Smallmouth Bass (*Micropterus dolomieu)*

Zachary Wile

Fish 423: Olden

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Figure 1. A Smallmouth Bass (*Micropterus dolomieu*).

Classification

Order: Perciformes

Family: Centrarchidae

Genus: *Micropterus*

Species: *M. dolomieu*

Common names: smallmouth, bronzeback, brown bass, brownie, smallie, bronze bass, and bareback bass.

Identification Key

The smallmouth bass can be characterized by a generally brown (seldom yellow) body with red eyes. They have dark brown vertical bands, rather than a horizontal band along the side that is found in Largemouth Bass (*Micropterus salmoides)*. There are 13–15 soft rays in the dorsal fin (figure 1). The upper jaw of smallmouth bass extends to the middle of the eye. Covering the body externally is a protective layer of semi-overlapping scales, which are waterproof and lathered in a thick film of mucus (figure 1). Unlike *M. salmoides,* the upper jaw doesn't ever extend past the eye (Coble 1975).

Body lengths range from 30-40 cm on average but have been known to reach lengths of over 60 cm. Weights range from 0.5-1 kg on average but larger specimens have been caught up to 5 kg (Stroud 1975).

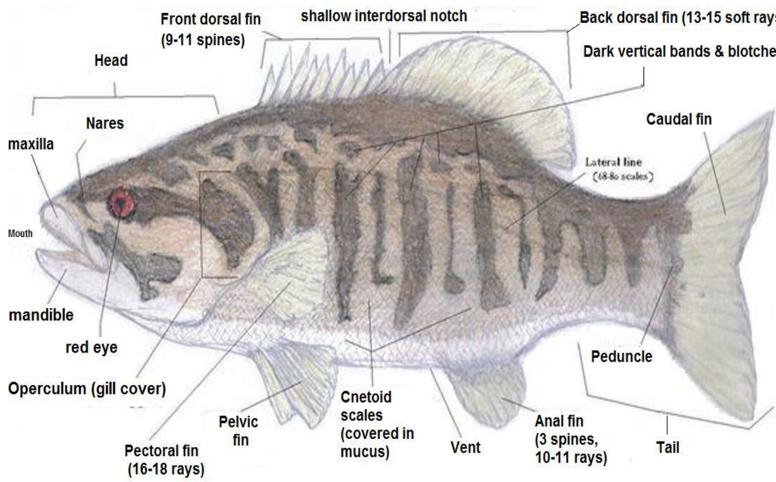

Figure 2. Smallmouth Bass, Micropterus dolomieu. Shows diagnostic information for identification (Fish of Wisconsin Field Guide).

Life History and Basic Ecology

Life Cycle

Micropterus dolomieu has four defined life stages. The embryonic stage is when the fish has yet to exit from the egg. The instant the fish emerge from the egg they are known as fry. The fish remain fry until they reach their juvenile size. They will finally become adult fish once they reach sexual maturity at the age of four to five years or 28-33 cm (Coble 1975).

Nest Building

Smallmouth Bass spawn in the spring and may lay their eggs in rivers, lakes or even tributaries (Webster 1954). Male bass move into spawning areas when the water nears 16º C (16ºC). The male usually selects the nest site and finds a place in cover such as a boulder or sunken tree away from the main current. Typically the nests are found in water from 0.33 meters to one meter but have been found as deep as six meters (Mraz 1964). The nest substrate usually consists of sand, gravel or rubble (Mraz 1964, Latta 1963) but there has been documented instances in which other substances such as wood or broken clam shells has been used in nest formation (Turner and MacCrimmon 1970). The male may make several nests before constructing the one in which the eggs will be deposited (Mraz 1964).

Nests are constructed by the male using a sweeping motion of the tail and making a circular nest with a slight downslope to the center (Beeman 1924). The nest is about 0.66 meters in diameter, but ranging between 0.33 meters and one meter, with a depression of five to ten centimeters (Doan 1940).

Spawning

Spawning may occur as soon as the nest if fully constructed but may be delayed over a week depending on temperature and the readiness of a female. Prior to spawning, the male may not stay close to the nest, and other fish that come close may not disturb the male (Pflieger 1966). Females come to the spawning areas from deeper waters. When the male first sees a female, he will rush towards her and try to bring her to the nesting site. The female will swim away at first until returning shortly thereafter, this process goes on several times until the spawning begins. As the pair moves over to the nest, the male may nudge or bite the female (Bower 1897). Immediately before spawning, the fish settle over nest, side by side facing in the same direction. The female then turns slightly onto her side and releases her eggs next to the vent of the male. The male instantly releases its milt (sperm) to fertilize the eggs (Coble1975).

Growing Patterns

Age (Years)	**1**	**2**	**3**	**4**	**5**
Length (cm)	**9.4**	**17.0**	**23.4**	**27.9**	**32.3**
Age (years)	**6**	**7**	**8**	**9**	
Length (cm)	**35.8**	**38.1**	**40.4**	**42.9**	

Table 1. Average total lengths of Smallmouth Bass for one to nine years of age. (Adopted from Coble 1975).

M. dolomieu demonstrate a large range of growth rates throughout North America. Growth rate is greatly influences by temperature and food supply. In wild populations, higher growth rates are generally associated with warmer summer temperatures, but the effects of temperature can be concealed by other factors such as shortage of food (Coble 1975, Keating 1970). Experiments done in the laboratory indicate that temperatures from 26ºC-29ºC are ideal, showing high growth rates and lower and higher temperatures (Peek 1965). Males and females are believed to grow at the same rate (Latta 1963, Doan 1940), but as with most fish, the females tend to grow larger.

Feeding Habits

From the time they begin feeding, their diet changes from small to large organisms as the fish grows. The age at which the smallmouth bass diet changes depends on the size of the bass, size of prey and prey availability. If zooplankton is available, the young bass will begin feeding on zooplankton such as Copepods and Cladocera. As they get older, insects become a larger portion of their diet and finally crayfish and other fish (Doan 1940, Tester 1932).

Reproductive Strategies

The smallmouth bass reproduces several times throughout its life and has a relatively high fecundity; with each female emitting 20-50 eggs each time, usually lasting from 4-10 seconds (James 1930). After laying the eggs the female loses her spawning color pattern and leaves the nest. When the eggs have been successfully deposited, the male viciously guards the nest and drives away other fish. It is possible that the male can successfully spawn with several females in the same nest. There have been observed instances of one male mating simultaneously with two females (Beeman 1924).

Environmental optima and Tolerances

M. dolomieu occur in naturally in large, clear water lakes as well as cool, clear streams with moderate current containing a substrate of rock and gravel. They are also found in small ponds and muddy streams (Cleary 1956). Smallmouth bass can tolerate intermittent turbidity (Webster 1954, Cleary 1956), but excessive turbidity and silt can hinder a population (Coutant 1975).

A typical stream would have trout species in the upper, cooler regions; smallmouth bass would inhabit the middle region of the stream with cool water, rocky bottom and a good gradient with large pools between riffles. A similar species, Largemouth Bass (*Micropterus salmoides)* would be in the lower regions consisting of a slower current, mud bottom and aquatic vegetation (Clary 1956). A study done by Reynolds (1965) found the importance of rubble, gravel and current to Smallmouth bass. He found that *M. dolomieu* were almost always located over rocky clumps below a riffle.

The best lakes for smallmouth are larger than 100 acres, more than 10 meters deep with thermal stratification and have clear water with vegetation and large areas of rock and gravel (Hubbs and Bailey 1938). Smallmouth bass usually inhabit water less than 13 meters but have been found at higher depths (Webster 1954). Often they are found over rocky ledges and bars in water 1-6 meters deep.

In streams, smallmouth are not typically found in areas of strong current, but hidden near objects in the current such as logs or rocks (Hubbs and Bailey 1938, Munther 1970). Smallmouth bass seem to be attracted to darkness and quiet water (Haines and Butler 1969). Paragamian (1973) frequently found adult smallmouth in pools with moderate surface current with rocky substrates while juveniles were found more often in calmer water near rocks and vegetation. Smallmouth bass have also been found near the surface sunning themselves (Webster 1954, Munther 1970).

In summer months, *Micropteru dolomieu* have been found in waters ranging from 19ºC to 22ºC (Hile and Juday 1941, Hallam 1959). In winter smallmouth bass move to deeper waters to find dark, current void crevices between rock, holes and hollow logs (Webster 1954, Munther 1970). They begin moving down deeper, generally when the water reaches 50°F (Munther 1970), but even as high as 60°F (Hubbs and Bailey 1938, Beeman 1924, Webster 1954). Lethal temperatures vary and heavily depend on previous extreme temperatures and how the fish have acclimated to them.

Smallmouth need more than 6 ppm dissolved oxygen for optimal growth (Bulkley 1975). Their average production rates are reduced by 10% when the amount of oxygen is lowered to 3 ppm at 15° C and are reduced by 20% if oxygen is lowered to 4 ppm at 20° C (Bulkley 1975).

Biotic Associations

Many species have been found associated with smallmouth bass; part of this is due to the fact that the smallmouth bass is so widespread. Three main species brought up in the discussion of biotic association with smallmouth bass are the rock bass (*Ambloplites rupestris*), the white sucker (*Catostonus commersoni*) and the northern pike (*Esox lucius*) (Hinch, Collins and Harvey 1991). Northern pike prey heavily on smallmouth bass, as it is a staple of their diet once they reach a certain size.

Figure 3. Stomach contents of a northern pike (Esox lucius) found to be full of juvenile smallmouth bass. http://nwsportsmanmag.files.wordpress.com/2011/04/ pike-11.jpg.

Lakes containing both smallmouth bass and northern pike tend to have lower levels of smallmouth bass populations (Hinch, Collins and Harvey 1991). The stomachs of over 9,700 smallmouth bass were examined from April through August during 1996 and 1997 and came up with the result that juvenile salmonids were not a major component of smallmouth bass diets (Naughton et al. 2004). Juvenile salmonids amounted up to approximately 11% of smallmouth bass diets by weight in the forebay in 1996 and 5% in the Snake and Clearwater River arms in 1997, with smaller proportions at other locations (Naughton et al. 2004). Smallmouth bass are considered to be a top predator even though its diet changes dramatically (Carey et al. 2011, Olson and Young 2003, Warren 2009). As well as interacting as predators, smallmouth bass may also compete with the native salmon. In the Willamette River (Oregon), similarities in the diets between juvenile Chinook salmon and juvenile smallmouth bass suggested that limited resources limitations could lead to competition (Table 5 from Carey et al. 2011).

Current Geographic Distribution

Distribution in the United States and PNW

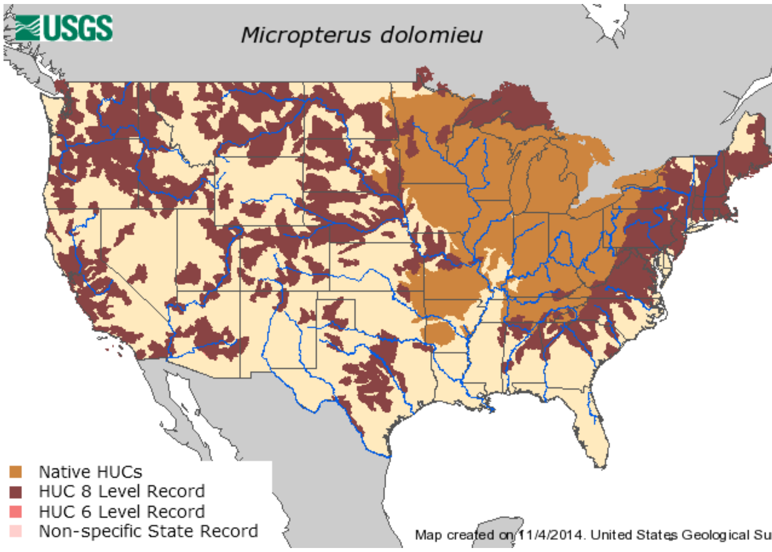

Figure 4. Native and invasive regions of *Micropterus dolomieu*. (Adopted from US Geological Survey 2014).

In the United States, the native range of the smallmouth bass includes the upper and middle Mississippi River basin, the Saint Lawrence River–Great Lakes system, and up into the Hudson Bay basin (Page and Burr 1991).

Smallmouth bass have a widespread non-native range, stretching out to the Pacific Northwest and the Eastern States as far as Maine (figure 4). They are primarily spreading through stocking to create a sport fishing location. The smallmouth bass has been stocked extensively and is reported as being stocked in 41 out of the 50 states including Hawaii (Page and Burr 1991).

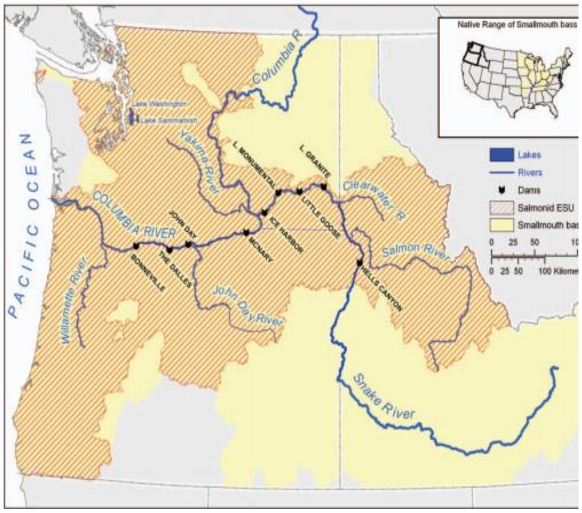

Figure 5. Smallmouth bass (*Micropterus dolomieu*) distribution in their native range (NatureServe, 2009) and in the PNW.

For over the last 135 years, smallmouth bass have been transplanted outside their native range. Smallmouth bass was first introduced to the Pacific Northwest Region as a sportfish over 80 years ago and is now widely dispersed (Carey et al. 2011). Smallmouth bass have spread and flourished in the Columbia and Snake Rivers primarily due to habitat created by human activities. The reservoir habitat made by dams generates slow backwaters and warmer temperatures throughout the river, which benefits smallmouth bass populations and disfavoring natives such as salmon (Zimmerman and Parker 1995, Naughton et al. 2004, LaVigne et al. 2008).

In the Pacific Northwest, *M. dolomieu* has widespread established populations. Reports indicate that smallmouth bass have established populations in the Colombia, John Day, Willamette and Snake rivers. They have also established in Lake Washington and Lake Sammamish (figure 5).

History of Invasiveness

Micropterus dolomieu has a long history of introduction and subsequent invasions, both in the United States and elsewhere. From their native range in the northern and eastern United States, they have expanded their range tremendously. Throughout the PNW, smallmouth bass were historically stocked for sport fishing by governing bodies and locals who did not realize the potential negative repercussions on native species, particularly salmon (Carey et al. 2011). Rahel (2004) and Johnson et al. (2009) proposed that unauthorized stocking has occurred in other regions of North America, and it is believed that it has been a widespread practice in the Pacific Northwest. All forms of stocking may collectively supplement and expand current smallmouth bass populations and cause further hindrances in efforts to conserve native species (Carey et al. 2011). Smallmouth bass supports popular recreational fisheries and has been intentionally stocked in over 20 countries, as far from their native range as Japan and South Africa (Iguchi et al. 2004, Woodford et al. 2005, Aday et al. 2009). Smallmouth bass have also been introduced to Europe and South America (Robbins and MacCrimmon 1974).

Invasion Process

Pathways, vectors and routes of introduction

The primary introduction pathway of *Micropterus dolomieu* is the intentional stocking of the fish for recreational purposes (Rahel 2004). As a pivotal sport fish species, *M. dolomieu* has been intentionally introduced across the country initially by the United States Fish Commission, and later by various state agencies, to stimulate fishing opportunities in various parts of the country. Since then, numerous accounts of illegal stocking have occurred. Illegal stocking, or bait-bucket transfer, also frequently occurs, in which

Micropterus dolomieu are intentionally introduced to an ecosystem before obtaining any authorization. Half of unauthorized introductions involved illegal stocking by the public (Table 2 from Rahel 2004). The percentage of authorized stocking is decreasing today (Figure 6). This is typically done to promote fishing opportunities in the recipient ecosystem for those stocking the water body, but unregulated introduction can play a large role in facilitating the spread of this species (McMahon and Bennett 1996).

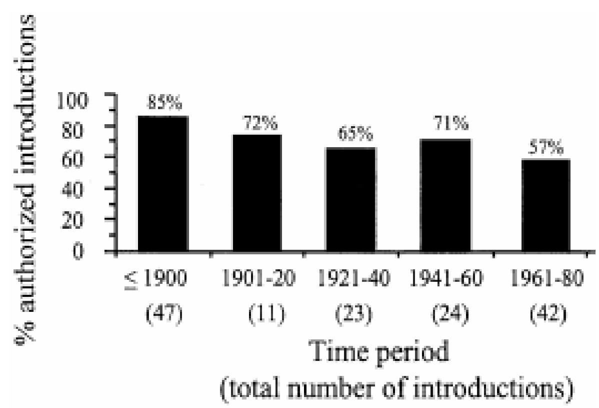

Figure 6. Percentage of authorized introductions from 1900-1999 (Adopted from Rahel 2004).

There are also inadvertent stockings in which the culprits are not aware they are introducing a fish species into a water body. Often referred to as accidental introductions (Rahel 2004). In an attempt to stock smallmouth bass in Wyoming, while the fish were being stocked, it was noticed that the shipment also contained young walleye (*Sander vitreus* or *Stizostedion vitreum*) (Rahel 2004). This is an example of stock contamination.

The original stocking in Washington State involved intentionally releasing roughly 5,000 the Yakima River in 1925 (Carey et al. 2011). Smallmouth bass is now one of the most widespread non-native species of fish in the Pacific Northwest (Boersma et al. 2006, Sanderson et al. 2009, Figure 5), found in both lentic systems, such as Lake Washington and Lake Sammamish, Washington (Figure 5), and lotic systems, such as the Columbia River and Snake Rivers (Tabor et al. 1993, Zimmerman and Parker 1995, Naughton et al. 2004, Figure 5).

Factors influencing establishment and spread

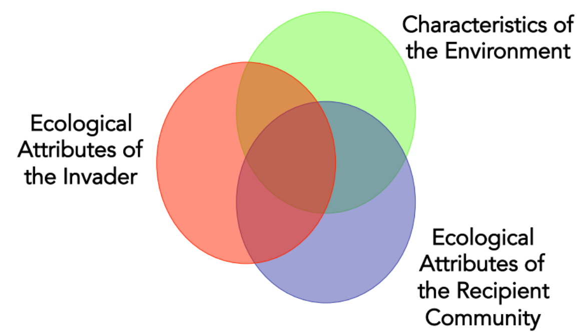

Figure 7. The likelihood of a species establishment depends on these three factors. The region that all three overlap means there is a chance of an invasion. (From Olden lecture slides)

The establishment and spread of a species is determined by the environmental tolerances of that species, as well as specific life-history characteristics. Ecological attributes of the invader applies to the overall traits the non-native species possesses. Factors regulating the speed of spread include type of dispersal pathway, propagule pressure, reproductive rates and other life-history characteristics, environmental and landscape characteristics and ecological attributes of the recipient communities. The characteristics commonly associated with invasive species are: abundant and widely distributed in native range, wide environmental tolerance, high genetic variability, short generation time, rapid growth, early sexual maturity, high reproductive capacity, broad diet, rapid dispersal ability and being associated with human activities. Smallmouth bass exemplify most, if not all, of these traits which are what makes them such a potent invader.

Potential ecological and/or economic impacts

There are many potential ecological and economic impacts associated with the introduction of *M. dolomieu* outside of its native range. As a piscovorous adult fish, smallmouth bass can eat a tremendous of native species. They have been known to prey on juvenile salmonids Columbia River near Richland, Washington (Tabor et al. 1993). Smallmouth bass reportedly consumed 9% of an estimated 2.7 million juvenile salmonids consumed by predatory fishes in the John Day Reservoir, Columbia River each year, from 1983-1986 (Rieman et al. 1991). In the middle Columbia River, there was a reported a high incidence of predation by smallmouth bass, although their estimates followed hatchery releases of juvenile salmonids (Tabor et al. 1993). There are 138 lakes that are currently suitable for the introduction and establishment of smallmouth bass in British Columbia, just north of the Pacific Northwest. Twenty of the 138 high risk lakes (14.1%) contain at least one salmon species, while 122 of the 138 lakes (88.4%) contain at least one species of trout and 29 lakes (21.0%) contain at least one bass species (Sharma et al. 2009). Tools that allow predict ions of the potential distribution for a non-native species, including its likelihood of arrival and establishment, enlighten the risk assessments and assist decision makers with prioritizing limited resources for control and management. A wide variety of predictive models have been applied to non-native species but most have focused on only single steps in the invasion cycle (Wonham et al. 2005, Drake and Lodge 2007). The widespread introduction and potential spread of top predators, including smallmouth bass, are likely to have negative implications for native fish populations. Smallmouth bass could have a serious impact on the productivity and viability of the populations of many different species. Also the introduction of littoral predators, such as smallmouth bass, may have negative implications for trout populations (Sharma et al. 2009). The factors listed in Figure 7 show that *M. dolomieu* can have an effect on native populations if they are present in the specific body of water.

44 native species of fish are threatened or endangered by alien-invasive fish (Wilcove and Bean 1994). An additional 27 native species of native fish species are also negatively affected by introductions (Wilcove and Bean 1994). Introduced fish species frequently alter the ecology of aquatic ecosystems (Pimental et al. 2005). Annually, nonindigenous species cause environmental damage and economic losses in excess of US $137B in the USA alone (Pimentel et al. 1999)

Although some native fish species are reduced in numbers are brought to extinction or hybridization by alien fish species, alien fish do provide some benefits in the improvement of sport fishing. Sport fishing contributes $69 billion to the economy of the United States (Bjergo et al. 1995, USBC 2001). However, based on the more than 40 alien invasive species that have negatively affected native fishes and other aquatic biota, and considering the fact that sport fishing is valued at $69B annually (USBC 2001), the conservative economic losses due to exotic fish is $5.4B annually.

Management strategies and control methods

There are several different management strategies and control methods for *Micropterus dolomieu* populations, the most effective of which, is prevention. As a non-native sportfish, smallmouth bass are difficult to remove from a body of water since they cause issues with policy considerations for state and federal (Carey et al. 2011, Rinne et al. 2004). Techniques for managing smallmouth bass include stocking, impositions of creel limits, seasonal limits and length limits (Coble 1975). Stocking smallmouth bass into waters in which there is no established population is generally considered a safe procedure if biologists have determined that the environment is suitable for *M. dolomieu* and their introduction will not be detrimental to the native species (Coble 1975).

Smallmouth bass are not typically stocked in waters they already inhabit due to their high reproductive potential (Coble 1975). Creel limits, or the maximum number of a species of fish that can be taken per person in a calendar day, are often unnecessary because few anglers ever catch the limit anyway, but some may see it as a challenge to do so and cause there to be more fishing pressure (Watson 1965).

Predation Reduction

It is imperative that management strategies must be tested and implemented on the predatory impacts that smallmouth bass have on native fish (Carey et al. 2011). Some of the options are to alter dam procedures, which limits the dispersal of *M. dolomieu* and is considered to be less injurious (Carey et al. 2011). Larger water flow creates a decreased temperature and water clarity, and these are both are known to decrease the predation rates of smallmouth bass (Vigg et al. 1991, Petersen, 1994, Fayram and Sibley 2000, Naughton et al. 2004, Tabor et al. 2007). Fortunately, conditions for reduced predation by smallmouth bass are surprisingly similar to those for more efficient movement of salmon smolts (Naughton et al. 2004).

Population Control

Presently, the general statewide angler harvest restrictions for black bass in Oregon and Washington specify no minimum size, five fish per day, and no more than three fish greater than 15 inches (WDFW, ODFW). Many anglers are opposed to keeping their catch unless they wish to eat the fish so imposing regulations such as required keeping of fish is not a practical route (Johnson et al. 2009). Predation rates on salmon by *M. dolomieu* are greater when the bass are less than 250 mm (Fritts and Pearson 2006), but the majority of anglers do not target these smaller fish. In order to address the opposing management obstacles of smallmouth bass, site-specific regulations are a probably beginning (Carey et al. 2011). For example, in areas in which the smallmouth bass could have a large impact on native salmon, regulations could try and eliminate smallmouth bass population (Carey et al. 2011). Sound management practices can help gain an upper hand on controlling non-native populations of smallmouth bass.

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http://www.walleyesunlimited.com/adopt-fish/fish-smallmouthbass.html

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Washington Department of Fish and Wildlife

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Expert contact information in PNW

Allen Pleus
ANS Coordinator
(360) 902-2724
Allen.Pleus@dfw.wa.gov

David H. Bennett
Fish and Wildlife Resources Department
University of Idaho, Moscow, ID 83844
dbennett@uidaho.edu

Martyne Reesman
ODFW Aquatic Invasive Species Technician
martyne.j.reesman@state.or.us

Matt Voile, Noxious Weeds/Invasive Species, Section manager
(208) 332-8667
matt.voile@agri.idaho.gov

Paul Castrovillo
Pest Survey and Detection Program, Program Manager, Entomologist
(208) 332-8620
paul.castrovillo@agri.idaho.gov

Tom Woolf
Aquatic Plant Program
Program Manager
(208) 608- 3404
tom.woolf@agri.idaho.gov

Rick Boatner
ODFW Aquatic Invasive Species coordinator
rick.j.boatner@state.or.us

Current Research and Management Efforts

Currently there is ongoing research into the possible effects of climate change on growth and prey consumption of stream-dwelling smallmouth bass in the central United States (Pease and Paukert 2014). Their research delves into the population-level effects of climate change on warm-water fishes, including smallmouth bass. Bioenergetics simulations indicated that prey consumption will increase in all populations with moderate stream warming (2–3 °C). Growth potential is predicted to increase by if it is not limited by food availability with stream warming by 2060. Growth potential was most pronounced for southern populations (Pease and Paukert 2014). It is imperative to have a better understanding of how *M. dolomieu* populations will respond to climate change is recommended for effective management and conservation.

Loppnow and Venturelli (2014) have recently published an article for the removal of smallmouth bass from bodies of water. Their research indicated that removing young of the year smallmouth bass is an effective control method. Their results suggest that young of the year removal alone does not lead to overexploitation and can be projected to control some populations of smallmouth bass in a reasonable timeframe. This is more proposed for fisheries that do not want to lose smallmouth bass but rather simply keep their population levels low enough so that they do not overtake the native fish populations.

There has also been recent research into electrofishing capture of smallmouth bass in streams. Studies done by Dauwalter and Fisher (2007) indicate that electric capture of smallmouth would allow to mark the fish in an effort to greater understand their abundance in a body of water, specifically streams. As an alternative, relative abundance can be projected by dividing the number of individuals sampled by the probability of capture (Dauwalter and Fisher 2007). Their findings also showed capture probability generally decreased with mean thalweg (a line connecting the lowest points of a valley) depth, but differentially so with fish length (Dauwalter and Fisher 2007).

As with most non-native sport fish, the main difficulty in removing a desired sport fish such as *M. dolomieu* is that many anglers target this trophy fish and do not want to see it be removed from a body of water they have grown accustomed to visiting in order to catch it, especially when it is known to “inch for inch and pound for pound, the greatest game fish that swims” (Coble 1975). It makes it even harder for removal efforts to be put into place when the sheer number of angler for both bass species (*M. dolomieu* and *M. salmoides*) creates a huge economic incentive to devote resources to maintaining the fishery (table 1 in Carey et al. 2011).