A review of yellow perch (*Perca flavescens*) spawning biology and habitat enhancement

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SUMMARY. Yellow perch (*Perca flavescens*) are widely distributed in temperate waters of North America and are an important commercial and recreational species. Perch populations in Montana have been reported to spawn in April - early May at water temperatures of 46 - 50 °F (8 - 10 °C). Perch can utilize a variety of spawning substrates, but appear to prefer inundated terrestrial vegetation, woody debris, and submerged macrophytes. Perch year-class strength and recruitment has been related to a variety of factors including lake/reservoir water levels, influencing the amount of inundated terrestrial vegetation, presence of macrophyte or woody debris in the littoral zone, wind, temperature, and predation. Presumably vegetated or woody debris littoral spawning habitats influence year-class strength and recruitment by increasing egg and juvenile survival. These organic substrates provide structure for egg mass attachment and reduce the risk of wind driven currents physically destroying eggs or dislodging and dispersing eggs to less favorable benthic environments where they can be suffocated by sediments. These habitats may also provide predation protection for juveniles. Projects to enhance perch spawning habitat have been reported in Montana, North Dakota, South Dakota, Wisconsin, Michigan, and Ohio, and have most often used conifer trees and deciduous brush bundles. These materials were easily obtained for use in habitat projects and readily used by perch spawners, but decomposed quicker than synthetic structures. Longevity of these structures averaged four years and increased with year around submergence and larger structure size. Recommended depths for perch spawning structures are 6 - 20 ft (2 – 6 m) with structures best positioned horizontally to maximize area for perch to drape egg masses. There is no conclusive evidence that these structures actually increase perch year-class strength and recruitment. Direction of biologists familiar with local perch

populations is essential in determining habitat deficiencies, obtaining authorization and permits, and selecting locations and depths for habitat enhancement structures. Habitat enhancement for perch appears applicable to Canyon Ferry Reservoir where the availability of littoral vegetation and woody debris is limited due to low water levels during perch spawning. However, it will be difficult to provide a sufficient amount of spawning habitat to influence perch recruitment in a reservoir of this size. Any proposed structure placements for perch spawning enhancement will require careful planning, consideration of reservoir size, and good knowledge of average and extreme meteorological conditions (temperature, wind, etc...), water level management scenarios, and predation factors which may influence perch year-class strength and recruitment. Additional discussion and recommendations are presented.

Introduction

Yellow perch (*Perca flavescens*) and the closely related Eurasian perch (*Perca fluviatilis*) are widely distributed in freshwater habitats of the Northern Hemisphere (Thorpe 1977a; Scott and Crossman 1973). In North America, yellow perch (hereafter referred to as perch) naturally occurred from Nova Scotia south along the Atlantic to the Florida panhandle, and west from Pennsylvania to the Missouri River, including eastern Kansas northwest to Montana, and from the Canadian Rockies in Manitoba east (Scott and Crossman 1973). Perch may have been introduced into Montana as early as 1904, and are an important game species in Canyon Ferry Reservoir (Montana Department of Fish, Wildlife, and Parks (MFWP) 1992). Perch have been widely introduced and now exist in most northwestern states including Washington, Idaho, Utah, and Oregon (Scott and Crossman 1973). Perch are an important recreational and commercial species throughout their range, particularly in the Great Lakes, and an important prey species for predators such as walleye and sauger (*Stizostedion spp.*) (Nielsen 1980; Lyons 1987; Goeman et al. 1990; Johnson et al. 1992).

Canyon Ferry Reservoir, located in west central Montana, was filled in 1955 and is the first major impoundment of the Missouri river, with a surface area of 35,200 acres at full pool, a length of approximately 25 miles, and widths ranging from 1.0 to 4.5 miles (MFWP 1992). The lowest water levels typically occur in March with an average reservoir draw down of 12 ft and the reservoir fills during March-June (MFWP 1992). Notable sport fish in Canyon Ferry include perch, walleye (*Stizostedion vitreum*), ling (*Lota lota*) and rainbow trout (*Oncorhynchus mykiss*). The maximum reservoir draw down coincides with perch spawning in late April through mid-May, preventing the use of emergent shoreline vegetation for spawning habitat (Bandow 1969).

Objectives and Methods

The goal of this project was to develop a synopsis of perch spawning habitat enhancement techniques with emphasis on Montana waters, especially Canyon Ferry Reservoir. The objectives included reviewing perch spawning biology, including which substrates have been found optimum for perch reproduction, and summarizing knowledge on the use and effectiveness of artificial spawning habitat enhancement for perch in Montana and elsewhere.

An examination of the peer-reviewed fisheries literature and a survey mailed to 147 fisheries biologists/managers in 20 states and 5 Canadian provinces were conducted to gather information on perch (Table 1). State and provincial fisheries biologists were asked to provide any information on perch management/enhancement projects in their region (see Appendix A). Survey respondents were also asked to list any contacts to other workers studying perch.

Survey Results

A total of 74 responses (50%) were received from surveyed fisheries biologists/managers (Table 1). At least one response was received from each state or province queried. Many Western states (Arizona, California, Colorado, Idaho, Nebraska, Nevada, New Mexico, Oregon, and Washington) either have few perch, have not conducted related habitat studies, or do not actively manage perch. Perch are not present in Alaska and few populations exist in British Columbia. Manitoba, Ontario, and Saskatchewan manage perch populations, but have not conducted any known research on

Table 1. Response of state and provincial fish biologist/managers to survey on yellow perch spawning habitat and habitat enhancement projects.

State/Province	Letter of Request # Sent	# Returned	Information Received*
Alaska	4	2	d
Arizona	6	4	d
California	5	2	c
Colorado	3	2	c
Idaho	8	4	c
Michigan	13	7	a
Minnesota	7	1	c
Nebraska	5	4	c
Nevada	3	2	c
New Mexico	4	2	c
New York	9	2	b
North Dakota	3	3	a,b
Ohio	5	2	a, b
Oregon	5	1	c
Pennsylvania	8	5	c
South Dakota	4	2	b
Utah	5	4	c
Vermont	5	2	c
Washington	7	4	c
Wisconsin	9	5	a
Alberta	6	2	c
British Columbia	8	5	d
Manitoba	5	2	c
Ontario	5	1	c
Saskatchewan	5	4	c
Totals	147	74	

*Information Codes:
a -sent information on yellow perch habitat enhancement projects
b -sent information on yellow perch spawning habitat
c -manage yellow perch; but have not made requested studies
d -do not have/manage yellow perch

spawning habitat or enhancement projects. Formal research on perch spawning habitat has been conducted in South Dakota, Wisconsin, and Ohio. Only one written evaluation of a habitat enhancement project in Ohio was obtained from a gray literature (not published in peer-reviewed literature) report, but survey respondents reported habitat enhancement projects in Michigan, Montana, North Dakota, South Dakota, and Wisconsin. Survey respondents also listed key contacts to university researchers and other workers studying perch.

Perch Spawning Biology

Perch typically mature in their third year (males) and fourth year (females) (Collette et al. 1977; Scott and Crossman 1973), but also have been reported to mature early as two (males) and three (females) year-olds (Thorpe 1977a). Hayes and Taylor (1990) reported age at first spawning might be related to diet quality. They suggested perch populations consuming zooplankton, benthic macroinvertebrates, and fish matured later and grew larger, as opposed to those utilizing only zooplankton. Bandow (1969) reported most Canyon Ferry Reservoir male perch >5.0 inches (12.7 cm) (2 - 3 year-olds) and female perch >7.0 inches (17.8 cm) (3 - 4 year-olds) were mature. Perch require winter water temperatures <50 °F (10 °C) for gonadal development and maturation (Hokanson 1977). Gonadal development in Canyon Ferry perch began in early September and gonads of either sex were conspicuous by October (Bandow 1969). Perch have a high reproductive potential and fecundity increases with age and may range from 3,000 - 120,000 eggs/female (Thorpe 1977b; Weber and Les 1982). Fecundity of 6,600 - 47,000 in females 5.6 - 10.7 inches (14.2 - 27.2 cm) has been observed in Canyon Ferry (Bandow

1969). Rising water temperatures, completion of maturation, and photoperiod may be proximate cues for perch to move from deeper water to spawning areas (Hokanson 1977; Krieger et al. 1983). Spawning occurs from late February through July at temperatures of 37 - 61 °F (3 - 16 °C), with peak spawning usually near 50 °F (10 °C), throughout the geographical range of perch populations (Collette et al. 1977; Hokanson 1977; Thorpe 1977b; Ney 1978). Populations at the southern limit of perch range are adapted to spawn earlier and at higher temperatures, while those at the northern limit spawn later at lower temperatures at the cost of gamete viability in populations nearing perch range/temperature limits (Hokanson 1977; Thorpe 1977b). Spawning in Montana and South Dakota perch populations has been reported from April - May at temperatures from 46 - 55 °F (8 - 13 °C), with peak spawning in main stem Missouri River reservoirs usually during the first week of May at temperatures of 50 °F (10 °C) (Echo 1955; Nelson and Walburg 1977). Bandow (1969) reported that Canyon Ferry Reservoir perch spawned from the last week in April though mid-May at temperatures of 45 - 57 °F (7 - 14 °C). Perch spawning usually consists of several males pursuing a single female who extrudes a convoluted egg mass up to 2 m in length (Balon et al. 1977; Thorpe 1977a). Perch are generally less aggregated during spawning due to the ability to use a variety of spawning substrates and spawn in various locations, as opposed to more discrete spawning grounds used by other percids such as walleye (Balon et al. 1977; Collette et al. 1977).

Perch Spawning Habitat

Perch typically spawn in shallow water with low current velocities at depths of 1 – 12 ft (0.3 - 3.7 m) (Echo 1955; Forney 1971; Weber and Les 1982; Kreiger 1983), but have been observed spawning at depths up to 39 ft (12 m) (Aalto and Newsome 1989).

Fisher et al. (1996) reported 26 of 31 observed yellow perch egg masses in Pickerel Lake, South Dakota were at depths of 1 – 3 ft (0.3 – 0.9 m) and 5 egg masses were at depths of 5 - 6 ft (1.5 – 1.8 m). Perch appear to spawn in shallower water where lake bottom slopes are gradual (i.e. Fisher 1996), and in deeper water where slopes are greater (i.e. Aalto and Newsome 1989). Perch utilize a variety of substrate for spawning including gravel, sand, macrophytes, and submerged brush and trees (Scott and Crossman 1973; Balon et al. 1977; Ney 1978; Weber and Les 1982). Balon (1975) and Balon et al. (1977) classified perch as phyto-lithophils noting that perch may utilize diverse spawning habitats, including vegetation and rocky substrates, and were better adapted to lentic environments than other percid lithophils such as walleye which require rocky substrate for spawning. Echo (1955) observed perch eggs masses in Lower Thompson Lake, Montana on submerged conifer trees (*Pinus ponderosa* and *Pseudotsuga taxifolia*), birch trees (*Betula fontinalis*), bulrush (*Scirpus validus*), stonewort (*Chara*), and gravel/mud bottom substrate, with conifer trees the most commonly observed substrate utilized down to gravel/mud bottom as the least, respectively. No indication of availability for each of these spawning substrates was noted. Day (1983) reported perch spawned on conifer tree structures in areas that had not been used for spawning prior to tree placement. Fisher et al. (1996) reported spawning perch most often selected periphyton-free woody debris in the main body of Pickerel Lake, South Dakota, as opposed to macrophytes in bays protected from wind or gravel bottom substrate. Perch spawning on recently placed structures including eight deciduous shrub bundles and eight conifer trees was monitored for one season in Lake Goldsmith, South Dakota (Fisher 1996). She detected no significant difference in selection for either structure even though the deciduous bundles grew abundant periphyton. Given similar availability, perch appear to prefer wood or macrophyte spawning substrate. Research is inconclusive on whether perch prefer periphyton free "clean" woody debris versus periphyton occluded "dirty" woody debris. Spawning on wood or macrophyte substrates may increase perch survival.

Perch Movements and Population Structure

Hatching of perch eggs occurs in two to three weeks at typical spring water temperatures 46 - 59 °F (8 - 15 °C) (Ney 1978). Echo (1955) reported perch hatching in approximately 23 days at 57 °F (14 °C). Perch larvae are pelagic and are found in shallow littoral areas near spawning sites after hatching but are often carried further offshore by currents (Mack 1983). Perch return inshore when they reach 1.0 – 1.6 in (25 - 40 mm) in length (Thorpe 1977a). Juvenile perch (age 0 - II) are generally located in shallow littoral habitats but may move to deeper waters in late summer - early fall (Ney 1978; Griswold and Bjornn 1989). Adult perch (>age II) are typically located offshore in deeper waters in aggregations stratified by age and size, are mostly active during the day, and have seasonal migrations from deeper wintering waters to shallow spawning areas in the spring (Collette 1977; Thorpe 1977b). Tagging studies indicate adult perch move little from specific areas which may lead to the formation of sub-populations (demes) in large impoundments with numbers in each deme varying independently of each other (Thorpe 1977b; Newsome and Aalto 1987; Aalto and Newsome 1989).

Habitat Influence on Perch Abundance

Several authors have positively related perch year-class strength and recruitment to the availability of macrophyte or woody debris spawning substrates. Weber and Les (1982) reported that more young-of-the-year perch were produced from areas with macrophytes than from those without. Beckman and Elrod (1971) noted strong year classes of perch could be due in part to the submergence of were terrestrial vegetation during filling of Lake Oahe, South Dakota. They reported perch abundance declined as the brush decomposed after full pool was reached. Nelson and Walburg (1977) reported a positive correlation between perch year-class strength and water levels, which influenced the amount of inundated terrestrial vegetation, in Lakes Francis Case and Oahe, South Dakota. Henderson (1985) found higher water levels, which increased the amount of inundated shoreline vegetation, were positively related with perch recruitment in South Bay, Lake Huron. Perch were more abundant in South Dakota lakes with extensive littoral aquatic macrophytes (Lakes Cochrane, Enemy Swim, and Pickerel) compared with populations in lakes with few macrophytes (Lakes Clear, Madison, and Spirit) where perch recruitment was erratic (Lott et al. 1996). High quality spawning habitat for perch is important since each year's reproductive potential is deposited in a single egg mass (Fisher 1996). Vegetation or woody debris in littoral habitats presumably influence perch year-class strength by increasing egg and juvenile survival. These spawning habitats may provide secure attachment structure for egg masses thus reducing the effect of wind driven currents, elevating egg masses and keeping them free of fine sediments and low dissolved oxygen environments, and providing predation protection.

Influence of Wind, Temperature, Food Habits, and Predation on Perch Abundance

Other factors including wind, temperature, food, and predation may influence perch year-class strength and recruitment. High wind driven currents can disperse perch eggs masses to less favorable environments and cause physical destruction of egg masses, especially in shallow lakes (Clady and Hutchinson 1975). Perch year-class strength has been positively related to spring water temperatures during and after perch spawning (Eshenroder 1977). Hokanson (1977) reported an increasing temperature regime during perch egg incubation enhanced survival. Clady (1976) and Forney (1979) suggested both lower water temperatures and high winds act in a complex manner causing both destruction of eggs and increased mortality of embryos and larvae. Aalto and Newsome (1993) suggested high winds in shallow lakes may increase perch egg mortality by physical destruction of eggs and larvae, while thermal shocks caused by upwelling of colder, deeper waters due to offshore winds, may increase egg and larval mortality in deeper lakes. Kallemeyn (1987) examined the effect of temperature, water levels, and wind on perch year-class strength in four Minnesota lakes. He found increased year-class strength was primarily related to higher, stable water temperatures, but was also positively related to water levels and inversely related to wind velocities.

Perch larvae begin feeding on zooplankton approximately three days after hatching (Siefert 1972). Young-of-the-year perch feed primarily on copepods and cladocerans (Ney 1987). Perch may be particularly sensitive during the switch from internal food sources to external feeding (Clady 1976). Fisher (1996) reported a weak perch year class in the consistently recruiting Pickerel Lake, South Dakota was likely a result of low zooplankton densities during the larval period.

Predation can significantly influence perch year-class strength and recruitment. Perch often occur in waters with percid piscivores including sauger and walleye (Ney

1978). Young-of-the-year perch may be heavily preyed upon by these species (Kelso and Ward 1977; Swenson 1977). Some authors have observed perch year-class strength and subsequent recruitment set at age 0 or age I (Griswold and Bjornn 1989; Anderson et al. 1997), however Nielsen (1980) found heavy predation by walleye in Lake Oneida, New York continued through age II and early measures of year-class strength were not good predictors of perch recruitment.

Enhancement of Spawning Habitat

Projects to enhance perch spawning habitat have been reported in Montana, North Dakota, Michigan, Ohio, South Dakota, and Wisconsin. Table 2 summarizes reported projects. Most projects have used brush bundles or conifer "Christmas" trees which are typically discarded after the holiday season and available for free. Several methods of bundling and weighting these structures have been reported. North Dakota biologists reported drilling holes in the base of at least five conifer trees, running cable between the trees, and weighted this with an 80-pound concrete block (Charging 1990). Montana and North Dakota have used single conifer trees with cement bases formed using 5 gal bucket molds, but this method has been reported as labor intensive (Vaughn, Schlueter, personal communication). Single weighted whole trees have been used in Ohio and Wisconsin (Day 1983; Van Dyck pers.comm.). In Canyon Ferry Reservoir, 6 ft x 8 ft bundled brush piles of juniper (*Juniperus* spp.) were placed in the southern portion of the reservoir (Spoon pers.comm.). Structures have also been constructed from rolled wood or plastic snow fence including fish "condos" and "bass bungalows" (Phillips 1990). These structures have greater longevity than conifer trees or brush bundles, but are more

Table 2. Summary of perch habitat enhancement projects.

Water Body	State	Structure Type	#Structure (if known)	Evaluation	Reference
various small lakes	MI	rock and brush filled log cribs		structures utilized for spawning	Ziegler (pers.comm)
Canyon Ferry Res.	MT	brush bundles '6 ft x 8 ft	60	structures utilized for spawning	Spoon (pers.comm.)
L.Elmo L.Josephine Anita Res.	MT	single conifers brush bundles stake beds		structures utilized for spawning	Vaughn (pers.comm.)
Fort Peck Res.	MT	conifer reefs snow fence		structures utilized for spawning fence blew out	Wiedenhaft (pers.com
Fresno Res.	MT	conifers reefs brush bundles		structures utilized for spawning	Gilge (pers.comm.)
Tiber Res.	MT	brush bundles conifer trees		all structures utilized for spawning	Hill (pers.comm.)
Bynum Res.		brush bundles Berkley "fish habs"		Berkley structures hard to place; expensive; some collapsed and pieces washed ashore	Hill (pers.comm.)
Ashley L.	MT	plastic snow fence		structures utilized for spawning	Vashro (pers.comm.)
Lower Thompson L.	MT	single conifer tree birch tree chicken wire	2 plots of 1 each	experimental structures perch spawned on conifer most often	Echo (1955)
various waters throughout state	ND	conifer reefs tires brush bundles	>12,500	structures utilized for spawning evaluation ongoing; no documented effect on recruitment	Kraft (pers.comm.) Schlueter (pers.comm.) VanEeckhout (1987) Chargring (1990)
Ferguson Res.	OH	single confer trees	53	structures utilized for spawning no effect on perch recruitment	Day (1983)
Lake Goldsmith	SD	conifer trees brush bundles	8 of each	experimental structures structures utilized for spawning no selection for either structure	Fisher (1996)
various 100 - 400 acre lakes	WI	single trees		structures utilized for spawning placed at 8 ft depth	Van Dyke (pers.comm.

expensive and labor intensive to construct. Spawning perch utilized plastic snow fence structures placed in Lake Ashley, Montana (Vashro pers.comm.). Perch spawners also used snow fence structures placed in Fort Peck Reservoir, Montana, but strong currents destroyed these structures (Wiedenheft pers.comm.). Seeding of the littoral zone with terrestrial vegetation such as Kochia (*Kochia spp.*) during low water levels has been suggested for use as perch spawning substrate where lake levels increase during perch spawning (Gilge, Schlueter pers.comm.). This method would not be applicable to Canyon Ferry Reservoir where water levels are lowest only for a short time during perch spawning, making establishment of such vegetation difficult or impossible. Stake beds, constructed of vertically arranged stakes or pallets, and automobile tire reefs are more difficult to construct than conifer tree reefs (Van Eeckhout 1987) and would probably not be applicable for spawning perch. Few commercially available habitat structures have been used in perch spawning habitat enhancement projects because of high cost and poor effectiveness for spawning perch (Phillips 1990; Hill, pers.comm.). Longevity of conifer and brush structures vary depending on branch thickness, weather conditions, and water levels, but averaged around four years in Montana and North Dakota (Gilge, Kraft, Schlueter pers.comm.). Structures with thicker branches and submerged year around last longer, whereas those subject to periodic de-watering due to reduced water levels decomposed more rapidly (Gilge, Schlueter pers.comm.). North Dakota estimated an average cost of $2.12 - 2.87/conifer tree for approximately 8,000 trees (11 lakes) in 1988 and 2,950 trees (5 lakes) in 1989 (Van Eeckhout 1987). This figure included labor, operating costs, and materials, but does not account for volunteer labor and donated material that reduced actual expenditures.

Documentation of perch utilization was the most common evaluation of perch habitat enhancement structures performed. Perch spawning has been reported on many of the conifer and bundled brush structures (Day 1983; Fisher and Willis 1997; Spoon, Van Dyck pers.comm.). Echo (1955) observed spawning perch use of three structures, an 8-foot conifer tree, a 10-foot birch tree, and 2 x 8 foot section of chicken wire, each in two separate plots, and found 19 perch spawned on the conifer, 2 on the birch, and none on the chicken wire. Fisher (1996) did not detect a preference by spawning perch for either eight conifer trees or eight deciduous brush bundles. She noted testing of at least 600 structures units of each type would be required to detect a significant difference given the observed variability. Clearly, further research is required to determine the optimum structure type for habitat enhancement projects.

Little information was found evaluating the effect of spawning habitat enhancement on perch year-class strength and recruitment. Day (1983) reported the addition of 53 conifer trees to a 123 acre Ohio reservoir did not effect perch recruitment. In 17,500 acre Lake Audubon, North Dakota, placement of 12,500 conifer trees grouped in bundles of at least five trees have had no effect on perch recruitment, but evaluation is ongoing (Kraft pers.comm.). The complex factors reported to influence perch year-class strength and recruitment including habitat, wind, temperature, and predation may override any increased survival of perch eggs and juveniles due to habitat enhancement projects. Further evaluation is required to determine the effectiveness of spawning habitat enhancement, but enhancement projects may benefit perch by increasing egg survival and providing predation protection to juveniles in lakes devoid of littoral vegetation and woody debris.

Individual experienced in structure placement for spawning perch made several suggestions. Bundled brush and conifer structures should be oriented so branches are horizontal to maximize area for perch egg mass attachment (Gilge, Kraft, Schlueter pers.comm.). Habitat structures should be deposited where they will be at a depth of >6 ft (1.8 m) to avoid boat entanglement. Day (1983) recommended placing structures at depths <9.8 ft (3 m) to maximize use for perch. Fisher and Willis (1997) recommended depths of 8 - 10 ft (2.4 - 3.1 m) and distances of 30 - 35 yd (27 - 31 m) from shore. Placing structures before reservoir ice-out has been reported, however this method does not allow precise placement of structures at preferred depths (Van Eeckhout 1987; Gilge pers.comm.).

Recommendations

Several methods of habitat enhancement may be considered for perch. Management of reservoir water levels, influencing the amount of inundated terrestrial vegetation, can provide necessary spawning and rearing habitat and should be considered where feasible. Structure placements and seeding the littoral zone with terrestrial vegetation such as kochia during low water levels may increase spawning and rearing habitat, however there is a lack of conclusive evidence that perch populations benefit from these projects. This may be due to a combination of factors including the inability of enhancement projects to provide a sufficient amount of spawning habitat, increased predation of young perch by walleye and sauger, and abiotic factors such as fluctuating spring water levels, temperatures, and winds. Willis et al. (1997) noted that in large lakes (e.g. Canyon Ferry Reservoir) it may not be economically feasible to provide a minimum of 20% vegetation in the littoral zone stipulated in the habitat suitability index for optimum perch recruitment (Kreiger et al. 1983). They suggest habitat enhancement efforts should be focused on smaller lakes where the potential for significant benefit is highest. Habitat enhancement for perch is not applicable to all waters and should be only undertaken with caution. Structures may attract fish and increase harvest. Structure additions in waters where habitat is not deficient at best will have no effect on perch populations, but could conceivably reduce predation mortality and create an overabundance of perch with poor growth rates and lower maximum size (VanEeckhout 1987; Willis et al. 1997). Structure additions in these waters could also be detrimental to angling and other recreational users (VanEeckhout 1987). Therefore, habitat enhancement should only be considered as part of a well thought out management strategy for a specific body of water with full consideration of habitat, biotic, and angling effects on fish populations.

Assistance of biologists familiar with local fish populations is essential to any habitat enhancement project (Fisher and Willis 1997). They must be involved to determine habitat deficiencies, assist in obtaining authorization and permits, and in selecting proper materials and placement locations. Several general safety recommendations apply to structure placements in lakes and should be strictly adhered to. Structures must be navigable and sunk at least 6 ft (1.8 m) below the surface to avoid boat entanglement, located outside of swimming areas; structures should be bound together to remain intact, weighted to remain stationary when sunk, and submerged during open water periods to ensure proper placement (Van Eeckhout 1987). Structures should be submerged year around to maximize longevity.

Perch have readily used both conifer tree and brush bundle structures and have not shown selection to either type. This material appears optimum for spawning perch, is often easily obtainable, and when possible should be selected for habitat enhancement structures. If chosen, several conifer trees should be linked together to reduce labor of placing single trees. Both conifer trees and brush bundles should be positioned so branches are projecting horizontally to maximize area for perch to drape egg masses. These structures have the drawback of decomposing in several years but will likely continue to be utilized even after needles have disappeared and some decomposition has begun.

The availability of spawning substrate preferred by perch and reported to influence year-class strength (e.g. inundated terrestrial vegetation, woody debris, and aquatic macrophytes) is limited in Canyon Ferry Reservoir. Spawning perch have readily used previous deployments of bundled juniper brush at Canyon Ferry, and further structure additions will likely be utilized by spawning perch. However, it will be difficult to provide a sufficient amount of spawning habitat to affect perch recruitment in a reservoir of this size. Structures may also attract adult perch and increase angling mortality on them. New water level management scenarios in reservoirs of Canyon Ferry's size would likely be the most effective method of perch spawning habitat enhancement. Increased water levels during perch spawning have been positively related to perch year-class strength in other large Missouri River reservoirs (Nelson and Walburg 1977).

A range of biotic and abiotic factors potentially effect perch year-class strength and recruitment. Any proposed structure placements for perch spawning enhancement will require careful planning, consideration of reservoir size, and good knowledge of average and extreme meteorological conditions (temperature, wind, etc...), water level management scenarios, and predation factors which may influence perch year-class strength and recruitment.

Literature Cited

Aalto, S.K., and G.E. Newsome. 1993. Winds and the demic structure of a population of yellow perch (*Perca flavescens*). Canadian Journal of Fisheries and Aquatic Science 50: 496-501.

Aalto, S.K., and G.E. Newsome. 1989. Evidence of demic structure for a population of yellow perch (Perca flavescens). Canadian Journal of Fisheries and Aquatic Science 46: 184-190.

Anderson, M.R., S.J. Fisher, and D.W. Willis. 1997. Assessment of an early index to yellow perch recruitment in Eastern South Dakota glacial lakes. South Dakota Department of Game, Fish and Parks Special Report 97-17.

Balon, E.K., W.T. Momot, and H.A. Regier. 1977. Reproductive guilds of percids: results of the paleogeographical history and ecological succession. Journal of the Fisheries Research Board of Canada 34: 1910-1921.

Balon, E.K. 1975. Reproductive guilds of fishes: a proposal and definition. Journal of the Fisheries Research Board of Canada 32: 821-864.

Bandow, F.L. 1969. Observations on the life history of the yellow perch and fish population trends in Canyon Ferry Reservoir, Montana. M.S. thesis Montana State University, Bozeman, Montana, 32pp.

Beckman, L.G., and J.H. Elrod. 1971. Apparent abundance and distribution of Young-of-year fishes in Lake Oahe, 1965-1969. American Fisheries Society Special Publication 8: 333-347.

Charging, D. 1990. Forage improvement will aid fish growth in Lake Audubon. Dakota Country, July, pp. 44-46.

Clady, M. 1976. Influence of temperature and wind on the survival of early stages of yellow perch (Perca flavescens). Journal of the Fisheries Research Board of Canada 33: 1887-1893.

Clady, M., and B. Hutchinson. 1975. Effect of high winds on eggs of yellow perch *Perca flavescens*, in Oneida Lake, New York. Transactions of the American Fisheries Society 104(3): 524-525.

Collette, B.B., M.A. Ali, K.E.F. Hokanson, M. Nagiec, S.A. Smirnov, J.E. Thorpe, A.H. Weatherley, and J. Willemsen. 1977. Biology of Percids. Journal of the Fisheries Research Board of Canada 34: 1890-1899.

Day, R.E. 1983. An evaluation of the addition of artificial spawning substrate on yellow perch reproduction and year class strength in Ferguson Reservoir. Ohio Division of Wildlife Project F-29-R22, 31pp.

Echo, J.B. 1955. Some ecological relationships between yellow perch and cutthroat trout in Thompson Lakes, Montana. Transactions of the American Fisheries Society 84: 239-248.

Eshenroder, R.L. 1977. Effects of intensified fishing, species change, and spring water temperature on yellow perch *Perca flavescens*, in Saginaw Bay. Journal of the Fisheries Research Board of Canada 34: 1830-1838.

Fisher, S.J. 1996. Early life history of yellow perch in Eastern South Dakota Lakes. M.S. thesis University of South Dakota, 123pp.

Fisher, S.J., and D.W. Willis. 1997. Brush piles serving a dual-purpose role for South Dakota fish. South Dakota Conservation Digest, March-April, pp. 12-13.

Fisher, S.J., K.L. Pope, L.J. Templeton, and D.W. Willis. 1996. Yellow perch spawning habitats in Pickerel Lake, South Dakota. The Prairie Naturalist 28(2): 65-73.

Forney, J.L. 1979. Evolution of a management strategy for the walleye in Oneida Lake, New York. New York State Department of Environmental Conservation Project F-17-R, 67pp.

Forney, J.L. 1971. Development of dominant year classes in a yellow perch population. Transactions of the American Fisheries Society 100: 739-749.

Gilge, K.W. 1998. personal communication. Fisheries Biologist, Montana Department of Fish, Wildlife, and Parks.

Goeman, T.J., D.W. Anderson, and D.H. Schupp. 1990. Fish community responses to manipulations of yellow perch and walleye abundance. Minnesota Department of Natural Resources Division of Fish and Wildlife Report 404, 21pp.

Griswold, R.G., and T.C. Bjornn. 1989. Development of indices of yellow perch abundance in Cascade Reservoir, Idaho. Idaho Department of Fish and Game Project F-71-R-12, 46pp.

Hayes, D.B., and W.W. Taylor. 1990. Reproductive strategy in yellow perch (*Perca flavescens*): effects of diet ontogeny, mortality, and survival costs. Canadian Journal of Fisheries and Aquatic Science 47: 921-927.

Henderson, B.A. 1985. Factors affecting growth and recruitment of yellow perch *Perca flavescens* Mitchill, in South Bay, Lake Huron. Journal of Fish Biology 26: 449-458.

Hill, W.J. 1998. personal communication. Fisheries Biologist, Montana Department of Fish, Wildlife, and Parks.

Hokanson, K.E.F. 1977. Temperature requirements of some percids and adaptations to the seasonal temperature cycle. Journal of the Fisheries Research Board of Canada 34: 1524-1550.

Johnson, B.L., C. Luecke, R.S. Stewart, M.D. Staggs, S.J. Gilbert, and J.F. Kitchell. 1992. Forecasting effects of harvest regulations and stocking of walleyes on prey fish communities in Lake Mendota, Wisconsin. North American Journal of Fisheries Management 12: 797-807.

Kallemeyn, L.W. 1987. Correlations of regulated lake levels and climatic factors with abundance of young-of-the-year walleye and yellow perch in four lakes in Voyageurs National Park. North American Journal of Fisheries Management 7: 513-521.

Kelso, J.R.M., and F.J. Ward. 1977. Unexploited percid populations of West Blue Lake, Manitoba, and their interactions. Journal of the Fisheries Research Board of Canada 34: 1655-1669.

Kraft, B. 1998. personal communication. Fisheries Biologist, North Dakota Department of Fish and Game.

Krieger, D.A., J.W. Terrell, P.C. Nelson. 1983. Habitat suitability information: yellow perch. U.S. Fish and Wildlife Service FWS/OBS-82/10.55, 37pp.

Lott, J.P., D.W. Willis, and D.O. Lucchesi. 1996. Relationship of food habits to yellow perch growth and population structure in South Dakota Lakes. Journal of Freshwater Ecology 11(1): 27-37.

Lyons, J. 1987. Prey choice among piscivorous juvenile walleyes (*Stizostedion vitreum*). Canadian Journal of Fisheries and Aquatic Science 44: 758-764.

Mack, R.R. 1983. The distribution and abundance of fish larvae in Clear Lake, Iowa. M.S. thesis Iowa State University, Ames, Iowa, 82pp.

Montana Department of Fish, Wildlife, and Parks. 1992. Canyon Ferry Reservoir/Missouri River Fisheries Management Plan 1993-1998. Helena, Montana, 71pp.

Nelson, W.R., and C.H. Walburg. 1977. Population dynamics of yellow perch (*Perca flavescens*), Sauger (*Stizostedion canadense*), and walleye (*S. vitreum vitreum*) in four main stem Missouri River reservoirs. Journal of the Fisheries Research Board of Canada 34: 1748-1763.

Newsome, G.E., and S.K. Aalto. 1987. An egg-mass census method for tracking fluctuations in yellow perch (*Perca flavescens*) populations. Canadian Journal of Fisheries and Aquatic Science 44: 1221-1232.

Ney, J. 1978. A synoptic review of yellow perch and walleye biology. American Fisheries Society Special Publication 11: 1-12.

Nielsen, L.A. 1980. Effect of walleye (*Stizostedion vitreum vitreum*) predation of juvenile mortality and recruitment of yellow perch (*Perca flavescens*) in Oneida Lake, New York. Canadian Journal of Fisheries and Aquatic Science 37: 11-19.

Phillips, S.H. 1990. A guide to the construction of freshwater artificial reefs. Sport Fishing Institute, Washington D.C. 24pp.

Schlueter, L. 1998. personal communication. Fisheries Biologist, North Dakota Department of Fish and Game.

Scott, W.B., and E.J. Crossman. 1973. Freshwater fishes of Canada. Bulletin 184. Fisheries Research Board of Canada, Ottawa pp. 755-761.

Siefert, R. E. 1972. First food of larval yellow perch, white sucker, bluegill, emerald shiner, and rainbow smelt. Transactions of the American Fisheries Society 101: 219-225.

Spoon, R.L. 1998. personal communication. Fisheries Biologist, Montana Department of Fish, Wildlife, and Parks.

Swenson, W.A. 1977. Food consumption of walleye (*Stizostedion vitreum*) and sauger (*S. canadense*) in relation to food availability and physical conditions in Lake of the Woods, Minnesota, Shagawa Lake, and Western Lake Superior. Journal of the Fisheries Research Board of Canada 34: 1643-1654.

Thorpe, J.E. 1977a. Synopsis of biological data on the perch *Perca fluviatilis* Linnaeus, 1758 and *Perca flavescens* Mitchill, 1814. FAO Fisheries Synopsis 113, 138pp.

Thorpe, J.E. 1977b. Morphology, Physiology, Behavior, and Ecology of *Perca fluviatilis* L. and *P. flavescens* Mitchill. Journal of the Fisheries Research Board of Canada 34: 1504-1514.

Van Dyck, G. 1998. personal communication. Fisheries Manager, Wisconsin Department of Natural Resources.

Van Eeckhout, G.V. 1987. Artificial fish habitat: powerful tool catch 22. North Dakota Outdoors, April-May, pp.26-29.

Vashro, J.E. 1998. personal communication. Fisheries Manager, Montana Department of Fish, Wildlife, and Parks.

Vaughn, M.W. 1998. personal communication. Fisheries Fieldworker, Montana Department of Fish, Wildlife, and Parks.

Weber, J.J., and B.L. Les. 1982. Spawning and early life history of yellow perch in the Lake Winnebago system. Wisconsin Department of Natural Resources Technical Bulletin 130, 52pp.

Wiedenheft, W.B. 1998. personal communication. Fisheries Manager, Montana Department of Fish, Wildlife, and Parks.

Willis, D.W., D.O. Lucchesi, and B.G. Blackwell. 1997. Influence of aquatic vegetation on natural recruitment of some centrarchid, esocid, and percid fishes: a literature review. Federal Aid in Sportfish Restoration Project F-15-R, 26pp.

Ziegler, W. 1998. personal communication. Fish Biologist, Michigan Department of Natural Resources.

Appendix A

Jason Selong
Montana Fish, Wildlife, & Parks
1400 South 19th Street
Bozeman, MT 59715

11/7/97

Dear Fisheries Manager/Biologist,

We are in the early stages of developing a new management plan for Canyon Ferry Reservoir, a mainstem Missouri River reservoir located near Helena, MT. Notable sport fish in Canyon Ferry include yellow perch, rainbow trout, and walleye.

We are seeking results of studies you may have conducted on yellow perch populations in your state. We are specifically interested in studies on yellow perch use/selection of various spawning and juvenile rearing habitats, as well as studies on artificial enhancement of perch spawning and rearing habitat. We are interested in any work you have conducted in this realm including peer reviewed articles, grey literature, internal reports, etc..

Please take a moment to fill out the enclosed, stamped reply card. Please send information on the aforementioned studies to the address listed above at your earliest convenience. Any comments or contacts for additional sources of information would be greatly appreciated. If you have any questions you may contact Montana Region 3 Fisheries Manager, Bruce Rich, at 406-994-4042. Thanks for your help.

Sincerely,

Jason Selong

Appendix A (cont'd.)

Please Check one of the following:

_____ We manage yellow perch and are sending the requested information.

_____ We manage yellow perch, but have not made studies similar to those requested.

_____ We do not manage yellow perch.

Comments: