

# State of Michigan's Status and Strategy for Eurasian Ruffe Management

## Scope

Invasive Eurasian ruffe (*Gymnocephalus cernua*), native to northern Europe and Asia, have threatened the Great Lakes and surrounding states since the late 1980s. The goals of this document are to:

- Summarize the current understanding level of the biology and ecology of Eurasian ruffe.
- Summarize the current management options for Eurasian ruffe in Michigan.
- Identify possible future directions of Eurasian ruffe management in Michigan.

## Biology and Ecology

### I. Identification

Eurasian ruffe, also known as blacktail or river ruffe, is a member of genus *Gymnocephalus* within Percidae. Eurasian ruffe is a small, aggressive, benthic fish native to Europe and Asia. The species resemble yellow perch with distinct walleye markings (McLean 1997). The Eurasian ruffe can be distinguished from other perch by their large, jointed dorsal fin composed of 11 to 16 spines with rows of dark spots between each spine. Adult ruffe are typically five to six inches long with large individuals rarely exceeding 10 inches. They have a small, downturned mouth, lack scales on their head, and are slimy when handled (McLean 1997). Eurasian ruffe have two dorsal fins, one spiny (anterior) and one soft (posterior), and are commonly mistaken for troutperch, which have only a single dorsal fin. Their coloration consists of an olive-brown dorsal surface, pale sides, and a yellow underside (Fuller 2014, Hajjar 2002). Eurasian ruffe have two ventral fins with sharp spines on the leading edges; the anterior fin has only one spine where the posterior fin has two spines. Their spiny fins and slimy surface provide protection from predators.

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It can be largely distinguished from other perch species, like yellow perch (*Perca flavescens*), by its lack of scales on the head, numerous spotted rows of spines on the dorsal fin, and slightly downturned mouth below its large, glassy eyes (McLean 1997). Eurasian ruffe are also much smaller in size and lack the distinct dark vertical stripes exhibited by *P. flavescens*.

## II. Life History

Females have an average life span of 7 years, while males average five. Although, they may grow more quickly under favorable conditions, such as in warm, clear waters, it generally takes 2 to 3 years for them to reach full maturity. However, reproductive events can take place as early as one year (Volta et al 2012). While the habitat, water condition, and time of year in which ruffe reproduce is highly variable, 59°F is generally the optimal temperature for early development (Ogle 1998).

Eurasian ruffe utilize a variety of spawning substrates, depositing their eggs in unguarded, open substrates approximately 9 feet below the water's surface. Eurasian ruffe have an r-select life history (Blanck 2007) with females producing 13,000 to 200,000 eggs per season, leading to rapidly growing populations (McLean 1997). Eggs adhere to submerged plants, rocks, logs, gravel, or branches and can even develop on sandy or clay bottoms (Ogle 1998). Growth often depends on water type, intraspecific density, and food supply.

## III. Diet

Eurasian ruffe consume small aquatic insects and other bottom-dwelling organisms (McLean 1997). Known as opportunistic feeders, Eurasian ruffe will eat almost anything, but the primary prey items for juveniles and adults are chironomids and macrocrustaceans. Zooplankton comprises an important part of their juvenile diet, while their specific adult diet often depends on their trophic status in the particular water body they inhabit (Ogle 1998). Food sources regularly consist of soft-bodied taxa, such as chironomid midge larvae, mayflies, and non-cased caddisflies, (Fullerton et al. 1998) and as size increases prey selection begins to favor benthic individuals. Lacustrine ruffe have also been known to prey on fish eggs (McLean 1997) and small fishes (Volta et al. 2013), but not as a primary food source. Eurasian ruffe may forage in soft sediment areas thus reducing substrate variation (Fullerton et al. 1998).

## IV. Habitat

Able to survive in a wide range of environments, Eurasian ruffe are more tolerant of murky, eutrophic water conditions when compared to other species (McLean 1997). Eurasian ruffe can be found in lacustrine and lotic systems as well as brackish waters with salinities up to 12 parts per thousand (Ogle 1998). Areas of slow moving water with soft bottoms devoid of vegetation are preferred by Eurasian ruffe (Ogle 1998), but they will commonly use macrophyte or cobble substrates as well. Their optimal growth and feeding temperatures are between 60 and 70°F (Holker and Thiel 1998). Eurasian ruffe most commonly inhabit the lower part of water column preferring the lower temperatures, currents, and light intensity. During the day, Eurasian ruffe typically reside in deeper eutrophic waters to avoid predation but have also been observed in shallow and oligotrophic environments (McLean 1997). At night, they migrate to shallower water to feed and can typically outcompete native perch thanks to their well developed lateral line and extremely light sensitive eyes (Schleuter and Eckmann 2006). Eurasian ruffe are

relatively tolerant of low dissolved oxygen concentrations and can survive concentrations as low as 1.5 mg/L<sup>-1</sup>, though only for a short time (Blanck et al. 2013). Eurasian ruffe require a pH above 5 and show a slightly lower tolerance to pH fluctuations than other perch species (Holker and Thiel 1998).

#### V. Effects from Eurasian Ruffe

Eurasian ruffe populations threaten aquatic ecosystems and commercial/sport fishing (McLean 1997). With their high reproductive rate and adaptive capabilities, they outcompete native fish species for food and habitat. As Eurasian ruffe become abundant, negative impacts are expected on native species (Gunderson et al. 1998). For example, Eurasian ruffe forage on lake herring eggs in Lake Superior could lead to a drastic decrease in herring populations (McLean 1997). Due to their economic value, the species of main concern are yellow perch, walleye, and whitefish (Gunderson et al. 1998). An increase in Eurasian ruffe abundance could push these valued fish species out of their niches and, in turn, affect spawning sites.

Yellow perch also prefer soft-bodied taxa such as midge larvae, mayflies, and non-cased caddisflies resulting in a dietary overlap with Eurasian ruffe (Fullerton et al. 1998). Eurasian ruffe population growth could lead to changes in yellow perch diets by forcing yellow perch to consume more zooplankton (Fullerton et al. 1998). This could lead to ecosystem shifts and impact native planktivores. Eurasian ruffe can also have large impacts on substrate-specific benthic communities in invaded areas by reducing the overall abundance and richness of macroinvertebrates (Fullerton et al. 1998). On the other hand, the species can be a consistent food source for other prized fish; Eurasian ruffe are being incorporated into the regular diet of walleye and pike within Lake Superior (Fullerton et al. 2006).

#### **Current status and distribution in Michigan**

Introduced to western Lake Superior in 1986, Eurasian ruffe populations have rapidly expanded their range into other waterways. Eurasian ruffe have spread naturally along the southern shore of Lake Superior, and their range now includes almost all counties in the Upper Peninsula bordering Lake Superior. Eurasian ruffe can be found in the Thunder Bay River in Michigan, at the Thunder Bay Harbor, in Ontario along Lake Superior, and in Alpena, Michigan near Lake Huron (McLean 1997). The species has quickly become dominant in the St. Louis River estuary and it is predicted that it will establish itself in all five of the Great Lakes (McLean 1993). However, as of 2012 no Eurasian ruffe were detected in the lower Great Lakes (Bowen 2013).

Eurasian ruffe was first documented in the upper peninsula of Michigan in August 1994 at the mouths of the Black and Ontonagon rivers (McLean 1993). According to United States Geological Survey (USGS) and the Midwest Invasive Species Information Network (MISIN), Eurasian ruffe can be in the five tributaries of the Sand, Flag, Iron, Amnicon, and Brule Rivers, as well as Torch Lake, Portage Lake, Little Lake Harbor, and Grand Marais-West Bay, impacting a total of 12 northern Michigan counties (Figure 2).

## **Management of Eurasian Ruffe**

Containing the spread of Eurasian ruffe should be a top priority for Michigan. To prevent Eurasian ruffe dispersal, natural resource management agencies have enforced regulations in Minnesota, Wisconsin, Michigan, and Ontario making it illegal to transport Eurasian ruffe or to harvest fish bait from Eurasian ruffe-infested waters (McLean 1998). A combination of management methods can be implemented including increased predation, ballast water management, piscicides, and baitfish management (Hajjar 2002).

### **I. Prevention**

The early detection of Eurasian ruffe populations is vital in slowing and preventing their spread (Fuller 2014, Hajjar 2002). Anglers are likely candidates for transporting Eurasian ruffe to inland waters. Eurasian ruffe could accidentally be introduced or transported in live wells, bilge water, and bait buckets. Pike anglers in particular have been known to use ruffe as live bait and may become a substantial invasion vector if left unchecked. Fortunately, all Great Lake states and Ontario currently have regulations regarding Eurasian ruffe transport.

Properly cleaning boats and fishing gear before entering a waterbody is essential in controlling the spread of Eurasian ruffe. Identification guides and informative signage could be helpful since Eurasian ruffe can be confused with other species such as perch, white bass, and freshwater drum (McLean 1992). Proper identification can ensure that they are not released back into water bodies and can limit further dispersal (Fuller 2014, Hajjar 2002). The regular sampling of suspected infested waters is also an important step in preventing their spread.

Additionally for cargo carriers, ballast water should be monitored on a regular basis to detect the presence of invasive species since their presence can vary by season (Endresen et al. 2004).

### **II. Management/Control**

The current surveillance of Eurasian ruffe relies on bottom trawls, gill nets, and angler reports (Edwards 1998). Economically, the Eurasian ruffe control program is an investment in the Great Lakes fish stock and is essential to stock preservation (Leigh 1998).

#### **a. Physical**

Bottom trawls were successful in catching ruffe in Duluth Harbor, Minnesota and were estimated to have removed ~ 50% of the population. Estimates from follow-up studies projected that following 16 to 28 days of consistent trawling, a population would be depleted by up to 90% (Ruffe Control Program 1996). However, this would require constant trawling as well as a substantial monetary commitment.

Modified versions of a Windermere trap could also be used to monitor and control Eurasian ruffe populations. Field tests conducted in the St. Louis River estuary (western Lake Superior) indicated that these traps are effective in capturing Eurasian

ruffe (Edwards 1998). Traps are inexpensive, lightweight, collapsible, and can be easily deployed and retrieved from small boats providing a low cost, easy application alternative to bottom trawling.

Electric and bubble barriers have been implicated as a useful method to limit the spread of Eurasian ruffe (Dawson et al. 2006). Electric barriers to prevent the spread of Asian carp have already been constructed at the Chicago Sanitary and Ship Canal and similar barriers can be used against Eurasian ruffe. In addition to electrical barriers, bubble walls also discourage the passage of ruffe – in some cases more effectively than electrical barriers (Dawson et al. 2006). Until permanent physical barriers can be constructed these methods should be investigated to slow the spread of ruffe into inland Michigan waterways.

Gillnetting is also effective in controlling populations of Eurasian ruffe, but is not species specific and may remove high numbers of native species. This method also does not give an accurate representation of ruffe populations, with overestimates being common (Prchalova et al. 2007). Even when throwing back non-target species, high mortality rates are likely to result from injuries suffered during capture. Windermere traps could be used when gillnetting, fish barriers, and/or bottom trawling are not effective or feasible (Edwards et al. 1998). Additional gear employed to capture ruffe include but is not limited to mini-fyke nets, boom electrofishing, and backpack electrofishing, although these methods have had limited success when used on a large scale (Bowen 2013).

#### b. Biological

Managers first tried to control Eurasian ruffe populations by limiting catch sizes and by stocking predators, such as walleye, pike, and muskie, into invaded lakes and rivers (McLean 1998). However, the results were disappointing due to the Eurasian ruffe's life history and low predation rates (McLean 1997). Because of their spiny fin rays and slimy body, Eurasian ruffe are not consumed as a primary food source in North American systems. However, some studies show predation rates have been rising over recent years as native species have adapted to feeding on ruffe (Fullerton et al. 2006).

Eurasian ruffe also produce an alarm pheromone that may prove useful in biological control (Maniak et al. 2000). When injured, this pheromone is released from the skin and inhibits swimming and feeding functions. These pheromones are extremely specific. Extracts from frozen Eurasian ruffe skin could be used to repel or exclude Eurasian ruffe from water bodies, rivers, and connected inland waterways (Maniak et al. 2000). The use of an alarm sperm antibody also has the potential to disrupt the reproductive process of Eurasian ruffe in certain spawning areas and keep Eurasian ruffe from spreading (Bills et al. 1992).

### c. Chemical

Eurasian ruffe can be killed by any of the fish toxicants registered in the United States; these include rotenone, antimycin, 3-trifluoromethyl-4-nitrophenol (TFM) and Bayluscide. TFM is most selective for Eurasian ruffe since the species is 3 to 6 times more sensitive to TFM than brown trout and yellow perch. Applying piscicides to river basins and lakes during spawning seasons (April through late summer) could drastically reduce the numbers and dispersal of Eurasian ruffe. TFM treatments should allow selective removal of Eurasian Ruffe from streams and waterways with limited mortality among non-target species (Boogaard et al. 1996). TFM has met the safety requirements of the EPA and has no long-term effects on the environment, on humans, or on other aquatic species. It does not leave persistent residues in the water or environment and does not combine with any other chemicals (Leigh 1998). TFM is most effective when applied at the mouth of rivers during spawning or wherever Eurasian ruffe have a tendency to be concentrated. Treatments have been used before in the Brule River in Wisconsin and killed 97% of Eurasian ruffe with very little effect on native species (Bills et al. 1992). However, the effectiveness of these piscicides on Eurasian ruffe depends on the fish's ability to detect these chemicals (Gunderson et al. 1998).

### **Future Directions for Michigan and Eurasian Ruffe management**

The movement of Eurasian ruffe into Michigan's inland lakes and rivers could have devastating consequences on many native species and aquatic environments. Assessing rapid response programs and developing action plans that are consistent and coordinated between states and agencies is important to Eurasian ruffe management. The Ruffe Control Committee, appointed by the Aquatic Nuisance Species Task Force in 1996, had eight objectives to aid in the management of Eurasian ruffe populations. These objectives included population reduction, ballast water management, population investigation, surveillance, fish community management, education/outreach, and baitfish management. Many, if not all, of these objectives are still relevant today.

Conducting regular sampling in areas likely to be colonized by Eurasian ruffe will provide information on the range of the species through the detection of newly established populations. Knowledge of range expansions needs to be documented in order to plan and evaluate further control actions. Sites likely to be colonized by Eurasian ruffe should be sampled regularly by bottom trawling and populations may be removed by physical or chemical means in river mouths and bays. Sampling water from targeted sites for eDNA has proven useful in the past and could be an effective method of detecting and monitoring Eurasian ruffe in waterways (Ruffe Control Committee 1996).

Public outreach and education is also important to the success of any control program. Anglers and commercial fishermen must be aware of the presence of Eurasian ruffe in fishing waters so new sightings can be reported. An effort must be made to alert the public on the distribution, identification, and dispersal mechanisms of Eurasian ruffe.

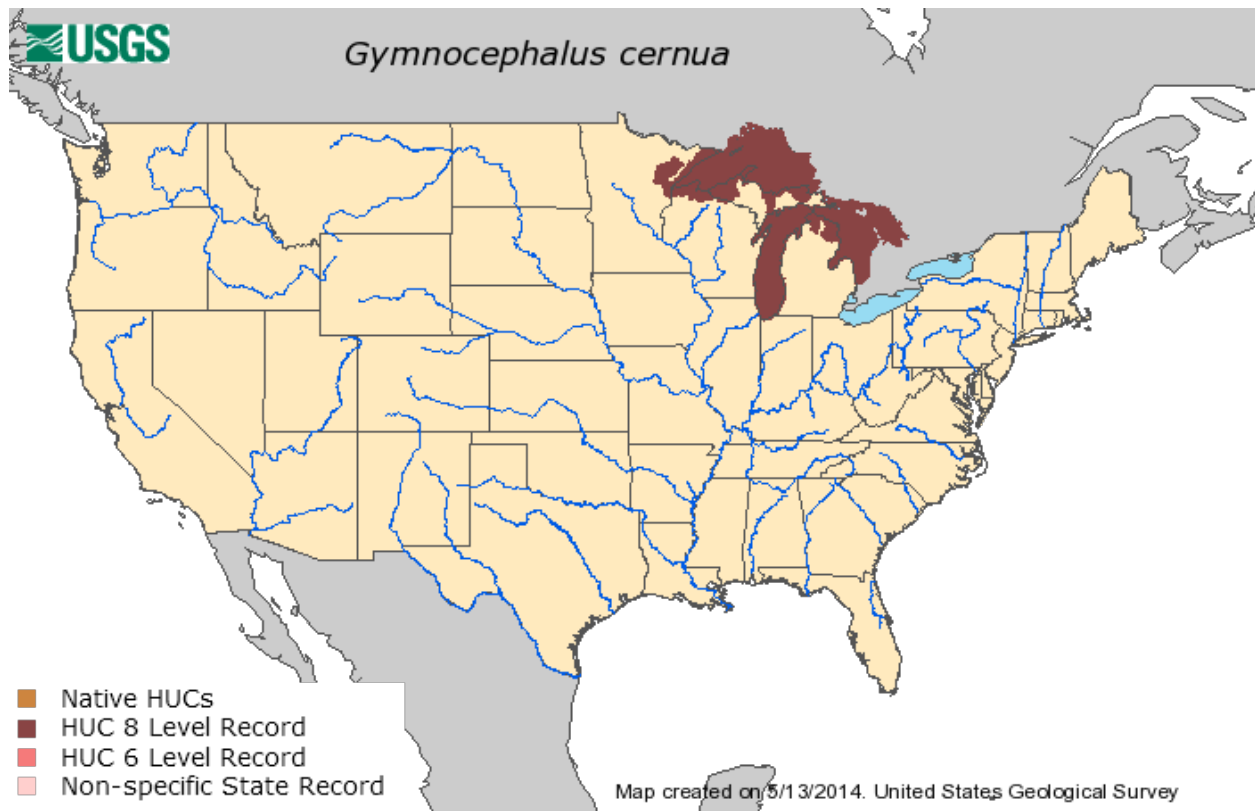


Figure 1. Distribution of Eurasian ruffe (*Gymnocephalus cernua*) in the United States (Fuller et al. 2014). Accessed May 15, 2014.

## Michigan Counties with Eurasian Ruffe Detections

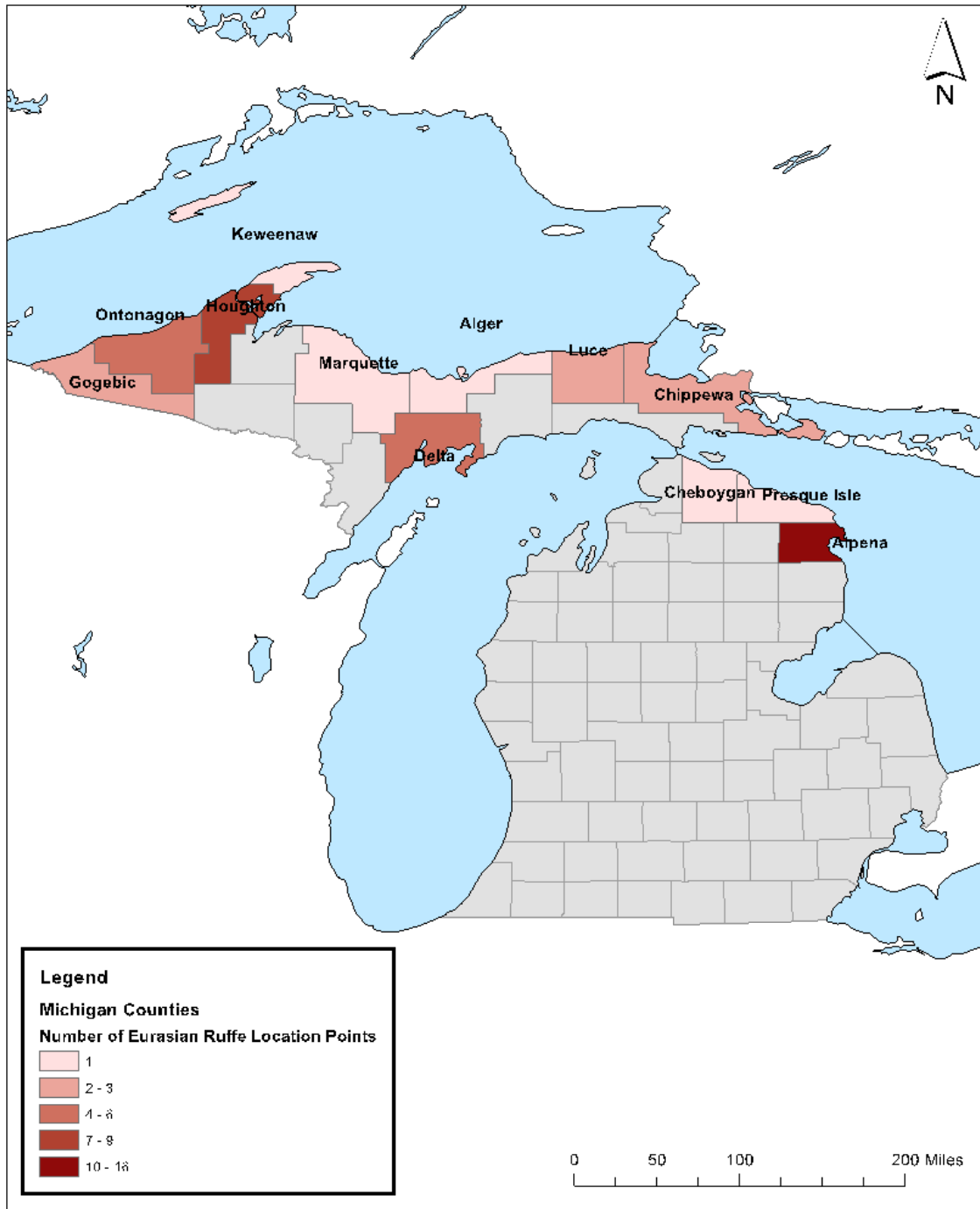


Figure 2. Number of unique coordinate location points within Michigan counties at which Eurasian ruffe were detected. This data is according to the United States Geological Survey (USGS), Midwest Invasive Species Information Network (MISIN), Biodiversity Information Serving Our Nation (BISON), and the State of Michigan fishery databases.



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