Bald Mountain Pond
Conservation of Endemic Arctic Charr

By: Elizabeth Thorndike
Rangeley Lakes Region

August 2018

Maine Department of
Inland Fisheries & Wildlife
Fisheries and Hatcheries Division

This document was prepared to increase public understanding and awareness of past, current, and future planned efforts by the Maine Department of Inland Fisheries and Wildlife (herein "Department") to conserve Bald Mountain Pond Arctic charr, and to facilitate opportunities for public support.

Arctic Charr

Arctic charr (*Salvelinus alpinus)* (herein charr) inhabit post-glacial systems and primarily exist in Arctic environments. Maine's Arctic charr populations represent the most southerly distribution in the world, a species generally found north of 45° latitude. The role of Arctic charr in ecosystems can vary from primary predator to secondary consumer and they are considered to be highly adaptable to resource opportunities. Despite being environmentally adaptable, charr do not coexist well with many other species of fish and most exist within a monospecific population or with one or two other species. Populations of charr coexisting with other species demonstrate distinct niche separation within the water body.

Maine is the last state in the continental U.S. to support natural populations of charr. Maine's charr are not open to commercial harvest, but most are open to angling (recreational harvest allowed, but regulated) during summer months, and all but one are closed to winter angling. Maine's limited distribution of charr is the result of their narrow habitat requirements and intolerance to habitat changes, particularly introductions of new species. Currently 11 endemic (14 total) populations of charr exist in Maine. Aside from Maine, this so-called Laurentian lineage of charr (*Salvelinus alpinus oquassa*) also occurs in southeast Quebec and New Brunswick, Canada. Within Maine, there are indications of significant evolutionary divergence among charr populations prompting the Department to conservatively manage Maine's populations as evolutionarily distinct (Maine Arctic Charr Management Plan; Frost 2001).

Background – Bald Mountain Pond

Area description-

Bald Mountain Pond (herein BMP; Figure 1), located in Bald Mountain Township (Somerset County), is one of the headwater ponds to the West Branch of the Piscataquis River. The outlet, Bald Mountain Stream, flows east 8.4 miles before merging with the West Branch of the Piscataquis River. Surrounding the pond are nine tributaries, several providing suitable brook trout spawning and nursery habitat. Historically, BMP was utilized for log driving and a remnant log driving dam at the outlet is still present (Figure 2); however, the dam is no longer intact and does not act as a barrier to upstream fish movement.

The majority of the land surrounding BMP is owned by Weyerhaeuser and is actively managed and harvested for timber production. Bordering the northern fringe of the pond is the

Appalachian National Scenic Trail and corridor, averaging 1000 feet in width. The Maine Bureau of Parks and Lands owns a narrow strip of land bordering the pond and a section that crosses the Appalachian Trail on the northern end. Its shoreline is undeveloped except for three camps currently leased through Weyerhaeuser.

Public access to the pond involves traversing over 15 miles of moderately maintained logging roads; the Bald Mountain Pond Road dead ends at the traditional boat launch to BMP. These roads can be reached off Route 16 between Abbott and Bingham. The unimproved boat launch at the southwest end of the pond is currently owned by Weyerhaeuser and open to public access. The launch receives no maintenance and may accommodate watercraft up to 18 feet. During periods of low water, boat access is more difficult due to large impeding rocks.

The Maine Department of Inland Fisheries and Wildlife (MDIFW) first surveyed BMP in 1965. The original survey involved arriving by plane to set overnight gillnets to document which fish species were present, and collect standard water quality characteristics and some physical measurements. Bald Mountain Pond has a surface area of 1,152 acres, a maximum water depth of 65 feet, and a mean depth of 18 feet, making it the fourth largest Arctic charr water in Maine (Table 1).

Water quality-

Dissolved oxygen and water temperature profiles were collected during the late summer on five occasions between 1966 and 2008. Aside from a sample collected in 1989, the four other profiles (1966, 1973, 1997, and 2008) suggested sufficient late summer habitat for charr and brook trout, with minimal dissolved oxygen depletion (< 5ppm) below the thermocline. However, late summer oxygen profiles collected each year from 2014 through 2016 documented extreme oxygen depletion below the thermocline (<3ppm), indicating a drastic reduction (compared to previous years' samples) in the amount of available late summer charr habitat. It is unclear if these years of oxygen depletion are related to the illegal introduction of rainbow smelt or if the pond has been experiencing late summer water quality limitations (undetected in most previous samplings due to timing) as seen in 1989.

Deteriorating water quality following an introduction of rainbow smelt could be a result of over-foraging on the zooplankton community. A study conducted on a Colorado reservoir found that the zooplankton community collapsed following the introduction of rainbow smelt (Johnson & Goettl, Jr, 1999). In response, the phytoplankton communities bloomed in the absence of predation from zooplankton. An overabundance of phytoplankton can severely deplete dissolved oxygen levels (Fondriest Environmental, Inc. 2014); therefore, through a series of interactions, smelt can cause a significant reduction in a waterbody's dissolved oxygen concentration.

Historic Recreational Fishery -

Bald Mountain Pond has been managed by the Department for charr and brook trout; the latter providing the dominant sport fishery that is known for producing trout of large size quality. Due to BMP's remote location and lack of nearby sporting camps, only 20 voluntary creel data trips have been recorded to date. Of those, 70 percent of anglers reported catching legal-size brook trout. The angler data suggests a high size quality trout fishery with 75 percent of trout being over 12 inches and 31 percent over 16 inches.

Initially BMP's brook trout population was thought to be stable, lacking the need for supplemental stocking. An angler complaint of deteriorating brook trout fishing was recorded in 1988 and the Department responded the following year. A resurvey in 1989 found only older aged brook trout (suggesting a lack of recruitment), and discovered several tributaries blocked by beaver dams. Following the resurvey, BMP was stocked once with 4,372 fall fingerling brook trout and the local warden was asked to direct beaver trappers to the tributaries. A second complaint was filed in 1996 by an angler who requested stocking and indicated poor brook trout fishing. The Department again conducted a resurvey the following year, sampling only one trout, an indication of low abundance. In response, an annual stocking of 5,000 fall fingerling brook trout was initiated in 1998. A 2008 resurvey found hatchery trout made up only 15 percent of the sample collected and, due to the increased rate of natural production, the scheduled annual stockings were terminated that year. No brook trout have legally been stocked into BMP since 2007.

Charr in BMP have historically been small in size, averaging 7.5 inches (angler data) in length due to their planktivorous diet. Of the 20 recorded trips by anglers, only 4 reported catching charr. Those anglers successful in catching charr noted they were targeting the species. In 1980, eight charr averaging eight inches in length were kept. In 1991, six charr were caught with one being released. The minimum harvest length limit for charr and trout increased from 6 to 10 inches in 1992 and, since then, no charr have been legally harvested according to volunteer logs. Two trips in 2008 and 2009 reported catching 13 sublegal charr, lengths ranging from 5.5 inches to 9.5 inches. Anglers generally do not target charr due to their small size, difficulty to target, and low catch rate. Interviews with anglers support the notion that charr are rarely encountered, as anglers have often mentioned they were unaware of their presence and only few anglers reported catching charr as bycatch while brook trout fishing.

Current Management -

Bald Mountain Pond is managed to provide a high-quality, self-sustaining brook trout population, which is the focus of the recreational sport fishery. Furthermore, the conservation and stewardship of the unique endemic species of charr has been, and continues to be, a management priority. Conservation efforts have shifted from a status monitoring program to one that is more remedial in nature in response to recent introductions of invasive species. To assist in conserving the charr population following the illegal introduction of rainbow smelt, Department objectives focused on learning more about charr behavior within BMP; specifically, their direct and indirect interactions with smelt, seasonal movements, and spawning locations. Remedial measures also included exploring strategies to suppress the population of invasive smelt to minimize potential negative effects on charr. Additionally, lake trout (not native to BMP) have recently been sampled in BMP, resulting in efforts to assess their presence, viability as a self-sustaining population, and opportunity for suppression/eradication.

A Changing Fish Community

The Conservation of the charr within BMP has been a focus of management since documentation of their presence in 1973, when a no live fish as bait regulation was instated. In 1992, a minimum length limit of 10 inches on trout and charr was adopted, preventing recreational harvest of most (if not all) Arctic charr (historical data indicated charr at BMP did not exceed 10 inches in length). The current S-17 regulation (daily bag limit 2 fish, minimum length limit 10 inches, only 1 may exceed 12 inches) was adopted in 1996, and in 2003 an artificial-lures-only regulation was put in place to reduce hooking mortality (Table 2).

Fish species documented during MDIFW's initial survey of BMP in 1965 included only brook trout and white sucker. This original survey of BMP was conducted after lake turnover and therefore many other existing species of fish were not documented at that time. American eel, common shiner, and lake chub were documented in 1966 in a follow-up survey that occurred while the lake was stratified. Charr were first documented in 1973 after an angler presented a charr caught at BMP to Regional fisheries staff. In 1989, the first minnow trap was deployed, documenting banded killifish, creek chub, and redbreast sunfish. Banded killifish and creek chub were believed to be historically present, but absent during prior surveys due to sampling gear bias. Redbreast sunfish were not considered to be native to BMP; therefore, they were the first illegally introduced fish species documented at BMP. Three other non-native species have since been found in BMP: golden shiners in 2008, and rainbow smelt and lake trout in 2014. Maine Warden Service is aware of these illegal introductions and remains vigilant in responding to any leads, particularly regarding the recent introduction of smelt and lake trout.

Maine fisheries biologists have long been concerned about the introduction of rainbow smelt and other fishes into trout and charr waters. The primary concern is that of direct competition with, and potential predation on, native fish. Smelt are primarily zooplanktivores, as are the charr in BMP. In addition to diet overlap between the two species, larger smelt may also prey upon young charr, but this has yet to be confirmed.

Rainbow smelt were first reported in BMP by a bait dealer in 2007, who claimed smelt were caught in bait traps set for suckers. The following year (2008) the lake was sampled and no smelt were captured in 98.5 hours of gillnetting, nor were they documented through stomach analysis of 31 brook trout. No further reports occurred until the spring of 2014 when an angler reported "clouds of bait" observed on their fish finder and multiple size classes of rainbow smelt in the stomachs of brook trout. On July 7, 2014, Department Biologists deployed small mesh gillnets in BMP and confirmed the presence of smelt. A total of 2.45 hours of gill netting captured 9 smelt, sizes ranged from 5.0 inches to 7.6 inches and smelt were present in 40 percent of the brook trout (captured in the same gillnets) stomachs.

A "no live fish as bait" regulation had been in place since 1973, therefore it is unlikely that the introduction of rainbow smelt would be the result of anglers legally using live fish as bait. The origin of introduction was more likely the result of an illegal introduction by a misguided individual under the impression smelt would improve the fishery by providing an additional source of forage.

The origin of lake trout also remains unknown and could be a result of an illegal introduction, immigration of transient lake trout from elsewhere within the drainage, or an unintentional stocking by MDIFW. There are 44 populations of lake trout within a 50-mile radius of BMP that could serve as a source for an illegal transfer. As for transient lake trout, there is a possibility that individuals could have migrated from nearby waters into BMP, as this type of behavior among lake trout has been documented by Department biologists in the past. If BMP's lake trout were transients from other waters, they may have originated from one of two self-sustaining lake trout populations downstream; Foss Pond, a native (never been stocked) population is 38 stream miles away, and Whetstone Pond is 32.5 stream miles away and was last stocked in 1950. There are currently no known fish barriers between either of these ponds and BMP. The third potential source, an unintentional MDIFW stocking of lake trout, may have occurred where both brook and lake trout are raised at the same state fish hatchery (Governor Hill Hatchery) that supplied brook trout stocked into BMP. Bald Mountain Pond was stocked annually with fall yearling brook trout from 1998 through 2007. In four of the nine years that brook trout were stocked into BMP, lake trout were also housed at the same source hatchery. Although highly unlikely, there is a chance that lake trout at the hatchery could jump from one raceway to another and end up mixed in with brook trout. Brook trout were stocked as fall fingerlings (age 0+ and 6-8 inches in length), and if lake trout were located in adjacent pools they would be of the same age and up to 6 inches in length at the time of stocking.

Regardless of origin, no juvenile lake trout have been captured to date. Therefore, there is no evidence to suggest that a self-sustaining population of lake trout currently exists in BMP.

Furthermore, it is improbable that sufficient numbers of lake trout, if incidentally stocked or migrated, would create a self-sustaining population, particularly in such a large lake.

Arctic Charr Population and Habitat Monitoring

Historically, the status of BMP's charr has been both stable and robust, with adults averaging 6.3 inches in length. Combined, surveys conducted prior to the reported introduction of smelt in 2008 captured 46 charr in 98.5 gillnet hours (0.46 charr/gillnet hour) representing 4 age classes (2+ through 5+; Table 3), with an average length of 6.6 inches and an average Fulton's K (condition factor) of 0.866. Surveys since 2014 indicated poor year classes with mainly older ages present in the population (Table 3). These observations are often correlated to populations experiencing inconsistent and/or poor recruitment.

Highlights from annual charr investigations between 2014 and 2017 are discussed below.

2014

Acknowledging charr populations can be displaced by invasive species, like smelt, the Department took immediate action to obtain information on the habits and movement of charr in BMP. A charr radio telemetry project began on September 23, 2014. A total of 22 charr were caught in 51.1 gillnet hours (0.45 charr/gillnet hour). Several complications arose during the tagging and recovery procedure. Issues associated with the rapid change in water temperature (due to lifting sampling nets up to the boat from deep water) and the fish's inability to quickly adjust their swim bladder were the greatest problems. Due to these complications, only four fish were released equipped with radio tags and those fish were tracked via watercraft or fixed wing aircraft over a seven-week period. Of those four fish, two individuals exhibited no spawning behavior and were assumed to be immature. The remaining two charr exhibited potential spawning behavior, leading to the discovery of two separate potential spawning shoals.

The two shoals were targeted by the Department's SCUBA team based on recorded movements of tagged charr. In November, these shoals were examined for spawning substrate and potential charr activity. The first shoal (shoal one), also the location of a 1979 gillnetting effort that successfully collected charr, is located near the southern end of the main basin. This shoal is very large and consists of ledge and large boulders with small patches of gravel intermixed. Shoal two, located near the shoreline in the northeastern cove was predominantly large boulders with limited cobble interspersed among larger material. No charr eggs or sign of spawning activity was observed by either diver. Suitable spawning habitat was not located, although only a limited area of shoal one was explored in comparison to its size.

2015

In 2015, another radio telemetry effort was attempted, this time benefiting from lessons learned in 2014 and using improved techniques to handle charr. Nets were set from July through September, although the water quality was notably different than historically recorded with low dissolved oxygen at depths charr traditionally inhabited. These conditions made collecting charr difficult; only 12 were captured in 70.5 gillnet hours (0.17 charr/gillnet hour). In addition to the difficulty of locating charr, there was now additional stress on captured fish due to marginal water quality. Of the 12 charr captured, only 3 were successfully released with radio tags. Suspended gillnet sets were attempted in addition to traditional gillnetting during October to target the narrow band of suitable charr habitat. These efforts (194.2 gillnet hours) resulted in the capture of two charr, of which one was successfully tagged and released. The four charr captured by gillnets and released with radio tags failed to survive. It is believed these fish drifted during recovery and expired in a zone of depressed dissolved oxygen.

Given the difficulty of capturing charr in gillnets, additional capture attempts were made in the fall using trapnets. Five trapnets were set beginning October 14, and led to the capture of just three charr in 1,065.75 hours of effort; all were successfully released with radio transmitters. These three fish were tracked during the day and at night from a combination of watercraft, fixed wing aircraft, and snowmobile. The first charr was located four times before its tag was recovered on shore seven days after release. It was unclear if the charr died after spawning or from capture related stress. Charr two, was tracked consecutively for six weeks after release, leading to multiple locations around the pond, including returning to the site of capture, and shoal one. The third charr was also tracked for six weeks and spent a substantial amount of time around an island off the mouth of the East Inlet. This area is located between the two successful trapnet sites. Tracking of the two remaining charr in February of 2016 located both charr residing in shallow waters on the northern shore.

The Department has been successful at capturing charr by hook and line in other waters and attempts were made to determine if charr in BMP were susceptible to capture utilizing this method. Relying on location information gathered from tracking, a team of six expended approximately 70 hours targeting charr in February, but none were captured.

An additional effort to capture charr for radio tagging utilized “charr traps”, resembling a large minnow trap 3.5 feet in length. These traps have been successful at capturing charr in Norway (Amundsen et al. 1993) and used experimentally by the Department in select waters in Maine. Traps were deployed during the month of September for 714 hours and were unsuccessful at capturing charr.

2016

The successful capture and tagging of three charr by trap netting in 2015 prompted an extensive trap netting effort in 2016. Nets were deployed on September 26 and a total of nine nets were set along the eastern shore, including at those sites that led to captures in 2015 along with sites near shoal one. Sites where trapnets could be deployed were difficult to locate due to the shoreline composition largely comprised of large angled boulders and steep ledge drop offs. Total net time fished was equal to 11,475 hours (478.1 days) with only one charr captured on November 10 (32 times more trap netting effort per charr than in 2015). This fish was successfully radio-tagged and released then tracked over a seven-week period until signal was lost. It is believed the tag prematurely expired after a signal could not be located during several tracking attempts made from a fixed wing aircraft in December. Prior to expiring, this fish spent a considerable amount of time in the vicinity of shoal one. This shoal appears to be annually visited by tagged charr, however, our efforts have been unsuccessful in consistently capturing charr with either trapnets, fyke nets, or gillnets at this location. An underwater camera was also used during tracking events to potentially observe spawning, but no charr were observed.

From 2014 to 2016, all successfully tracked charr were frequently observed moving into deeper water away from shore at night. During the day tagged fish were frequently located near shore at potential spawning locations. One population of charr in Maine has been observed spawning during daylight hours and it is speculated that BMP charr may also spawn diurnally. After tracking charr movement in BMP for three years, indications are that most mature fish show signs of spawning behavior beginning in mid-October through mid-November. During these times, surface water temperatures generally range from 40° F to 48° F.

Because spawning charr were so difficult to capture with trapnets, Biologists attempted using gillnets in late October and November over potential spawning locations and in close proximity to tagged charr. However, no charr were captured during 29.8 hours of gillnetting.

2017

Future work plans were developed during an annual meeting of the Department's BMP Charr Conservation Committee in January of 2017. These work plans included a recommendation to attempt to capture charr in the month of June using gill nets. This sampling scheme was recommended because it was one of the few technique/timing combinations not yet attempted, and the risk of net induced mortality was expected to be lower than later in the year when water temperatures increase. No charr were captured during a total of 45.8 hours of gillnetting. However, a sample of brook trout was collected and sent to the Department's Fish Health Lab to be tested for diseases of regulatory concern. This testing was done to determine if BMP charr could be transferred into another water as a potential strain conservation strategy; no diseases of concern were found.

Since 2014, the Department has experimented with several techniques to capture charr. Because a combination of various capture techniques and sampling dates were used in the past (including pre-2014), catch rates were not always comparable for long-term population status monitoring. In order to create a more comparable dataset, the Department developed an annual charr status monitoring protocol in 2017 which included setting gillnets for one day in August with short net sets to minimize mortality on captured charr. Gillnets were set in four other years in the past, therefore the 2017 sample could be compared to those years and every year that follows for status monitoring. During 2017, 20 gillnet sets (set for a combined 16.1 hours) failed to capture any charr. Prior to 2017, the mean August catch rate for charr at BMP was 2.6 hours per charr. The years of highest catch rates were 1973, 2008, and 2015 when it took approximately 2 hours of effort to capture one charr (Figure 3).

Assessment and Remediation of Introduced Threats

Rainbow Smelt

The Department confirmed the presence of smelt in July of 2014 and concluded the population was well-established and self-sustaining. Since confirmation, the Department has undertaken extensive experimental efforts to suppress the competing smelt population. In the spring of 2015, Biologists surveyed the shoreline and tributaries to identify spawning locations. Smelt were found to spawn in three of BMP's nine tributaries (an additional spawning tributary was identified in 2016); the primary tributary for spawning was found on the west shore, and has since been referred to as "The Brook". Egg deposition was documented as medium to heavy throughout a 50 yard stretch just upstream of its confluence with BMP. Each of BMP's nine tributaries were annually investigated for spawning activity to ensure suppression efforts were occurring on all tributaries where smelt were spawning.

Once spawning areas were identified, various smelt suppression methods were considered including using electric current to induce egg mortality. Dwyer et al. (1993) found that the intensity of voltage, duration of exposure to electricity, and egg stage development were all positively correlated to cutthroat trout egg mortality. In addition, during the early stages of development, 100% of cutthroat trout eggs were stopped from developing by applying 550–700 volts over a span of 10–20 seconds (Figure 4). In 2015 the Department applied this same method to rainbow smelt eggs using backpack electrofishing units. This method has been replicated every year since (including 2018) accounting for 1,700 minutes of effort (Table 4) spread across four tributaries. From these efforts, it was determined that streams with highly homogenous substrate demonstrate a higher rate of success in egg mortality than streams with heterogenous substrate due to larger/overlapping rocks providing a buffer to eggs from electricity in the latter. Therefore, The Brook, which contains mostly gravel and small cobble and is one of the most utilized for spawning, has received the most amount of electroshocking. To evaluate the success and efforts of electroshocking, zooplankton nets were set for 30-minute intervals at the mouth of tributaries 10–20 days after spawning to capture smelt fry. Annual evaluations began in 2016 and to date no smelt fry have been captured from The Brook, suggesting that the electroshocking treatments have been successful at suppressing smelt hatch rates.

Fewer eggs were observed in The Brook in 2017 than in previous years. During the spring of 2017, a large rain event occurred prior to hatching of smelt fry, potentially disrupting eggs and hatch rates. The Brook begins on the slopes of Bald Mountain, experiences flash flooding at a greater extent than other tributaries, and was observed to have substantial substrate movement after this rain event.

The second primary spawning tributary, referred to as “Bridge Brook” was located in 2016. Smelt ran approximately half a mile upstream of BMP through slow-moving water before reaching suitable spawning habitat. The spawning habitat in Bridge Brook consists of deep, fast moving water over large rocks and boulders. Egg deposition was found between large rocks, decreasing the overall effectiveness of electroshocking on eggs. Plankton nets documented smelt fry numbers ranging from 0 to 68 smelt across three years of evaluations.

The Department also investigated additional techniques to suppress the smelt population in BMP. During the 2016 spawning run, efforts were made to remove adult smelt entering The Brook for five nights. Approximately 797 pounds of smelt (an estimated 91,655 individuals) were removed from The Brook during the five nights of sampling. Physical removal proved to be extremely labor intensive and was determined to not be as time/cost effective as egg electroshocking. Shoreline spawning was documented at the mouth of The Brook and multiple other locations around the lake. In addition to being inefficient, the decision to cease adult removal was also due in part to concerns that spawning habits may be disrupted to the point where adult smelt would no longer spawn in The Brook (due to the tendency to return to natal shorelines) thus eliminating the opportunity to electroshock eggs. During spawning runs from 2016 through 2018, burlap was placed at locations of high egg deposition in the tributaries to allow for the physical removal of fertilized eggs prior to hatching. While this technique was effective at removal of eggs deposited on burlap, it could not be applied to all sections of streams.

Although subjective, visual assessment of the 2018 smelt runs suggested a reduction in egg deposition from previous years. Assessments prior to 2018 recorded concentrations of egg deposition to be moderate to heavy with areas of light deposition in the four tributaries utilized for spawning. Whereas, in 2018, two of the three tributaries still utilized were evaluated as having only small concentrations of moderate to light egg deposition.

Lake Trout

Lake trout were first documented in BMP on September 25, 2014 via a gillnet deployed by the Department meant to obtain Arctic charr for an ongoing radio telemetry study. A single lake trout, 15 inches long and scale-aged to 4+ was captured. Out of an abundance of caution, a tissue sample was sent to the University of Maine, Orono to be analyzed for species confirmation. The lab results confirmed the field identification: the fish captured on September 25 was indeed a lake trout. In response, during the summer of 2015, the Department deployed large-mesh gill nets at depths lake trout typically occupy. No lake trout were captured in 49.5 hours of gillnetting. Because no lake trout were captured, and due to concerns regarding potential charr bycatch, the Department decided to not replicate this effort in subsequent years.

Since 2014, the Department received two reports of lake trout being captured by anglers (one in 2015, and one in 2016), and both were accompanied with pictures. Those anglers were also interviewed by Department employees for species and location verification. In June of 2017, MDIFW Fisheries Biologists captured two lake trout in gillnets while targeting charr. These lake trout were measured at 23.6 inches and 29.5 inches and aged at 8+ and 10+, respectively. To date, there has been no documentation of lake trout spawning within BMP. No juvenile or spawning adult lake trout have been captured in over 407 hours of gillnetting and 12,541 hours of fall trap netting.

Fish Health Study

The Department completed a fish health study as a proactive measure to allow for a potential translocation of charr and/or to begin a captive brood stock program if either are feasible and pursued as the best conservation option. In accordance with the Northeast Fish Health Committee, three consecutive negative inspections over a continuous two-year period are required to obtain class AW (wild). Under a charr population of low abundance, surrogate charr were used to assess fish health. Two samples were submitted in 2015 containing brook trout and rainbow smelt; samples submitted for screening in 2016 and 2017 consisted of brook trout and a lake trout. To date, no diseases of regulatory concern have been detected within BMP, and therefore, BMP has been classified as AW (wild), allowing charr to be transferred to another water. To maintain classification and remain prepared for potential translocation, MDIFW will annually submit a sample of brook trout for testing of any diseases of regulatory concern to the Department's Fish Health Lab.

Remediation Alternatives

<u>Option 1)</u> No action

The approach of no action would allow charr the opportunity to coexist or cease to exist in the presence of smelt (and perhaps lake trout if they establish a population) without intervention. This would run the risk of extirpation of a limited population of Maine charr. Extinction of this population of charr is not a certainty as other waters in Maine support coexisting charr and smelt populations. However, BMP's charr population closely resembles that of other waters within the state which were unsuccessful in adapting to illegally introduced species (e.g., Big Reed Pond and Wadleigh Pond).

The brook trout population should be less affected as spawning and nursery habitat occur in tributary streams rather than shoreline where fry are most susceptible to smelt predation. Brook trout have been documented successfully utilizing smelt as forage, and since the introduction of smelt, no significant change in brook trout population has been documented.

<u>Option 2)</u> Suppression

Smelt

a) *Mechanical Control* – Using nets to physically remove adult smelt prior to spawning as a means to reduce the population would minimize pressure and competition on the native charr population. Although this approach is a low-cost alternative, it would be a long-term commitment and labor intensive. Smelt have been documented spawning across vast reaches of shoreline, diluting the effects of physical removal. Moreover, the remote location of BMP makes it difficult to access in the spring (when smelt are spawning) due to poorly maintained and/or inaccessible roads. This method would also require working at night for consecutive days (maybe weeks), further increasing the challenge of accomplishing this task.
b) *Induced egg mortality* - Suppression of smelt by means of electroshocking fertilized eggs is another low-cost method requiring long-term commitments. This approach also lacks the ability to target those fish that spawn along the shoreline. Indications are that electroshocking can be extremely effective under textbook stream conditions (i.e., homogenous substrates). However, of the two main spawning tributaries known at this time, only one demonstrates characteristics favoring smelt suppression via electroshocking.
c) *Commercial harvest* – Bald Mountain Pond has not been placed on the list of waters open to commercial smelt harvest due to concerns of charr bycatch and associated potential impacts to the charr population. Furthermore, the remote nature of this water

would likely severely limit harvest use opportunities. Commercial harvest and exploitation is not expected to result in a meaningful reduction in smelt, particularly under current daily harvest restrictions and the anticipated low level of use.

d) *Non-Reproducing Hatchery Fish Introduction* – Non-reproducing hatchery fish, such as splake, could be introduced to reduce the smelt population and potentially allow the charr population to naturally recover within BMP. This approach would not involve a long-term time commitment, has a low initial cost, and retains the ability to limit duration of treatment. Predation on charr and additional competition from non-reproductive hatchery fish are potential negative consequences of this option.

Lake trout

Lake trout in Bald Mountain are believed to exist in low numbers. Further efforts by the Department to physically remove lake trout would most likely be ineffective and prove to be an inadequate use of staff time. More meaningful efforts to monitor and suppress lake trout numbers may be realized through public awareness. The Department is proposing a no size and bag regulation on lake trout at BMP during the 2018 APA rulemaking packet. Along with a regulation change, the Department plans to display signs at the boat launch highlighting the potential presence of lake trout (unknown if any individuals still exist) and encouraging their removal. Raising public awareness and involvement on lake trout's negative impacts on the endemic charr population should encourage anglers to remove any lake trout caught and may limit their impacts to BMP's native fishes.

<u>Option 3)</u> Conservation of charr population genetics

Maine's 14 charr populations are genetically isolated, locally adapted, and represent the most southern distribution of the Laurentian sub-species of charr comprised of over 300 populations. Extirpation of the BMP charr could represent a loss in diversity of ecological adaptations, particularly within Maine, but genetic implications are less clearly understood. With advances in the field of genetics technology, future discrimination capabilities may offer finer resolution and more insight. As a precaution, in recognition of this uncertainty, the Department has undertaken a very conservative approach to managing charr as distinct populations. However, notwithstanding timely conservation efforts undertaken by the Department at BMP, the viability of this population could already be threatened. Recent sampling suggests the charr population to be low in abundance and may be less resistant/resilient to environmental stressors.

Broodstock Program and Translocation

To prevent potential extirpation of BMP charr and preserve local adaptations of the lineage, a captive broodstock program would allow propagation in a hatchery environment and provide offspring. Offspring from captive rearing could be utilized to restock BMP after chemical reclamation or be used to establish a population in a suitable donor water. Translocation of offspring propagated in a hatchery, or moving adult charr directly from BMP to a donor water may preserve the distinct characteristics of the BMP charr in the event BMP was found to be unsuitable for continued charr existence.

If adequate numbers of individuals from BMP are not captured for hatchery propagation, genetic rehabilitation using another source water may limit inbreeding and increase population size. The primary concerns of utilizing donor brood received from other charr populations are the potential loss of local adaptations, outbreeding depression, and genetic dilution of the BMP lineage. Sources and amounts of genetic admixture should be assessed carefully, as evidence suggests, when used sparingly, genetic admixture can offer a degree of genetic rescue (Tallmon et al. 2004). The Department does not currently have the capacity for charr cultivation. Furthermore, the owner of a private fish cultivation facility with charr cultivation experience conveyed strong reservations regarding survival and successful cultivation of the very small size charr occurring in BMP.

“Replacement” - *Introduction of Floods Pond Brood*

If the BMP charr population is lost, an approach to restore Arctic charr from another source back to the pond would be considered. Translocation and introduction of charr from Floods Pond has been successful in some waters (Enchanted P and Long P). Arctic charr can undergo adaptive phenotypic changes in response to new environments over a relatively short timescale to potentially produce a sustainable population and fill a similar ecological role as that of the historic charr population (Michaud et al. 2008). This method would be recognized as suboptimal with respect to preserving adaptations specific to BMP and the overall diversity of adaptations found in Maine. However, this approach would preserve the future ecological and evolutionary legacy of a population, despite the potential loss of a distinct population. Since Floods Pond charr coexist with smelt, the current Floods Pond phenotype may be well adapted to BMP’s current situation.

Potential hybridization between charr and lake trout is another consideration that may influence the success of a replacement charr strain. Among vertebrates, hybridization and introgression are most common in fishes (Wilson and Bernatchez, 1998). Hybridization is predominantly the result of a lack of a conspecific mate, and the likelihood of successful hybridization is limited when species greatly differ in size (Wirtz, 1999). Hybridization among lake trout and Arctic charr has been documented; a study found that the frequency of hybrid lake trout and Arctic charr ranged from 1 to 6 percent in 4 of 11 Canadian lakes where both species co-occur (Wilson and Hebert, 1993). No signs of hybridization have been observed at BMP, and the likelihood of hybrids being formed is considered to be low. Charr may also hybridize with other members of the *salvelinus* genera, including brook trout that coexist with charr in most of Maine's charr waters.

<u>Option 4)</u> Chemical Reclamation

Applying rotenone to chemically reclaim BMP to remove non-native species is likely to be the highest cost remediation option. Though this approach would have the greatest potential for complete population and ecosystem restoration, it would also involve capturing charr then securing and cultivating them in captivity, followed by treating the pond, tributaries, and outlet with rotenone to remove all fish species (targeting smelt and lake trout). Upon completion, and once the rotenone has degraded, BMP could be restocked with captive wild and cultivated charr. Currently, the greatest limiting factor remains the inability to obtain charr brood in sufficient numbers for culture and/or reintroduction after reclamation. An alternative approach to reintroduction of BMP brood would be introduction (replacement) of translocated charr from another endemic population within Maine. Of notable concern at BMP is the current environment, specifically the suppressed water quality that compromises the viability of recolonization following a reclamation or translocation

Outside of the current inability to obtain brood and the challenges associated with securing a culture facility are the complex parameters surrounding the reclamation of BMP. The Department has investigated the myriad of water-specific attributes that must first be assessed to determine cost, feasibility, and the likelihood of success of a reclamation at BMP. Results from the assessment related to the chemical reclamation of BMP are outlined below.

Bald Mountain Pond has a surface area of 1,152 acres with a maximum depth of 65 feet and a mean depth of 18 feet. The shoreline is composed of a mix of ledge and boulders. Numerous shoals, coves, and islands also exist throughout the pond. These habitats would create navigational and safety challenges for watercraft and applicators. A Geographic Information System modeling approach was used to estimate the volume of water above (epilimnion) and below (hypolimnion) the thermocline (typically 30 feet at BMP). The hypolimnion was estimated to be 1,607-acre feet which would require 1,590 gallons of liquid rotenone (318 five-gallon cans). The epilimnion was estimated to be 16,359-acre feet, and would require 133,540 pounds of powdered rotenone (1,214 drums of 110 pounds each). The total estimated cost of only chemical and receiving costs of product needed to treat the pond, would be approximately $450,726.

The pond has nine noteworthy tributaries entering from all sides. Seven of the nine tributaries are relatively small and could be treated on foot with a manually operated backpack sprayer. The additional two are wide, low-gradient tributaries, requiring a small watercraft for a combined 1.25+ miles of chemical application.

The large, unobstructed outlet, Bald Mountain Stream, flows east into the West Branch of the Piscataquis River. Based on streambed elevations, it would be considered unattainable to lower BMP below the natural topography of the outlet to create retention capacity and avoid outflow treatment considerations. Therefore, treating the outlet may require additional rotenone costs as well as application of potassium permanganate ($KMnO_4$) to neutralize the outflow. Another challenging factor is the cove leading toward the pond's outlet is over 1.25 miles long with multiple islands and numerous rocks posing increased hazard and difficulty. This cove is not navigable with boats at normal water levels and would involve using liquid rotenone with manually operated backpack sprayers from canoes, adding additional cost and a significant amount of staff time.

Bald Mountain Pond is in a relatively remote location, adding further complications. The drive to BMP's boat launch includes over 15 miles of dirt logging roads. Transport over dirt roads has led to compaction of rotenone powder in past reclamations in Maine, resulting in a significant amount of additional time and energy needed to prepare powder for distribution. The act of transporting the required quantity of rotenone would add further complications and costs. Currently, there are no existing structures near BMP's boat launch. A required safe and secure onsite storage location would have to be constructed to properly store supplies prior to and during the reclamation event. During years with below-average water levels, the unimproved boat launch can limit access to boats with shallow hulls or those that are greater than 18 feet long. Limitations of boat size could significantly hinder reclamation time and safety.

The Department's reclamation team currently consists of 10 licensed applicators and 4 boats. Based on application rates from previous projects, (assuming 4 teams of 2) it would take 95.7 hours to apply all the product within the pond (81.6 hours for powder and 14.1 hours for the liquid rotenone). This estimate does not account for safety breaks or travel time from the rotenone storage site (boat landing) to the entirety of the pond. The additional two licensed applicators would be tasked with treating the nine tributaries and the outlet.

The physical attributes of BMP, including its large area (if chemically reclaimed, BMP would be the largest project ever undertaken in the history of the Department), water depth, hazardous habitats, and numerous tributaries pose great challenges. When combined, these factors significantly reduce the likelihood of a complete eradication of rainbow smelt and lake trout. In addition, the remote location, coupled with the large amount of product needed to treat the pond, creates compounding adverse challenges. Furthermore, the rotenone standard operating procedures specify lentic systems to be treated within a 48-hour window to ensure complete eradication. Thus, a project of this size would require a much larger application crew than currently exists and extensive equipment upgrades. Due to the factors outlined above, chemical reclamation of BMP is not considered viable at this time.

Planned Actions and Recommendations

Conserving the local adaptations and characteristics of BMP charr remains the focus of ongoing conservation efforts. The inability to reliably capture charr in sufficient numbers to support restocking following a reclamation, translocation, or a captive brood program remains the greatest impediment to meeting conservation needs. Recent sampling indicates the current population of charr is very low. The apparent rapid decline in the charr population is likely misrepresented as smelt were well established in BMP upon documentation. The combination of limited late summer charr habitat in recent years is likely exacerbated with the competition and potential predation from smelt. Limited summer habitat over multiple years could cause year class failures as charr compete for suitable habitat amongst native and introduced species.

Moving forward, the Department plans to continue monitoring the charr population in preparedness for action in the event a resurgence in the population occurs and translocation or a captive brood program becomes feasible. In the meantime, translocation waters will be identified based on water quality, physical characteristics, and past experiences. Maine State Heritage Fish waters offer the most suitable habitat and may be the focus rule changes to utilize these waters for translocation of charr from BMP. Efforts would also be directed at securing a facility to support culture of BMP charr, including funding sources to support associated costs.

Experimental smelt suppression by way of electroshocking eggs will continue again next year (2019) and perhaps longer as a temporary measure to reduce potential interactions. Water quality plays an integral role in the viability of managing BMP for charr in the future. As a result, beginning in June of 2019, the pond will be sampled monthly (through September) to collect temperature and dissolved oxygen profiles. Annual charr population status monitoring will continue to occur in August with short period gillnet sets. Baited charr traps, a technique recently refined by the Department, will also be experimentally fished in 2018. During annual gillnet sampling, a sample of brook trout will be collected to maintain the fish health classification needed for potential charr translocation. The status of lake trout will continue to be monitored during all field surveys and all encountered lake trout will be euthanized. During the 2018 APA rulemaking process, the Department will propose a no size or bag limit regulation on lake trout.

Long-term charr conservation actions at BMP will be continuously adjusted to reflect the best, cost-effective conservation techniques for charr based upon past and present data. Stocking or translocation of a charr into BMP from another Maine water would only be considered after the charr status in BMP is determined extant and lake trout are not considered a threat to the genetic integrity of charr. A stocking or translocation would follow MDIFW stocking policy and would therefore be subject to a peer review and public comment.

Acknowledgements

Sincere thanks to the following MDIFW staff for providing valuable edits, contributions, suggestions, and additional information during the development of this document: David Howatt, Frank Frost, Francis Brautigam, Matt Lubejko, Joe Overlock, and Commissioner Chandler Woodcock.

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Table 1. Occurrence of Arctic charr waters in Maine.

County	Lake	Town	Acres	Abundance
Aroostook	Black Lake	T15 R9 WELS	147	High
	Deboullie Lake	T15 R9 WELS	262	Moderate
	Gardner Lake	T15 R9 WELS	288	Moderate
	Pushineer Pond	T15 R9 WELS	55	Low
			752	
Franklin	Long Pond [1]	Township E	254	High
Hancock	Floods Pond	Otis	654	High
	Green Lake [1]	Dedham	2,989	Low
			3,643	
Piscataquis	Rainbow Lake	Rainbow Twp	1,664	Moderate
	Reed Pond (Big)	T8 R10 Wels	90	Very low
	Wadleigh Pond	T8 R15 Wels	157	High
	Wassataquoik Lake	T5 R10 Wels	178	High
			2,089	
Somerset	Bald Mountain Pond	Bald Mountain Twp	1,152	Low
	Enchanted Pond [1]	Upper Enchanted TWP	330	Very low
	Penobscot Lake	Dole Brook Twp	1,162	High
			2,644	
		Total:	9,382	

[1] Population introduced from Floods Pond, Otis.

Table 2. Sport fishery regulations at Bald Mountain Pond, Bald Mountain Township, Somerset County. 1973 – present. Closed to ice fishing. Open water fishing is permitted from April 1 – September 30.

YEAR	FISHERY REGULATIONS
2012–Present	Artificial lures only. 2 trout; minimum length limit on trout: 10 inches, only 1 may exceed 12 inches. Tributaries: No live fish as bait
2003–2011	Artificial lures only. 2 trout; minimum length limit on trout: 10 inches, only 1 may exceed 12 inches
1996–2002	No live fish as bait. 2 trout; minimum length on trout; 10 inches, only 1 may exceed 12 inches
1992–1995	No live fish as bait. 5 trout; minimum length on trout: 10 inches
1982–1991	No live fish as bait. 5 trout; minimum length on trout: 6 inches
1973–1981	No live fish bait. 8 trout or 7.5 lbs; minimum length on trout: 6 inches
Pre-1973	General Law

Table 3. Mean charr length (inches) and weight (pounds) by year sampled in Bald Mountain Pond.

		Age II+	Age III+	Age IV+	Age V+	Age VI+	Age VII+	Age VIII+
Year	No. Fish	L W	L W	L W	L W	L W	L W	L W
1989	1	- -	7.4” 2.0	- -	- -	- -	- -	- -
1997	10	- -	6.8” 1.6	- -	- -	- -	- -	- -
2008	46	4.8” 0.5	6.3” 1.2	7.1” 1.6	8.1” 2.2	- -	- -	- -
2014	23	- -	4.8” 0.4	5.9” 0.7	6.1” 0.7	7.1” 1.1	9.1” 2.6	10.0” 4.3
2015	18	- -	5.2” 0.6	- -	7.1” 1.5	8.2” 2.2	9.2” 3.4	10.4” 4.8
2016	1	- -	- -	- -	7.3” * 1.6	- -	- -	- -
2017	1	- -	- -	- -	- -	- -	9.7” 3.7	- -

*Scales collected had poor centers and were found unreadable, age is estimated by mean length.

Table 4. Total minutes smelt eggs were electroshocked at Bald Mountain Pond by year.

Year	Minutes	Volts
2015	104	700
2016	395	700–1000
2017	799	800
2018	372	800–900

Figure 1. Map of Bald Mountain Pond, Somerset County.

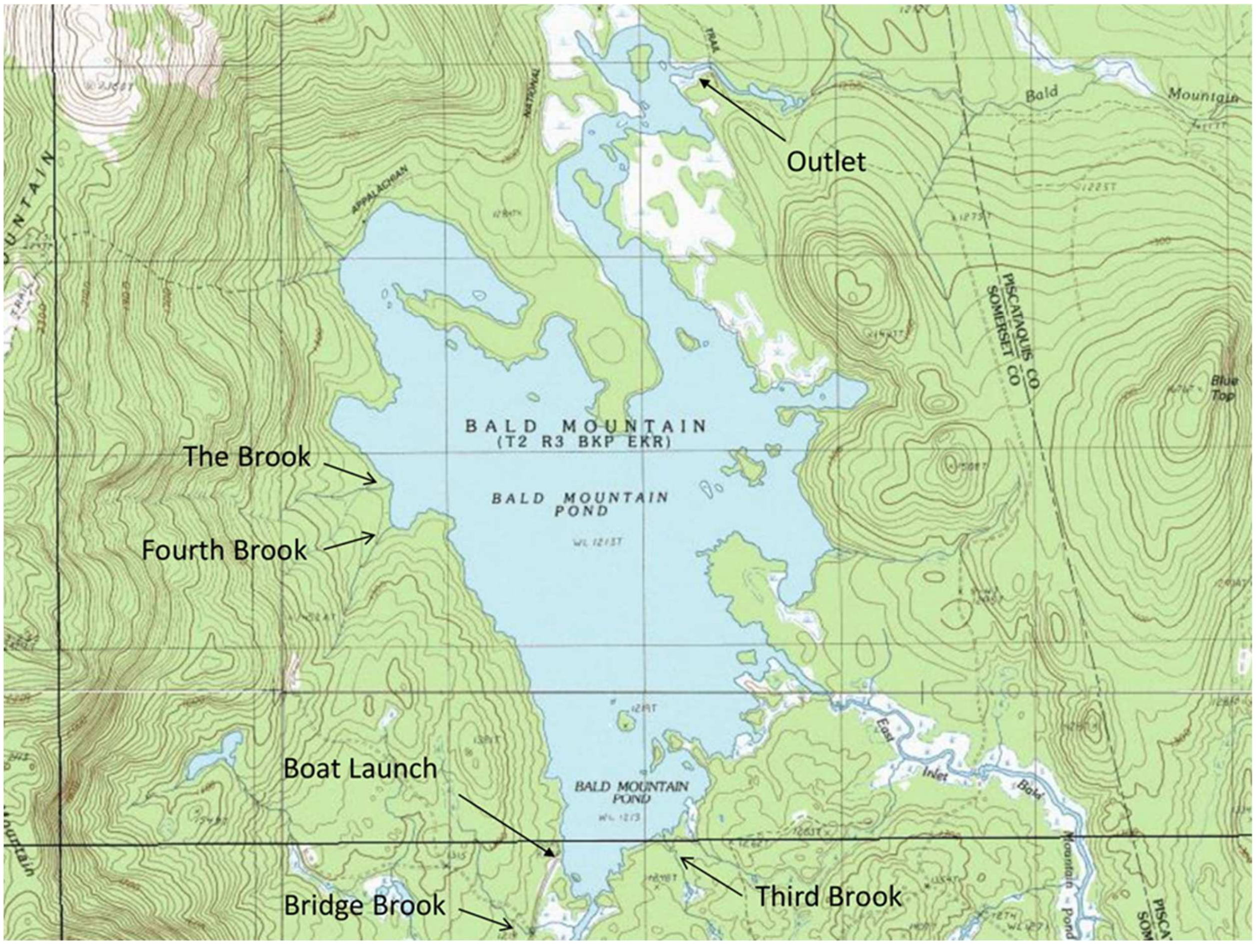


Figure 2. Photograph of log driving dam in operation at outlet of Bald Mountain Pond, August 10, 1950.

Stream: Bald Mountain Stream.

Township: Bald Mountain T 2 R 3, Somerset County

Subject: Dam at Bald Mountain Pond.

Operator: Hollingsworth and Whitney Company

Location: At the outlet to Bald Mountain Pond.

Date of Photo; August 10, 1950 Photo No. 262

164

Figure 3. Hours per charr catch rates during August gillnetting at Bald Mountain Pond.

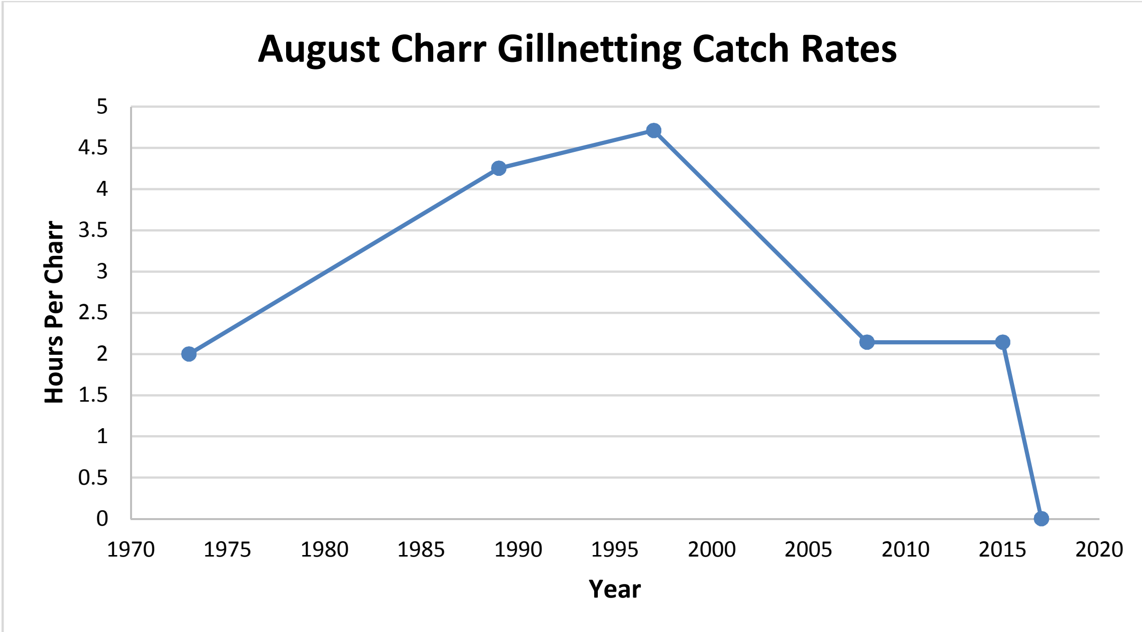
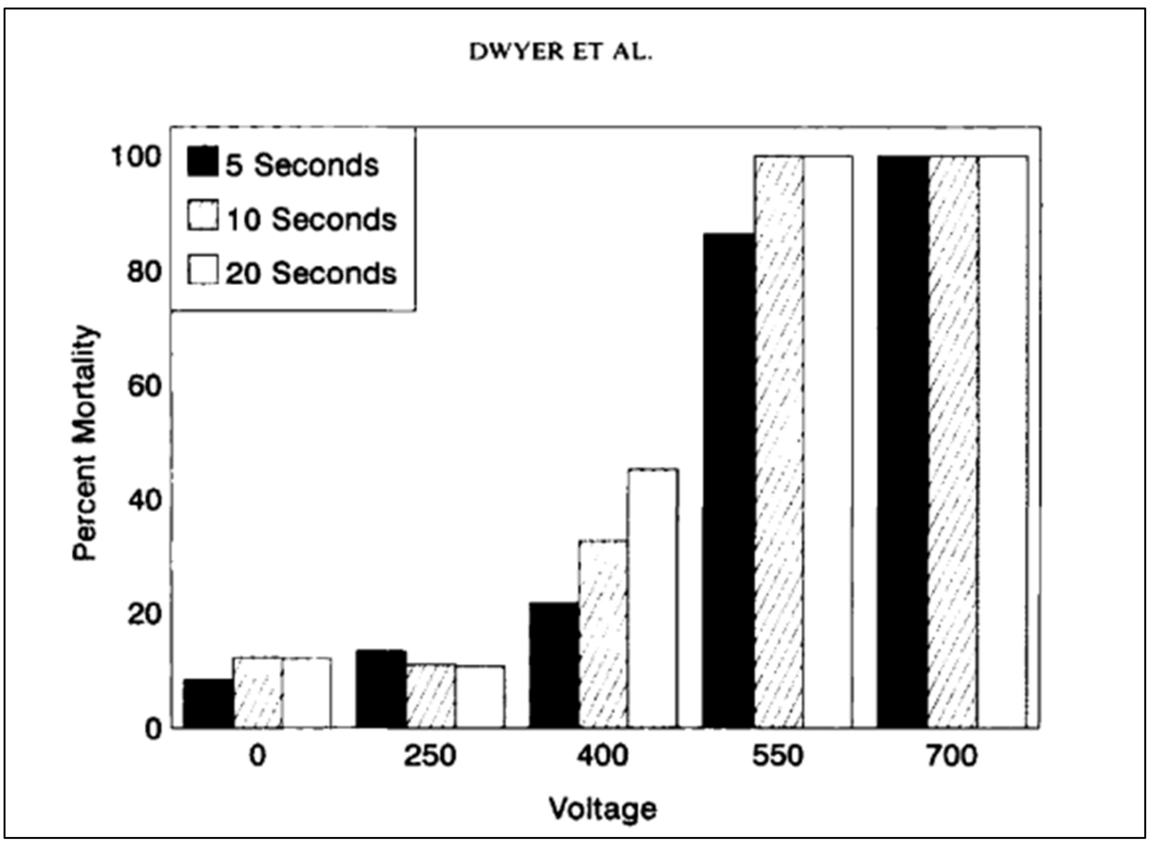


Figure 4. Percent mortality (mean) of cutthroat trout eggs exposed to electroshock in tanks at one of four voltages and three time durations on Day 8 post-fertilization. Mortality was determined 10 days after treatment (Dwyer, Erdahl, & Fredenberg).



COOPERATIVE

STATE FEDERAL

PROJECT

This report has been funded in part by the Federal Aid in Sport Fish Restoration Program. This is a cooperative effort involving federal and state government agencies. The program is designed to increase sport fishing and boating opportunities through the wise investment of angler's and boater's tax dollars in state sport fishery projects. This program which was founded in 1950 was named the Dingell-Johnson Act in recognition of the congressmen who spearheaded this effort. In 1984 this act was amended through the Wallop Breaux Amendment (also named for the congressional sponsors) and provided a threefold increase in Federal monies for sportfish restoration, aquatic education and motorboat access.

The program is an outstanding example of a "user pays-user benefits" or "user fee" program. In this case, anglers and boaters are the users. Briefly, anglers and boaters are responsible for payment of fishing tackle, excise taxes, motorboat fuel taxes, and import duties on tackle and boats. These monies are collected by the sport fishing industry, deposited in the Department of Treasury, and are allocated the year following collection to state fishery agencies for sport fisheries and boating access projects. Generally, each project must be evaluated and approved by the U.S. Fish and Wildlife Service (USFWS). The benefits provided by these projects to users complete the cycle between "user pays – user benefits."

Maine Department of Inland Fisheries and Wildlife
284 State Street, 41 SHS, Augusta, ME 04333-0041