Erwin National Fish Hatchery

Broodstock Strain Management Plan

Updated December 2018

Introduction

Congressional Act 28 Stat. 362 (August 5, 1892) provided for "*investigation and report respecting the advisability of establishing a fish-hatching station at some suitable point in the State of Tennessee.*" Four sites with springs suitable for the trout hatchery were found out of thirty potential sites that were examined. The Commissioner of Fisheries, in his report for the fiscal year 1897 recommended to Congress that a hatchery be built in the State of Tennessee at one of the four sites. Congressional Act 28 Stat. 387 (August 18, 1984) mandated funding of a fish hatchery which was to be located in Unicoi County, near Erwin, Tennessee. The station was established as a Fisheries station in 1897 when 10.83 acres of land were purchased at a cost of $1,025 which included the spring water supply. The Hatchery residence, outbuildings, and six ponds were constructed and the hatchery became operational at the end of November 1897. The first shipment of 25,000 rainbow trout eggs were received on December 17, 1897 from Wytheville, Virginia to initiate production.

The Erwin NFH, since its inception, been primarily a rainbow trout hatchery. The hatchery originally produced trout for stocking in mountain streams of Tennessee, North Carolina, and Virginia. Early records indicate that warm water species such as largemouth Bass, bluegill, and goldfish were also reared at the station, but on a limited basis. At the present time, rainbow trout and brook trout are being raised at the hatchery. The station began its role as an integral part of the National Broodstock Program in 1980.

Station Mission

Currently, the hatchery produces between 13 and 16 million eyed eggs annually from four stains of fish. The eggs are shipped to Federal, State, and Tribal hatcheries in support of various fishery management efforts in which there is Federal interest. A majority of these eggs are distributed to hatcheries in the southeastern United States. Rainbow trout are stocked in large numbers throughout the southeast to mitigate fish losses due to Federal water development projects. Eggs are also provided to schools, universities, and research facilities. ENFH functions as the primary broodstock facility for Erwin x Arlee Domestic backcross (EED), Fish Lake-Desmet (FLD) strains of rainbow trout, and Soda Lake Wild (SLW) brook trout. The hatchery is also the backup facility for the Arlee Domestic (ARD) strain of rainbow trout. A "backup" facility represents the same genetic material as a primary broodstock at another location and has the capability to replace that primary broodstock without loss of genetic integrity, should that broodstock be compromised by disease or some other catastrophic event.

The mission of ENFH is guided by the strategies and actions defined in the Service document "VISION FOR THE FUTURE – Action Plan for Fisheries Resources." Hatchery broodstock operations are performed using sounds genetic principles, ensuring that hatchery broodstock populations are managed to maintain genetic diversity, and avoid potential impacts on wild stock genetic integrity. Broodstock hatchery products are monitored for quality, thereby assuring optimum performance for hatchery reared fish following release.

Physical Facilities

The Erwin National Fish Hatchery (ENFH) is located in Unicoi County, Tennessee. It currently occupies 31.53 acres of land situated in a hollow, surrounded by forested hills. The elevation is 1790 feet above sea level. The hatchery water supply originates from two springs that produce a combined total of 1200 GPM. The main spring produces 840 GPM. This water is gravity fed to the upper (six) production raceways. An additional 360 GPM of spring water is collected at the second spring and is pumped to the upper raceways. Both water sources mix and supply rearing water to the entire hatchery. Water temperature is a constant 55F with only slight deviations due to effects of ambient air temperatures. Water originating from these springs is characteristically high in nitrogen with saturations level normally exceeding 120%. Other water quality parameters include: pH – 7.5, dissolved oxygen – 8.5ppm, dissolved solids 108ppm, and hardness ($CaCO_3$) – 84ppm. Oxygen supplementation of the hatchery water supply is accomplished through the use of a liquid oxygen injection system. Liquid oxygen is metered into the upper production raceways through packed columns. Liquid oxygen is supplies to the lower raceways through a reuse system. A portion of the hatchery effluent water is pumped back to an aerator building and thence into the heads of each of the lower raceways. Liquid oxygen is added to the water as it leaves the aerator building and is supplied to these lower raceways through this reuse system.

Fish rearing units include 16 – 2.5’ x 18’ indoor concrete nursery tanks (eight for fish rearing and eight for egg incubation and processing); 6 – 8’ x 75’ outdoor concrete production (early rearing) raceways; 14 – 8’ x 95’ outdoor concrete broodstock raceways; and 4 – 8’ x 75’ outdoor concrete broodstock raceways. All of the outdoor raceways are partially covered with weatherports to protect the broodstock and discourage bird predation. Eggs are incubated in 28 jar incubators. Sixteen of these jars are 10 gallon Eagar jars and 16 are the Erwin type incubation jar.

The Hatchery has been renovated many times since initial construction in 1897. The shop and garage buildings were constructed during the mid 1950’s. The hatchery building and quarters #67 (manager’s residence) were constructed during 1961 and 1962 respectively. Water supply pipelines and raceways were also constructed during the 1960’s. Quarters #1 is the only existing building from the original facility. Built in 1903, this building served as the hatchery superintendent’s residence. In 1982, the U.S> fish and Wildlife Service and Unicoi County entered into an agreement that established Quarters #1 as the Unicoi County Heritage museum. Operated by the Erwin/Unicoi County Chamber of Commerce, the Heritage Museum contains numerous exhibits highlighting local heritage and history.

Current Obstacles to Mission Fulfillment

The highest priority for ENFH is to maintain the hatchery’s disease free status. Without this disease free status the hatchery cannot ship eggs, thus preventing the hatchery from fulfilling its main priority. Disease (IPNV and ERM) was diagnosed in 1980 and 1981. The hatchery was subsequently disinfected and the springs water supply covered with rock. IPNV was again diagnosed in 1991. The hatchery was again depopulated and thoroughly disinfected. All outdoor rearing units at ENFH are partially covered with Hansen Weatherports discourage contamination of hatchery water supply. Full coverage, such as that existing at Ennis NFH, Iron River NFH, or White Sulphur Springs NFH is needed to prevent future contamination events. With the current infrastructure in place the facility is not biologically secure and future contamination events are likely to occur.

Lower raceway water quality that has historically had detrimental effects on fish and egg performance. The effects of elevated ammonia levels and lower pH found as a result of reusing water have been alleviated by ensuring production is carried out in a matter to not exceed flow and density indices of 0.03 and 0.10 respectively. This has been accomplished without impacting the current operations.

The pumps and motors that comprise the heart of the reuse system, associated with the lower 18 raceways, were replaced in 1997 and the entire system is protected with an alarm system. Also replaced in 1997 was the single pump that provides additional fresh water to the upper six raceways

The hatchery's N.P.D.E.S. permit, which expired in June 1997, was renewed in November 2000, after much negotiation with Tennessee Dept. of Environment and Conservation. The Department had studied the effects of chemical use on the receiving stream. Ms-222 and Argentyne did not exhibit acute toxicity at the current application rates. Formalin did exhibit toxicity in the screening test although hydrogen peroxide did not. Formalin is no longer used to control fungus on trout eggs. Hydrogen peroxide is now used exclusively for this purpose. This will greatly reduce any toxic effect that hatchery chemical discharge has on the benthic invertebrates in the receiving stream. Hatchery personnel should continue to find ways to reduce the use of toxic chemicals in hatchery operations.

Development of the land adjacent to the hatchery continues to occur and could eventually compromise both the quantity and quality of the hatchery water supply. The hatchery will have to continue to vie for the available water resources with homeowners, small businesses, and heavy industry in the future. Local zoning laws permit both industrial and residential use in the area adjacent to the hatchery. In order to prevent contamination of the spring water supply, hatchery personnel will need to be vigilant for unlawful dumping of petroleum products, solvents, and other toxic chemicals from adjacent businesses and residences.

Future Mission Support Strategies

Rapid backfilling of positions as employees retire will be critical to sustaining uninterrupted operations at ENFH. Two employees are planning to retire in this fiscal year. Erwin operates with minimal staff as it is and keeping staffing levels at the current level or higher will be crucial to accomplishing our mission.

ENFH will continue a strong emphasis on technology development. Technology advances developed within the National Fish Hatchery System ensure that the Service maintains a leadership role in the management of the Nation's fishery resources.

Physical needs mentioned previously must be addressed through the Service Maintenance Management System (MMS).

Rainbow Trout/Erwin-Arlee Backcross
Broodstock Management Plan

Current Program

The Erwin-Arlee Backcross (EED) was developed by hybridizing the Erwin and Arlee strains, then fertilizing F_1 generation eggs with sperm from Erwin males. This effort was an attempt to diversify the extremely domesticated Erwin strain fish. A total of 240 mated pairs were used to establish this brood lot. At present, Erwin NFH egg production goals include producing approximately 4 million eyed EED eggs annually. A majority of requested eggs are for use in mitigation programs to compensate for fish losses due to federal water development projects. Mature brood fish occupy 8 raceways and are held at a 0.10 density index or less. Immature brood fish (less than age one) are fed at a hatchery constant of 15. Mature brood fish are fed at a rate of 0.8% of body weight daily. Hand feeding is used as the method of feeding. All mature brood fish held in the lower raceways receive a combination of fresh spring water, serial reuse water, and recirculated reuse water. Winter water temperatures range from 54-56^{o}F due to the effects of ambient air temperature. Water recirculation during the summer months can result in water temperatures near 60^{o}F in the lower eighteen raceways.

Samples of 1993 year class Erwin-Arlee backcross (EED) strain rainbow trout were submitted to Dr. Robb Leary, Population Geneticist, University of Montana for eletrophoretic and meristic analysis. Analysis indicates that, *"Compared to other broodstocks of rainbow trout, the Erwin X Arlee Backcross has slightly lower than normal average expected heterozygosity but slightly above normal average number of alleles per locus and proportion of polymorphic loci. Furthermore, this broodstock has a slightly lower than average amount of asymmetry. Thus, there is no indication that this broodstock has lost significant amounts of genetic variation."* Data derived from samples taken from future generations of fish will be compared to this baseline data to determine if current broodstock management practices are effectively maintaining the genetic integrity of the stocks. At a minimum, re-analysis should take place every two generations (every four or five years).

Selection of Future Broodstock

This strain was established in September 1991 and 1992, following receipt of eyed eggs from Ennis NFH, Montana. This was necessary due to the diagnosis of IPNV and subsequent hatchery disinfection at Erwin NFH during the spring of 1991. At age two, fish are sorted approximately one month prior to the anticipated date of spawning. During this time, male and female fish are separated. Female fish are checked for ripeness once per week after initial sorting. Fish are anesthetized using approximately 90 mg/L MS-222. The water containing the MS-222 also contains 3.0% salt (NaCl) which effectively controls Saprolegnia sp. fungus infection in fish. Eggs are manually stripped from ripe females. All eggs for future broodstock are derived from paired (one male, one female) matings. The eggs from one two year old female are collected directly into a pan containing an isotonic (0.75% NaCl) fertilization medium. Sperm from a single three year old male fish is added. Males are used only once during a spawning season. The eggs and sperm are thoroughly mixed. After one minute, the eggs are rinsed with raceway water and placed in 75 mg/L iodophor (Argentyne) for 30 minutes. Eggs for

future broodstock are collected from the three middle egg takes within a spawning season. The first and last takes are disregarded. This results in three sublots. A minimum of 500 fish are spawned during this time. All females that are spawned during this three week period contribute eggs which are used for future broodstock. For each paired mating, a spoonful of eggs (approximately 50 eggs) is taken for use as future brood. A certain number of eggs/fish are randomly selected from each brood sublot to form the future broodstock lot. The number of eggs/fish retained from each brood sublot is proportional to the total number of females ripe on that date.

Three hundred 2 year old males are randomly selected from fish spawned during the current year and these are retained for use as sperm donors the following year.

Incubation Methods and Egg Shipment

Following treatment in 75 mg/L iodophor solution for 30 minutes, the freshly fertilized eggs are rinsed and poured into jar incubators. The incubators have been calibrated (using displacement measurement) to measure the number of ounces of eggs contained in each jar. Hatchery staff then enumerate the eggs by determining numbers of eggs per ounce. Three - 50 egg samples are collected, excess water removed, and placed into a 50 ml buret that contains a predetermined amount of water. Water displacement is measured and is used to determine egg size. Jar incubators are supplied with 2 gpm of fresh spring water. Daily hydrogen peroxide treatments are used to control fungus. A flow through treatment at a concentration of 800 ppm works very effectively. Iodophor is added to each egg jar daily to provide a 75 mg/L flush treatment for the control of soft egg disease.

Normally, eggs are strongly eyed in 14 days. On the 14th day, the eggs are shocked by dropping them approximately 3 feet into a tub of water. Three Jensorter egg pickers are used to remove dead eggs. Picked eyed eggs are again enumerated and measured using displacement prior to shipping. Excess water is removed, and the eggs are placed on nylon-reinforced paper towels for wrapping. The wrapped eggs are placed in styrofoam trays. The top tray (top two during warm weather) contains ice chips. The trays are placed in styrofoam coolers and inserted in cardboard boxes.

Eyed eggs from this strain are normally available from August through October. Federal Express is used for delivery.

Rainbow Trout/Arlee Strain
Broodstock Management Plan

Current Program

The Arlee strain (ARD) was established in October - November 1991 and 1992, following receipt of eyed eggs from Ennis NFH, MT. This was necessary due to the diagnosis of IPNV and subsequent hatchery disinfection at Erwin NFH during the Spring of 1991. This brood lot was derived from 160 paired matings of two year old brood fish, and 103 paired matings of three year old brood fish. At present, Erwin NFH egg production goals include producing 2.5 million ARD eggs in calendar years 2002 and 2003. Egg requests for the next two years do not exceed station production goals. A majority of requested eggs are for use in mitigation programs to compensate for fish losses due to federal water development projects. Mature brood fish occupy 3 raceways (4356 ft^3 total) and are held at a .10 density index. Immature brood fish (less than age one) are fed at a hatchery constant of 15. Mature brood fish are fed at a rate of 0.8% of body weight daily. Hand feeding is used as the method of feeding. All mature brood fish held in the lower raceways receive a combination of fresh spring water, serial reuse water, and recirculated reuse water. Winter water temperatures range from 54-56^oF due to the effects of ambient air temperature. Water recirculation during the summer months can result in water temperatures near 60^oF in the lower eighteen raceways.

Samples of 1993 year class Arlee (ARD) strain rainbow trout were submitted to Dr. Robb Leary, Population Geneticist, University of Montana for electrophoretic and meristic analysis. Analysis indicates that, *"Genetic differences exist between the 1993 year class of Arlee rainbow trout from the Erwin National Fish Hatchery and the 1992 year class of Arlee rainbow trout from the Ennis National Fish Hatchery. The differences are slight and probably have little if any biological significance. The available data indicate based on average expected heterozygosity, the proportion of polymorphic loci, and the average number of alleles per locus the Erwin Arlee broodstock has average to above average amounts of genetic variations. This broodstock also has about the average number of asymmetric characters per individual compared to the other rainbow trout broodstocks indicating it has normal developmental characteristics. Thus, there is no evidence that this broodstock has lost significant amounts of genetic variation."* Data derived from samples taken from future generations of fish will be compared to this baseline data to determine if current broodstock management practices are effectively maintaining the genetic integrity of the stocks. At a minimum, re-analysis should take place every two generations (every four or five years).

Selection of Future Broodstock

At age two, fish are sorted approximately one month prior to the anticipated date of spawning. During this time, male and female fish are separated. Female fish are checked for ripeness once per week after initial sorting. Fish are anesthetized using approximately 90 mg/L MS-222. The water containing the MS-222 also contains 3.0% salt (NaCl) which effectively controls Saprolegnia sp. fungus infection in fish. Eggs are manually stripped from ripe females. All eggs for future broodstock are derived from paired (one male, one female) matings. The eggs from one two year old female are collected directly into a pan containing an isotonic (0.75% NaCl) fertilization medium. Sperm from a three year old male fish is added. Males are used only once during a spawning season. The eggs and sperm are thoroughly mixed. After one minute, the eggs are rinsed with raceway water and placed in 75 mg/L iodophor (Argentyne) for 30 minutes.

Historically, two year old males and females have been mated to provide eggs for future broodstock. This method has been abandoned because of concerns that mating males and females from the same year class will result in an accelerated loss of genetic variability within the strain.

Eggs for future broodstock are collected from the three middle egg takes within a spawning season. The first and last takes are disregarded. This results in three sublots. A minimum of 500 fish are spawned during this time. All females that are spawned during this three week period contribute eggs which are used for future broodstock. For each paired mating, a spoonful of eggs (approximately 50 eggs) is taken for use as future brood. A certain number of eggs/fish are randomly selected from each brood sublot to form the future broodstock lot. The number of eggs/fish retained from each brood sublot is proportional to the total number of females ripe on that date.

Three hundred 2 year old males are randomly selected from fish spawned during the current year and these are retained for use as sperm donors the following year.

Incubation Methods and Egg Shipment

Following treatment in 75 mg/L iodophor solution for 30 minutes, the freshly fertilized eggs are rinsed and poured into jar incubators. The incubators have been calibrated (using displacement measurement) to measure the number of ounces of eggs contained in each jar. Hatchery staff then enumerate the eggs by determining numbers of eggs per ounce. Three - 50 egg samples are collected, excess water removed, and placed into a 50 ml buret that contains a predetermined amount of water. Water displacement is measured and is used to determine egg size. Jar incubators are supplied with 2 gpm of fresh spring water. Daily hydrogen peroxide treatments are used to control fungus. A flow through treatment at a concentration of 800 ppm works very effectively. Iodophor is added to each egg jar three times per week to provide a 75 mg/L flush treatment for the control of soft egg disease.

Normally, eggs are strongly eyed in 14 days. On the 14th day, the eggs are shocked by dropping them approximately 3 feet into a tub of water. Three Jensorter egg pickers are used to remove dead eggs. Picked eyed eggs are again enumerated and measured using displacement prior to shipping. Excess water is removed, and the eggs are placed on nylon-reinforced paper towels for wrapping. The wrapped eggs are placed in styrofoam trays. The top tray (top two during warm weather) contains ice chips. The trays are placed in styrofoam coolers and inserted in cardboard boxes.

Eyed eggs from this strain are normally available during the months of November and December. Federal Express is used for delivery.

Rainbow Trout/Fish Lake-Desmet Strain
Broodstock Management Plan

Current Program

The Erwin NFH serves as the primary facility for the Fish Lake- Desmet strain Rainbow trout (the Ennis NFH serves as the backup). The Fish Lake-Desmet strain (FLD) was established in May 1992 and 1993, following receipt of eyed eggs from Egan State Fish Hatchery, UT. This was necessary due to the diagnosis of IPNV and subsequent hatchery disinfection at Erwin NFH during the Spring of 1991. The number of matings used to establish this brood lot is unknown. At present, Erwin NFH egg production goals include producing 2.1 million FLD eggs in calendar years 2003 and 2004. Egg requests for the next two years do not exceed station production goals. Fish Lake-Desmet broodstock eggs were supplied to Ennis NFH, MT in the Spring of 1997 and again in 1998. A majority of requested eggs are for use in mitigation programs to compensate for fish losses due to federal water development projects. Mature brood fish occupy 6 raceways (7706 ft^3 total) and are held at a .10 density index. Immature brood fish (less than age one) are fed at a hatchery constant of 15. Mature brood fish are fed at a rate of 0.8% of body weight daily. Hand feeding is used as the method of feeding. All mature brood fish held in the lower raceways receive a combination of fresh spring water, serial reuse water, and recirculated reuse water. Winter water temperatures range from 54-56^oF due to the effects of ambient air temperature. Water recirculation during the summer months can result in water temperatures near 60^oF in the lower eighteen raceways.

Samples of 1995 year class Fish Lake-Desmet (FLD) strain rainbow trout were submitted to Dr. Robb Leary, Population Geneticist, University of Montana for electrophoretic and meristic analysis in June of 1995. Analysis indicates that, *"There is no evidence that the Fish Lake-Desmet broodstock has lost appreciable amounts of genetic variation. In this broodstock, estimates of the amount of genetic variation and the amount of asymmetry are close to mean observed in rainbow trout broodstocks."* Data derived from samples taken from future generations of fish will be compared to this baseline data to determine if current broodstock management practices are effectively maintaining the genetic integrity of the stocks. At a minimum, re-analysis should take place every two generations (every four or five years).

Selection of Future Broodstock

At age two, fish are sorted approximately one month prior to the anticipated date of spawning. During this time, male and female fish are separated. Female fish are checked for ripeness once per week after initial sorting. Fish are anesthetized using approximately 90 mg/L MS-222. The water containing the MS-222 also contains 3.0% salt (NaCl) which effectively controls Saprolegnia sp. fungus infections in fish. Eggs are manually stripped from ripe females. All eggs for future broodstock are derived from paired (one male, one female) matings. The eggs from one three year old female are collected directly into a pan containing an isotonic (0.75% NaCl) fertilization medium. Sperm from a three year old male fish is added. Males are used only once during a spawning season. The eggs and sperm are thoroughly mixed. After one minute, the eggs are rinsed with raceway water and placed in 75 mg/L iodophor (Argentyne) for 30 minutes. Historically, two year old males and females have been mated to provide eggs for future broodstock. This method has been abandoned because of concerns that mating males and females from the same year class will result in an accelerated loss of genetic variability within the strain.

Eggs for future broodstock are collected from the three middle egg takes within a spawning season. The first and last takes are disregarded. This results in three sublots. A minimum of 500 fish are spawned during this time. All females that are spawned during this three week period contribute eggs which are used for future broodstock. For each paired mating, a spoonful of eggs (approximately 50 eggs) is taken for use as future brood. A certain number of eggs/fish are randomly selected from each brood sublot to form the future broodstock lot. The number of eggs/fish retained from each brood sublot is proportional to the total number of females ripe on that date.

Three hundred 2 year old males are randomly selected from fish spawned during the current year and these are retained for use as sperm donors the following year.

Incubation Methods and Egg Shipment

Following treatment in 75 mg/L iodophor solution for 30 minutes, the freshly fertilized eggs are rinsed and poured into jar incubators. The incubators have been calibrated (using displacement measurement) to measure the number of ounces of eggs contained in each jar. Hatchery staff then enumerate the eggs by determining numbers of eggs per ounce. Three - 50 egg samples are collected, excess water removed, and placed into a 50 ml buret that contains a predetermined amount of water. Water displacement is measured and is used to determine egg size. Jar incubators are supplied with 2 gpm of fresh spring water. Daily hydrogen peroxide treatments are used to control fungus. A flow through treatment at a concentration of 800 ppm works very effectively. Iodophor is added to each egg jar three times per week to provide a 75 mg/L flush treatment for the control of soft egg disease.

Normally, eggs are strongly eyed in 14 days. On the 14th day, the eggs are shocked by dropping them approximately 3 feet into a tub of water. Three Jensorter egg pickers are used to remove dead eggs. Picked eyed eggs are again enumerated and measured using displacement prior to shipping. Excess water is removed, and the eggs are placed on nylon-reinforced paper towels for wrapping. The wrapped eggs are placed in styrofoam trays. The top tray (top two during warm weather) contains ice chips. The trays are placed in styrofoam coolers and inserted in cardboard boxes.

Eyed eggs from this strain are normally available from January through April. Federal Express is used for delivery.

Brook Trout/Soda Lake Wild Strain
Broodstock Management Plan

Current Program

The Erwin NFH serves as the primary facility for the Soda Lake Wild strain brook trout (Story State Fish Hatchery in Wyoming is considered the backup). The Soda Lake Wild strain (SLW) was established at ENFH in October 2015, following receipt of eyed eggs from Story SFH in Wyoming. The number of matings used to establish this brood lot is unknown. At present, Erwin NFH egg production goals include producing 600,000 eggs in annually. Egg requests for the next two years do not exceed station production goals. A majority of requested eggs are for use in mitigation programs to compensate for fish losses due to federal water development projects. Mature brood fish occupy 2 raceways and are held at a .10 density index. Immature brood fish (less than age one) are fed at a hatchery constant of 15. Mature brood fish are fed at a rate of 0.8% of body weight daily. Hand feeding is used as the method of feeding. All mature brood fish held in the lower raceways receive a combination of fresh spring water, serial reuse water, and recirculated reuse water. Winter water temperatures range from 54-56^{o}F due to the effects of ambient air temperature. Water recirculation during the summer months can result in water temperatures near 60^{o}F in the lower eighteen raceways.

Selection of Future Broodstock

At age two, fish are sorted approximately one month prior to the anticipated date of spawning. During this time, male and female fish are separated. Female fish are checked for ripeness once per week after initial sorting. Fish are anesthetized using approximately 90 mg/L MS-222. The water containing the MS-222 also contains 3.0% salt (NaCl) which effectively controls Saprolegnia sp. fungus infections in fish. Eggs are manually stripped from ripe females. All eggs for future broodstock are derived from paired (one male, one female) matings. The eggs from one three year old female are collected directly into a pan containing an isotonic (0.75% NaCl) fertilization medium. Sperm from a three year old male fish is added. Males are used only once during a spawning season. The eggs and sperm are thoroughly mixed. After one minute, the eggs are rinsed with raceway water and placed in 75 mg/L iodophor (Argentyne) for 30 minutes. Historically, two year old males and females have been mated to provide eggs for future broodstock. This method has been abandoned because of concerns that mating males and females from the same year class will result in an accelerated loss of genetic variability within the strain.

Eggs for future broodstock are collected from the three middle egg takes within a spawning season. The first and last takes are disregarded. This results in three sublots. A minimum of 500 fish are spawned during this time. All females that are spawned during this three week period contribute eggs which are used for future broodstock. For each paired mating, a spoonful of eggs (approximately 50 eggs) is taken for use as future brood. A certain number of eggs/fish are randomly selected from each brood sublot to form the future broodstock lot. The number of eggs/fish retained from each brood sublot is proportional to the total number of females ripe on that date.

Three hundred 2 year old females are randomly selected from fish spawned during the current year and these are retained for use as sperm donors the following year.

Incubation Methods and Egg Shipment

Following treatment in 75 mg/L iodophor solution for 30 minutes, the freshly fertilized eggs are rinsed and poured into jar incubators. The incubators have been calibrated (using displacement measurement) to measure the number of ounces of eggs contained in each jar. Hatchery staff then enumerate the eggs by determining numbers of eggs per ounce. Three - 50 egg samples are collected, excess water removed, and placed into a 50 ml buret that contains a predetermined amount of water. Water displacement is measured and is used to determine egg size. Jar incubators are supplied with 2 gpm of fresh spring water. Daily hydrogen peroxide treatments are used to control fungus. A flow through treatment at a concentration of 800 ppm works very effectively. Iodophor is added to each egg jar three times per week to provide a 75 mg/L flush treatment for the control of soft egg disease.

Normally, eggs are strongly eyed in 14 days. On the 14th day, the eggs are shocked by dropping them approximately 3 feet into a tub of water. Three Jensorter egg pickers are used to remove dead eggs. Picked eyed eggs are again enumerated and measured using displacement prior to shipping. Excess water is removed, and the eggs are placed on nylon-reinforced paper towels for wrapping. The wrapped eggs are placed in styrofoam trays. The top tray (top two during warm weather) contains ice chips. The trays are placed in styrofoam coolers and inserted in cardboard boxes.

Eyed eggs from this strain are normally available from October through early December. Federal Express is used for delivery.