance, increased chlorophyll a measurements, areal hypolimnetic oxygen deficits (AHOD), and phytoplankton abundance (Harman et al. 2002).

However, alewives do provide a beneficial food source for larger predators, such as lake trout and walleye. Stomach samples collected from captured Otsego Lake walleye show that they forage on alewife almost exclusively (Cornwell and McBride 2007). Since walleye stocking began, hydro acoustic, trap net, and gill net data have displayed moderately decreasing densities

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of alewife (Brooking and Cornwell 2007; Cornwell 2005). Large zooplankton populations such as *Daphnia* spp. have increased in correlation to decreasing alewife abundance (Albright 2007). Thus ecological evidence indicates that stocking walleye has had a beneficial impact on Otsego Lake's ecosystem (Cornwell 2005). However, in order to develop a true evaluation of the success of the walleye stocking program, walleye abundance needs to be measured.

Fisheries researchers and managers commonly rely on measures of fish abundance based on catch per unit effort (CPUE) rather than on fish population estimates, because CPUE require less effort and expense (Harley et al. 2001). However, repeated measures of CPUE may not accurately reflect population abundance (Beverton and Holt 1957). Thus, while the overall goal of this project was to evaluate the walleye stocking program, in order to meet that goal, an accurate estimate of the adult walleye population was determined through mark and recapture analysis. The resulting estimate of walleye density (fish/ha) was then compared to standard gill net and electro-fishing CPUE measures of abundance.

MATERIALS & METHODS

Otsego Lake (42.40ºN, 74.55º W), located in Otsego County, New York, is a relatively young glacially-formed, oligotrophic lake, with a maximum depth of 50.5 m (Harman et al. 1997). The lake's four primary tributaries, Shadow Brook, Hayden, Cripple, and Leatherstocking Creeks were used to trap net walleye en route to spawn (Figure 1). Sunken Island, a rocky shoal at the north end of the lake, was also used as a trap net site, since walleye are known to congregate at that location (Stich et al. 2007). The Sunken Island shoal and the entire shoreline of the lake were boat electro-shocked for recapture samples.

Trap nets were deployed immediately following ice-out on 9 April 2008 and were checked daily until 25 April. All walleye were marked during this period. Recapture samples were collected with a boat electro-fisher on the nights of 9, 10, 15, and 31 of May 2008. A different section of the lake was shocked each night.

All captured walleye were double-marked by a dorsal fin hole-punch at the base of the third spine and with visible implant elastomer (VIE) posterior to the left eye. Although Thompson et al. (2005) concluded that fin-clipping is a more desirable method of marking walleye, all advanced pond fingerlings stocked into Otsego Lake have been fin clipped, thus a different marking method was needed. Each capture site hosted a different elastomer color. Jaw-tags supplied by NYSDEC were also attached to 490 legal-sized walleye to measure angler exploitation rates.

Data from NYSDEC's warm-water gillnet survey performed in the fall of 2008 were collected and used to supplement the population estimate. Petersen mark-recapture and Schnabel multiple census population estimates were calculated using Bailey (1951), Ricker (1975), and Schnabel (1938), with reference to Clopper and Pearson (1934) for confidence intervals. The

2008 Otsego Lake walleye surveys were compared to Canadarago, Cayuta, and Oneida Lake's respective walleye data (Brooking et al. 2007; VanDeValk et al. 2008).

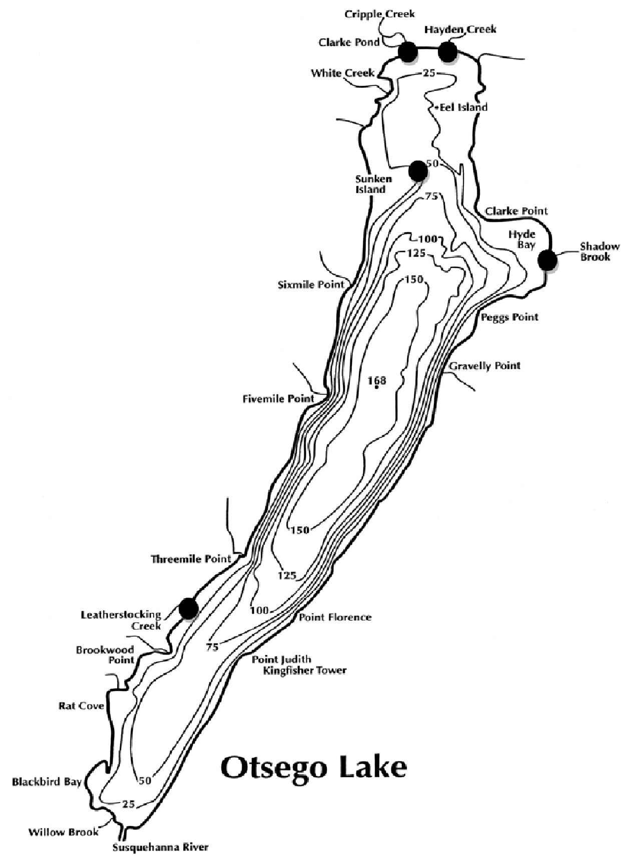

Figure 1. Trap net (marking) locations at four Otsego Lake tributaries and Sunken Island.

RESULTS

From 9 April to 25 April 2008, 439 male and 189 female walleye (total = 628) were marked at the trap net locations. Of the 237 walleye captured during the spring electro-fishing recapture sample, 27 yielded marks. During the fall gillnetting effort, 7 of the 110 captured walleye yielded marks. From April to October, 9 of the 490 jaw-tagged walleye were reported to have been harvested by anglers.

Petersen Mark & Recapture

Using Bailey's modification of the Petersen formula (Bailey 1951), electro-fishing recapture data indicated that 5,345 adult walleye exist in Otsego Lake (Table 1). The 95% confidence interval was 3,428 – 7,262. From the gillnet data collected, a lake-wide population estimate yields 9,958 walleye. The 95% confidence interval for this estimate is wide, ranging from 3,278 – 16,638 (Table 1). Combining the two recapture methods produced the smallest range of abundance (95% confidence interval of ± 987) and therefore the population estimate of 6,428 adult walleye was deemed the most accurate.

A density estimate of 3.76 walleye per hectare was calculated by dividing the population estimate by the surface area of Otsego Lake. Otsego Lake walleye density estimate was the lowest among other central New York Lakes (Oneida, Canadarago, and Cayuta, Figure 2), though these lakes are all considered high-density walleye lakes in NY.

Table 1. Otsego Lake 2008 walleye population estimates from two recapture methods.

Recapture Method	**Number Marked**	**Number Recaptured**	**Number With Marks**	**Population**	**Confidence Interval-95%**
Gillnet	628	110	7	9,958	± 6,680
Electro-fishing	628	237	27	5,345	± 1,917
Combined	628	347	34	6,428	± 987

Schnabel Multiple-Census

Walleye were frequently recaptured in trap nets before the end of the marking period. The recaptures included a mixed sample of walleye marked from the same net in which they were initially marked as well as from other trap net locations. Using the Schnabel multiple-census method (Schnabel 1938), population estimates were calculated from each net location and further averaged together for a lake-wide population estimate of 5,809 fish (Table 2).

Table 2. Otsego Lake 2008 multiple-census population estimates by trap net location.

	Cripple	**Hayden**	**Shadow**	**Leatherstocking**	**Sunken**	**Average**
Schnabel Est.	6,589	9,355	8,929	2,607	1,568	5,809
Confidence Interval 95%	6,212–7,014	9,171–9,547	8,481–9,427	2,356–2,919	1,165–2,399	---
Confidence Range	802	376	946	563	1,234	---

Catch Per Unit Effort

Catch per unit effort (CPUE) as measured by fall gill netting (11 fish/net) following the standard NYSDEC percid sampling manual, indicate that Otsego Lake's walleye density was average among central New York lakes, however, gill net data proved to be a poor predictor of walleye density (Figure 2).

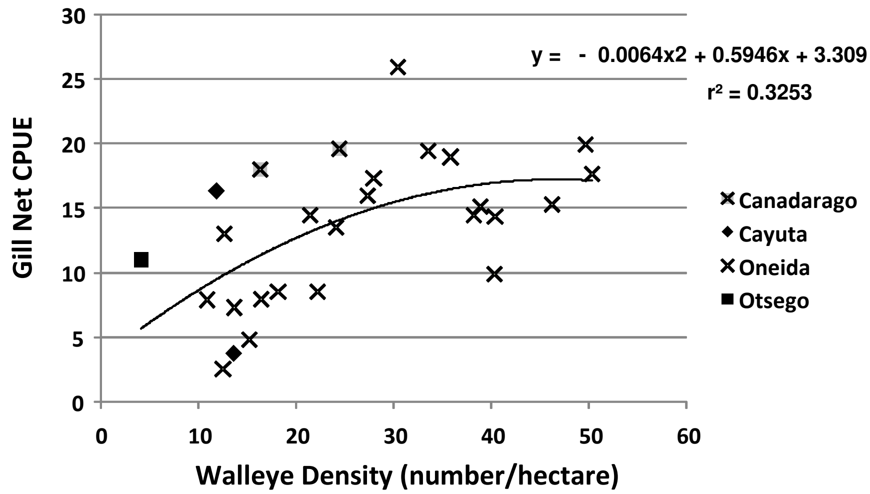

Figure 2. Gill net CPUE versus walleye density from population estimates**.**

Spring electro-fishing of Otsego Lake yielded catch rates of 24.6 fish/hr, which were comparable to fall sampling at other lakes (Figure 3). However, again the correlation between electro-fishing CPUE and walleye density based on mark-recapture population estimates was weak.

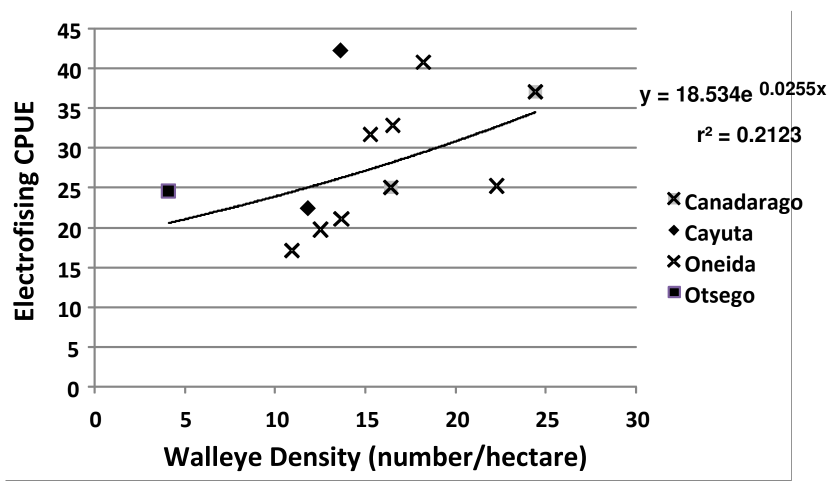

Figure 3. Electro-fishing CPUE versus walleye density from population estimates.

Gill net and electrofishing catch per unit effort data should both be measuring walleye population abundance and therefore should be strongly correlated. However, this was not the case (Figure 4).

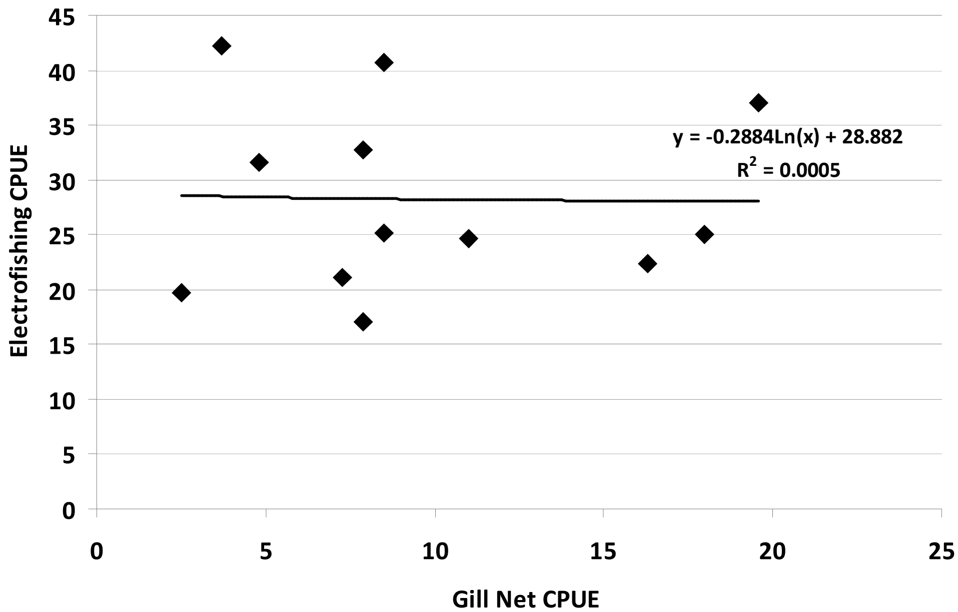

Figure 4. Electro-fishing catch per unit effort (CPUE) versus gill net catch per unit effort utilizing Otsego, Oneida, Canadarago, and Cayuta Lake Data.

DISCUSSION

Many evaluations of walleye stocking programs have been performed (Laarman 1978; Bennet and McArthur 1992; Johnson et al. 1996) indicating varying degrees of success. Most studies focused on recruitment augmentation rather than establishing new, self-sustaining populations (Ellison and Franzin 1992). Natural recruitment of walleye is believed absent in Otsego Lake, since alewife often suppress icthyoplankton (Mason and Brandt 1996; Brooking et al. 1998). Brooking et al. (1997) failed to recover any stocked larval walleye in lakes inhabited by alewife. Thus an adult walleye population in Otsego Lake is likely dependent on the survival of stocked fingerlings to adulthood.

Since 2000, 404,500 (40-50 mm) pond fingerlings and 51,000 (100-150 mm) fall fingerlings have been stocked into Otsego Lake (Cornwell and McBride 2007). Of these 455,500 walleye stocked prior to this study, approximately 6,400 (1.4%) survived to adulthood according to the Petersen mark-recapture estimate. Although similar to the Petersen estimate, the Schnabel multiple-census is probably less reliable due to the wide variation in population estimates at each marking location (see Table 2). Thus, the best estimate of walleye population size comes from combining electro-fishing and gillnetting data (Table 1).

The low rate of return on the walleye stocking program corresponds to the findings in other lakes (Johnson et al. 1996; Santucci and Wahl 2003; VanDeValk et al. 2007). Santucci and Wahl (1993) recovered less than 1% of fingerlings stocked in the 48-61 mm size class after four years. The low survival rate of stocked fingerlings to adulthood is either due to a failure in recruitment (Nate et al. 2000), predation from other fish (Johnson et al. 1996), or a combination of both. Walleye fingerlings were found to be readily consumed by yellow perch and smallmouth bass within 24 hours of stocking into Otsego Lake (Lydon 2007; Cornwell 2005). High overwinter mortality may also be a factor in poor recruitment of yearling walleye (Kocovsky and Carline 2001).

Johnson et al. (1996) advocate that fisheries managers should be prepared for and accept modest gains in a fish population from ambitious stocking programs. In order for the Otsego Lake walleye stocking program to be more successful, several steps could be taken to produce more desirable results. A way to improve survivability of walleye is to stock fingerlings >200 mm (Santucci and Wahl 1993) originally cultured in nursery ponds rather than a hatchery setting (McWilliams and Larscheid 1992). McDonnell and Cornwell (2002) found higher survivability 24 hours after stocking if fingerlings were stocked at night as opposed to during the day. All stocked fingerlings should be as large as is practical (>100 mm), of pond origin, and stocked at night.

Because they require less effort and expense, fisheries researchers and managers commonly use measures of fish abundance based on catch per unit effort rather than fish population estimates. The population estimates calculated in this study were significantly less than the number of walleyes indicated by NYSDEC annual surveys. Electrofishing and gillnet catches have indicated high numbers since initial stocking (Cornwell and McBride 2007); however these data may be skewed due to the highly mobile character of Otsego Lake walleye compared to those found in shallow weedy lakes. Stich et al. (2007) found that the walleye of Otsego Lake commonly made migrations as far as 6-7 miles within several hours. Due to the steep-sided nature of Otsego Lake, fish may be found in a much smaller littoral zone where sampling is done, resulting in artificially high CPUE estimates.

Multiple methods of calculation indicate Otsego Lake's walleye population is lower than indicated from gill net and electro-fishing data. Correlations between CPUE and walleye density (population size) are highly variable in New York lakes. A mark-recapture estimate is the most statistically reliable method of measuring the abundance of a fish population.

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