

# Outlook for Muskellunge, Northern Pike, and Chain Pickerel Culture in Kentucky

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## Introduction

In the United States and Canada, economically important "coolwater" gamefishes include the largest members of the perch and pike families. The Pike family Esocidae, includes the muskellunge (Esox masquinongy), northern pike (Esox lucius) and the chain pickerel (Esox niger). Tiger muskellunge, a hybrid of the northern pike-muskellunge, are frequently stocked for sportfishing. Chain pickerel are considered to have little economic value by sportsmen (Scott and Crossman 1973). However, these fish and their hybrids may have value as a predator species in small southern impoundments.

Coolwater fishes thrive at water temperatures which range between 64 to 77 degrees F (Kendall 1978). Generally, these temperatures are considered too warm to allow the survival of coldwater fishes (trout and salmon), and too cold to permit the optimum growth of warmwater fishes (catfish and sunfish). In Kentucky, the potential for coolwater fish production may be limited for some species by warm summer water temperatures (> 90° F). Spring-fed trout culture facilities could culture these fishes in water-warming ponds

Muskellunge live and spawn in lakes and rivers which have dense, aquatic or flooded terrestrial vegetation. Spawning occurs in spring when water temperatures have risen between 49 and 59 degrees F.

as a supplemental crop. Other surface and groundwater sources may also be appropriate.

All members of the pike family consume large numbers of fish as food. Intentional or accidental introductions of these fishes into native or non-native waters may destroy resident fish populations or interfere with current management programs. Contact the Kentucky Department of Fish and Wildlife Resources or a Kentucky State University Aquaculture Extension Specialist **before** stocking any of these fishes into private waters.

## Distribution and Life History of the Muskellunge

Muskellunge inhabit the pools of medium to large streams and rivers in north east, south east and south-central Kentucky. Most of these populations are maintained by stocking programs (Burr and Warren 1986). The species range is limited to the freshwaters of eastern North America (Scott and Crossman 1973).

Female muskellunge, which are typically larger than males, mate with one or more males. The fertilized eggs are scattered into the vegetation. Mature female fish produce approximately 120,000 eggs.

Frequently, only one third of the fertilized eggs are viable after spawning. Hatching occurs in 8 to 14 days at water temperatures which range between 53 and 63 degrees F. Fry feed heavily on large zooplankton, while fingerlings 1.5 inches long feed almost exclusively on fish.

Growth rates of muskellunge vary throughout their range. Fish growth depends on the availability of forage fish of adequate size and quantity. Muskellunge may grow 10 to 12 inches long during their first growing season. Female fish grow larger and faster, and live longer than males. Females may weigh up to 70 lbs and live for approximately 20 years. Both sexes mature at 3 to 5 years of age (Scott and Crossman 1973).

Optimum water temperature for muskellunge is close to 78 degrees F. This species can withstand water temperature as high as 90 degrees F and can tolerate low concentrations of dissolved oxygen (Scott and Crossman 1973).

Muskellunge are ambush predators which dart out of cover to capture their prey. Perch, suckers, catfish, sunfish, and large minnows are often consumed (Scott and Crossman 1973). Northern pike, perch, black bass, rock bass and sunfish will prey upon young muskellunge. Northern pike spawn earlier than muskellunge and in similar locations. Pike may compete directly with muskellunge for food, space and spawning habitat. Early spawning, faster growth, and early conversion to a fish diet may enable northern pike to dominate muskellunge when the two species overlap (Scott and Crossman 1973). Northern pike appear to be more tolerant of cold water temperatures and seem to prefer lakes. Muskellunge are more successful in river environments. Muskellunge have light colored bodies with dark markings (Hall 1986).

Muskellunge may be mistakenly identified as northern pike. Northern pike have dark colored bodies with light markings. Tiger muskellunge may be difficult to identify from pure bred muskellunge (Hall 1986).

### **Culture of Muskellunge**

Muskellunge broodstock can be caught in spawning areas with trap nets, pound nets, or preferably by electrofishing. Egg damage can be reduced when broodstock are obtained by electrofishing. Sex is determined by examining the vent region. Spawning can be induced by hormone injection. Prior to egg removal, females are anesthetized and placed on an inclined fish holding rack. An inflatable blood pressure cuff is used to express the eggs into a pan. A catheter is used to check sperm motility in males before milting. One or two drops of sperm, removed from two or three males, is diluted in a saline solution and mixed with the eggs (Hall 1986).

The eggs are incubated in hatching jars. One to 2.5 quarts of eggs (30,800 - 67,700 eggs/quart) are incubated in each jar. Water flow rates are adjusted to range between 0.5 and 2.5 gallons per minute. Small-sized gravel is placed in the bottom of the jars. This prevents the eggs from being damaged by upwelling current during the initial incubation stage. Optimum water temperatures for egg incubation ranges between 48 and 55 degrees F. Eggs are treated daily with diquat or formalin to control fungal growth. Shortly after hatching has begun, the eggs are placed in a container where water temperatures have been raised 10 to 12 degrees F. Incubation time is reduced by increased water temperature. Hatchlings are then transferred to vertical flow incubators (Stickney 1993).

The screens in the vertical flow incubator trays (appropriate for the incubation of larger salmonid eggs) must be replaced with fine mesh screens (18 x 18 meshes per square inch). This prevents the loss of smaller muskellunge eggs. Approximately 30,000 to 35,000 fry can be reared in one incubation tray. Layers of artificial turf are placed in the incubation basket to prevent the fry from suffocating. The basket cover must be tightly sealed to prevent egg loss. Debris should be removed from the tray baskets during the first 5 days of incubation. Fry are transferred to a separate container while the trays are being cleaned. Incubator water flow rates should range between 4 to 5 gallons per minute. Fry are incubated for 6 to 10 days at water temperatures of approximately 62 degrees F (Stickney 1993).

Muskellunge fry do not readily accept artificial feed. Fry are typically stocked into fertilized ponds at 6 to 9 days of age. Water temperature at the time of stocking should be approximately 62 degrees F. Nursery ponds are filled with filtered water shortly before stocking to control the introduction of predators. In Iowa, alfalfa pellets have been used to fertilize nursery ponds at 389 lbs/acre. Fry should be stocked only when zooplankton populations of appropriate size are available. Sudden decreases in pond temperature may cause fry to stop feeding and starve; stocking should be planned accordingly. As many as 48,000 fry may be stocked per acre foot of pond volume. To prevent cannibalism, white sucker, carp, goldfish or fathead minnow fry must be available for 3/4 inch long muskellunge. However, muskellunge fry may choke on food organisms which are too large. Nine to ten days after muskellunge begin feeding, newly hatched white sucker fry should be

Spawning occurs in spring when water temperatures reach 40 to 52 degrees F. Northern pike spawn during daylight

fed daily to muskellunge at a ratio of 10:1. Forage fish must be in good health and of varied sizes for larger muskellunge. Muskellunge convert forage fish at a ratio of 2.75 to 3.50 lbs of food for each 1.0 lb of body weight gained. These fish may be stocked as fry into a sport fishery, or at 12 inches long, at the end of the first growing season (Hall 1986).

The ability to control hatchery water temperatures and a sufficient supplies of forage fish has limited muskellunge production. Growth rate is reduced but food conversion tends to improve, when muskellunge are reared in tanks. Commercial prices for muskellunge are approximately \$0.75 per inch. The expense and availability of adequate forage fish will probably limit muskellunge production to the sport fishery. Economical production of this species as a food-fish will likely depend on the development of a prepared diet (Hall 1986).

### **Distribution and Life History of the Northern Pike**

Northern pike have been stocked into some Kentucky reservoirs; however, they have been caught infrequently (Burr and Warren, 1986). This species has a circumpolar distribution in the northern hemisphere. Northern pike have been widely introduced throughout North America as a sport fish and to control forage fish. Northern pike live in a wide variety of habitats. Pike are used as a predator species in Canada farm ponds, often to control bluegill populations. Northern pike may prey upon or compete for food with the black basses, muskellunge and walleye (Scott and Crossman 1973).

hours over densely vegetated river floodplains, marshes, and the bays of large lakes. One or more males fertilize the eggs

of the larger female. The eggs are scattered over flooded terrestrial or aquatic vegetation. Individual females may produce an estimated 32,000 adhesive eggs. Eggs typically hatch in 12 to 14 days. Fry remain attached to vegetation by adhesive glands located on the head. The yolk is absorbed after 6 to 10 days (Scott and Crossman 1973).

Fry feed on zooplankton and aquatic insect larvae. Fingerlings switch almost entirely to a fish diet when they reach 2 inches in length. Northern pike may reach 6 inches long by the end of their first summer.

Adult pike feed opportunistically on any fish or animal available. Optimum food size ranges between one-third and one-half the pike's body length. It has been estimated that 5 to 6 lbs of food is required for each 1 lb of increase in a northern pike's body weight (Scott and Crossman 1973).

Growth is variable throughout the pike's range depending on locality, length of growing season, availability of food, and water temperature. Females grow larger and live longer than males. Female northern pike grow faster than males in the southern portion of their range and may reach 46 lbs. Pike mature between 2 to 6 years of age depending on locality. Males typically mature earlier than females (Scott and Crossman 1973). Northern pike may naturally hybridize with the muskellunge, chain pickerel, redbfin pickerel (Esox americanus) and the grass pickerel (Esox americanus vermiculatus). Typically, only the females of these hybrids are fertile (Kendall 1978).

### **Culture of Northern Pike**

Northern pike broodfish can be captured with trap nets, pound nets, or fyke

The northern pike x muskellunge hybrid, called the "tiger muskellunge," is considered an improved sportfish over the

parent species. Knotless-nylon netting helps reduce injury to the fish. Incubation of pike eggs is similar to that of muskellunge eggs, but at slightly lower water temperatures. Northern pike will accept specially prepared coolwater fish diets. This allows intensive culture in tanks and troughs. If feasible, intensive culture practices using prepared diets is more economical than traditional pond culture techniques. Fry are fed with automatic feeders at 3 to 5 minute intervals for 16 hours each day. Automatic feeders should distribute the food over 90% of the rearing unit's surface area. Intervals between feedings may be increased to 10 minutes when the fingerlings learn to accept prepared food; and then increased to 15 minutes when pike are 4 inches long. Rearing units should be cleaned twice each day to remove excess food (Stickney 1993).

Baffles on the bottom of a tank or raceway will increase water flow and direct food waste towards the drain. Swimming pool vacuums and siphons can be used to remove wastes (Kendall 1978). Suckers, goldfish and fathead minnows are good forage fish for larger pike. Northern pike grow rapidly and must be graded every three weeks to control cannibalism (Piper et al. 1989). Pike are highly aggressive and cannibals should be removed if possible (Stickney 1993).

In Kentucky, warm summer water temperatures may limit the potential for pike culture in small ponds. Northern pike could be an alternative predator species for larger ponds and lakes. In most instances, lack of adequate spawning habitat limits pike reproduction (Lopinot 1992). Introduced populations of northern pike might adversely impact sport fisheries in Kentucky reservoirs.

### **Culture of Tiger Muskellunge**

parent species. This hybrid demonstrates hybrid vigor in growth, body proportions, and activity (Scott and Crossman 1973).

Most commonly, the tiger muskellunge is a cross between the northern pike male - muskellunge female (original cross); however, the availability of broodfish often determines the breeding strategy. The muskellunge female is larger than the northern pike and produces more eggs of greater individual size. The larger eggs are thought to produce larger fry which may have greater survival (Hall 1986).

Egg incubation and fry feeding techniques are similar to those for the parent species. Fry are fed artificial diets or brine or fery shrimp. Artificial feed is introduced with automatic feeders at frequent intervals. Constant-flow formalin treatments may be used in raceways, tanks and troughs to control gill fungus. Typically, 60 to 65% of the fry will survive to the fingerling stage (Hall 1986).

Fingerlings which are 30 days old and 3 to 5 inches long, can be reared indoors at low densities. Advanced fingerlings, 30 to 60 days old and 8 to 12 inches long, are reared in outdoor raceways. Survival of tiger muskellunge fingerlings may be as high as 80 to 90%. Food conversion ratios may be as low as 1.5 to 2.0 : 1 for all juvenile stages. Cost estimates to produce 1 lb of fish cultured (98 days) on live versus prepared food were \$16.62 and \$1.52, respectively (Hall 1986).

Warm water temperatures during summer would likely limit Tiger muskellunge culture in Kentucky. Boodstock acquisition, and the expense of eggs or fingerlings may further limit current production. Tiger muskellunge could potentially interfere with muskellunge stocking programs located in northeast, southeast and south-central regions of Kentucky. Nevertheless, of the large esocids, the tiger muskellunge may be best suited for commercial food-fish production.

## **Distribution and Life History of the Chain Pickerel**

The chain pickerel typically inhabit slow moving streams and densely vegetated lakes. Their distribution is confined to eastern and south-central North America (Scott and Crossman 1973). The species is limited primarily to the Mississippi embayment of west Kentucky (Burr and Warren 1986).

Chain pickerel spawn in spring when water temperatures reach 47 to 52 degrees F. Spawning usually occurs during daytime over flooded vegetation at depths of 3 to 10 feet. The adhesive eggs are scattered over the vegetation and fertilized by one or two males. Mature females may contain over 8,000 eggs. The eggs hatch in 6 to 12 days. Pickerel fry attach to the vegetation by an adhesive gland located on the snout. After the yolk is absorbed, the fry feed on invertebrates and larval fish. Young of the year pickerel may reach 4 to 5 inches in length. At this size, the diet of fingerlings will change almost exclusively to fish and large invertebrates. Female fish grow faster and larger than males. Females also mature sooner and live longer than males. Chain pickerel may weigh up to 9 lbs and may live for 3 to 9 years (Scott and Crossman 1973).

Pickerel are opportunistic carnivores which ambush their prey. Prey include sunfish, catfish, minnows and other pickerel. Chain pickerel often inhabit ponds with a maximum depth of less than 10 feet and feed actively throughout the year. Summer water temperatures of 70 to 86 degrees F are preferred; however, pickerel can survive water temperatures as warm as 98 degrees F. Additionally, pickerel can tolerate pH as low as 3.8 (Scott and Crossman 1973).

Pickereel will naturally hybridize where species overlap. Hybrids of the chain pickereel x grass or redfin pickereel are fertile. These hybrids may provide a good intermediate-size predator for farm ponds. The hybrids of the northern pike male x grass pickereel female have demonstrated high survival. This hybrid is sterile and may have the potential for stock-out in waters where strict control of predator fish is desired. Progeny from the chain pickereel x northern pike offer no improvement over the parent species (Kendall 1978).

Unfortunately, literature regarding the culture of the chain pickereel appears to be limited. Its potential as a culture species or as a food-fish has not been explored. The chain pickereel and its hybrids may possess desirable sportfish potential for Kentucky's small lakes and ponds. Pickereel would be able to tolerate the extremes of water temperatures which occur throughout the year in Kentucky's small impoundments. Pickereel offer productive angling throughout the year. Tolerance of low pH may allow pickereel to inhabit ponds where acid waters can not be easily treated.

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