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Redear Sunfish Management in Michigan

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Abstract.–Redear sunfish *Lepomis microlophus* were first stocked in Michigan waters in the mid-1950s, and some good populations and fisheries developed and became self-perpetuating for over three decades. These fisheries produced occasional trophy-size redear sunfish in an area of the state which was heavily fished and produced few panfish trophies from native species. No other large-scale, purebred stocking programs for redear sunfish occurred until 1984. A redear sunfish management plan was developed and adopted by Fisheries Division in 1991. The primary goal of the program was to offer an opportunity for anglers to catch some large, possibly trophy-size panfish in the southern part of Michigan's Lower Peninsula. This was adopted by Fisheries Division and stocking continued through 1998. A total of 57 lakes have been stocked, primarily with fall fingerlings, at various stocking rates - mostly ranging between 50 and 200 fingerlings per surface acre of water. Fingerlings were reared in ponds. In most situations, lakes were stocked for two or three years in succession in attempts to create breeding populations with multiple year classes. Nearly 40 new redear sunfish populations have resulted since the recent stocking efforts began in 1984. Several other lakes were recently stocked, so it is too early to verify their survival. Comparisons of panfish sizes (average and largest per species) greatly favor redear sunfish over bluegill *Lepomis macrochirus* and pumpkinseed *Lepomis gibbosis*. Of 30 lakes with mature redear sunfish populations (over 5 years old), the average size in trap net catches was 8.7 in, and the average of the maximum-size individual was 10.3 in. Average sizes for bluegills and pumpkinseeds in the same lakes were 6.6 in and 6.5 in, respectively; and maximum sizes averaged 8.8 in and 7.6 in, respectively. Most new redear sunfish populations appear to be self-perpetuating and managers do not anticipate the need for maintenance stocking. No significant impacts to pumpkinseed populations could be demonstrated by comparing catch and growth statistics before and after redear sunfish introductions. If the length of the growing season is the major factor in redear sunfish survival, much more of Michigan's Lower Peninsula could be considered for introductions. There is some evidence that redear sunfish prey on exotic zebra mussels *Dreissena polymorpha.* More education is needed so that anglers will be better able to distinguish redear sunfish from large bluegill and pumpkinseed. New redear sunfish fisheries have produced trophies as is evidenced by reports to the Master Angler Program. The primary goal of the redear sunfish management program has been realized.

Introduction

Several creel surveys on southern Lower Michigan inland lakes have indicated that panfish are some of the most sought-after fish by area anglers (Herman 1989; Waybrant and Thomas 1988). This was further emphasized in a study of travel and tourism in Michigan where

64% of licensed residents sought panfish (Latta 1990). Creel surveys have also shown that bluegill *Lepomis macrochirus*, pumpkinseed *Lepomis gibbosus*, and other panfish were usually the species of greatest abundance in the sport catch. However, in most southern Lower Michigan lakes very few of these fish ever reach lengths of 10 in - what many anglers consider "trophy size" for panfish. This is likely due to a combination of high angling mortality and below optimal growth rates. A panfish which can attain "trophy size" in public lakes, under heavy fishing pressure, would be welcomed by anglers. The redear sunfish *Lepomis microlophus* was proposed as a panfish which had these desired qualities.

Redear Sunfish Natural History

A great deal of redear sunfish natural history has been researched and recorded in a U.S. Fish and Wildlife Service, Habitat Suitability Index Model (Twomey et al. 1984). Collective references in that study lead to the following general assumptions regarding redear sunfish:

> *The redear sunfish is native from the Mississippi River in Missouri and southern Indiana to North Carolina, south through Florida, and west to eastern Texas. The species has been successfully introduced into Arizona, California, and southern Michigan; and stocked in new waters in Oklahoma, Missouri, Ohio, Indiana, and Illinois.*
>
> *Redear sunfish prefer warm, large lakes, marshes, and reservoirs with vegetated shallow areas and clear water. In riverine habitats, they prefer large, clear, low gradient rivers with sluggish currents and some aquatic vegetation. Redear sunfish are usually outnumbered by other centrarchid species when they occur in the same freshwaters; but in marshes and brackish waters, redear sunfish generally have larger standing crops than the other centrarchids present.*
>
> *Newly hatched redear sunfish feed on green algae and micro crustaceans. As they grow they use copepods, cladocerans, and amphipods as primary food items. Major food items reported in most food studies for larger redear sunfish include midge larvae, snails, mayfly larvae, and dragonfly larvae. Foods of secondary importance include copepods, cladocerans, ostracods, water boatman, and small clams. Feeding primarily on the bottom, redear sunfish seldom eat surface insects. Their apparent preference for snails has earned them the name of "shellcrackers". Redear sunfish tend to congregate around brush, stumps, and logs and so have also been referred to in some locals as "stump knockers".*
>
> *Redear sunfish tend to be community spawners and nest most often in water depths of 2 to 4 ft. They display a great variation in spawning season. Within most of their range, redear sunfish usually begin to spawn in May to June, and may continue to spawn until September. They use a wide range of spawning habitats and nesting substrates. The most suitable pH for the species is between 6.5 and 8.5.*

Temperature and latitude tolerances reported by Twomey et al. (1984) were derived largely from data obtained during the 1950s and 1960s (or earlier). Those studies indicated that growing seasons ≥ 180 frost-free days are optimal for the species. However, fish surveys have shown that several redear sunfish populations in Michigan have thrived for the past 40 years in areas having an average of only 150 to 160 days of frost-free growing season (Table 1; Figures 1 and 2) (Eichenlaub et al. 1990).

In southern Lower Michigan redear sunfish grow quickly and reach large size. In some lakes they have attained lengths of 8 in in three growing seasons (age 2.5). A few individuals longer than 12 in have been reported by anglers and captured in survey nets. During a 1986 all-summer fishing contest sponsored by a local newspaper in Branch County (Behnke 1986), 35 redear sunfish were entered which measured 10 in or longer (range: 10 - 12.75 in). Only 8 bluegills over 10 in were entered in the contest. Until recently the state record redear sunfish was

13.25 in and 1 lb, 15 oz, and was caught in Coldwater Lake, Branch County in 1995 (Walker 1998). In May 2002, the current state record was established with a 12.75 in, 1 lb, 15.5 oz redear sunfish caught by an angler in Thompson Lake, St. Joseph County. The largest redear sunfish catch recorded in the United States was taken in South Carolina in 1998 and weighed 5 lb, 7.5 oz (Dzialo 1999).

State average total lengths of redear sunfish in Michigan, by age and month, were calculated in the early 1990s by Schneider (2000). With average growth rates, redear sunfish reach 10 in at age 6 (Table 2). Bluegills growing at state average rates may reach 9 in in their tenth year. Not enough information on large pumpkinseeds exists to suggest how old they would be when, and if, they reach 9 in in length with average growth rates, but they would at least be older than 10 years.

After several years of observations, an Indiana Department of Natural Resources, fisheries biologist reported that redear sunfish didn't seem to "stunt" in growth like some other panfish species (Neil Ledet, 1987, personnel communication). While growth rates varied somewhat, this species seemed to have done well everywhere Indiana had stocked them. One Michigan population exhibited slow growth after three years of very high stocking rates. A shallow, small lake (40th Street Pond in St. Clair County), with already abundant panfish populations, was subjected to stocking rates which were 3 to 4 times higher than the majority of initial stocking rates in other Michigan lakes (Table 1). Five years after stocking, trap net survey results indicated that this redear sunfish population had the lowest average size and smallest individual redear sunfish of maximum length, when compared to other Michigan lakes where redear sunfish populations had attained an age of at least five years (Table 3).

Redear sunfish are considered good to eat (Calhoun et al. 1966). Also, observations over several years of surveying lakes in Michigan indicated that this species may have some immunity to common fish parasites which often are considered distasteful by anglers. Infestations of trematodes, which cause what is commonly referred to as "black spot" and "yellow grub" diseases, have not been observed in any significant quantities in Michigan redear sunfish – despite the redear sunfish's preference for snails as a primary food. Snails are one of the hosts to these parasites and because redear sunfish eat snails as a primary food, it seems likely that they would frequently be in contact with the infectious swimming stage of these trematodes.

Redear sunfish have a reputation of being rather hard to catch on hook and line (Bennett 1962). However, this characteristic allows them to grow old and attain large size. They are most vulnerable to angling during their spawning season. The most preferred bait is live worms fished on the bottom, but Michigan anglers have caught redear sunfish on gray crickets and wax worms fished at mid-depths, on rubber spiders fished at the surface, and on a variety of artificial lures (author's personal experience and Walker 1998).

The most extensive food study of redear sunfish in Michigan (Huckins 1997) indicated that they had a significant predisposition for snails as a primary food item (see section on "Redear Sunfish as a Competitor with Native Fish" in this report).

History of Redear Sunfish Management in Michigan

The earliest recorded collection of redear sunfish in Michigan occurred in July 1947 in Silver Lake, Branch County (Fukano et al. 1964). It is believed that these fish originated from plantings in Lake George made by the Indiana Conservation Department. Lake George is located on the border of Michigan and Indiana, and redear sunfish apparently moved into Silver Lake via a channel that connects the two lakes.

Several lakes in southern, Lower Michigan (Table 1; Figure 2) were stocked with redear sunfish fingerlings in 1954 and 1956 (Michigan Department of Conservation Stocking Records - 1954, 1956). From these introductions, some migrations, and possibly private plants, a few lakes have produced good-size redear sunfish and most have given anglers an occasional trophy-size panfish over the last four decades.

In the mid-1950s a few lakes in the northern regions of Michigan's Lower Peninsula were stocked with redear sunfish - as far north as

Cheboygan County. All of these introductions eventually failed. The lack of success is not surprising considering that most of these introductions were "one-time plants" in waters which may have been less than ideal habitat for the species. Some of these populations were decimated by winterkills (Fukano et al. 1964). In addition, many of the plants made in these more northern waters had much lower stocking densities than the successful plants in southern regions. However, even though the northern introductions did not result in significant fisheries, some fish did survive for several years. From a fingerling plant in 1954, M. H. Patriarche (Fukano et al. 1964) reported excellent growth of surviving redear sunfish captured in 1956 and 1957 surveys of Jewett Lake in the Rifle River Recreation Area, Ogemaw County. However, success of reproduction was poor. The plantings were made when there were "large numbers" of bluegill, in addition to other species, in the lake. It was reported that under these circumstances the species "didn't get a fair test". Fukano et al. (1964) recommended stocking redear sunfish with largemouth bass in some southern Michigan lakes following reclamation or winterkill.

According to conversations with retired Fisheries Division personnel, redear sunfish were apparently used for hybrid sunfish research in Michigan during the 1970s; however, no documents have been found which recorded the results of this research.

From 1956 until the recent program began in 1984, no other large-scale purebred redear sunfish plantings occurred in Michigan waters.

Recent Redear Sunfish Management

The presence of redear sunfish populations in several lakes in southern, Lower Michigan for nearly three decades provided a basis for experimental introductions in other nearby waters. Surveys of fish populations in these lakes showed no apparent ill effects from redear sunfish introductions (Fisheries Division files and personal observations). In fact, these lakes held some of the best sportfish populations in the 9-county area of southern Lower Michigan, formerly known as District 13 of the Michigan Department of Natural Resources, Fisheries Division. The experimental program to introduce redear sunfish into several other lakes in the southern part of Michigan's Lower Peninsula began in 1984. This management primarily consisted of rearing and stocking fingerlings, subsequent surveys to ascertain survival, and refinement of management techniques. A redear sunfish management plan was developed in 1990 after it appeared that initial plants would lead to manageable fisheries (Towns 1991). The plan called for additional rearing and stocking of redear sunfish, followed by netting surveys to help evaluate results.

Rearing

Extensive culture in drainable ponds was the primary technique used to rear redear sunfish from 1984 through the mid-1990s. Some non-drainable ponds were used very successfully in recent years with harvest of fingerlings achieved using small-mesh/large-frame fyke nets. Broodstock were captured with trap nets in mid-May each year and transferred to rearing ponds. These adults remained in the ponds during the entire nesting and rearing period. From 4 to 6 pairs of adults per surface acre of rearing pond has produced similar fingerling harvests as twice as many adults, therefore the lower density has been preferred. A rather high broodstock mortality rate has occurred in some cases, so fish handling has been kept to a minimum. Harvest of fingerlings has occurred in September through November at harvest rates of about 25,000 to 30,000 fingerlings per acre; however, annual production has been variable. Depending on the growing season and contamination of ponds by other fish species, the harvested redear sunfish fingerlings have ranged in size from 1.0 to 2.5 inches in total length.

More recently efforts to rear large yearling redear sunfish have been successful. Redear sunfish spring yearlings (2–3 inches) have been stocked with walleye in rearing ponds managed for fall fingerling walleye production. Both species have done well, and late fall harvests have resulted in redear sunfish production of about 50 per surface acre averaging 4.7 in to 6.2 in.

Stocking

Redear sunfish stocking rates generally used in Michigan lakes from 1984 through the 1998 were based on those used by the State of Indiana, Department of Natural Resources, Division of Fisheries and Wildlife, which has had an active redear sunfish management program for many years (Gerald Spoonmore, personal communication, 1984). Stocking rates have generally been 100 fingerlings per surface acre in lakes from 50 to 750 acres in size. In larger lakes, where a large part of the surface area is over deep water, stocking rates have been reduced, but not below 50 fingerlings per acre.

In most cases, attempts were made to stock each new lake for 2 to 3 years in succession (Table 1) in an effort to develop multiple year-classes which could potentially develop self-sustaining populations. Self-sustaining populations were desirable since stocking could be curtailed if natural recruitment became sufficient.

In two cases significant numbers of adult redear sunfish were stocked in hopes of eventually creating viable populations via natural reproduction. Since those introductions (Long Lake and Union Lake, Oakland County) have only recently occurred (in 1997 and 1998) results of these efforts are not yet available.

Lakes have been selected for redear sunfish stocking based on several factors: 1) public access - assured and adequate boating access for public use; 2) water clarity - in their native range this species seems to prosper in clear water systems; 3) good pumpkinseed populations – the pumpkinseed is a close relative of the redear sunfish and prefers many of the same foods (primarily snails); 4) favorable limnological conditions - some very good redear sunfish fisheries existed for many years in lakes with marl and sand substrates, having large expanses of shallow shoal, but also having some deep basins; and 5) need for panfish management - in a few cases, redear sunfish were stocked in shallow lakes with abundant vascular plant growth and populations predominated by small panfish. It was hoped that redear sunfish would grow much larger than native stocks of bluegill and pumpkinseed in shallow weedy lakes, and offer anglers improved fishing opportunities. Lakes in this category included: Narrow Lake, Eaton County; Clear Lake, Gilletts Lake and Grass Lake, Jackson County; Tipsico Lake, Oakland County; and Four Mile Lake, Washtenaw County.

Results of Recent Management

Recent redear sunfish management in Michigan (since 1984) has been quite successful in achieving the initial goal of supplying trophy-size panfish to many inland lakes. Table 3 compares average sizes and the largest individuals captured in trap net surveys in 30 lakes where redear sunfish have been documented as present for at least five years prior to the survey. Of these lakes, 86.2% had 10-in or larger redear sunfish present in survey catches, but only 10.3% had any bluegills of that size and none contained 10-in pumpkinseeds. The average size of redear sunfish in these trap net surveys was 8.7 in (Table 3), which was more that two inches longer than a similar figure for either bluegills or pumpkinseeds (6.6 in and 6.5 in, respectively). Similarly, the largest individual of each species in the catch greatly favors redear sunfish with an average of 10.3 in, compared to 8.8 in for bluegills and 7.6 in for pumpkinseeds. These lakes have had dramatic changes in panfish population structure and angler opportunity.

Angling catches have been reported in most lakes that have mature redear sunfish populations (Table 1). Also, several fish qualifying for Michigan's Master Angler Program have been reported from lakes that were stocked since 1984 (Table 4). The distribution of bluegills that have qualified for Master Angler Awards has generally been concentrated in the northern portions of Michigan's Lower Peninsula. In 1995 there were 17 redear sunfish and 149 bluegills reported to the Master Angler Program. Redear sunfish produced more Master Angler Awards than bluegills in southern, Lower Michigan where the geographical distribution of the two overlap (Figure 3).

The survival of stocked redear sunfish has been verified (Table 1) in 43 of the 48 lakes (89.6%) stocked since 1984. Redear sunfish seem to do best in typical, southern Michigan warm-water lakes which are low in turbidity,

and not heavily influenced by rivers or riverine species. Trautman (1981) reported that wherever the redear sunfish has been introduced into waters north of its original range, the species has essentially inhabited non-flowing waters which were relatively clear and which contained some aquatic vegetation. In Michigan, a few exceptions have resulted where no stocked redear sunfish were captured in subsequent surveys, but some of these surveys took place under less-than-ideal conditions, usually with cool water temperatures or during storm events. Such conditions may have caused redear sunfish to stay in deeper waters and escape the nets. There have also been a few apparent failures where no redear sunfish were found, but where large numbers of common carp *Cyprinus carpio* were caught (Halfmoon Lake, Washtenaw County and Union Lake, Branch County). Common carp are known to consume large amounts of benthic foods while increasing turbidity in the water column - conditions that would negatively effect redear sunfish growth and survival. Extensive netting surveys did not capture redear sunfish in Devoe Lake, Ogemaw County, the northern-most lake of those stocked after 1984 (Personal Communication - Steve Sendeck). However, this lake was only stocked one time, in 1991, and so did not get a fair test.

One of the best records of success occurred in 1989 during a spring fish survey of Big Portage Lake, Jackson County when 194 redear sunfish were captured averaging 8.6 inches in length. This lake was first stocked in the fall of 1985 with 1.8 inch fingerlings. Other similar successes have occurred in Lower Brace Lake, Calhoun County; Saubee Lake, Eaton County; Baw Beese and Cub Lakes, Hillsdale County; Clear, Gilletts, Grass, and Lime Lakes, Jackson County; and Joslin, North, and Silver Lakes, Washtenaw County (Table 1).

Discussion

The primary goal of stocking redear sunfish in Michigan since 1984 has been to offer "trophy-size" panfish opportunities to inland anglers in an area of the state where panfish are highly prized and sought-after, but where few panfish reach sizes over 10 in. This species grows rapidly while being rather difficult to catch on hook and line. It therefore has the ability to supply a "trophy-size" panfish in lakes that are under intensive fishing pressure. Redear sunfish have not been used as a replacement for bluegill or other sunfishes. Rather, the primary emphasis has been to provide anglers with the opportunity for catching a few very large panfish in areas where little such opportunity previously existed.

Over 40 new redear sunfish fisheries have been established in southern Lower Michigan since an intensive stocking effort began in 1984. These efforts have produced good fisheries, offering anglers more opportunities to catch larger panfish. Several trophy-size redear sunfish have been reported to Fisheries Division, Master Angler Program (Table 4) during the past 20 years, and biologists have speculated that many more are being caught but not reported. Many anglers who fish on inland lakes do not readily give up their secrets regarding large panfish catches and locations. Since the early and mid-1990s, after advertising the redear sunfish program via newspapers, magazines, television shows, and club presentations, information on catches seemed to increase. Also, it is likely that many anglers are confusing this species with large bluegill, and simply do not realize that they are catching redear sunfish. Large female redear sunfish do not display a heavy red margin on their opercle and have a similar appearance to large bluegill. Anglers most often confuse redear sunfish with bluegill or pumpkinseed, but when placed side-by-side the differences are apparent (Figures 4 and 5).

Most redear sunfish introductions in Michigan have become self-perpetuating and managers do not anticipate needing more fingerling plants to sustain them. A few lakes may need occasional stocking to keep populations at fishable levels, but periodic, spring fishery surveys can be used to monitor population status. Redear sunfish are quite easily caught in trap nets during the spring when water temperatures are between 60° F and 70° F.

Redear sunfish management in Michigan has typified anthropocentric resource management (managing natural resources for the benefit of people) (Stanley 1995). Such management practices have been predominant in the past century. More recently, some aquatic conservation professionals have questioned

management practices to enhance populations of non-native fishes to benefit people. This group promotes the concept that the natural world has inherent value and so natural resources should be managed for their own good and protection (the biocentric philosophy). Rahel (1997) reported that today's fish managers must consider both views. In Michigan, by 1984, an invivo experiment had been in place for nearly three decades, because several lakes had been stocked in the mid-1950s (Table 1). Thirty years later, surveys of these fish populations revealed exceptional warm-water fisheries with significant numbers of redear sunfish exceeding 10 in.

Genetics Issues

One concern related to the introductions of new species is the potential for them to spread genetic material via hybridization, thereby changing native populations. While some hybridization has been documented, problems seem unlikely since redear sunfish coexist in the same water bodies with pumpkinseed, bluegill, green sunfish *Lepomis cyanellus*, and other panfish species in other parts of North America. In Michigan, observations during netting surveys have indicated that some hybridization has occurred between redear sunfish and green sunfish, between redear sunfish and pumpkinseed, and between redear sunfish and bluegill, as a result of redear sunfish introductions (MDNR, Fisheries Division files). In a few cases, hybrids have represented from 2% to 13% of the trap net catch by number and 1% to 9% by weight (Clear Lake and Big Portage Lake, Jackson County, respectively). However, very few hybrids have been observed in recent surveys of lakes that have had redear sunfish populations for over 40 years. Significant hybridization problems should have been detected by now if they exist.

Redear sunfish hybrids in newly stocked waters were robust and exhibited fast growth, as determined by growth analysis using scales. They have been observed guarding nests during spawning season; however, it is doubtful that many of them are fertile (John Epifanio, Illinois Natural History Survey - personal communication). Childers and Bennett (1961) attempted to produce hybrids by isolating males of one species (bluegill, redear sunfish, or green sunfish) with females of another (six possible combinations) in ponds that contained no other fish. Each of the F1 crosses was attempted two or more times. Only the green sunfish x bluegill and redear sunfish x green sunfish crosses produced significantly large numbers of F1 hybrids. When F1 hybrids were isolated in ponds, the redear sunfish x green sunfish reproduced successfully; however, the bluegill x redear sunfish combination failed to reproduce successfully.

Redear Sunfish as a Competitor with Native Fish

Some fisheries managers have speculated that redear sunfish may out-compete native panfishes in Michigan, especially pumpkinseed. Redear sunfish and pumpkinseed both consume snails. In fact, no other native fish species in Michigan's inland lakes uses snails as a primary food item, so it is logical to assume that there will be competition between these species. In centrarchids, molariform teeth are present only in redear sunfish and pumpkinseed (Trautman 1957), and mollusk-eating in centrarchids is usually associated with increases in the proportion of molariform teeth on the pharyngeal jaws, among other things (Lauder 1983). Lakes that have large pumpkinseed populations (especially where pumpkinseeds grow to larger average sizes than bluegills) have proven to be good candidates for redear sunfish introductions in Michigan. In these lakes it might be expected that redear sunfish introductions would reduce pumpkinseed populations as these species compete for similar food items.

Huckins' (1997) observations from a pond competition experiment, and from fish surveys, suggested that pumpkinseed and redear sunfish compete, and that competition for snails is the mechanism of the interaction. Redear sunfish were superior to pumpkinseed in exploiting snails. However, this study also suggested that pumpkinseed may be better able to eat soft-bodied prey items - such as aquatic insects. Huckins' analysis of pumpkinseed and redear sunfish populations in two Michigan lakes (Lee Lake, Calhoun County and Saubee Lake, Eaton

County) suggested the greater crushing strength of redear sunfish allowed them to shift from a diet of soft-bodied insects to a diet of snails at an earlier age than pumpkinseed. Pumpkinseeds ≤2.6 in were consuming primarily soft-bodied prey such as insect larvae, the bulk of which were dipteran. Diets of larger pumpkinseeds (≥2.6 in SL) also tended to be dominated by chironomid larvae (about 37% of diet biomass), with snails making up less of the diet (about 29% of the diet biomass). In contrast, Huckins found redear sunfish in the same lakes showed a striking shift in diet between small (<1.6 in SL) and large individuals. Diets of small redear sunfish contained approximately 30%-50% each of snails and zooplankton, and the remainder was dominated by dipteran larvae. Redear sunfish larger than 1.6 in showed an extensive shift to molluscivory - approximately 87% of the average diet was composed of snails. It is probable that where snails are prevalent the superior snail crushing ability provides an advantage to redear sunfish, but it is not so overwhelming that pumpkinseed will likely be extirpated after redear sunfish introductions.

Michigan fishery surveys have found pumpkinseed populations co-existing with redear sunfish in lakes that have had large redear sunfish populations for several decades. Fish populations in Lake George, Silver Lake, and Coldwater Lake in Branch County and in Crooked Lake in Washtenaw County are good examples. Pumpkinseeds were present in most recent trap net surveys of these lakes, but in low numbers. In an effort to further examine this issue, survey catch data for pumpkinseed were examined in other lakes where redear sunfish have been introduced (Table 5). In some instances, specific pumpkinseed data were not recorded in early (pre-redear sunfish introduction) surveys. In other cases, redear sunfish and pumpkinseed have co-existed for only a few years, so long-term effects from any competition could not be measured. However, in most cases, where pumpkinseed survey data exist, there seems to be no obvious negative relationship. In 40 post-redear sunfish introduction surveys, trap net catch-per-effort (CPE) of pumpkinseeds decreased in 21 situations, increased in 18, and stayed the same in 1. However, overall average pumpkinseed CPE declined from 7.6 to 4.7. Total CPE of redear sunfish and pumpkinseeds combined increased in 36 of the 40 surveys.

Pumpkinseed growth index changes showed no specific pattern after redear sunfish were introduced. Adequate growth index data for pumpkinseed (pre- and post-redear sunfish introductions) were available for 9 lakes. Four of these indicated that pumpkinseed growth increased after redear sunfish were introduced, four indicated decreased pumpkinseed growth, and one was unchanged. The average of these nine lakes was an increase in pumpkinseed growth index from 0.2 to 0.3 in after redear sunfish were introduced.

Some sciaenid, catostomid, and cyprinid species consume snails (French 1993) and other food items that are also eaten by redear sunfish. However, in Michigan most of these species are more closely associated with flowing waters or impoundments which have high common carp *Cyprinus carpio* populations, and these are habitats where redear sunfish introductions have apparently failed. It is probable that turbid conditions and competition with a large biomass of suckers, common carp, and other benthic feeders have been too harsh for redear sunfish survival.

Ictalurids also consume molluscs, but they are omnivorous, feeding on a large variety of materials from plants to fish (Scott and Crossman 1973). If introduced redear sunfish began to have a large impact on a snail population, ictalurids could easily shift their food gathering to other available items. It is doubtful that redear sunfish would have a severe or even measurable impact, on bullhead *Ameiurus* sp., madtom *Noturus* sp. or channel catfish *Ictalurus punctatus* growth or survival.

Redear Sunfish Predation on Zebra Mussels

There has been some speculation that redear sunfish may benefit from recent unwanted introductions of zebra mussels, while helping to control mussel populations. French and Bur (1992) suggested that fishes with molariform pharyngeal teeth may shift their main diet to zebra mussels that colonize new habitats in eastern North America outside of the Great Lakes. They will likely not exterminate zebra mussels, but may reduce their populations

(Robinson and Wellborn 1988). Some studies have demonstrated that redear sunfish preyed on zebra mussels in aquarium experiments, but preferred native snails. In fact, even in high zebra mussel:low gastropod ratio experiments, gastropods were the first consumed. However, adult redear sunfish fed on zebra mussels up to 0.8 in. long, and juvenile redear sunfish greater than 2.4 in were able to crush shells of juvenile mussels up to 0.08 in. long. Sunfish ingested a larger portion of mussel shells than gastropod shells because the zebra mussel body adhered to its inner sides of shells (J. R. P. French, U.S. Fish and Wildlife Service, unpublished data). Another report (French 1993) suggested that both pumpkinseed and redear sunfish will probably prey heavily on zebra mussels in shallow vegetated habitats because both sunfishes can remove mollusks from vertical surfaces. More study is needed to determine if redear sunfish can detach and consume zebra mussels once they are firmly attached to hard substrates. Some managers have speculated that if redear sunfish can consume significant quantities of zebra mussels in inland lakes it may help to release some of the energy that has been tied up in mussels and out of the native food chain. MacIsaac et al. (1992) reported that zebra mussel populations in western Lake Erie possessed a tremendous potential to filter the water column and redirect energy from pelagic to benthic food webs. Fishes that prey on these mussels would convert these nutrients into fish flesh.

Future Management

Redear sunfish seem to have naturalized to many of Michigan's southern inland lakes. They may not exist elsewhere in Michigan – simply because they have not yet been introduced, in good condition, into favorable habitats. Previous introductions into northern regions were in less than ideal conditions (Fukano et al. 1994), so a good test of the species in northern areas has not yet been done. It is possible that winter temperature and duration are primary factors that may limit the survival of redear sunfish in northern areas, since its original range extended only as far north as southern Indiana (Twomey et al. 1984). However, the climate in Michigan is greatly affected by the buffering capacity of the surrounding Great Lakes. For example, lands along the Michigan coast of Lake Michigan as far north as Leelanau County have a similar number of frost-free days (Figure 2) to those areas where redear sunfish have thrived in southern Michigan (Figure 1). Indeed, some areas in the southwest and southeast of Michigan's Lower Peninsula have longer growing seasons than the central, southern area where successful introductions have occurred. Redear sunfish would likely survive and do well in many western and southeastern counties of Michigan's Lower Peninsula, especially in clear lakes where average sizes of pumpkinseeds rival those of bluegills. Problems associated with survival in northern latitudes also could be linked to the timing (day length) of reproduction versus water temperature. If this were a major factor, stocking of fall fingerlings reared in southern ponds may solve the problem, but the subsequent population would likely have to be maintained by stocking.

Stocking criteria for any future redear sunfish introductions in Michigan waters have been developed (Dexter and O'Neal, in press). In lakes with established fisheries, where an eventual reproducing redear sunfish population is desired, fall fingerling redear sunfish (1.5 in) should be stocked at 100 per surface acre for three years in succession. This method assumes that at least two of the three year-classes will survive in high enough numbers to establish a breeding population. Newly established populations should be surveyed in the fourth or fifth year to ascertain survival, and determine if successful natural reproduction has occurred. Subsequent stocking may not be necessary, but if survival to adult size has been low, alternate year stocking may be used to maintain the fishery.

Managers contemplating future introductions of redear sunfish into Michigan Lakes should thoroughly review Michigan Fish Stocking Guidelines (Dexter and O'Neal in press) and consult the protocols of the American Fisheries Society (AFS) set forth in their policy statement on introductions of aquatic species (AFS 2002).

Acknowledgements

There have been many biologists and technicians who contributed to various phases of recent management of redear sunfish in Michigan. Ken Dodge is recognized for his leadership in steering the administration of the program during the mid-1980s through the mid-1990s. Mike Herman's enthusiasm and hard work toward panfish management in southern Lower Michigan has been a driving force in the success of the redear sunfish program. Jeff Braunscheidel's contributions have included new management techniques. Many technicians have participated in rearing, harvesting, and evaluating redear sunfish under the direction and assistance of William Rupright, Joseph Leonardi, and Todd Somers. I wish to especially thank Mike Herman and Matthew Smith for compiling historical data, and Jim Schneider and Rick Clark, who helped with some of the statistical analysis and editing for this report.

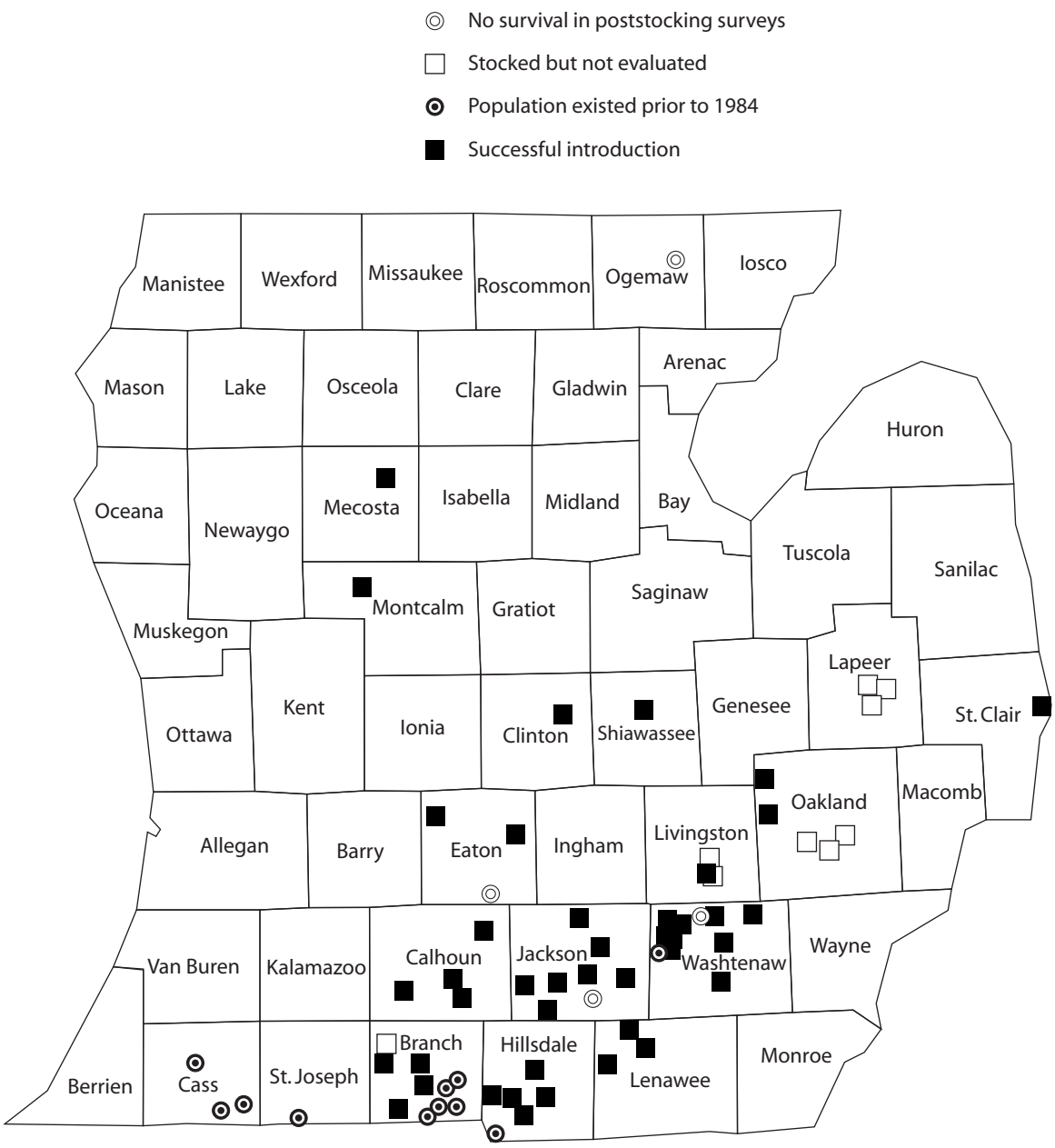

Figure 1.–Locations of Michigan lakes stocked with redear sunfish.

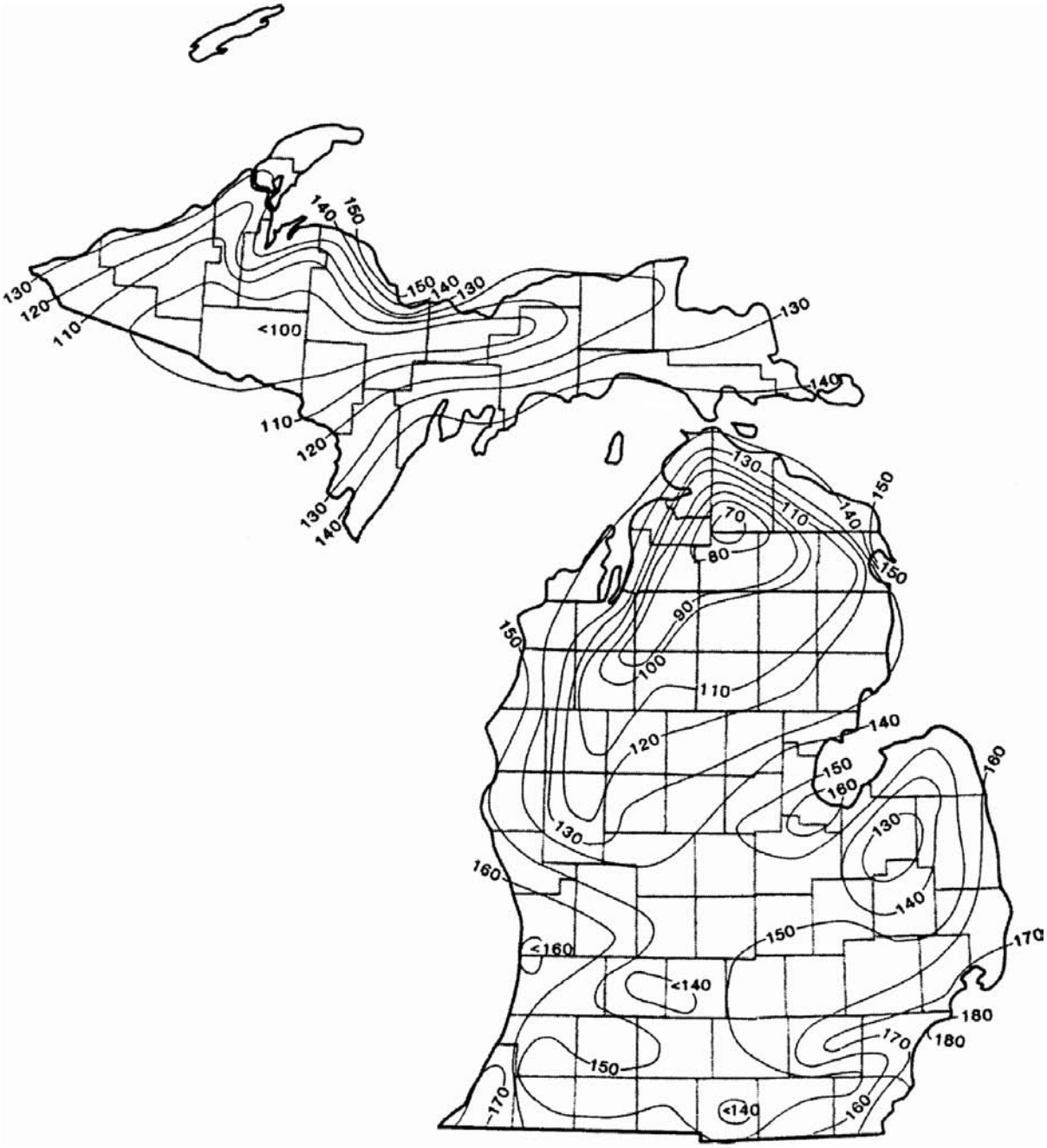

Figure 2.–Number of days between last spring and first fall 32ºF occurrences for selected probabilities 1930-79. (Eichenlaub, et al. 1990)

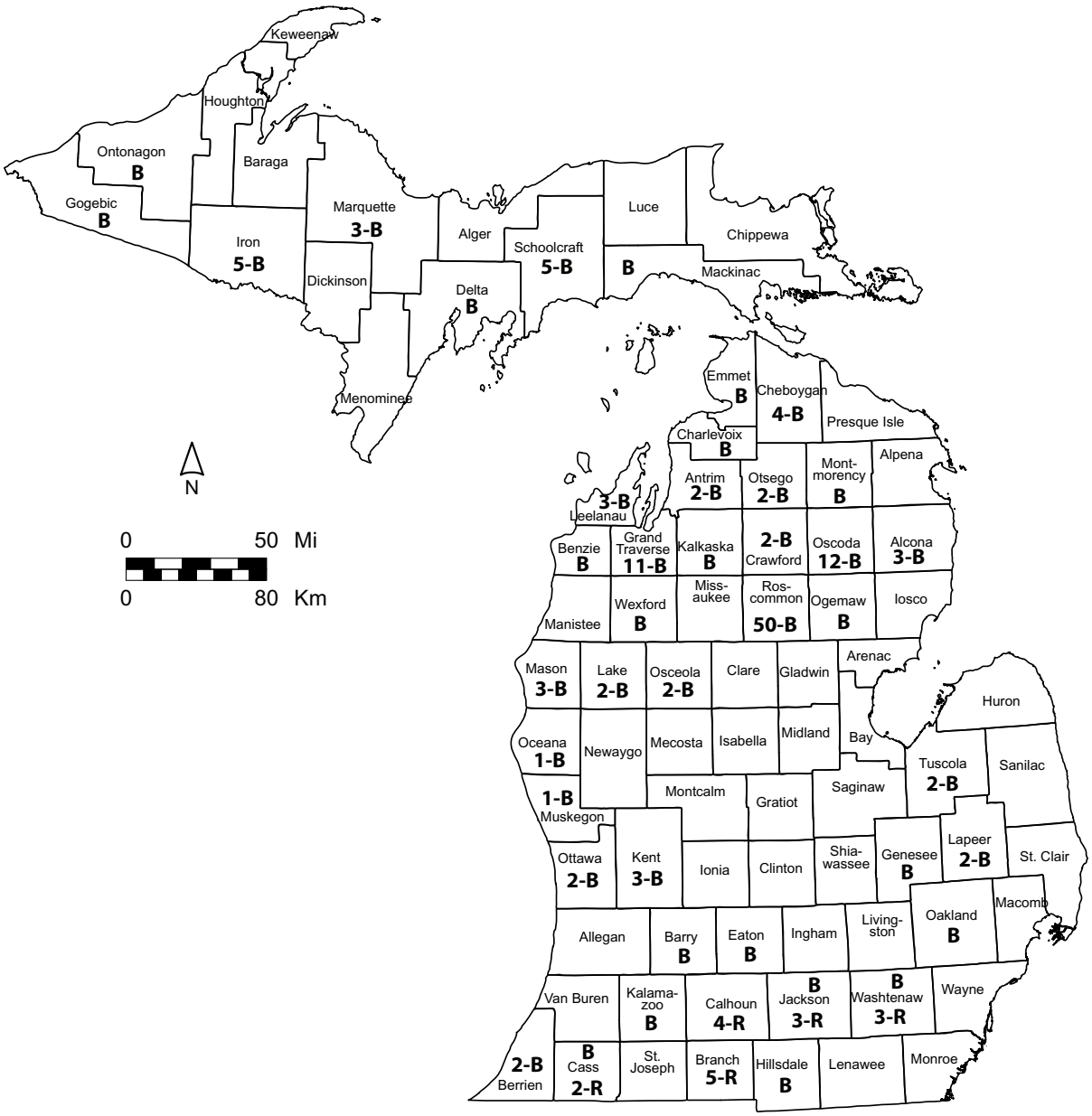

Figure 3.–Locations of Michigan Master Angler Program entries for bluegill (B) and redear sunfish (R) in 1995.

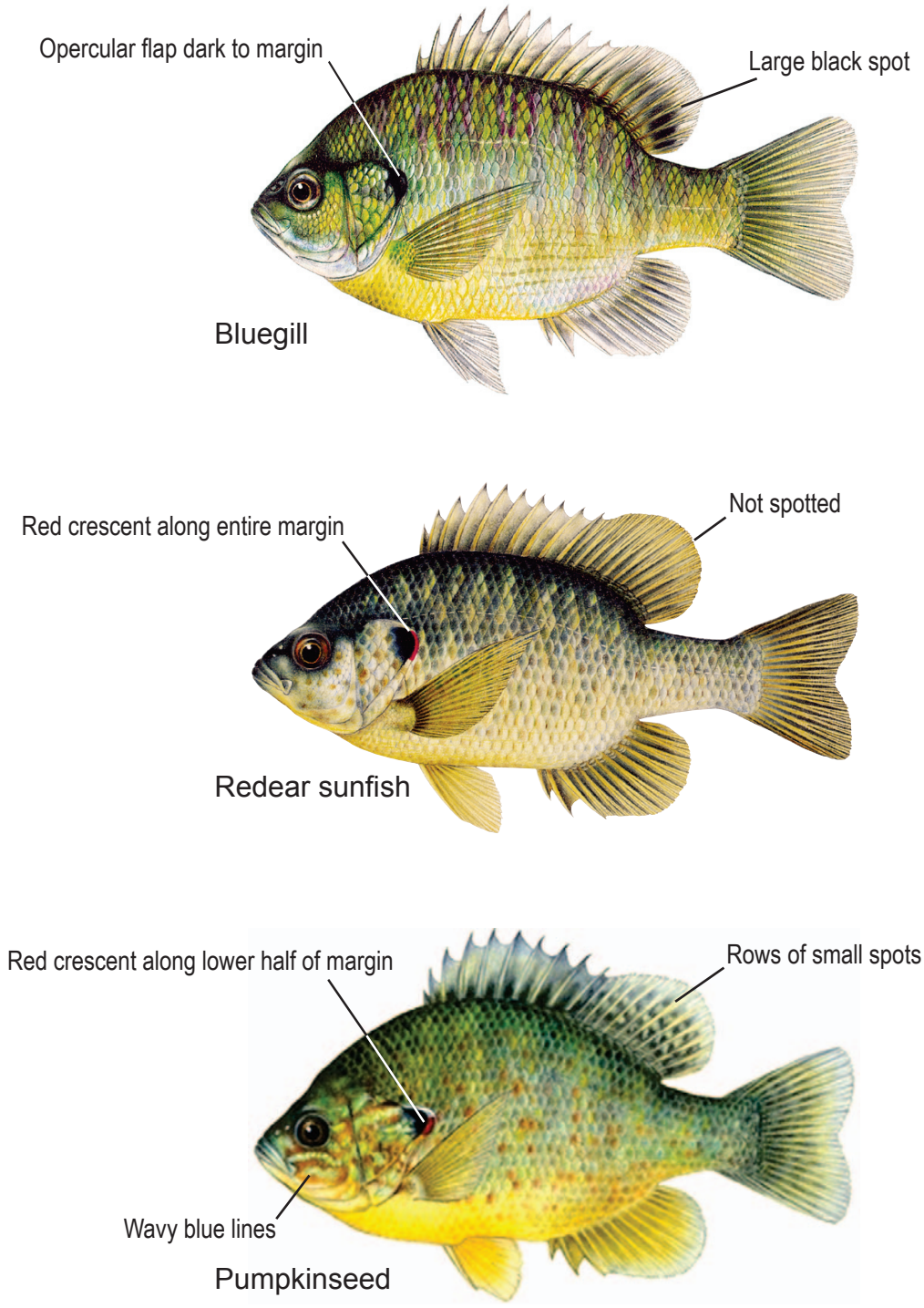

Figure 4.–A physical comparison of female bluegill, redear sunfish and pumpkinseed. Note that the redear sunfish is more uniform in color (olive-drab) with a complete crecent of light red color along the posterior margin of the opercular flap; dorsal and anal fins are plain (not spotted), pectoral fins are long and there are no wavy blue lines in the cheeks. This graphic is best viewed in color and will be available in color in the electronic version of this report on the Fisheries Division Library internet web site.

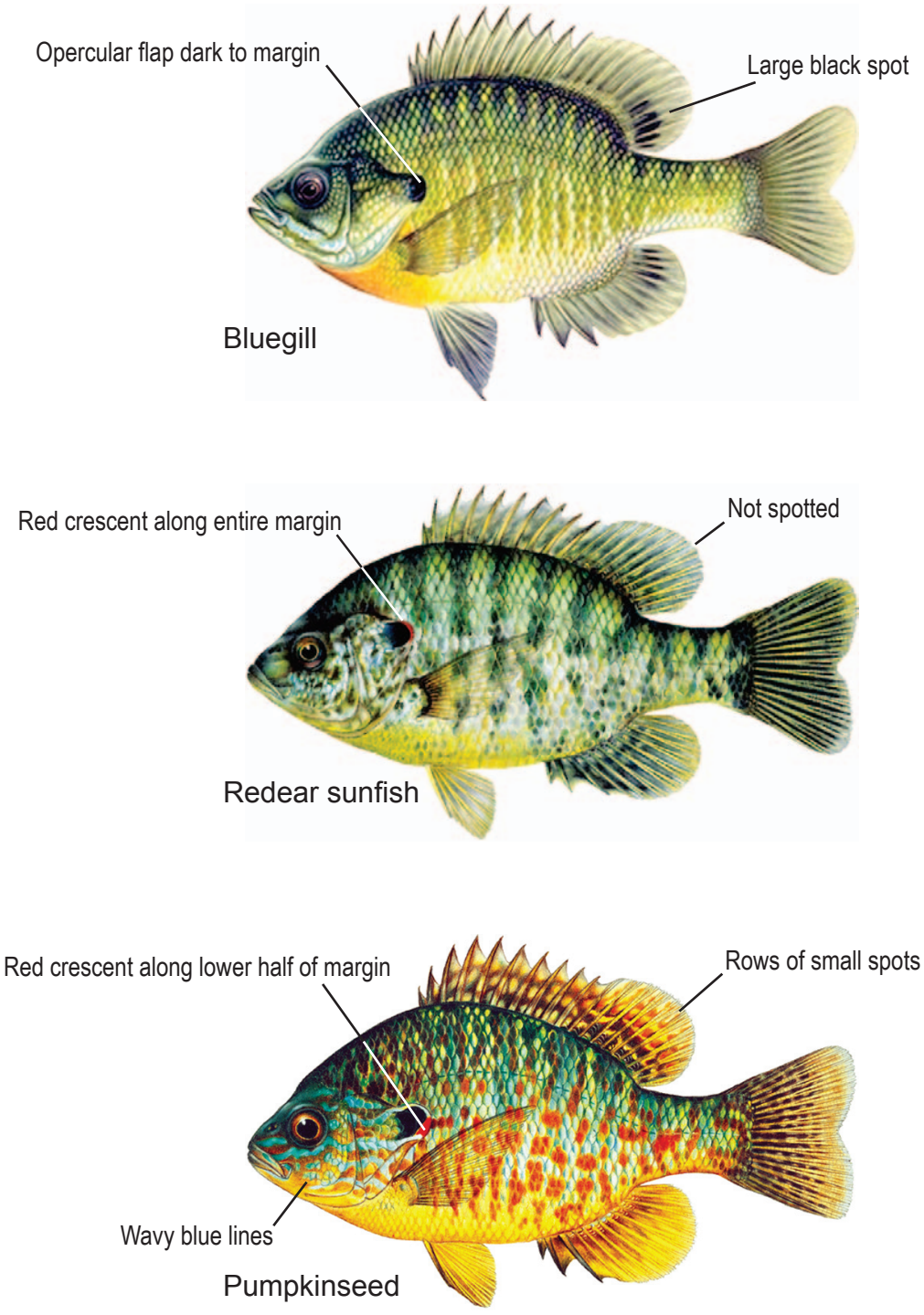

Figure 5.–A physical comparison of male bluegill, redear sunfish and pumpkinseed. Note that the redear sunfish is darker (olive-drab) with a complete crecent of red color along the posterior margin of the opercular flap; dorsal and anal fins are plain (not spotted), pectoral fins are long and there are no wavy blue lines in the cheeks. This graphic is best viewed in color and will be available in color in the electronic version of this report on the Fisheries Division Library internet web site.

Table 1.–History of stocking and biological field surveys for redear sunfish in Michigan. Sizes are in inches. Survey catches are from trap nets unless otherwise indicated.

County / Water body	Stocking				Survey	Redear sunfish			Bluegill			Angler	Largest redear	Largest	Largest
	Year	Number	Number/ acre	Average size	year	Number caught	Number/ lift	Average size	Number caught	Number/ lift	Average size	reports	sunfish	bluegill	pumpkinseed
Branch															
Cary Lake	1991	23,300	294.9	1.1	1994				106	13.3	6.8	no			
	1992	7,900	100.0	1.0	1998	11	2.8	10.2	288	72.0	7.4	no	10.8	9.5	7.0
	1993	8,000	101.3	1.4											
Coldwater Lake[1]	1956	151,000	267.0		1983	82	6.8	9.3	120	10.0	6.5	yes	12.1	9.4	
					1994	279	46.5	8.8	728	121.3	6.3	yes	11.9	10.1	7.2
					1988	270	45.0	8.8	92	15.3	7.1	yes	10.9	9.4	9.5
					1996	239	79.6	9.1	55	18.3	6.3	yes			
Gilead Lake	1986	12,300	94.6	2.0	1991	10	2.0	7.5	672	134.4	7.5	yes			
	1991	24,300	186.9	1.1									10.4	9.2	8.0
	1993	10,000	76.9	1.4											
Huyck Lake	1958	27,500	147.8	fry	1975	14[1]	0.9	11.7	210	13.1	5.3	yes		9.2	
Marble Lake					1986	16[1]	2.0	7.6	752	94.0	6.4	yes	8.5	8.3	6.5
Matteson Lake	1986	9,000	29.3	2.0	1988	3	0.5	7.5	373	62.2	6.5	yes	7.4	8.0	7.2
Oliverda Lake	1990	8,000	62.5	1.7										8.7	5.5
Rose Lake	1989	17,750	96.0	1.3	1993	72	12.0	8.5	386	64.3	6.7	yes			
	1991	62,700	176.6	1.1											
	1992	34,017	50.0	1.0	1998	61	7.6	8.8	414	51.8	5.5	yes	10.1	10.2	8.0
Union Lake	1989	6,000	14.0	1.3	1991	0	0.0	0.0	118	14.8	7.7	no		9.5	7.5
	1990	7,278	11.4	1.7	–										
Silver Lake	1956	46,250	240.8		1987	176[1]	19.5	8.2	75	8.3	7.5	yes			
	1985	10,500	49.3	1.8	1995	616	205.3	9.3	86	28.7	7.9	yes			
					1997	73	18.3	9.3	151	37.8	6.8	yes	11.0	9.0	6.5

Table 1.–Continued.

County / Water body	Stocking Year	Stocking Number	Stocking Number/ acre	Stocking Average size	Survey year	Redear sunfish Number caught	Redear sunfish Number/ lift	Redear sunfish Average size	Bluegill Number caught	Bluegill Number/ lift	Bluegill Average size	Angler reports	Largest redear sunfish	Largest bluegill	Largest pumpkinseed
Calhoun															
Brace Lakes	1984	30,000	162.2	1.6											
	1986	3,000	16.2	2.0											
Upper Brace Lake					1990	54	5.4	8.0	105	21.0	7.1	yes			
Lower Brace Lake					1990	143	28.6	8.0	297	59.4	6.2	yes			
					1996	100	16.7	9.2	65	10.8	6.4	yes	10.9	8.5	6.5
Duck Lake	1984	84,000	133.5	1.6	1987	16	1.6	8.2	109	10.9	7.2	yes			
	1986	20,000	31.8	2.0	1991	23	4.6	7.3	62	12.4	6.8	yes			
	1988	65,133	103.6	1.0	1996	30	7.5	8.5	47	11.8	7.0	yes	10.7	9.2	8.2
	1995	27,000	43.0	2.0											
Lee Lake	1984	23,500	202.6	1.6	1990	51	8.5	8.7	104	17.3	6.7	yes			
	1991	6,275	54.1	1.5	1994	42	10.5	8.1	305	76.3	6.4	yes	10.3	8.9	7.2
	1992	23,250	200.4	1.2											
Kalamazoo River	1985	10,000													
	1986	100,000[2]													
	1989	40		>5.0											
Cass															
Baldwin Lake					1973	74	12.3	7.7	126	21.0	5.5				
Long Lake					1973[4]	4	1.8	6.4	96	44.2	6.4				
Stone Lake	1967	100,000			1969[4]	14	7.0	6.3			4.3				
Clinton															
Lake Ovid	1995	46,125	111.9	2.0	1997	1	0.1	5.5	3550	295.8	6.2		5.8	8.6	8.6
	1997	45,517	110.5	2.5	1997[4]								5.8	7.5	7.5

Table 1.–Continued.

County / Water body	Stocking				Survey year	Redear sunfish			Bluegill			Angler reports	Largest redear sunfish	Largest bluegill	Largest pumpkinseed
	Year	Number	Number/ acre	Average size		Number caught	Number/ lift	Average size	Number caught	Number/ lift	Average size				
Eaton															
Narrow Lake	1985	10,500	118.0	1.8	1987[3]	0	0.0	0.0	64	16.0	6.3	no		9.0	6.9
	1995	9,000	96.8	2.0	1994	0	0.0	0.0	6,198	1033.0	5.6	no		8.5	6.9
	1996	4,370	47.0	2.8	1997	0	0.0	0.0	291	24.3	7.0	no		8.5	7.5
	1997	11,895	127.9	2.0											
Lake Interstate	1995	521	26.0	4.0	1997	3	0.3	7.8	0	0.0	0.0	no	8.9		6.5
	1996	1,075	53.8	2.8											
	1997	5,978	298.9	2.5											
Saubee Lake	1986	6,000		2.0	1989	24	3.0	7.2	390	48.8	6.5	yes	7.5	7.5	7.5
					1993	103	20.6	7.4	210	42.0	6.6	yes	9.8	8.5	7.0
Hillsdale															
Baw Beese Lake	1991	97,700	236.0	1.1	1996	65	24.0	8.3	189	47.3	5.9	yes	10.5	9.8	9
	1993	30,200	72.9	1.4											
	1995	73,950	38.0	2.0											
Bear Lake	1991	25,000	213.7	1.1	1994	10	1.3	7.9	337	42.1	7.0	no			
	1993	9,000	76.9	2.0	1997	17	4.3	8.5	393	98.3	7.9	yes	9.1	9.4	6.9
	1994	6,634	57.0	2.1											
Bird Lake	1991	25,000	221.2	1.1	1994	15	3.8	7.2	271	67.8	6.3	no			
	1993	9,000	88.0	2.0	1998	17	4.3	8.3	330	82.5	6.8	no	10.2	9.6	6.7
Cub Lake	1985	13,200	103.1	1.8	1988	7	1.2	8.1	113	18.8	7.4	yes			
	1989	5,085	74.0	1.25	1993	195	32.5	7.4	279	46.5	7.3	yes			
					1997	61	7.6	8.6	109	14.6	8.0	yes	10.0	9.3	7.8
Hemlock Lake	1990	12,300	87.9	1.7	1994	43	5.4	8.4	283	35.4	6.5	yes	10.2	8.3	7.0
	1991	7,166	51.2	1.8											
	1992	15,840	113.2												
Long Lake					1985	77	15.4	6.8	258	51.6	6.3	yes	9.7	8.8	6.7

Table 1.–Continued.

County / Water body	Stocking				Survey year	Redear sunfish			Bluegill			Angler reports	Largest redear sunfish	Largest bluegill	Largest pumpkinseed
	Year	Number	Number/ acre	Average size		Number caught	Number/ lift	Average size	Number caught	Number/ lift	Average size				
Jackson															
Big Portage Lake	1985	30,300	69.7	1.8	1989	194	32.3	8.6	128	21.3	6.5	yes			
	1987	2,100	4.8	2.0	1993	79	13.2	8.5	137	22.8	6.3	yes	10.4	8.7	8.1
	1991	19,328	44.4	1.5											
Clark Lake	1984	62,500	107.8	1.6	1988[3]	0	0.0	0.0	135	22.5	7.3	no		8.8	8.8
Clear Lake	1987	13,600	100.0	1.0	1991	71	14.2	8.4	288	57.6	6.5	yes			
					1995	228	57.0	8.1	361	90.3	5.8	yes	10.2	7.6	7.5
					1998	26	6.5	8.9	181	45.3	6.9	yes	10.5	8.3	8.5
Gilletts Lake	1986	2,000	5.7	2.0	1990	18	4.5	8.4	288	57.6	6.5	yes			
	1987	35,000	100.0	1.0	1995	106	26.5	8.5	218	54.5	6.6	yes	9.5	7.5	7.9
	1991	17,472	49.9	1.8											
Grass Lake	1987	35,000	100.0	1.0	1990	55	9.2	7.7	133	22.2	5.6	yes			
	1991	18,100	52.0	1.8	1995	168	42.0	8.7	91	22.8	6.0	yes	10.3	6.9	7.0
	1992	27,720	79.2	1.0											
Lime Lake	1985	17,000	177.1	1.8	1990	41	4.1	8.4	92	9.2	6.1	yes			
	1989	21,240	221.0	1.3	1995	141	35.3	8.5	20	5.0	6.7	yes	10.6	7.4	7.2
	1991	5,267	54.9	1.5											
	1992	9,600	100.0	1.0											
Pleasant Lake	1991	49,000	182.2	1.1	1994	3	0.5	6.2	212	354.3	6.5	no			
	1992	26,900	100.0	1.0	1998	16	2.0	8.5	957	119.6	6.4	no	9.0	9.2	8.2
	1993	27,000	100.4	1.4											
Round Lake	1985	16,300	105.2	1.8	1990	12	2.4	10.6	308	61.6	7.1	yes	11.0	9.5	8.9
	1991	15,738	101.5	1.8	1995	9	2.3	9.2	226	56.5	6.7	yes			
	1992	15,500	100.0	1.0											
Swains Lake	1987	7,000	100.0	1.0	1990	160	16.0	8.0	169	16.9	7.3	yes			
	1988	9,678	138.3	>1.0	1993	54	13.5	7.1	262	65.5	6.4	yes			
					1996	244	61.0	8.4	150	37.5	7.2	yes	10.2	8.3	6.5

Table 1.–Continued.

County / Water body	Stocking Year	Stocking Number	Stocking Number/ acre	Stocking Average size	Survey year	Redear sunfish Number caught	Redear sunfish Number/ lift	Redear sunfish Average size	Bluegill Number caught	Bluegill Number/ lift	Bluegill Average size	Angler reports	Largest redear sunfish	Largest bluegill	Largest pumpkinseed
Lapeer															
Duperow Lake	1998	2,108	351.3	3.3											
Twin Lake	1998	1,321	66.0	3.3											
Watts Lake	1998	600	150.0	3.3											
Lenawee															
Devil's Lake	1985	77,600	58.3	1.8	1988	4	0.8	7.5	57	11.4	5.8	yes		9.3	9.2
	1991	69,043	51.9	1.7											
Sand Lake	1991	38,394	87.3	1.5	1994	1	0.3	7.5	251	62.8	6.0	no	7.5	9.8	8.0
	1992	33,000	75.0	1.0											
Wamplers Lake	1990	40,000	51.3	1.7	1994	50	8.3	8.5	144	24.0	6.6	yes	9.5	8.5	8.5
	1991	40,285	51.6	1.8											
Livingston															
Bishop	1992	11,900	100.0	1.1	1993				660	132.0	6.2				
	1993	10,000	84.0	2.3	1996	124	12.4	7.7	954	95.4	6.7	yes	10.3	8.2	8.5
	1994	5,900	49.6	2.0											
	1995	16,945	142.4	2.0											
Lake Chemung	1994	5,106	16.5	2.1	1995				372	46.5	7.4	no		9.5	8.5
	1995	38,400	123.9	2.0											
	1997	29,466	95.1	2.5											
East Crooked Lake	1995	25,200	100.0	2.5											
	1997	28,058	79.6	2.5											
	1998	2,512	10.0	3.3											
Whitmore	1995	67,700	100.0	2.0	1998	9	1.1	6.7	536	67.0	6.2	no	7.0	8.1	7.1
	1997	70,202	103.7	2.4											

Table 1.–Continued.

County / Water body	Stocking				Survey year	Redear sunfish			Bluegill			Angler reports	Largest redear sunfish	Largest bluegill	Largest pumpkinseed
	Year	Number	Number/ acre	Average size		Number caught	Number/ lift	Average size	Number caught	Number/ lift	Average size				
Mecosta															
Pretty Lake	1991	42,692	356.0	2.1	1992[3]				37	9.3	6.9				
	1992	12,100	101.0	2.0	1995	31	7.8	8.1	61	15.3	7.2	yes	9.2	8.0	8.4
Montcalm															
Rainbow Lake	1991	57,745	346.0	1.7	1995	23	5.8	7.6	31	7.8	5.8	yes	10.9	7.2	7.6
	1992	16,451	98.0	1.8											
	1993	12,714	75.6	1.5											
Oakland															
Dickenson Lake	1995	6,000	136.4	2.5	1998	0.0	0.0	0	165	13.8	5.7		0.0	10.1	6.9
	1996	5,000	113.6	2.0	1998[4]	3	4.1/hr	6.3	111	154/hr	3.7		6.8	7.1	5.7
	1997	5,769	131.1	2.6											
Cass Lake	1995	61,781	48.3	1.1	1996				867	10.3	6.6		0	9.4	6.7
	1996	9,206	7.2	1.5											
	1996	30	0.02	9.6											
Long Lake	1997	1,775	11.4	5.1											
	1998	857	5.5	4.7											
Tipsico Lake	1993	62,231	206.7	1.4	1997	26	4.33	7.2	248	41.3	5.1	yes	9.3	8.6	8.8
	1994	39,556	131.4	1.5											
	1995	68,391	227.2	1.1											
	1996	16,902	56.2	1.5											
Union Lake	1998	1,552	3.3	6.2											
Ogemaw															
DeVoe Lake	1991	10,000	95.2	1.8											

Table 1.–Continued.

County / Water body	Stocking				Survey year	Redear sunfish			Bluegill			Angler reports	Largest redear sunfish	Largest bluegill	Largest pumpkinseed
	Year	Number	Number/ acre	Average size		Number caught	Number/ lift	Average size	Number caught	Number/ lift	Average size				
Shiawasee															
Hopkins Lake	1993	3,000	300.0	2.3	1997	8	1.0	7.4	304	38.0	6.0	no	8.2	7.9	7.0
	1994	2,000	250.0	2.1											
	1995	2,000	250.0	2.0											
	1996	1,028	128.5	2.8											
St. Clair															
40th St. Pond	1993	20,979	466.2	1.4	1998	124	20.6	5.8	558	93.0	4.8	no			
	1994	10,000	222.2	1.5											
	1995	20,912	464.7	1.1											
St. Joseph															
Fish Lake					1973	44	7.3	7.6	108	18.0	6.2				
Thompson Lake[5]					2002	218	54.5	9.4	173	43.3	8.2	yes	12.4	10.0	9.4
Washtenaw															
Bruin Lake	1990	15,200	111.8	1.6	1994	16	4.0	6.4	364	91.0	6.8	yes			
	1991	6,825	55.5	1.8	1998	6	0.8	9.2	151	18.9	5.6	no	10.1	8.3	7.7
	1993	14,000	103.0	1.4											
Crooked Lake	1956	20,000	177.0		1988	48	12.0	9.9	58	14.5	7.3	yes	10.6	8.8	7.5
Four Mile Lake	1987	13,400	52.3	1.0	1990	3	0.3	8.8	138	13.8	6.2	no			
	1991	26,000	101.6	1.1	1995	49	6.1	8.6	114	14.3	5.9	yes	10.0	7.9	8.3
	1992	25,344	99.0	1.0											
	1993	27,600	107.8	1.4											
Halfmoon Lake	1987	23,600	100.0	1.0	1991	0	0		384	96.0	7.5	no		9.7	8.5
Independence Lake	1991	16,000	83.3	1.1	1994	70	17.5	6.6	480	120.0	5.4	yes	7.7	8.0	8.0
	1993	22,400	116.7	1.0											

[1] Previous redear sunfish population existed.
[2] Estimated escapement from rearing pond due to flood waters.
[3] Poor weather conditions during the survey led to the poor catch.
[4] Electrofishing survey
[5] Recent information from a lake not formerly known to hold a redear population.

Table 1.–Continued.

County / Water body	Stocking				Redear sunfish				Bluegill				Largest		
	Year	Number	Number/ acre	Average size	Survey year	Number caught	Number/ lift	Average size	Number caught	Number/ lift	Average size	Angler reports	redear sunfish	Largest bluegill	Largest pumpkinseed
Washtenaw															
Joslin Lake	1995	18,700	100.0	1.8	1997	189	21.0	6.8	540	60.0	7.0	Yes	9.5	8.5	8.5
	1996	5,540	30.0	2.0	1998	264	26.4	8.1	167	16.7	7.0	Yes	8.7	8.0	8.2
	1997	16,602	89.0	2.5											
Mill Lake	1990	16,762	98.6	1.4	1994	57	14.3	7.4	129	32.3	6.2	Yes			
	1991	7,100	50.0	1.8	1997	32	4.0	7.5	219	27.4	6.3	Yes	10.4	7.7	6.9
	1993	14,400	118.1	1.7											
North Lake	1991	28,800	126.9	1.1	1996	79	19.8	8.5	67	16.7	7.3	Yes	10.6	8.0	8.4
	1992	23,760	104.7	1.0											
	1993	23,000	101.3	1.4											
Silver Lake	1991	40,000	196.1	1.1	1994	29	4.1	7.9	296	42.3	6.2	Yes			
	1993	12,000	58.8	2.3	1998	193	48.3	9.3	72	18.0	6.8	Yes	11.3	10.0	8.9
	1995	17,000	112.0	2.0											
South Lake	1995	8,640	44.0	1.8	1998	103	12.8	7.8	204	25.5	5.9	Yes	10.5	8.8	8.4
	1996	11,827	60.0	2.0											
	1997	15,258	77.0	2.5											

[1] Previous redear sunfish population existed.
[2] Estimated escapement from rearing pond due to flood waters.
[3] Poor weather conditions during the survey led to the poor catch.
[4] Electrofishing survey.
[5] Recent information from a lake not formerly known to hold a redear population.

Table 2.–State average total length (inches) by age and month for bluegill, pumpkinseed, and redear sunfish in Michigan (Schneider 2000).

Age	Month	Bluegill	Pumpkinseed	Redear sunfish
0	Jan-May			
	Jun-Jul			
	Aug-Sep			
	Oct-Dec	1.8	1.8	1.9
1	Jan-May	1.8	1.8	1.9
	Jun-Jul	2.4	2.4	2.8
	Aug-Sep	3.3	3.3	3.6
	Oct-Dec	3.8	3.8	4.4
2	Jan-May	3.8	3.8	4.4
	Jun-Jul	4.2	4.2	5.0
	Aug-Sep	4.7	4.6	5.6
	Oct-Dec	5.0	4.9	6.2
3	Jan-May	5.0	4.9	6.2
	Jun-Jul	5.3	5.2	6.9
	Aug-Sep	5.8	5.4	7.4
	Oct-Dec	5.9	5.6	7.6
4	Jan-May	5.9	5.6	7.6
	Jun-Jul	6.2	5.8	8.0
	Aug-Sep	6.6	6.0	8.3
	Oct-Dec	6.7	6.2	8.7
5	Jan-May	6.7	6.2	8.7
	Jun-Jul	6.9	6.3	9.0
	Aug-Sep	7.1	6.5	9.1
	Oct-Dec	7.3	6.6	9.6
6	Jan-May	7.3	6.6	9.6
	Jun-Jul	7.4	6.8	9.8
	Aug-Sep	7.6	7.0	10.1
	Oct-Dec	7.8	7.1	10.3
7	Jan-May	7.8	7.1	10.3
	Jun-Jul	8.0	7.2	10.5
	Aug-Sep	8.1	7.4	10.7
	Oct-Dec	8.2	7.5	10.8
8	Jan-May	8.2	7.5	10.8
	Jun-Jul	8.4		
	Aug-Sep	8.5		
	Oct-Dec	8.6		
9	Jan-May	8.6		
	Jun-Jul	8.7		
	Aug-Sep	8.8		
	Oct-Dec	8.9		
10	Jan-May	8.9		

Table 3.–Comparison of panfish sizes in lakes where redear sunfish populations have attained at least five years of age.

Lake[1]	Years since first redear sunfish introduced	Redear sunfish		Bluegill		Pumpkinseed	
		Average size	Largest	Average size	Largest	Average size	Largest
Cary Lake	7	10.2	10.8	7.4	9.5	6.5	7.0
Coldwater Lake	unknown	9.3	11.9	6.5	10.1	6.4	7.2
Lake George	40	8.8	10.9	6.3	9.4	n/a[2]	9.5
Gilead Lake	5	7.5	10.4	7.5	9.2	6.8	8.0
Huyck Lake	17	11.7	11.7+[3]	5.3	9.2	5.0	5.0+[3]
Marble Lake	unknown	7.6	8.5	6.4	8.3	6.0	6.5
Rose Lake	9	8.8	10.1	5.5	10.2	6.9	8.0
Silver Lake	41	9.3	11.0	6.8	9.0	7.3	6.5
Lower Brace Lake	12	9.2	10.9	6.4	8.5	6.5	6.5
Duck Lake	12	8.5	10.7	7.0	9.2	7.7	8.2
Lee Lake	10	8.1	10.3	6.4	8.9	6.2	7.2
Baw Beese Lake	5	8.3	10.5	5.9	9.8	7.4	9.0
Bear Lake	6	8.5	9.1	7.9	9.4	6.5	6.9
Bird Lake	7	8.3	10.2	6.8	9.6	5.2	6.7
Cub Lake	12	8.6	10.0	8.0	9.3	6.0	7.8
Big Portage Lake	8	8.5	10.4	6.3	8.7	6.4	8.1
Clear Lake	11	8.9	10.5	6.9	8.3	8.0	8.5
Gilletts Lake	9	8.5	9.5	6.6	7.5	6.6	7.9
Grass Lake	8	8.7	10.3	6.0	6.9	6.2	7.0
Lime Lake	10	8.5	10.6	6.7	7.4	5.8	7.2
Pleasant Lake	7	8.5	9.0	6.4	9.2	6.0	8.2
Round Lake	5	10.6	11.0	7.1	9.5	7.2	8.9
Swains Lake	9	8.4	10.2	7.2	8.3	6.5	6.5
40th St. Pond	5	5.8	7.1	4.8	8.3	4.4	6.0
Bruin Lake	8	9.2	10.1	5.6	8.3	5.2	7.7
Crooked Lake	32	9.9	10.6	7.3	8.8	7.3	7.5
Four Mile Lake	8	8.6	10.0	5.9	7.9	6.9	8.3
Mill Lake	7	7.5	10.4	6.3	7.7	5.7	6.9
North Lake	5	8.5	10.6	7.3	8.0	7.6	8.4
Silver Lake	7	9.3	11.3	6.8	10.0	8.0	8.9
Averages		8.7	10.3	6.6	8.8	6.5	7.6

[1] Lakes listed in order by county, as referenced in Table 1.
[2] Average size not reported, but assumed smaller than largest size
[3] Largest size not reported, but assumed greater than the average size

Table 4.–Trophy redear sunfish reported in Michigan's Master Angler Program from 1986-2002.

Year	Lakes with populations prior to 1984	Lakes stocked since 1984[3]	Total
1986		1	1
1987	--	--	--
1988	2	1	3
1989	1[1]	2	3
1990	4[1]	1	5
1991	3	--	3
1992	4	5[2]	9
1993	7	2	9
1994	6	--	6
1995	9	8	17
1996	3[1]	5	8
1997	3	3	6
1998	1	6	7
1999	2	17	19
2000	3[1]	23	26
2001	3	35	38
2002	9[1]	25	34

[1] At least one redear sunfish was reported from a lake with no known date of stocking.

[2] One fish was entered too late to be included in the program, but was included.

[3] Lakes stocked since 1984 include: Portage Lake, Grass Lake, and Round Lake - Jackson County; Joslin Lake, Four Mile Lake, and North Lake - Washtenaw County; Gilead Lake - Branch County; Tipsico Lake, Long Lake, and Union Lake - Oakland County; Devils Lake and Wamplers Lake - Lenawee County; Duck Lake - Calhoun County; Crooked Lake - Livingston County; North Lime Lake - Jackson County; Long Lake, Boot Lake, and Baw Beese Lake - Hillsdale County; Fine Lake – Barry County; Lake Ovid – Clinton County.

Table 5.–Pumpkinseed catch, average lengths, and mean growth indices from trap net surveys of lakes before and after redear sunfish introductions in lakes where significant redear sunfish populations have developed. Sizes are in inches.

	Before redear sunfish introduction					After redear sunfish introduction						
	Pumpkinseed					Redear sunfish			Pumpkinseed			
County Water body	Survey year	Number caught	Number/ lift	Average size	Growth index	Survey year	Number caught	Number/ lift	Number caught	Number/ lift	Average size	Growth index
Branch												
Cary Lake	1984	na				1998	11	2.8	7	1.8	6.5	
Coldwater Lake						1983	82	6.8	0			
						1994	388	38.8	8	1.3	6.4	
Lake George						1996	239	79.6	0			
Gilead Lake	1987	15	3.0	6.0		1991	10	2	3	0.6	6.8	
Huyck Lake	1961	na				1975	14	0.9	16	1.0	5.0	
Rose Lake	1983	na				1993	72	12.0	5	0.8	6.9	
						1998	61	7.6	4	0.5	7.3	
Silver Lake						1987	176	19.5	3	0.3	7.1	
						1995	616	205.3	3	1.0	6.8	
						1997	73	18.3	14	3.5	5.9	
Calhoun												
Lower Brace Lake	1982	11	2.8	5.1		1996	100	16.7	1	0.2	6.5	
Duck Lake	1961	na				1987	16	1.6	124	12.4	7.1	1.0
						1991	23	4.6	18	1.0	7.4	
						1996	30	7.5	14	3.5	7.7	0.5
Lee Lake	1986	0	0			1990	51	8.5	3	0.5	6.8	
						1994	42	10.5	38	9.5	6.2	0.3
Eaton												
Saubee Lake	1987	14	4.7	5.9		1989	24	3	41	5.1	6.2	
						1993	103	20.6	24	4.8	5.7	0.2

Table 5.–Continued.

County / Water body	Before redear sunfish introduction: Pumpkinseed Survey year	Number caught	Number/ lift	Average size	Growth index	After redear sunfish introduction: Redear sunfish Survey year	Number caught	Number/ lift	Pumpkinseed Number caught	Number/ lift	Average size	Growth index
Hillsdale												
Baw Beese Lake	1988	10	1.3	6.3		1996	65	24.0	11	2.8	7.4	1.0
Bear Lake	1987	1	0.3	6.7		1994	10	1.3	27	3.4	7.1	0.5
						1997	17	4.3	2	0.5	6.5	
Bird Lake	1987	8	2.7	6.3		1994	15	3.8	24	6.0	5.2	-0.3
						1998	17	4.3	19	4.8	5.2	0.4
Cub Lake	1984	13	2.2	6.0		1993	195	32.5	1	0.2	6.5	
						1997	61	7.6	4	0.5	6.0	
Hemlock Lake	1983	0				1994	43	5.4	8	1.0	6.0	
Jackson												
Big Portage Lake	1982	82	10.2	6.0		1989	194	32.3	16	2.7	6.8	0.8
						1993	79	13.2	21	3.5	6.4	-0.1
Clear Lake	1985	23	5.7	7.3		1991	71	14.2	31	6.2	6.6	-0.2
						1995	228	57.0	18	4.5	6.8	0.0
						1998	26	6.5	4	1.0	8.0	
Gilletts Lake	1985	167	27.8	5.6		1990	18	4.5	16	4.0	7.6	
						1995	106	26.5	15	3.8	6.6	0.5
Grass Lake	1986	141	23.5	6.0		1990	55	9.2	66	11.0	6.1	0.3
						1995	168	42.0	29	7.3	6.2	0.1
Lime Lake	1982	13	1.6	5.5		1990	41	4.1	9	1.8	6.5	0.3
						1995	141	35.3	11	2.8	5.8	-0.1
Pleasant Lake	1986	7	1.8	4.6		1998	16	2.0	88	11.0	6.0	0.3
Round Lake	1985	11	1.8	6.8	0.6	1990	12	2.4	16	3.2	7.2	1.7

Table 5.–Continued.

County Water body	Before redear sunfish introduction					After redear sunfish introduction						
	Pumpkinseed					Redear sunfish			Pumpkinseed			
	Survey year	Number caught	Number/ lift	Average size	Growth index	Survey year	Number caught	Number/ lift	Number caught	Number/ lift	Average size	Growth index
Jackson continued												
Swains Lake	1979	72	7.2	5.4	0.2	1996	9	2.3	0			
						1990	160	16.0	14	2.8	7.3	0.2
						1993	54	13.5	1	0.3	5.5	
						1996	244	61.0	3	0.8	6.5	
Wamplers Lake	1989	128	10.7	7.5	1.0	1994	50	8.3	114	19.0	7.5	0.8
Livingston												
Bishop Lake	1993	42	8.4	6.4	-0.3	1996	124	12.4	72	7.2	6.8	-0.1
Mecosta												
Pretty Lake	1992	34	8.5	6.9	0.4	1995	31	7.8	32	8.0	7.2	0.1
Montcalm												
Rainbow Lake	1990	34	8.5	5.5	-0.1	1995	23	5.8	37	9.3	7.1	0.4
Oakland												
Tipsico Lake	1988	85	4.7	5.3	-0.8	1997	26	4.3	55	9.2	5.9	-0.4
St. Clair												
40th St. Pond	1988	na				1998	124	20.6				

Table 5.–Continued.

County Water body	Before redear sunfish introduction					After redear sunfish introduction						
	Pumpkinseed					Redear sunfish			Pumpkinseed			
	Survey year	Number caught	Number/ lift	Average size	Growth index	Survey year	Number caught	Number/ lift	Number caught	Number/ lift	Average size	Growth index
Washtenaw												
Bruin Lake	1988	14	1.8	6.2		1994	16	4.0	12	3.0	6.2	0.1
						1998	6	0.8	14	1.8	5.2	-0.3
Crooked Lake						1988	48	12.0	5	1.3	7.3	
Four Mile Lake	1985	89	14.8	6.8	0.4	1995	49	6.1	13	1.6	6.9	0.3
Independence Lake	1983	29	7.3	6.7		1994	70	17.5	97	24.3	5.7	-0.9
Joslin Lake	1988	102	25.5	6.5	0.1	1997	189	21.0	128	14.2	7.2	0.3
						1998	264	26.4	147	15.4	7.2	0.7
Mill Lake	1987	24	3.0	6.5	0.1	1994	57	14.3	20	5.0	5.9	-0.7
						1997	32	4.0	9	1.1	5.7	
North Lake	1988	53	8.8	6.9	0.0	1996	79	19.8	28	7.0	7.6	0.6
Silver Lake	1987	9	1.8	6.4		1994	29	4.1	112	16.0	6.6	0.2
						1998	193	48.3	42	10.5	8.0	1.1
South Lake	1987	20	5.0	6.5	0.9	1998	103	12.8	36	4.5	6.4	0.5

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