Culture of Salmonids

Overview

The stocking of New Jersey waters with trout spans well across an entire century. The stocking program, fish culture technology and attitudes have changed considerably during this time frame. Initially viewed as only serving the wealthy, the stocking of trout was not supported by the New Jersey Fish and Game Commission. The first stocking of brook trout by the Commission in 1879 was only in response to a severe drought and was intended to replenish native populations which were believed to be decimated. The idea caught on however and more focused efforts were made for expanding recreational opportunities across the state.

The first stocking records date back to 1879. The mode of transport was by train, using milk cans. Upon arrival trout were transferred to wagons which transported the fish to streams. Fish were initially purchased under contract from private hatcheries. In 1912, the State began construction of its own hatchery in Hackettstown and began producing fingerlings. Production of catchable size brook, brown and rainbow trout began in 1914. By 1932, the Hackettstown hatchery was raising over 500,000 trout for distribution across the state. The transport of fish was now done by truck but milk cans still served as holding areas. In the years that followed disease outbreaks among the hatchery stock due to the intensive culture increased, as did the demand for other warmwater species. In 1980, the construction of the Pequest Trout Hatchery began and the production of all trout, with the exception of lake trout, was transferred there when the facility opened in 1983.

Presently, the DFW owns and operates two state-of-the-art- facilities, the Pequest Trout Hatchery and the Hackettstown Hatchery. Together, they meet the State's demand for coldwater and warmwater fish species. The Pequest Trout Hatchery raises over 770,000 catchable trout annually and distributes them using a fleet of tank trucks equipped with on board aeration systems. The fish are distributed to 180 lakes and streams during which over 1,000 stocking points are visited. The Hackettstown hatchery raises over 2 million fish representing16 warmwater/coolwater species. Currently, lake trout is the only salmonid raised at the Hackettstown facility.

Pequest Trout Hatchery

<u>Facility Description</u>

The Pequest Trout Hatchery is located in the Pequest River valley near the town of Oxford, in Warren County. The hatchery encompasses approximately fifty acres within a four thousand-acre wildlife management area. There are sixty-four concrete raceways, ten feet wide by one hundred

feet long. A stable, cold water supply is a critical factor in trout propagation and maintenance of a production cycle. Seven on-site artesian wells supply the hatchery with up to seven thousand gallons of water per minute. This groundwater supply has a constant temperature of 11°C (52°F) year round and is capable of maintaining a continuous flow of water through the hatchery system. Flow from each of the operating wells is monitored closely and controlled remotely through phone lines. Consistent and reliable operation of the wells requires an intensive maintenance schedule.

Opportunity – Phone lines currently used to monitor and operate wells are aging and may not be reliable in the future. The purchase of a broad spectrum radio well communication system should be investigated to replace existing communication system.

The groundwater is aerated and then by gravitational flow cascades through the raceway system eventually discharging into the Pequest River. Due to the sensitivity of an intensive rearing facility and that water flow can not be interrupted, an emergency back up system was installed when the facility was constructed. Three of the wells have their own direct drive diesel motor that activates any time the power is interrupted for any reason. A fourth diesel generator, which operates two additional wells and emergency lighting, is located in the basement of the nursery building. A contracted alarm company monitors emergency situations and notifies personnel along with on site sirens.

The intensive rearing of fish produces a considerable amount of waste products. To address both fish and domestic waste, the Pequest facility houses its own sewage treatment plant. A separate clarifier de-waters the trout waste into sludge. The trout sludge is land applied on the Pequest Wildlife Management Area in a joint venture with the local farmers and Soil Conservation Service. The application of sludge is monitored under the facility's NJPDES permit (NJ0033189) with required annual testing of heavy metals and priority pollutants. The domestic side of the plant is completely separate from the trout waste and is tested for toxic organics, metals, and other chemical parameters. Two active discharge permits are required for the operation of the Pequest complex. The first is surface water discharge (OO1) which covers the flows through the raceways and discharge into the Pequest. The permit requires monthly, quarterly, or semiannual monitoring for flow, BOD, PH, Total Suspended Solids, Nitrogen Ammonia, Fecal Coliform, Chlorine Produced Oxidants, Temperature, Dissolved Oxygen, and Total Phosphorus. The second active permit is for ground water (JO1). Parameters tested throughout the year are: Flow, PH, Nitrogen Ammonia, Nitrate Nitrogen, Kjeldahl Nitrogen, Total Dissolved Solids, and Chlorine. This is the flow that runs through the domestic package plant and is combined with the total discharge. A treatment plant operator, with a minimum of an S-4 license, is required to oversee the operation of the plant. Other regulatory agencies involved in the operation of the hatchery are: Bureau of Water Allocation for water supply permit, quarterly diversion reports and potable water testing; Bureau of Applicability and Compliance monitors fuel storage tanks; Bureau of Pretreatment and Residuals oversees trout sludge and land application; NJ Department of Community Affairs covers fire safety and inspections; the Warren County Health Department; NJ Department of Health oversee Right To Know procedures; US Fish and Wildlife Service issues a Federal Fish and Wildlife Depredation Permit. In addition, DFW's Lab Services,

Purchase Bureau, Human Resources, and the US Geological Survey are directly involved in the operation of the Pequest facility.

History of Trout Culture

Production of trout commenced in the fall of 1982, when the construction of the facility was completed, with the arrival of 560,000 disease-free rainbow trout eggs from the federal hatchery at White Sulphur Springs, West Virginia. An additional 680,000 brook trout and 610,000 brown trout eggs were obtained from the North Attleboro National Fish Hatchery in Massachusetts. In the spring of 1984, following the hatching of these eggs and a 17-month growing period, the first trout reared at Pequest were released in New Jersey lakes and streams. Trout from the first egg hatch were also reared to maturity and retained as broodstock to provide an internal source of eggs and sperm for the production of future generations of disease-free trout. The hatchery maintains a quality broodstock population of trout through an annual selection process.

Culture Techniques

Annual production goals are satisfied by harvesting approximately 650,000 eggs from both brook and rainbow trout broodstock and 400,000 eggs from brown trout broodstock. The production cycle begins in early fall when eggs from the broodstock trout are collected and fertilized. This process, known as "stripping," is performed by manually applying pressure to the trout's abdomen, forcing females to expel ripe eggs and males to expel milt (the fluid containing sperm). The eggs and milt are mixed together in plastic basins to achieve fertilization. Fertilized eggs are then placed in incubators in the nursery building where running water, held at a constant temperature of 11°C (52°F), supplies them with dissolved oxygen until hatching occurs. Trout eggs incubated at this temperature hatch in about 30 - 35 days.

The overall hatch rate for all three species averages 65 percent. Upon hatching, the young trout are called "sac-fry" because the yolk sac, which nourishes the fry, remains attached to the trout's abdomen. The sac-fry are removed from the incubators and placed in fiberglass holding tanks in the main portion of the nursery building. The yolk sac is gradually absorbed by the sac-fry over a two-week period. When this internal food supply has been exhausted the trout are termed "fry" and begin to swim freely and feed upon an external food supply. Automatic feeders suspended over the nursery tanks feed the fry a commercially prepared, high-protein diet eight times daily.

After the winter and early spring growing cycle, which has an 85-95 percent survival rate, the trout average three to four inches and are called fingerlings. The fingerlings are sorted by size

and their numbers are reduced to allow the remaining production fish more room to grow. The smaller, surplus fingerlings are either stocked or used in inter-state bartering programs. The production fingerlings are then moved to a series of outdoor raceways that have been divided into "pools." Each pool is set up with 13,500 fish, with 19 pools each of brook and rainbow trout and ten pools of brown trout. In 2003, in response to angler requests, brown trout production was increased by 25,000 modifying pool set up to 19 pools of brook, 17 pools of rainbow and 12 pools of brown trout. Since the hatchery already operates at full capacity, rainbow trout production was reduced as a result of this change.

Pequest Trout Hatchery Production Targets

Species	Prior 2003*	2003*
Brook	237,500	250,000
Brown	125,000	150,000
Rainbows	237,500	200,000

*Numbers are approximate targets for species composition. Actual production numbers vary each year, and are dependent on a variety of factors.

After the summer growing period, the fish are again sorted for size, and the larger fish are retained and used to re-set the raceways with a density of 12,500 fish per pool. Approximately 600,000 trout are set to ensure that the spring baseline trout quota of 575,000 trout, averaging 10.5 inches in length, will be achieved. Surplus fish resulting from this sort (approximately 48,000 fish, averaging 5.8 inches) are held and stocked during the third week of the fall trout-stocking program. The production fish are then fed four times daily. Inventories are conducted and feed totals are calculated monthly and used to adjust trout growth rates.

By mid March the production trout are nearly 1½ years old and weigh ½ pound apiece. Over the next ten weeks these fish are loaded onto trucks and stocked statewide under the spring trout-stocking program. During the three weeks of pre-season stocking, the excess and spent broodstock are also liberated along with the production stock until their supply is exhausted. Once these catchable-size trout are shipped, fingerlings that hatched from eggs collected the previous fall are quickly moved from the nursery into the raceways.

After several years of operation and success in meeting production goals for the spring program, it was determined that production could be expanded for new programs. A small number of raceway pools, underutilized in the late summer and early fall, were put into production to provide trout for the fall, winter, and sea-run trout programs. Increased water flows and feeding rates were used to accelerate the growth of yearling fish kept in these pools. The fall program consists of about 45,000 yearling rainbow trout, averaging ten inches, which are available for stocking in October. The winter program consists of 12,000 rainbow trout, averaging 11 inches, which are available for stocking by late November.

Implementation of the DFW's 2005 trout proposal (See Appendix A) will result in substantial changes to the 2006 fall and winter trout programs. In the fall of 2006 the 45,000

yearling rainbow trout, traditionally reared will be replaced with 20,000 two-year-old fish representing all three species and ranging in size from 14" to 16". A similar change for the 2006 winter program will result in 5,000 two-year-old rainbows being distributed. These changes are anticipated to increase angler interest and participation in fall and winter trout fishing.

Opportunity: Investigate the feasibility of decreasing numbers of trout stocked to increase overall size of trout stocked.

Thirty thousand surplus brown trout from the spring yearling sort are reared to eight inches for the sea-run program for stocking in late October. In the future this number may be decreased to improve hatchery operations.

Opportunity: Investigate the feasibility of reducing brown trout allocated for the sea run program to improve hatchery operations.

Charles O. Hayford Hatchery (Hackettstown)

Facility Description

The Hatchery is located in the Musconetcong River watershed in Hackettstown, Warren County. The Hackettstown Hatchery is one of the oldest fish hatcheries in the country dating back to 1912. For over 70 years it was the only state-run hatchery in New Jersey. In 1983, the production of brook, brown and rainbow trout shifted to the newly constructed Pequest Trout Hatchery. The hatchery at Hackettstown retained the production of lake trout because the lake trout eggs are obtained from outside sources that are not certified disease-free.

The water source at the Hackettstown Hatchery is gravity flowed spring water. These springs provide about 1300 gallons per minute flow and maintain a temperature of 11°C. Following renovations in 2000, this same spring water is now pumped up into a head tank and then gravity flows through the rearing tanks. During the pumping process the water is sent through an ultraviolet sterilizer and a degassing column and is also oxygenated.

History of Lake Trout Culture

New Jersey's lake trout program began in 1976 with the arrival of 31,000 eyed lake trout eggs from the Marquette State Fish Hatchery in Michigan. In March, 1977 the first stocking of lake trout in New Jersey took place at Round Valley Reservoir, Hunterdon County. This initial stocking totaled 7,330 lakers that averaged 5.6". Eggs were annually obtained from Michigan DNR through 1981, when hatchery renovations in Michigan eliminated this egg source. In 1981, New Jersey fisheries biologists spawned 2,500 eggs from broodstock

collected in Round Valley Reservoir. From 1981-1988, eyed eggs were obtained from the U.S. Fish and Wildlife Service through the Jackson National Fish Hatchery in Jackson Hole, Wyoming. These Wyoming lake trout were the Jenny Lake strain. In 1988 a lake trout program was initiated at Merrill Creek Reservoir.

From 1988-1991, staff from the Lebanon lab and the Hackettstown hatchery collected over 175,000 eggs from Round Valley Reservoir broodfish. Hatching results from these eggs ranged from 20% to 47%. These hatching rates were low compared to the 95% rates of the Michigan and Wyoming eggs. Possible reasons for low hatching success were broodstock age, spawning techniques, and diet of the wild broodfish. Wyoming's broodstock were six years old, whereas the age of broodstock captured from Round Valley Reservoir was variable. Wyoming used a captive broodstock at the hatchery and spawns these fish under controlled conditions. The Round Valley Reservoir broodstock were captured in large mesh gill nets and spawned on site, immediately following capture. Studies have shown that a fish diet, particularly a diet of alewives, can affect the hatching and swim-up success of each lot of fry.

Because the collection of broodstock from Round Valley Reservoir was labor intensive and the hatch rates were poor, it was deemed more cost effective to obtain eyed eggs from other sources. Since 1991, the hatchery at Hackettstown receives about 10,000 eyed eggs from the Story State Fish Hatchery in Story, Wyoming.

Lake Trout Culture Techniques

In early October, the Story Hatchery in Wyoming obtains lake trout eggs from broodfish. By mid-December, after a 52 day incubation period (at water temperatures approaching 5ºC), the eggs reach the eyed stage. At this stage in egg development they can be handled and are sent overnight express to the Hackettstown Hatchery. During shipping the eggs are packed in a cooler with a layer of ice over top of them to keep them cool and moist. They arrive at about 5ºC and are gradually warmed to 11ºC by dripping water over them for a couple of hours. Next they are placed in tray style incubators where they remain for an additional fourteen days until hatch occurs.

Hatching usually takes place over a two to three day period and then the eggs are placed on trays in a long, narrow trough. Over the next two weeks the sac fry feed off the nutrients contained in the sac they were born with. Toward the end of the two week period they become very active and begin to swim freely in the water column. This period is referred to as swim-up and they are fed a commercially prepared, high protein, high fat, pelleted feed. They grow approximately 0.75 inches per month and are periodically moved to larger tanks. They are trained to feed in a 100-gallon trough for the first thirty days. Once trained, they are moved to a 350 gallon circular tank where they grow to about two inches. Next they are transferred to a 1000 gallon rectangular tank where they will grow to four inches. Finally they finish their growth to seven and a half inches in a 2000 gallon tank. All of this time is spent indoors; however, prior to 2000 much of their growing time was spent outdoors in covered concrete raceways. Under these outside conditions the fingerlings endured predation (birds, mink, and otter) and other natural problems such as heavy snows, and flow problems (due to leaf-clogged screens).

Prior to stocking, the lakers are enumerated by weight, and fin clipped to mark the year class. Each year a different fin is clipped (five year rotation, using adipose, pectoral, and pelvic fins) to assist biologists in assessing and managing established populations. All of the lake trout stocked in Round and Merrill Creek Reservoir Valley (with the exception of the first year class) have been fin clipped. Stocking generally takes place the beginning of November when the reservoir surface water temperature drops and approaches the water temperature in the hatchery 11°C.

Throughout the period between 1976 and present, all lake trout eggs brought into the Hackettstown Hatchery have been from specific-pathogen-free stocks of Federal and State Hatcheries. The most serious fish health problem diagnosed in lake trout at the Hackettstown Hatchery was furunculosis, caused by the bacteria *Aeromonas salminicida*. Between 1976 and 1982, when the Hackettstown Hatchery functioned primarily as a trout hatchery, severe outbreaks of furunculosis occurred among lake trout reared from specific-pathogen-free eggs, and mortality rates often exceeded 50% of the stock. The disease has not been diagnosed in lake trout at the Hackettstown Hatchery since 1983 when production of other species of trout at Hackettstown was discontinued, indicating that other species of trout reared at Hackettstown served as carriers of the infection. Fish health inspections of lake trout reared at the Hackettstown Hatchery, conducted annually since 1989, have failed to detect carriers of *Aeromonas salmonicida* or of any other of the major salmonid pathogens.

The only other significant health problem in Hackettstown Hatchery lake trout was encountered in sac fry. Between 1986 and 1991, lake trout eggs were collected annually from adults in Round Valley Reservoir and used to supplement production from outside sources. Early life stage mortalities were experienced throughout that period in progeny of Round Valley Reservoir lake trout (RVR fry), but not in fish obtained as eggs from federal hatcheries (NFH fry). Survival of RVR fry between hatch and swim-up was 40% or less in five of the six years from 1986 to 1991. RVR sac fry were less active than NFH fry, had pale colored yolk sacs, and in some years suffered from blue sac and coagulated yolk. In 1992, collection of eggs from RVR brood fish was discontinued due to the relatively high mortality rates in the early life stages. A study into the possible role of thiamine deficiency in the mortalities was conducted during 1996 and 1997 was inconclusive. While thiamine levels in RVR eggs and fry (1.4 - 10.0 nmoles/g) were considerably lower than in NFH fry (19.6 nmoles/g), the levels were not below threshold levels that have been reported for thiamine deficiency (0/9 nmoles/g).

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Fish Health Management for Salmonids

Overview

Although diseases and parasites of wild trout in New Jersey have not been widely studied, there is currently no evidence suggesting that pathogens threaten the long-term viability of these fish populations. However, diseases and parasites have been encountered throughout the history of public fish culture in New Jersey and have been problematic at times within the confines of the hatchery facilities. The DFW's Hackettstown Hatchery, continuously operated since 1913, experienced a variety of pathogen-related problems including some which are considered to be major obligate pathogens of salmonids (furunculosis, whirling disease, bacterial kidney disease, and infectious pancreatic necrosis).

In the early 1980's all of the salmonid production except lake trout shifted to the newly constructed Pequest Trout Hatchery, and pathogen-related problems at Hackettstown Hatchery subsided. Salmonid eggs from certified disease-free sources were used to commence production at the Pequest Trout Hatchery. Since 1985, when the initial egg stocks matured as broodstock, no additional eggs or fish from outside sources have been introduced into the Pequest Trout Hatchery. Outbreaks of bacterial gill disease and coagulated yolk disease have occurred at this hatchery, however mortality has never exceeded 1 % of hatchery production. With the exception of two years, losses with coagulated yolk disease for the most part have been insignificant.

Procedures and policies have been developed to prevent or minimize the introduction and transfer of pathogens within the DFW's fish culture operations and in wild fish populations. Measures taken at the Pequest Trout Hatchery include restriction of visitors to peripheral areas of the facility, exclusion of outside equipment and vehicles from the nursery and raceway area, and disinfecting of any essential equipment which must be brought in from other areas.

Pequest Trout Hatchery

The Pequest Hatchery began operation in 1982 and achieved full production by 1984. Major emphasis was placed on starting and maintaining the Pequest Hatchery as a specific-pathogen-free facility in order to avoid the economic loss and unreliable production cycles that were experienced at the Hackettstown Hatchery due to fish diseases. This is accomplished by following the developed hatchery access guidelines (Appendix E) and fish health policies.

Original stocks of trout for the Pequest Hatchery were obtained from USFWS facilities that had been inspected and certified free of the major salmonid pathogens. All fish were obtained as eggs that were disinfected with iodophor before being placed in Pequest Hatchery incubators. From 1982 through 1984, rainbow trout eggs were obtained annually from the White Sulfur Springs NFH in West Virginia. In 1982 and 1983, brook and brown trout eggs were procured from the North Attleboro NFH in Massachusetts; however, because of the diagnosis of furunculosis at that facility in 1984, eggs were not

obtained from North Attleboro NFH after 1983. In 1984, Owhi strain brook trout eggs were obtained from the White Sulfur Springs NFH; however, brook trout egg production at Pequest was begun that year and fish from that strain were not incorporated into the Pequest Hatchery brood stock. Due to the unavailability of certified stocks, no brown trout eggs were obtained from other hatcheries in 1984.

Egg production from Pequest Hatchery brood stocks of all three species was accomplished in 1985, and no eggs or fish from outside sources have been brought into the Pequest Hatchery since that time.

Currently, the only disease problems, which have been associated with significant mortalities of trout at the Pequest Hatchery, are bacterial gill disease and coagulated yolk disease.

Bacterial gill disease

Bacterial gill disease is caused by common waterborne *Flavobacteria*, which infect gill tissue and cause disease under conditions associated with intensive rearing. It is not known to occur in wild fish. Mortalities among Pequest Hatchery stocks have been controlled by chemotherapy and by alteration of environmental conditions (improved sanitation and increased water flow). Mortalities due to bacterial gill disease have never exceeded 1% of production in any given year, and its impact on the trout-rearing program at the Pequest Hatchery has been minimal.

Chloramine-T offers the most effective and efficient treatment for bacterial gill disease. Treatment is performed by making an aqueous solution of Chloramine-T and dripping it into raceways or tanks to achieve a 10-20 ppm concentration for one hour. The drug is used experimentally and substantial documentation requirements are associated with its use. The Food and Drug Administration disallowed its use from 2001 to 2003 awaiting additional information from the manufacturer. In July of 2003 it was once again approved for experimental use. The use of chloramine–T, however, raised issues with meeting NJPDES permitting requirements for chlorine oxidant discharge. As of August 2003 its use at the hatchery was discontinued until measures could be taken to dechlorinate the hatchery effluent following Chloramine-T treatments. A portable dechlorination system was developed and tested for use at the hatchery in October of 2003. The dechlorination of the hatchery effluent, during treatments, keeps the chlorine oxidant discharge within established NJPDES guidelines.

A less problematic but also less effective treatment for bacterial gill disease is sodium chloride (salt). Treatment requires fish to be removed from the raceways and immersed in a bath solution of salt for 1-10 minutes in tanks or tubs. Even with repeat treatments control is limited. Salt baths require considerable labor but pose no discharge issues.

Coagulated yolk disease

Coagulated yolk disease is a poorly understood syndrome affecting eggs and fry. The cause of the disease has not been clearly defined and the disease may be caused by different factors or conditions in different hatcheries where it occurs. Although a chronic

problem in brook trout at the Pequest Hatchery since 1984, losses have generally been insignificant in terms of their impact on hatchery production. An exception occurred in 1991 and 1992 when losses among swim-up fry exceeded 90%. Subsequent investigations have failed to identify the cause; however, alteration of egg incubation procedures has resulted in a greatly reduced incidence of coagulated yolk disease in the years since 1992.

Only two parasites, *Trichodina* and *Ichthyobodo*, have been identified from trout in the Pequest Hatchery. *Trichodina*, a ciliated protozoan, was occasionally found on the skin of yearling trout of all three species between 1990 and 1992. *Ichthyobodo*, a flagellated protozoan, infected fry and fingerlings in nursery building tanks from 1997 to 1999. Neither of these parasites was associated with significant mortalities and both appear to have been successfully eradicated from hatchery stocks through chemotherapy.

External parasites are typically controlled by formalin. However, treatment has only been used 2 or 3 times over the past 20 years for parasite control at Pequest. There is no withdrawal period, fish can be consumed immediately following treatment. When used for parasite control, Formalin is dripped into rearing water in raceways or tanks to achieve a 170 ppm concentration for one hour. Depending on the parasite involved, control is achieved in 1 to three treatments. Acetic acid has been used on several occasions for control of external parasites on trout. Treatment is administered by removing fish from the rearing tank and immersing them in an acetic acid solution for up to one minute. This treatment is labor-intensive and has generally been used only on small fish.

Formalin is also used as a fungicide on eggs. Formalin is FDA-approved for food fish use under the brand names Formalin-F, Paracide-F, and Parasite-S. Formalin is dripped into egg incubators to achieve a 1667 ppm concentration in the water for 15 minutes each day. Control is generally good, but fungus does colonize the eggs in spite of treatment. It is therefore used as a daily treatment throughout the incubation period. Formalin use is not labor intensive since entire raceways or incubators can be treated but treatments must be performed daily.

Oxytetracycline has been used on infrequent occasions at Pequest for control of systemic bacterial infections. It is FDA-approved for that use with a 21-day withdrawal period. Oxytetracycline is administered with the feed and can be purchased already incorporated into pellets directly from feed suppliers. Extra labor is involved in feeding fish on a medicated separately from other lots, but this has not been problematic. The medicated diet is fed daily for 10 days.

Romet 30 is also available for treating systemic bacterial infections in the same manner as oxytetracycline. It has never been used at our hatcheries, but is mentioned here because it is FDA approved and can be used if Oxytetracycline-resistant bacteria are encountered. Romet 30 carries a 42-day withdrawal period.

A suspected viral agent, described as a "Toga-like" virus, was found in brown trout during annual inspections conducted in 2000 and 2001. The suspect virus is not associated with any known disease and its significance to the health of Pequest Hatchery stocks is not known. It was not found in any of the lots of Pequest Hatchery trout, which have been inspected annually since 2002.

Hackettstown Hatchery

The Hackettstown Hatchery has been in continuous operation since 1913. Upon completion of the Pequest Hatchery, emphasis at the Hackettstown Hatchery was shifted from trout to warm and cool water fish. Brook, brown, and rainbow trout have not been reared at the Hackettstown Hatchery since 1983. Chinook salmon and steelhead trout were obtained in 1986 and 1987 from the New York DEC (Altmar SFH) for a short-lived experimental anadromous salmonid program. After these fish were released in the fall of 1987, no additional salmonids have been brought into the Hackettstown Hatchery from outside sources except lake trout and occasionally trout from the Pequest Trout Hatchery.

During the years when brook, brown, and rainbow trout were reared at the Hackettstown Hatchery, various diseases were diagnosed, including some which are considered to be major obligate pathogens of salmonids (furunculosis, whirling disease, bacterial kidney disease, and infectious pancreatic necrosis). Many of the diseases encountered at Hackettstown may have been brought into the facility by fish procured from outside sources (commercial hatcheries, federal hatcheries, other states' hatcheries, and wild populations). A complete description of the history of diseases and parasites, as well as, egg and brood stock sources for the Hackettstown hatchery can be found in the DFW's Fish Health Plan (DFW 1991).

As stated previously, lake trout are currently the only salmonid species being reared at Hackettstown. Lake trout are raised primarily from eggs received from outside hatcheries, although eggs collected from wild brood stock at Round Valley Reservoir have been occasionally used. Lake trout eggs for the rearing program at Hackettstown were initially obtained from the Marquette, Michigan SFH (1976-1980) and later from the Jackson NFH (1981-1987), Ten Sleep, Wyoming SFH (1992), and the Story, Wyoming SFH (1993-2003). All eggs received from hatcheries outside of New Jersey have been from specific-pathogen-free stocks that were inspected for IPN (infectious pancreatic necrosis), VHS (viral hemorrhagic septicemia), and IHN (infectious hematopoietic necrosis) viruses, *Aeromonas salmonicida* (furunculosis), *Renibacterium salmoninarum* (bacterial kidney disease), *Yersinia ruckeri* (enteric redmouth), PKX (proliferative kidney disease), and *Myxobolus cerebralis* (whirling disease).

Historically (before 1982), furunculosis (*Aeromonas salmonicida*) was the biggest problem encountered in lake trout at the Hackettstown Hatchery. Occasionally, bacterial gill disease also caused some losses, but not often.

Furunculosis

Furunculosis, a skin infection caused by the bacterium *Aeromonas salmonicida*, was recognized in brown trout at the Hackettstown Hatchery as early as 1916. It became one

of the most serious diseases encountered at Hackettstown and accounted for numerous mortalities over the years. Brook and brown trout suffered the most serious mortalities from furunculosis, while rainbow trout were seldom affected. Early control efforts involved moving affected fish to the coldest spring water available and avoiding contact with other lots of fish. Later therapies included medicated feeds using sulfonamide drugs (1946) and later an oxytetracycline antibiotic (Terramycin) was used. Severe outbreaks occurred during the 1970's among lake trout and brook trout that had been reared from eggs obtained from certified specific-pathogen-free hatcheries. Lake trout are raised in upper raceways directly fed from springs and never held in raceways fed by water that had passed over other species because of their extreme susceptibility to furunculosis.

Furunculosis has not been diagnosed in lake trout at the Hackettstown Hatchery since 1983 when production of other species of trout was discontinued. The absence of clinical cases of furunculosis may be in large part due to the low densities at which lake trout are reared. Fish health inspections of lake trout reared at the Hackettstown Hatchery, conducted annually since 1989, have failed to detect carriers of *A. salmonicida.*

Occasionally, external parasites such as Trichodina, Ichthyophthrius, and Gyrodactylus were found on lake trout at Hackettstown; however, since the lakers received the best water, these too were uncommon. In the years since trout production was shifted to Pequest, disease outbreaks have been rare among lakers at Hackettstown. One outbreak of bacterial gill disease occurred in July of 2001. The only other notable problems were early life stage mortalities manifested as blue-sac disease and coagulated yolk disease which were seen sporadically between 1986 and 1997. These always involved fry from Round Valley Reservoir egg takes. The possibility of the role of thiamine deficiency in early life stage mortalities was investigated, but no definitive conclusion could be reached. While thiamine levels in eggs and fry from Round Valley fry were much lower than levels in eggs and fry which we received from other hatcheries, they were not as low as levels generally associated with thiamine deficiency.

In addition to chemicals used for the treatment of specific diseases and parasites an anesthetic, Tricaine methanesulfonate, is used at both hatcheries. It is FDA-approved for that use with a 21-day withdrawal period under brand names Finquel and Tricaine-S. Carbon dioxide has been tried at Pequest, but was not considered a viable alternative to Tricaine. Concerns regarding adverse affects on fertilization rates when used on brood stock have been expressed, but do not seem to be a significant problem.

Fish Health of Wild Trout Populations

New Jersey's naturally reproducing trout populations are highly valued for sportfishing and are recognized as indicators of high water quality. Sampling from a large or unknown-sized population for pathogen detection requires the lethal sampling of at least 60 fish from each discreet population to detect a prevalence level of 5% with 95% confidence. Because individual wild trout populations in New Jersey streams tend to be relatively small the DFW has been reluctant to sacrifice the numbers of fish necessary to conduct extensive parasitologic and pathologic investigations. However, several studies

have yielded some information on the occurrence of parasites and diseases in New Jersey's naturally reproducing trout populations.

As part of the Fish Health Project (F-35-R-NJ), a survey of the parasites of freshwater fishes in New Jersey was conducted over a twelve year period, from 1976 to 1987 (DFW, 1991). Forty-two trout were examined from over 2400 fish of various species that were collected statewide. Parasites found in these trout included protozoans (*Ichthyophthirius multifilis, Scyphidia*, and *Trichodina)*, monogenean (*Gyrodactylus*), trematodes (*Allocreadium lobatum* and *Crepidostomum farionis*), nematodes (*Sterliadochona tenuissima*, acanthocephalans *Acanthocephalus dirus* and *Leptorhynchoides thecatus*), and a parasitic crustacean (*Argulus*).

In August 1998, an investigation on the health status of trout in Van Campens Brook was conducted as part of the USFWS National Wild Fish Health Survey. Thirty-four brook trout and 53 rainbow trout were collected from the brook at Millbrook Village and examined for the presence of potential pathogens by USFWS fish health biologists. Pathogens of concern included IPN (infectious pancreatic necrosis), VHS (viral hemorrhagic septicemia), and IHN (infectious hematopoietic necrosis) viruses, *Aeromonas salmonicida* (furunculosis), *Renibacterium salmoninarum* (bacterial kidney disease), *Yersinia ruckeri* (enteric redmouth), and *Myxobolus cerebralis* (whirling disease). None of those pathogens were found in trout collected from Van Campens Brook.

It is interesting to note that Van Campens Brook had been stocked with trout by DFW on an annual basis from 1921 until 1982 when it was designated as a Wild Trout Stream. The stocked trout were reared at the Hackettstown Hatchery or were obtained from various hatcheries in the National Fish Hatchery System. Several of the pathogens targeted under the National Wild Health Survey had been endemic at the Hackettstown Hatchery during the years when Van Campens was stocked with hatchery fish. This study provided evidence that naturally reproducing trout populations free of major salmonid pathogens could be developed in waters that had been previously stocked with carriers of those pathogens.

Specific sources of parasite and disease introduction into New Jersey cannot be accurately determined. However, the importation of fish was likely responsible for the occurrence and spread of pathogens, particularly prior to the 1970's when hatchery fish health inspection and certification programs were begun by the U.S. Fish & Wildlife Service. For much of the period from 1912 through 1983, when the Hackettstown Hatchery produced trout, carriers of several bacterial, viral and parasitic diseases were stocked into waters throughout the state, including many waters which now contain naturally reproducing trout populations.

Opportunity – Investigate the feasibility of testing wild trout populations for the presence of pathogens known to be a concern to coldwater trout species. These include but are not limited to IPN (infectious pancreatic necrosis), VHS (viral hemorrhagic septicemia), and

IHN (infectious hematopoietic necrosis) viruses, *Aeromonas salmonicida* (furunculosis), *Renibacterium salmoninarum* (bacterial kidney disease), *Yersinia ruckeri* (enteric red-mouth), and *Myxobolus cerebralis* (whirling disease).

Fish Health Policies

Policies concerning fish introduction and fish health management were developed under the Federal Aid Fish Health Project (F-35-R) following review of all pertinent information on the distribution of parasites and diseases of freshwater fish in New Jersey, past and present stocking practices, and potential sources of pathogen introduction. Policies dealing with the stocking of fish into New Jersey lakes and streams were implemented in 1991 using the already existing stocking permit system.

Policy #1 *Standard operating procedures to reduce the introduction of troublesome pathogens at both the Pequest Trout Hatchery and the Charles O. Hayford Hatchery in Hackettstown will be followed.*

Pequest Trout Hatchery:

Rationale: A great number of other diseases and parasites may infect salmonids. These other organisms may not have applicable standard detection techniques, they may not be covered by other fish health plans, the risk of their introduction may not be as great, or the consequences of their introduction may not be as severe as the major pathogens that are specifically addressed in this policy. Included in this category are common external parasites such as *Ichthyophthirius* and *Trichodina* which may be thought of as a controllable annoyance rather than a serious problem. However, their introduction into the hatchery necessitates that some chemical control measures be taken or that fish cultural practices be modified. In some instances, sublethal effects such as reduced growth rates or increased food conversion rates may result. In any case, the impact of their presence can be measured economically either directly through the cost of treatment chemicals and feed, or indirectly due to a reduction in palatability, appearance, or stamina of the fish.

Fish stocks reared at the Pequest Hatchery were obtained as eggs from the USF&WS hatcheries with A-1 or A-2 classifications and have been annually inspected for pathogens of concern. The pathogens covered under this policy are organisms that realistically can and should be avoided. Standard techniques for their detection and identification are available and widely used. Many other fish health plans currently place restrictions on their introduction.

Rather than compile an extensive list of lesser concern disease organisms to guard against, this policy proposes general measures that will minimize the probability that any disease agent will be introduced. Since most organisms are not normally transmitted on or with eggs, limiting introductions into the hatchery to eggs will greatly reduce the probability that any agent will be introduced. Combining that measure with sanitation of the eggs with broad-

spectrum germicides further reduces that probability. Other policies, such as the hatchery access guidelines and prohibition of fish stocking in the immediate vicinity of the hatchery, are general measures directed toward reducing the risk of any organism being introduced into the Pequest Hatchery.

Procedure: The following standard operating procedures will be followed to monitor and reduce the risk of pathogen introduction:

1) Periodic examination of all stocks using moribund fish when available, and thorough investigation of all unusual or unexplained mortality.
2) Annual inspection for the major pathogens:
   Infectious Pancreatic Necrosis Virus (IPNV)
   Infectious Hematopoietic Necrosis Virus (IHNV)
   Myobolus cerebralis (Whirling disease)
   Renibacterium salmoninarum (Bacterial Kidney Disease)
   Aeromonas salmonicida (Furunculosis)
   Yersinia ruckeri (Enteric Redmouth)
3) Iodophor disinfection (100 ppm iodine for 10 minutes) of all eggs transferred into the facility; and,
4) Periodic review and modification of hatchery access policy.

Hackettstown Hatchery

Rationale: Any organism capable of causing disease among the various species of fish raised at the Hackettstown Hatchery is considered undesirable. Various disease agents were introduced with fish brought in from various sources over the 80 years of the hatchery's existence, and the consequences were often devastating. While some of these diseases still continue to present an occasional problem, the effects of many have been neutralized through progressive management techniques. IPNV, furunculosis and whirling disease were all endemic in Hackettstown Hatchery stocks, but have not been found in annual salmonid inspections conducted over the past 10 years. In order to avoid the repetition of past mistakes, this policy takes steps to reduce the risk of introduction of pathogens not already present. Rather than to compile a list of pathogens of concern for each species reared at the Hackettstown Hatchery, general measures are proposed which will reduce the risk of any pathogen being introduced and allow for hatchery managers to weigh benefits versus risk in each proposed introduction.

Procedure: The following standard operating procedures will be followed to monitor and reduce the risk of pathogen introduction:

1) Propagation of fish species having brood stocks already present at the Hackettstown Hatchery should be done using those stocks; they should not be supplemented by wild fish or fish from other hatcheries unless there is a demonstrated need.
2) If adequate health information is not available on a stock of fish being introduced into the hatchery, the introduced fish should be held in an area of the hatchery where they are physically separated from hatchery fish stocks to the extent possible, and the effluent from their holding pond should be discharged directly from the hatchery and not used for rearing other fish.
3) Consideration should be given to developing hatchery brood stocks when possible rather than to depend on wild brood stock populations or other outside sources of eggs or juveniles.
4) If fish must be obtained from outside sources, they should be obtained as eggs whenever possible.
5) Eggs hatching and juvenile rearing should be done in areas separate from adult or brood stock holding areas using ultraviolet disinfection and egg disinfection (iodophor) when possible.
6) Routine health monitoring of all stocks and annual inspection of salmonids should be performed; and,
7) Resident fish should be removed from all springs and supply structures, and springs and water supply pipes should be disinfected.

Policy #2 *Introduction of new stocks of fish into the Pequest Hatchery to supplement or replace existing stocks will only be in the form of pathogen-free eggs.*

Rationale: Eggs must be obtained from a hatchery stock which has been annually inspected and found free of the following pathogens, and has no prior history of their presence: IPN, VHS, and IHN viruses, *Aeromonas salmonicida* (furunculosis), *Renibacterium salmoninarum* (bacterial kidney disease), *Yersinia ruckeri* (enteric redmouth), and *Myxobolus cerebralis* (whirling disease).

The above should be considered the minimal acceptable standard for introduction of fish into the Pequest Hatchery. A health history of the fish stock from which the eggs originate should be obtained in order to evaluate the potential for introducing other parasites and diseases.

Procedure: Inspection must be performed using sample sizes and methods recommended by the American Fisheries Society Fish Health Section (Thoesen 1994), those described in the USF&WS Fish Health Policy, or generally accepted methods published in peer-reviewed journals.

Policy # 3 A complete health history for any fish stock transferred from another fish culture facility to the Hackettstown Hatchery will be required.

Rationale: Health history information will be reviewed and an evaluation made on the probability of exposing hatchery fish stocks to pathogens not already present at the facility. The decision on whether or not to transfer the fish will be made on an individual case basis. Any salmonids introduced into the hatchery must be from stocks of fish that have been annually inspected and found free of the following pathogens and have no prior history of their presence : VHS virus, IHN virus, *Renibacterium salmoninarum* (bacterial kidney disease), and *Yersinia ruckeri* (enteric redmouth). It is further recommended that the fish be obtained from a stock that has been inspected and found free of IPN virus, *Aeromonas salmonicida* (furunculosis), and *Myxobolus cerebralis* (whirling disease) and has no recent (past 3 years) history of their presence.

Procedure: Inspection must be performed using sample sizes and methods recommended by the American Fisheries Society Fish Health Section (Thoesen 1994), those described in the USF&WS Fish Health Policy, or generally accepted methods published in peer-reviewed journals.

Policy # 4 A comprehensive fish health assessment will be performed before any stock of trout is to be considered for use as a brood stock, to provide eggs and fish for hatchery rearing.

Rationale: Round Valley Reservoir is the source of lake trout brood stock used in the Hackettstown Hatchery rearing program. IHN, VHS, and enteric redmouth are not present at the Hackettstown Hatchery and their introduction would have a potential impact on the lake trout rearing program or other salmonid rearing programs which might be undertaken in the future.

Procedure: The assessment should include inspection for IPN, VHS, and IHN viruses, *Aeromonas salmonicida* (furunculosis), *Renibacterium salmoninarum* (bacterial kidney disease), *Yersinia ruckeri* (enteric redmouth), and *Myxobolus cerebralis* (whirling disease) using standard procedures (American Fisheries Society Fish Health Section Blue Book 1994 or equivalent). Sample sizes for the inspection must be sufficient to detect an assumed incidence of 5% for the viral pathogens and 10% for the bacterial pathogen (all at 95% confidence levels).

Hatcheries which provide the appropriate documentation that they have been inspected and found free of the pathogens listed above will be certified for stocking in Round Valley Reservoir. A list of Certified Hatcheries will be maintained by the DFW and provided to individuals who request stocking

permit applications for areas of special concern such as Round Valley Reservoir.

Policy # 5 All fish released into New Jersey waters under the fish stocking permit program must be procured from a hatchery that has been approved by the DFW.

Rationale: By statutory authority, N.J.S.A. 23:5-33.1, the stocking of any fish into the fresh waters of New Jersey requires a stocking permit from the DFW of Fish, Game, and Wildlife. The stocking permit regulation was originally intended to prevent the introduction of exotic species and other fish species that might conflict with management objectives in a particular body of water. The fish health management plan, however, allowed fisheries managers to also consider the health status of fish being stocked.

Infectious Hematopoietic Necrosis (IHN) and Viral Hemorrhagic Septicemia (VHS) are diseases which are not known to be present in New Jersey or elsewhere on the east coast of North America. IHN is endemic in some west coast salmonid stocks and VHS is found in Europe and recently was detected in salmon returning to several hatcheries in Washington State. Because IHN and VHS pose a potential threat to native and cultured fish stocks in New Jersey and throughout the east, special precautions are necessary to prevent their introduction. Based upon information on the distribution of fish pathogens and on past stocking practices, it is believed that fish from hatcheries outside of the endemic range of IHN and VHS provide a minimal risk of introducing new fish pathogens into the majority of fish populations in New Jersey. However, in some waters where particularly sensitive fish populations exist, a higher degree of certainty about the disease status of introduced fish is necessary. For those waters of special concern, hatcheries may be required to provide documentation showing that all fish stocks have been inspected and found free of serious fish pathogens.

Procedure: To obtain approval a fish culture facility must comply with the following:

(1) Annually submit a "Health History Request Form" indicating which fish species are offered for sale, the origin of all fish stocks, and their health status; and
(2) Provide documentation (health inspection or certification reports) that all fish (including eggs or gametes) received from sources within the enzootic area of IHN or VHS viruses, have been inspected and found free of those viruses; and
(3) Provide documentation that a complete health inspection (including parasitological examination) has been performed on all fish stocks, which have been obtained from the wild.

In addition, fish culture facilities located west of the continental divide, or outside of North America, must comply with the following:

(1) Provide documentation that all stocks of fish reared in the hatchery have been inspected and found free of IHN and VHS viruses, the PKX organism, and *Ceratomyxa shasta*; and,
(2) Ship only fertilized eggs, which have been subjected to iodophor disinfection. No salmonid fish (fry, fingerling, or adult) other than certified, disinfected eggs may be brought into New Jersey from areas where IHN or VHS viruses are enzootic in salmonid stocks. Other species of fish may be brought into New Jersey if they are not considered potential carriers of the VHS or IHN viruses and the source hatchery must provide documentation that a complete health inspection (including parasitological examination) has been performed.

A list of commercial hatcheries which have submitted the above information will be maintained by the DFW and sent to all individuals requesting a stocking permit application. Hatcheries will be given the opportunity to be placed on the list at any time by completing a health history request form and providing the required health documentation. Hatcheries which do not meet the criteria listed above, or fail to provide the necessary information, or provide false information on the health history request form will not be included on the list. Stocking permit applications which include a source hatchery which is not included on the list will be denied.

The responsibility for and cost of any fish health inspections required for approval shall be borne by the individual importing the fish or by the hatchery of origin. The inspection should be conducted by a qualified individual at the place of origin. Inspection must be performed using sample sizes and methods recommended by the American Fisheries Society Fish Health Section (Amos 1985), those described in the USF&WS Fish Health Policy, or generally accepted methods published in peer-reviewed journals.

Policy # 6 No fish stocking permits will be approved to stock any species of fish in the Pequest River within the Pequest WMA.

Rationale: No major diseases or parasites of salmonids have been found in fish at the Pequest Hatchery and any disease which is introduced into the hatchery may cause fish mortality and increase operating costs. The portion of the Pequest River within the Pequest WMA is immediately adjacent to the Pequest Trout Hatchery and the potential for pathogen transmission from infected stocked fish is very high. The only fish that will be stocked in the Pequest River within the Pequest WMA will be trout reared at the Pequest State Fish Hatchery. Hatchery managers, the fish pathologist and the regional fisheries biologist will evaluate the stocking of ponds on Pequest River

tributaries with warmwater fish from the Hackettstown Hatchery on an individual case basis.

Policy # 7 Applications for permits to stock salmonids in waters within the Pequest River drainage, outside of the Pequest Wildlife Management Area, will be evaluated based upon the risk of exposure of Pequest Hatchery stocks to potential diseases or parasites, and considered for approval at the discretion of the regional fisheries biologist, fish pathologist, and hatchery superintendent.

Rationale: No major diseases or parasites of salmonids have been found in fish at the Pequest Hatchery and any disease which is introduced into the hatchery may cause fish mortality and increase operating costs. The major salmonid pathogens are of primary concern when evaluating an application. The restriction is limited to certifiable pathogens of salmonids (i.e. those for which detection methods are available and currently in use), rather than a complete ban on fish stocking in the Pequest River watershed. This would allow clubs and landowners to stock fish in waters under their control while minimizing the risk of introducing fish pathogens into the Pequest Hatchery.

Procedure: If it is determined that there is sufficient risk that stocked fish will enter the Pequest WMA or might expose Pequest Hatchery stocks to potential diseases or parasites, they must be obtained from a hatchery production lots which have been inspected within the previous 12 months and found free of the following pathogens, and have no recent (3 year) history of their presence: IPN, VHS, and IHN viruses, *Aeromonas salmonicida* (furunculosis), *Renibacterium salmoninarum* (bacterial kidney disease), *Yersinia ruckeri* (enteric redmouth), and *Myxobolus cerebralis* (whirling disease). Hatcheries will be required to provide documentation that during the past year fish from the same lot(s) have been inspected using standard procedures (American Fisheries Society Fish Health Section Blue Book or equivalent) and found free of the pathogens listed above. Sample sizes for the inspection must be sufficient to detect an assumed incidence of 5% for the viral pathogens, 5% for *Myxobolus cerebralis*, and 10% for the bacterial pathogens (all at 95% confidence levels). Hatcheries which provide the appropriate documentation that they have been inspected and found free of the pathogens listed above will be certified for stocking in the Pequest River drainage. A list of Certified Hatcheries will be maintained by the DFW and provided to individuals who request a stocking permit application for areas of special concern such as the Pequest River drainage.

Policy # 8 No permits will be issued for stocking fish in the Trout Brook watershed upstream of the Hackettstown Hatchery.

Rationale: Trout Brook flows through the Hackettstown Hatchery property and provides supplemental water for much of the pond rearing operation. Any

parasites or diseases introduced into the Hackettstown Hatchery would be difficult to eradicate because of the extensive system of ponds and resident fish populations within the facility. The introduction of any new parasites into the fish stocks would necessitate chemical control measures and thereby increase operating costs. The only fish that may be stocked in Trout Brook will be those fish reared at the Pequest Trout Hatchery and Hackettstown Fish Hatchery.

Policy # 9 *Permits to stock salmonids in trout production waters (including potential trout production waters) will only be issued if the source hatchery is certified free of Myxobolus cerebralis (whirling disease).*

Rationale: *Myxobolus cerebralis* has been associated with declines of salmonid populations in western North America, particularly rainbow trout, by causing mortality of fry. It has been found to develop in oligochaetes through various stages to a point where it is infective to salmonid hosts. Stocking of trout infected with *Myxobolus cerebralis* could result in its establishment in oligochaete populations and subsequently impact existing populations of wild trout or prevent the development of reproducing populations in waters otherwise suitable for trout reproduction.

Procedure: Hatcheries will be required to provide documentation that during the past year fish from the lot(s) to be stocked (or from a more susceptible species of salmonid reared in the same facility on the same water supply), have been inspected using standard procedures (American Fisheries Society Fish Health Section Blue Book or equivalent) and found free of *Myxobolus cerebralis*. Sample sizes for the inspection must be sufficient to detect an assumed incidence of 5% (at a 95% confidence level). Hatcheries which provide the appropriate documentation that they have been inspected and found free of the *Myxobolus cerebralis* (whirling disease) will be certified for stocking in trout production waters. A list of Certified Hatcheries will be maintained by the DFW and provided to individuals requesting permission to stocking salmonids in waters of special concern.

Management of Cultured Trout

Overview

Angler demand for trout challenges fishery managers to develop programs and strategies aimed at providing this user-group with a satisfying angling experience. Trout propagated in a hatchery setting provide resource managers with an effective management tool for creating and enhancing recreational coldwater fisheries. The DFW propagates trout at two facilities, the Pequest Trout Hatchery (primary facility) and the Charles O. Hayford Fish Hatchery at Hackettstown. Cultured (hatchery-reared) brook, brown, rainbow, and lake trout are stocked in a variety of settings and seasons and provide the major opportunity to fish for coldwater species statewide, both seasonally and year round. A survey of New Jersey anglers indicated that 47 percent of anglers purchased a trout stamp in 2002 (Responsive Management 2003). The majority of trout anglers fished for trout during the spring (84 percent) and fished for stocked trout (82 percent). In 2002 over 750,000 catchable and sub-catchable trout were reared and stocked during the spring, fall, and winter. This stocking program has an associated economic cost and must be managed to provide the most benefit to the angling community.

Management Strategies for Cultured Trout

The DFW currently has three trout stocking programs that utilize catchable trout (spring, fall and winter seasons), and two programs that utilize subcatchable trout (sea-run brown trout and lake trout). The spring stocking program is by far the largest and most popular of the trout stocking programs, but the other stockings programs are successful in providing additional opportunities for New Jersey anglers. These programs are described more fully later in this section,

The DFW's stocking programs are guided by two basic management strategies, "Put-and-Take" and "Put-Grow-and Take," which are intended to maximize the benefits of stocked trout to the angler.

Put-and-Take Management Strategy: Catchable-size brook, brown, and rainbow trout are stocked for immediate harvest to provide a short-term, seasonal fishery. Survival of stocked trout through the summer period is not expected (or poor) because suitable summer trout habitat (temperature < 21°C and dissolved oxygen > 4 mg/L) is absent, marginal, or sporadic. The trout-stocked waters managed under this stocking strategy include park ponds, shallow lakes, and warmwater streams. These waters are stocked in the spring and may be stocked again under the fall or winter program.

Put-Grow-Take Management Strategy: Brook, brown, rainbow, and lake trout are stocked for immediate and/or delayed harvest to provide a long-term, year-round fishery. Suitable habitat is consistently available to sustain trout throughout the year such that survival and growth of unharvested, stocked trout over more than one growing season is expected. Trout-stocked waters managed under this stocking strategy, that are stocked with catchable trout, include coldwater streams and deep lakes that are capable of

supporting trout year round, where wild trout populations are limited or absent. These waters are stocked in the spring and may be stocked again in the fall or winter. Subcatchable lake and brown trout are stocked under the lake trout and sea-run brown trout programs.

Opportunity – Management goals and objectives need to be established for put-and-take and put-grow-and-take stocking management strategies.

Spring Trout Stocking Program

The traditional trout fishery in New Jersey occurs in the spring and revolves around the season opener in early April that is eagerly anticipated by anglers. Approximately 575,000 catchable-size brook, brown, and rainbow trout (10.5-inch average size) are reared annually for the spring program. These trout are liberated over a ten-week period in 200 ponds, lakes, and stream segments statewide (Figure 10). A three-week "pre-season" period precedes the "opening day" of the trout season in April, during which most trout-stocked waters are closed to fishing and are heavily stocked. A seven-week "in-season" period follows opening day during which the frequency and quantity of trout stocked decreases incrementally for most waters (consult the Allocation Methodology for Cultured Trout section for a fuller explanation). During the spring period, the harvest of trout is encouraged in most of these waters through a liberal harvest regulation (6 trout per day, 7-inch minimum size).

Waterbody Selection Criteria

The addition or permanent deletion of waters to the State's trout stocking program must be done through the Fish Code process. The lengthy process involves Fish and Game Council approval, publication in the New Jersey Register, a two-month public comment period, a public hearing, and attorney review (see Trout Fishing Regulations section for specific details).

Opportunity – Specific criteria for expanding the trout stocked waters needs to be developed.

Opportunity – Identify current trout stocked waters having limited access, thereby offering only limited fishing opportunities and determine if stocking should be discontinued or if access issues can be rectified.

Trout Allocations

Allocations for waters are determined using a formula developed under a Trout Stocking Improvement Plan that was implemented in 1990. The formula takes into consideration stream size, access, proximity to other trout stocked waters, and population. A specifically designed computer program is used to generate weekly allocations based on the variables assessed for each water and hatchery production numbers. Numbers allocated to individual waters may change from year to year, although usually not substantially, depending on the addition or deletion of waters to the program or adjustments to variables for individual waters.

Opportunity – The frequency of stocking during the spring stocking period should be examined to determine if it provides for the most quality and satisfying angling experience possible.

Species Selection Criteria

For each trout-stocked water, the trout species that will have the least impact upon the resident fish population, and provide the highest survival and angler catch rates, shall be selected for stocking.

For many waters, the species selection is not critical and brook, brown, and rainbow trout may be stocked in any combination. However, in these situations brook trout are typically stocked early on because their willingness to bite usually results in high angler catch rates and satisfaction on opening day. By the 1st or 2nd week following opening day, when the hatchery supply of available brook trout has been exhausted, rainbow trout are then stocked. Towards the end of the spring stocking season (4th or 5th week), brown trout are stocked. Most waters stocked late in the season are generally capable of supporting trout year round and brown trout survival rates in these waters are generally better than the other two species.

The trout species selected for stocking in some waterbodies may be critical to ensuring their survival or that of the resident fish population, or in achieving waterbody-specific management objectives. Trout-stocked waters that fall into one of six categories listed below are stocked with the cultured trout species specified.

1) Trout Production Streams – Streams having reproducing trout populations are stocked with a cultured species that minimizes unfavorable interactions (interbreeding, inter-specific competition, etc.) with the reproducing species as follows:

Reproducing trout species	Acceptable cultured trout species
brook	rainbow
brown	brook and/or rainbow
rainbow	brook
brook and brown	rainbow
rainbow and brown	brook
brook and rainbow	rainbow or brook (the opposite of the dominant wild species)

The frequency of the stockings are based upon the size of the streams, based on flow, some are stocked only three times while others are stocked each week. Although current stocking practices are designed to minimize the impacts of stocking cultured trout in streams already supporting natural populations the consequences of these stockings on the natural populations has not been investigated.

Opportunity – Through review of scientific literature and field sampling results the impacts of stocking cultured trout in small trout production streams should be investigated to determine if alternative stocking practices are warranted.

2) Low pH Waters – Streams and lakes which have been identified as having poorly buffered, low pH (< 5.5) conditions are stocked with brook trout due to the species ability to tolerate low pH conditions.

3) Trophy Trout Lakes – Waters regulated as trophy trout lakes are stocked with ⅓ rainbow trout and ⅔ brown trout. There are currently two trophy trout waters, Round Valley Reservoir (Hunterdon) and Merrill Creek Reservoir (Warren). Trophy trout lakes are stocked three times during the spring season and since trout are sub-legal due to the increased size limit on these waters they are not stocked during the pre-season period.

4) Holdover Trout Lakes – Waters regulated as holdover trout lakes are stocked with ¼ rainbow trout and ¾ brown trout. These waters have sufficient summer habitat conditions to support trout year round. The creel on these waters is reduced, 2 and four respectively, from the 6 and 4 limits of general regulated waters. These waters are stocked pre-season, followed by 3 in-season stockings. They are currently stocked close to opening day for fear of illegal harvest during the pre-season period where catch and release is permitted on these specially regulated waters.

   Opportunity – Investigate the feasibility of stocking holdover lakes earlier in the pre-season period to promote fishing during the pre-season closure period. Although some illegal harvest may occur, recreational benefits may outweigh this concern.

5) Marginal Trout Lakes – Lakes having marginal summer trout habitat (i.e. holdover trout are occasionally, but not regularly, caught) are stocked early in the season with brook and rainbow trout and receive brown trout during their last in-season stocking. A number of these waters historically supported trout year round but over the years declining water quality has resulted in the reduction or elimination of summer trout habitat.

   Opportunity – The benefits of re-allocating trout from large marginal/non-trout lakes and reservoirs, where angler returns and interest is greatly reduced, to smaller non-trout lakes where angler returns are much higher should be investigated.

6) Trout Maintenance and Select Nontrout Streams – Streams in which trout survive year round or have marginal survival during the summer, and are stocked In-season Weeks 6 and/or 7, shall be stocked with brown trout, at a minimum, during those two weeks (if scheduled for stocking). Trout maintenance waters regulated as Year Round Trout Conservation Areas are stocked in the early days of pre-season stocking since they are open to fishing, catch and release only, when the vast majority of trout stocked waters are closed.

Opportunity – Investigate the feasibility of increasing the current allotment of brown trout, at the expense of brook and rainbow stockings, on trout maintenance waters currently regulated as Year Round Conservation Areas that do not have reproducing trout populations.

Opportunity – Special regulated waters have grown in popularity, increasing angling pressure, investigate the feasibility of increasing in-season stockings on these waters.

Opportunity – To improve angler satisfaction, investigate the feasibility of stocking a higher percentage of brown trout, particularly in the larger trout maintenance waters.

7) Non-trout Lakes and Streams – Lakes and streams that lack the capability to support trout during the critical summer months are stocked with brook and rainbow trout. The proportion of each particular species stocking is dependent on hatchery production.

Size Selection Criteria

The size of catchable trout that will have the least impact upon on the resident fish population, is compatible with the available habitat, and will provide a high return to the creel is selected for stocking. Catchable-size trout stocked in the spring are categorized into two sizes – quality (10.5 inch average) and broodstock, sometimes referred to as breeders (15 inches and larger). All waters stocked with trout in the spring receive quality-size trout. Broodstock are mixed in with the quality trout early in the stocking season (2% per load, until the supply is exhausted) unless the receiving water falls into one of the following four categories:

1) Trout Production Streams – These streams contain naturally reproduced trout that are seldom more than 12 inches long and do not compete well with the much larger broodstock trout.
2) Trophy Trout Lakes – Quality-size stocked trout stocked in these lakes are able to grow to trophy size in 1 – 2 years, negating the need to stock larger broodstock.
3) Holdover Trout Lakes – Quality-size stocked trout stocked in these lakes are able to grow to trophy size in 1 – 2 years, negating the need to stock larger broodstock.
4) Small Streams – Streams less than 33 feet wide and having flows less than 19 CFS (identified as Category D, E, and F in the trout-stocked waters database) that do not have a sufficient living space to adequately accommodate the larger broodstock.

Opportunity – In order to improve angler satisfaction, investigate the feasibility of stocking broodstock into identified lakes each spring to increase angling activity on these waters. Specific waters receiving broodstock would change each year. Consider the feasibility of stocking the larger fish during week 2 or 3 of the in-season period to generate renewed interest when typically angler interest in trout begins to decline.

Trout Distribution

The distribution of over 575,000 trout to 1,000 stocking points on 180 waterbodies, multiple times over a ten week period requires substantial internal agency communication, cooperation and coordination. The stocking schedule divides the waterbodies into individual loads for each day of the ten-week period. A load is typically comprised of several waterbodies within a general given area that is placed onto a truck and as many as eight trucks are dispatched each day. A variety of factors including the number and species of fish, proximity of waters, number of stocking points, waterbody regulations, distance traveled, available trucks, experienced staff, must be considered in determining the composition of each load. The Pequest Trout Hatchery has eight trucks each capable of transporting a maximum load of 2,000 pounds of fish, or approximately 4,000 catchable trout. Staff from the DFW's Bureau of Land Management (BLM) is assigned to drive the trucks during the 10-week spring stocking period. To reduce the cost and drain on personnel, the BLM also organizes volunteers (members of the DFW's Wildlife Conservation Corps) to assist drivers in stocking trout.

The Bureau of Freshwater Fisheries manages the list of more than 1,000 stocking points using a specifically designed database. Stocking locations are selected based upon public access, proximity to other stocking points, and accessibility for both anglers and hatchery trucks. Suggestions for additional stocking locations come from many sources including DFW personnel, the Fish and Game Council, sportsmen groups, local municipalities, landowners, and the general public. Regional fisheries biologists, BLM personnel and DFW law enforcement officials review potential stocking sites. Trout are stocked on waters that flow through privately owned land provided the owner allows the public access to the water. The DFW promotes an "ask first" policy when anglers are unfamiliar with a particular stream stretch. Unethical behavior by anglers such as destruction of property, garbage, and excess noise can result in stocking points being removed at the request of the landowner. Unfortunately, a number of sites are lost each year to such behavior. Stocking points are also removed due to change in land ownership, hazardous conditions, lack of angler participation, or adjacent development. The loss of stocking points, along a waterbody, can ultimately result in reduction of trout allocated in subsequent years.

A list of stocking points for waterbodies on a specific load are prepared for drivers using a specifically designed program. In addition to stocking point information, load sheets include driving directions, percentage of the load each point should receive, species to be stocked, and any additional pertinent information (i.e. trout tagging studies, float stocking details, specific stocking requirements for special regulation areas, and meeting locations for any necessary transfers of fish or personnel). The load sheets provide good communication between drivers, regional biologists and hatchery staff. The sheets are returned at the end of each route and suggestions for improvements or difficulties encountered can be relayed to appropriate staff.

In areas that cannot be accessed by large hatchery trucks, due to weight or physical barriers, fish are dispersed to smaller transfer trucks along route. Although the use of transfer trucks requires additional manpower it provides for a more equitable distribution of fish particularly in more remote stream stretches. In addition, they can save valuable time by allowing small lakes and ponds to be stocked along route while the larger trucks continues to disperse trout to other areas.

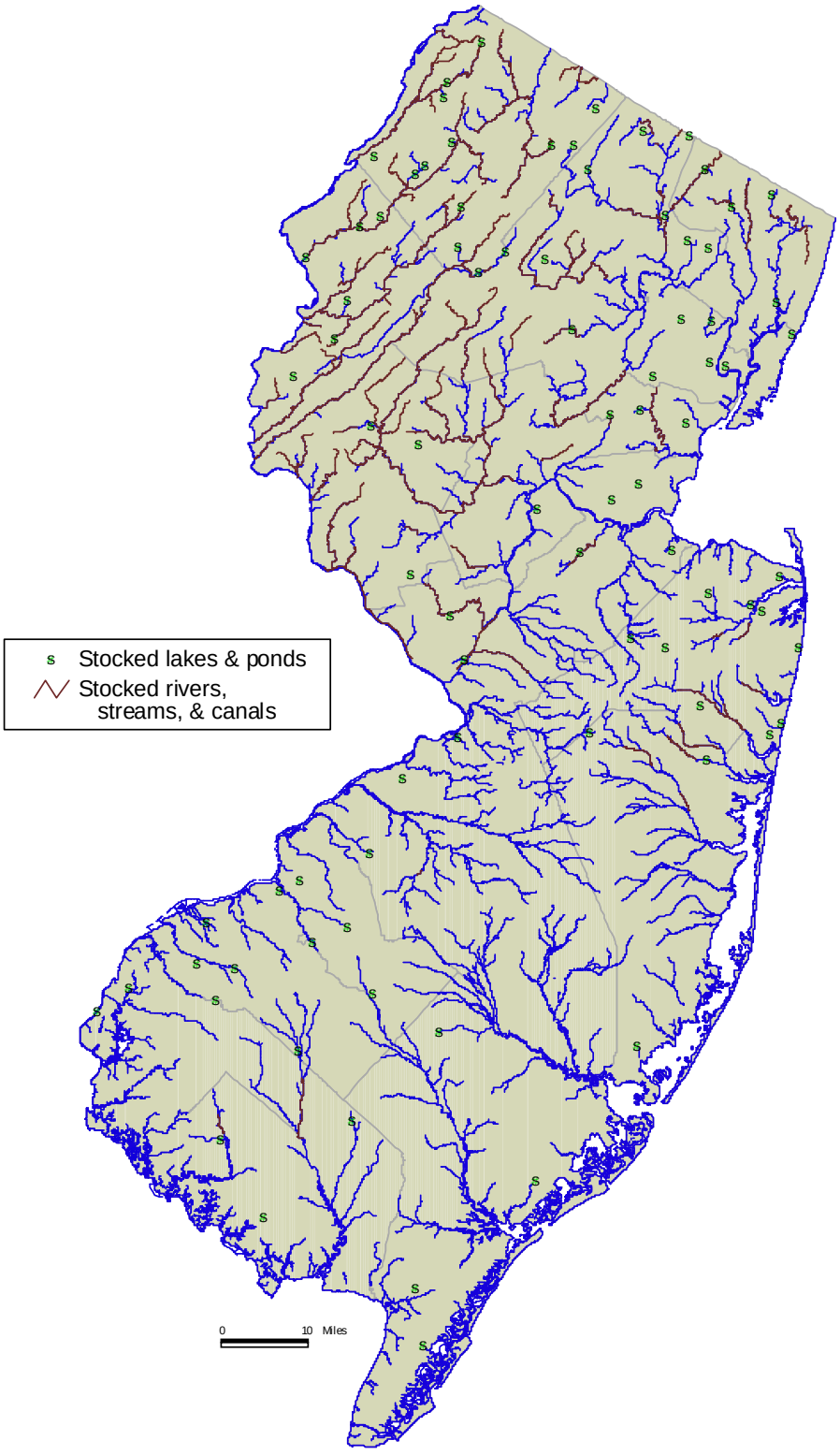

FIGURE 10.— New Jersey's trout-stocked waters for spring 2005.

Fall Trout Stocking Program

This stocking program was initiated in 1987 and is intended to complement the spring program and expand trout fishing opportunities statewide. Trout fishing typically tapers off during the summer when conditions are least favorable for trout (higher water temperatures and low stream flows) and anglers are less successful (fewer, more wary, trout). In October, as surface waters begin to cool, trout are stocked again to entice anglers to return to trout fishing. The 2003 angler survey found 47% of trout fisherman fished during the fall

Waterbody Selection Criteria

All streams with designated in-season stocking closures for the spring trout stocking program are stocked during the fall period. In addition, the Maurice River and 16 ponds/ lakes located in the southern portion of the state are also stocked to provide for a more equitable distribution of trout fishing opportunities across the state.

Trout Allocation

The fall baseline is 47,750 yearling rainbow trout, averaging ten inches, which are stocked in 16 northern and central-coastal streams and 16 southern ponds and lakes (Figure 11). The number of trout allocated to streams is 40,000 and individual stream allocations are determined using the formula concept developed under the Trout Stocking Improvement Plan. The formula takes into consideration stream size, access, proximity to other trout stocked waters, and human population density. A specifically designed computer program uses the stream's spring pre-season allocation to generate a reduced fall allocation, using the 40,000 fall baseline figure established for streams. Individual fall allocations for streams may vary from year to year, although usually not substantially, when adjustments are made to variables for individual waters. The baseline allocation for all fall-stocked impoundments was set at 7,750 trout when the fall program was first initiated. At that time, individual waterbody allocations were set by the Fish and Game Council, in consultation with Bureau staff, and have changed little over the ensuing years,

Species Selection

All waters stocked during the fall trout stocking program, from its prior to 2005 have received rainbow trout. Beginning in 2006 all three trout species (brook, brow, and rainbow) will be reared for release under the fall stocking program.

Size Selection Criteria

From the inception of the fall trout stocking program in 1987, through 2005, fall trout-stocked waters received yearling production fish 9 to 11 inch average size. Approximately 1,000 three-year old broodstock rainbow trout, averaging 17 - 18 inches, are also released during the fall stocking period.

Distribution

Distribution of trout during the fall program follow the same stocking points and designations as established for the spring. Prior to 2005 waterbodies were stocked for three weeks, beginning with the first full week of October. Since 2005, the stocking period has been shortened to two weeks, to facilitate the production of larger trout for the 2006 fall stocking program.

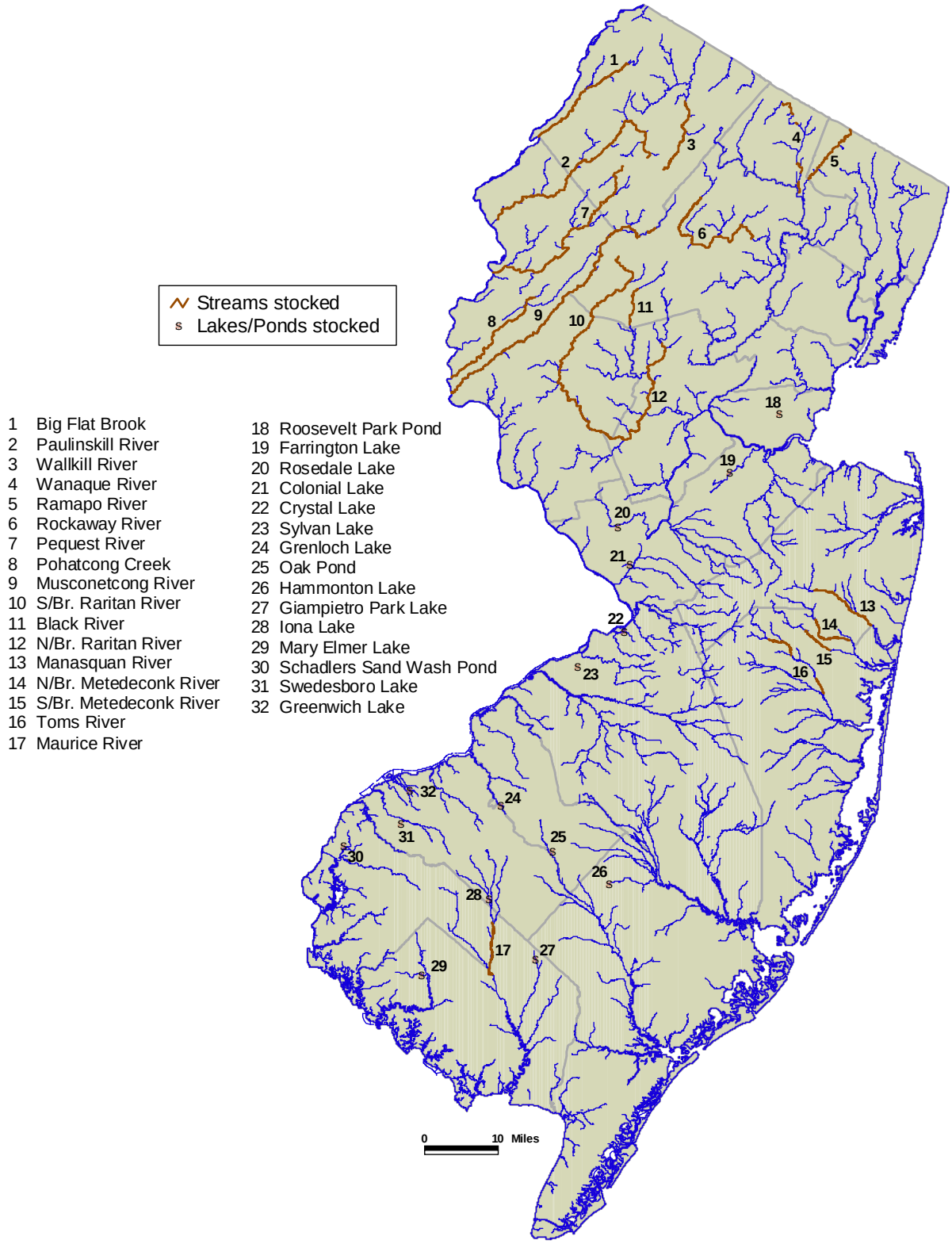

FIGURE 11.— New Jersey's trout-stocked waters for fall 2005.

Winter Trout Stocking Program

During the late fall and winter interest in trout fishing typically wanes when shorter day length, colder air and water temperatures, and inclement weather discourage angler outings. The Winter Trout Program was initiated in 2000 to add variety to the DFW's trout program by offering anglers the opportunity and incentive to venture forth and brave the winter elements in pursuit of trout. Under this program approximately 12,000 catchable-size rainbow trout (11-inch average size) are stocked in 24 lakes and ponds statewide (Figure 12).

A measurable objective of this program is to provide a fishery that results in a catch (or harvest) rate of at least 50% or angler usage equivalent to one angler trip generated per trout stocked. Results from a tagging study completed during the first year of the program were extremely promising, with six of eight study lakes reporting tag returns between 38 and 45%. As expected, two of the larger lakes within the program, Shepherd Lake and Furnace Lake, had lower than expected return rates of 13.3% and 25 %, respectively. Catch rates or harvest rates are likely higher than the tag returns indicate because reported because not all angler comply by returning tags from trout that they catch.

Winter-stocked trout that are not harvested during the winter period can add to angling opportunity the following spring. This was documented at several lakes, where the percentage of tagged trout caught after opening day was equal to or greater than the percentage caught during the winter season. This was partially attributed to several factors, including the presence of ice on lakes where ice fishing was not permitted (Verona Park Lake) or the presence of unsafe ice that limited angling for an extended period (Amwell Lake).

Three years after the initiation of the winter trout program, when the 2003 angler survey was completed, an encouraging 20 percent of trout anglers went fishing during the winter (Responsive Management 2003). In the northern part of the state, ice fishing is the primary mode of fishing targeted by this stocking program. However, the winter program is not entirely geared to ice fishing, as the presence of safe ice varies annually and seldom occurs in south Jersey.

Waterbody Selection Criteria

At the inception of the winter trout stocking program, the Fish and Game Council, in consultation with the Bureau selected lakes already approved for stocking under the spring trout stocking program. Lakes selected were less than 110 acres, having a moderate amount of shoreline access and/or a boat launch site having a publicly maintained access road during the fall and winter. Lakes already stocked under the fall program were excluded from the winter program. Precedence was given to smaller waterbodies because they offer a higher rate of return by anglers. Lakes were also selected for geographic distribution throughout the state.

Trout Allocation

The winter baseline is 12,940 yearling rainbow trout, averaging 9-11 inches, that are stocked in 24 ponds and lakes statewide (Figure 12). The Fish and Game Council established individual allocations for winter trout-stocked lakes at the inception of the program, in consultation with Bureau staff. Winter trout allocations are similar to each waterbody's respective spring pre-season allocation, with the exception that winter allocations on waters having established and consistent ice fisheries were increased over pre-season allocations. No individual waterbody receives more than 1,000 trout. Over the years there has been little change to the program, with the exception of a few waterbody changes.

Species Selection

All winter trout- stocked waters receive rainbow trout.

Size Selection Criteria

All winter trout- stocked waters receive production fish ranging from 10 to 11 inches in size.

Distribution

The distribution of trout into lakes stocked under the winter program occurs at the same stocking points and designations as established under the spring stocking program. Prior to November 2004, lakes located in the northern region of the state were stocked several days before Thanksgiving Day and south Jersey lakes were stocked during the first week in January. Since that time (commencing November 2004) all winter trout-stocked lakes have been stocked during the three days preceding Thanksgiving Day. This scheduling change increases the availability of freshly stocked trout, over a longer period of time, coinciding with the holidays

.

New Jersey's Winter Trout-Stocked Waters and Trout Allocations

Name[1]	County	Surface acreage	Year Stocked and Trout Allocation[2]					
			2000-2001	2001 – 2002	2002 – 2003	2003 – 2004	2004	2005
Amwell Lake (N)	Hunterdon	10	410	410	410	410	410	410
Barbours Pond (N)	Passaic	12	420	420	420	420	420	420
Birch Grove Park Pond (S)	Atlantic	30	460	460	460	460	460	460
Furnace Lake (N)	Warren	53	900	900	900	900	900	900
Green Turtle Pond (N)	Passaic	72	-	-	-	-	770	770
Haddon Lake (S)	Camden	10	-	-	250	250	480	480
Hook's Creek Lake (N)	Middlesex	10	520	520	520	520	520	520
Lake Aeroflex (N)	Sussex	101	1,000	1,000	1,000	1,000	1,000	1,000
Lake Ocquittunk (N)	Sussex	8	500	500	500	500	500	500
Lake Shenandoah (S)	Ocean	50	580	580	580	580	580	580
Laurel Pond (S)	Burlington	3	250	250	-	-	-	-
Little Swartswood Lake (N)	Sussex	75	1,000	1,000	1,000	1,000	1,000	1,000
Lower Echo Lake (N)	Union	6	420	420	420	420	420	420
Mill Pond (N)	Bergen	9	400	400	400	400	400	400
Mt. Hope Pond (N)	Morris	18	410	410	410	410	410	410
Mullica Hill Pond (S)	Gloucester	10	410	410	410	410	410	410
Riverview Beach Pond (S)	Salem	5	420	420	420	420	420	420
Rowands Pond (S)	Camden	3	250	250	250	250	250	250
Shaws Mill Pond (S)	Cumberland	30	510	510	510	510	510	510
Shepherd Lake (N)	Passaic	72	1,000	1,000	1,000	1,000	-	-
Silver Lake (N)	Sussex	21	600	600	600	600	600	600
Speedwell Lake (N)	Morris	23	520	520	520	520	520	520
Spring Lake (S)	Monmouth	16	480	480	480	480	480	480
Topenemus Lake (S)	Monmouth	21	470	470	470	470	470	470
Verona Park Lake (N)	Essex	13	500	500	500	500	500	500
Woodcliff Lake (N)	Hudson	15	510	510	510	510	510	510
		TOTALS	12,940	12,940	12,940	12,940	12,940	12,940

[1] N = northern lake/pond; S = southern lake/pond.

[2] During the first four winters of the stocking program (December, 2000 through January, 2004), the northern lakes/ponds were stocked in November (during the 3 week-days prior to Thanksgiving Day) and the southern lakes/ponds were stocked during the 1st full week in January (Monday and Tuesday). Beginning with the winter of 2004-2005, winter stocking occurred during the 3 weekdays prior to Thanksgiving Day (i.e. beginning November, 2004).

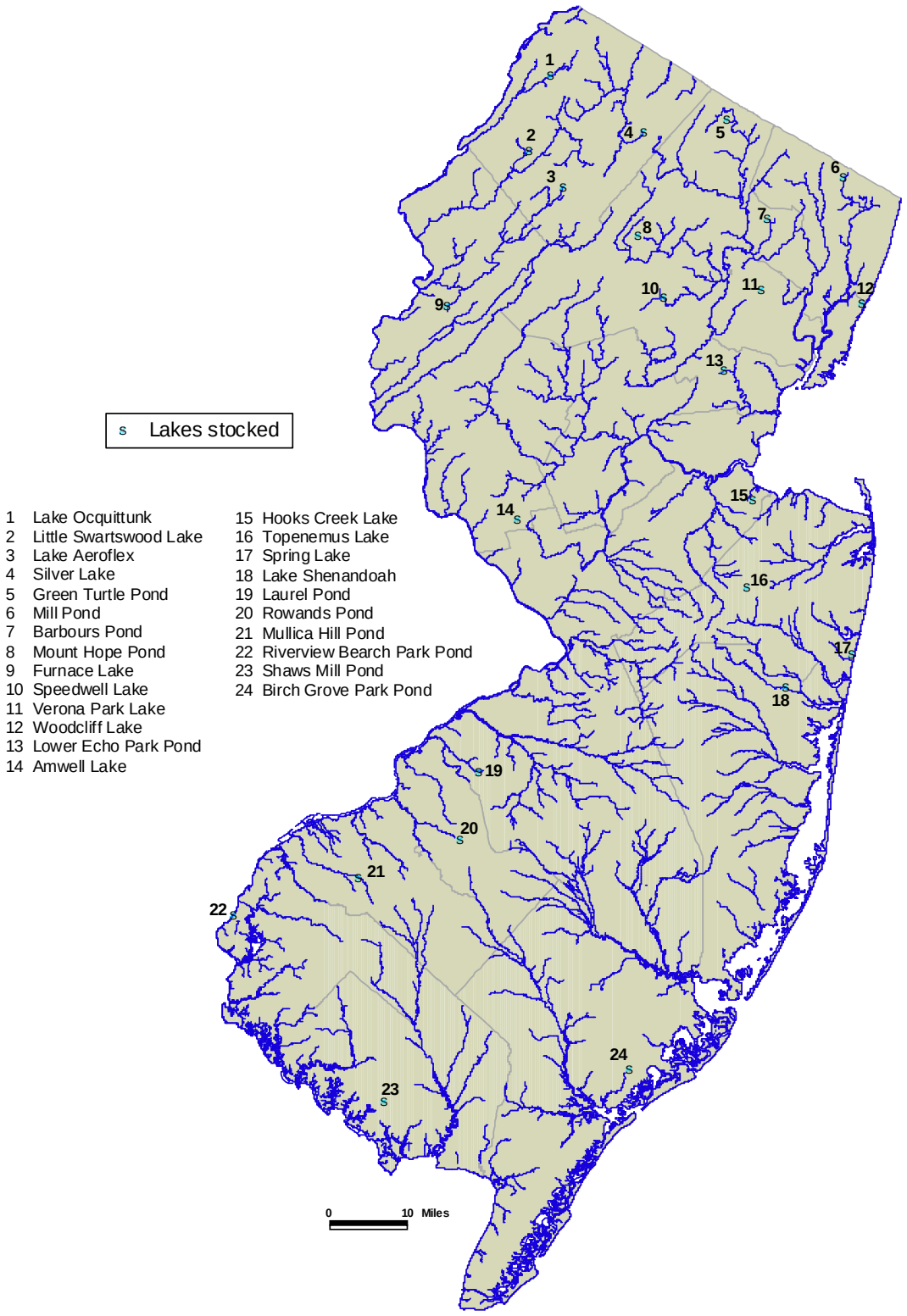

FIGURE 12.— New Jersey's trout-stocked waters for winter 2005.

Sea-Run Brown Trout Stocking Program

Brown trout will, after a period of freshwater residence, often migrate out to an estuary for one to two years to take advantage of an abundance of forage fishes. These migratory trout are called sea-run brown trout. The publicly accessible Manasquan River, in Monmouth County, has been stocked with trout for a number of decades under the spring stocking program, to provide a put-grow- and-take fishery. Periodically, a sea-run trout, usually a brown trout, is caught. These reported captures suggested that it might be possible to create a sea-run brown trout fishery in this Atlantic coast river.

From 1957 to 1962, low numbers of brown trout were periodically stocked in the Manasquan River. Fish stocked in 1961 and 1962 were from eggs of a "sea trout" strain obtained from Denmark and Scotland, however, they did not establish a successful fishery. This lack of success was attributed to insufficient numbers of fish being stocked over a short period of time to establish such a fishery.

In 1997 a pilot program was initiated on the Manasquan River, using surplus brown trout from the May sorting period at the Pequest Trout Hatchery. Since then, the Pequest Trout Hatchery has annually produced 18,000 – 30,000 eight-inch brown trout for this program. As of 2003, approximately 209,000 fish have been stocked over the seven-year period. The fish are stocked late October in the tidal freshwater and brackish portions of the Manasquan River. Trout Unlimited provided financial support when the program began, and members assisted with initial fin clipping efforts (for identification purposes).

Although catches have been reported, the largest of which was nine pounds and twenty – eight inches long, this widely publicized program has not resulted in as many catches as had been anticipated. It is now understood that the stocked trout do not return in large schools, but rather more individually or in small groups, and the amount of time spent in the lower brackish water is highly variable, with some fish returning after several months while others may return several years later. All of these factors play a role in the number of sea-runs caught by anglers. To date, there have been more than 80 catches of sea-run trout ranging in size from 2 - 8 pounds. Conversations with experienced anglers indicate that a large number of sea-run trout captures are not being reported, so as not to draw attention to this fishery.

Opportunity – Continue to publicize the program through articles, updates and news releases.

Opportunity – Visibly tag a proportion of the brown trout stocked to encourage reporting.

Opportunity – Institute a lottery or reward system to encourage reports of catches.

There is currently a lack of information on the potential for creating sea – run trout populations in New Jersey's coastal streams.

Opportunity – In addition to the Manasquan River explore the possibilities of stocking other waters such as Toms River and the Raritan River.

Opportunity – Continue to monitor these coastal waters for the presence of sea – run trout populations through angler reports and proven sampling methods.

Opportunity – Management goals, measurable objectives, and evaluation procedures need to be established for the Sea Run Brown Trout program.

Lake Trout Stocking Program

The criteria for maintaining a healthy, reproducing population of lake trout are deep and cold water, high dissolved oxygen, and a stable forage base. Only a few reservoirs in New Jersey offer lake trout suitable living conditions and potential spawning habitat. Lake trout fisheries have been established in suitable waters to provide anglers with an opportunity to fish for this salmonid species outside of its natural range. Round Valley Reservoir and Merrill Creek Reservoir have been stocked over a long period of time and maintain fishable lake trout populations. An angler fishing at Round Valley Reservoir in May, 2002 caught the current New Jersey state record for lake trout (32 pounds, 8 ounces).

Round Valley was stocked from 1977 to 1995 with a total of 82,139 fish. Natural reproduction was documented in 1985, and in 1995 stocking was discontinued after it was determined that natural reproduction could support this popular fishery. Merrill Creek Reservoir has been stocked annually with lake trout since 1988. However, annual fish surveys conducted since then have not documented reproduction, consequently lake trout continue to be stocked annually. More than 60,000 lakers have been stocked in this reservoir. Surplus fish have also been stocked in Lake Hopatcong, Swartswood Lake, and Lake Wawayanda. These waterbodies do not meet all the criteria necessary to sustain a good population of lake trout, hence it was not surprising that these stockings failed to produce a measurable fishery. Additional surpluses have also been given to the Pennsylvania Fish and Boat Commission in support of their programs.

More recently, since November of 2004, lake trout have been annually stocked in Monksville Reservoir, in response to a noticeable decline in the brown and rainbow trout fishery at the reservoir. The decline was attributed to heavy predation on trout by other introduced species such as walleye and muskellunge. When brown and rainbow trout stocking was discontinued after 2004, lake trout stocking was initiated in hopes that this salmonid might inhabit deeper water than the previously stocked salmonid species, and interact less frequently with other top predator fish species. It is too soon to gauge the success of these introductions.

Opportunity – Identify additional opportunities for the stocking of lake trout within the state.

Miscellaneous Salmonid Stockings

Opportunity – Investigate opportunities for stocking additional species or hybrids of trout to provide additional unique fishing opportunities within the state.

Surplus brook, brown and rainbow fingerlings

Overproduction of cultured trout is a necessary safeguard against unforeseen problems that can and do occur under intensive culture conditions in order to consistently meet the targeted quota necessary to implement current DFW stocking programs. At predictable times of the year the Pequest hatchery has excess trout which must be removed from the production cycle in order to ensure that the production capacity of the hatchery is not exceeded. This overproduction of trout can be broken down into three categories:

1) Spring Fingerlings (3-4" average size)
   Midway through the spring stocking season the hatchery begins the process of sorting fingerlings and setting them up in raceways for the following spring. The excess fingerlings resulting from this sorting procedure are available for stocking by May.

2) Spring Catchables (10.5" average size)
   Near the end of the spring stocking season, catchable trout in excess of the 575,000 baseline quota are available for stocking. These trout are kept in reserve until weeks 6 & 7, as a safeguard against unforeseen problems that may arise early on in the spring stocking program.

3) Fall Sub-catchables (5 – 7" average size)
   Early in the fall the sorting process is again conducted, resulting in excess trout (termed "surplus") which are typically stocked the third week of the fall stocking period.

The success of fingerling stockings has been studied (in other states) and found not typically necessary or successful in developing a good standing stock of trout. Except in certain situations, this is believed to be the case in New Jersey waters. Ideally the stocking of fingerlings should be reserved for those situations where there is a high probability of success. In the past, requests by regional fisheries biologists for fingerling trout have been limited to fingerling rainbows for newly constructed reservoirs (during the first year they were filled). Traditionally the overproduction fingerlings have been stocked primarily in nearby trout maintenance rivers and lakes, using the philosophy "it may not help, but it can't hurt." In 1993, the Bureau of Freshwater Fisheries developed a stocking plan for the use of hatchery surplus fish. The current version of this stocking plan can be found in Appendix F.

Private Stockings

Each year in addition to waters stocked with trout by the DFW there are also a number of stockings by private organizations and individuals. The waters stocked may be publicly

or privately owned. The stocking of fish or fish eggs in any waterbody having an inlet or an outlet requires a stocking permit issued by the DFW of Fish and Wildlife's Bureau of Freshwater Fisheries. The purpose of the permit is to prevent the stocking of exotic, harmful species (carp, goldfish etc.) and to have some assurance that the source of the fish is from a hatchery that does not have a history of particular diseases of concern to fisheries managers. Applications are reviewed by regional biologists and are issued out of the Lebanon Field Office.

Delaware River Anadromous Salmonid

Prior to the development of the "pollution block" in the middle Delaware River, 1871 into the 1880's, the Fish Commissions of New Jersey and Pennsylvania undertook efforts towards establishing Atlantic salmon in the Delaware Basin. Atlantic salmon fry were planted in the main stem Delaware River and two major tributaries, the Pequest and Musconetcong Rivers. In 1874, fish were seen at the Delaware Water Gap and an eight-inch specimen was reported caught in the Musconetcong River. The following year, the reports indicate that small salmon were commonly taken in the Delaware and Musconetcong Rivers, and in 1876 a "large number" were reported caught in the Pequest River. By 1877 salmon were apparently returning to spawn. Delaware Bay shad fishermen caught 8 to 20 pound salmon and other large salmon were seen throughout the length of the river that year. Yet in 1878 reports were almost non-existent and in the following years none were received. Low water, high water temperatures and pollution were the reasons given for the abrupt decline of returning fish and lack of spawning success. Stocking was abandoned in 1882. Pennsylvania resumed stocking in 1889 and in 1895 many large salmon were taken by commercial fishermen throughout the river. Around 1966 Pennsylvania stocked a small number of coho salmon in the Brandywine Creek with evidence that some migrated to sea, returned and were caught. In addition, a private organization reared and stocked steelhead trout near Easton, PA into either the Delaware or Lehigh Rivers with no evidence of success.

A feasibility study was conducted, in 1983, for the State of New Jersey, DFW of Fish, Game and Wildlife, by an independent consulting firm, Normandeau Associates (Normandeau, 1983). The study found it practical to consider three species of salmonids (steelhead trout, coho and chinook salmon) for introduction into the Delaware River.

The DFW submitted a proposal to undertake an experimental five year stocking and five year monitoring study to introduce Chinook Salmon and/or Steelhead trout in the Delaware River. In order to obtain federal funding for the study the DFW was required to prepare and complete an Environmental Impact Statement. The independent consulting firm, Versar, was contracted and completed the Draft Environmental Impact Statement (DEIS) in February 1992 (Versar, 1991). As required, public meetings were held and comments were received on the DEIS.

Approximately 125 people attended the two public meetings, and 42 persons provided oral and/or written comments. 41 people from the general public spoke against the Proposed Action, and only one was in favor. At the end of the public comment period a total of 173 written comments were submitted. Written comments on the DEIS yielded

15 in favor and 100 opposed. However, this did not include two petitions with a total of 122 signatures in favor of the stocking of chinook salmon and another petition containing 500 signatures supporting the introduction of steelhead.

Comments on the DEIS included but were not limited to:

- A source of eggs, which fit both run timing and disease status criteria, may not exist for chinook and coho salmon.
- Introduction of any Pacific salmon conflicts with National Park Service management plans for two parks on the Upper Delaware River
- Potential environmental impacts on Federally endangered mussel populations in the Neversink River
- Future FWS funding for Pacific salmon introduction is improbable because of Executive Order 11987 policy and the recent intentional introductions policy options prepared as part of the Non-indigenous Aquatic Nuisance Prevention and Control Act of 1990.
- Concern that although a limited experimental program may have negligible environmental impacts, a full scale program may and these were not addressed in the DEIS which only addressed the limited experimental program.
- Lack of support from other members of the Delaware River Fish and Wildlife Management Cooperative.

On July 2, 1992 the DFW announced a decision not to pursue their proposal to stock Pacific salmon in the Delaware River for the following reasons:

- Evaluation of the findings of the DEIS.
- Consideration of public comment on the proposal
- A salmon program would detract from a more immediate priority, promotion of a warmwater fisheries program
- A salmon program would require significant investment of resources over an extended period of time with no guarantee of success

Since the DFW withdrew its proposal to stock Pacific salmon in the Delaware River a Final EIS was never drafted on the proposed stocking. However, the proceedings and comments on the DEIS are documented in Notice of Withdrawal of Pacific Salmonid Stocking Proposal for the Delaware River Basin prepared by Versar in November of 1992 (Versar 1992).

Float stocking

When stream conditions permit, float stocking is another tool used to provide a more equitable distribution of trout through trout stocked stretches. It is useful in areas where stocking points are limited by an insufficient number of access areas or on streams where long stretches receive considerable fishing pressure to increase dispersal of anglers. Streams are not typically float stocked during the pre-season period due to high stream flows typically experienced in mid-March and since the majority of these waters are

closed to fishing during that time period. A small fish box is loaded and "floated" behind a small pram. The box is typically refilled at specific access areas along the stretch. In remote park areas, trout may also be distributed by park rangers using all terrain vehicles equipped with wooden tanks and oxygen bottles. Waters that are currently float stocked include:

Waterbody	**Stretch**	**Personnel**
N/Br Raritan River	Rt. 22 to Old York Rd. bridge	DFW staff
S/Br Raritan River	Neshanic Station to Rt. 606 bridge	DFW staff
Ramapo River	Audubon property to Lenape Ln. bridge	WCC Volunteers
Pompton River	Newark-Pompton Turnpike to Rt. 23 bridge	DFW staff
Passaic River	Lord Sterling Rd. bridge to S. Maple Ave.	DFW staff
Paulinskill River	Rt. 610 bridge to Sharp's Farm (off Rt. 521)	DFW staff
Round Valley Reservoir	---	WCC Volunteers
Swartswood Lake	---	State Park personnel
Lake Wawayanda	---	State Park personnel
Lake Aeroflex	---	State Park personnel
Merrill Creek Reservoir	---	Reservoir staff
White Lake	---	WCC Volunteers
Toms River	Trout Conservation Area	WCC Volunteers
Pequest River*	Trout Conservation Area	DFW staff
Musconetcong River*	Point Mountain TCA	Hunterdon County Park & WCC Volunteers
Flatbrook *	Roy bridge to Walpack bridge	WCC Volunteers
* Not float stocked but trout distributed through additional bucket and net stockings		

Stocking Contingency Plans

Occasionally waters are unable to accommodate all or part of their trout allocation because of unsuitable conditions. These problems are usually the result of weather-related conditions that may occur on short notice, or become apparent as the stocking season approaches or progresses. The Pequest Trout Hatchery does not have the capacity retain trout past the intended stocking period. Therefore, when unforeseen conditions arise that impact the distribution of trout, a contingency plan must be developed to ensure the trout are distributed in a timely fashion. Program adjustments, tailored to the specific situation, must be made quickly to ensure minimal disruption to the stocking program and hatchery production. Briefly described below are several problems that have occurred in the past, and the program adjustments that were made.

Drought – Lakes and larger rivers are usually buffered from the immediate effects of extended periods of low rainfall. However, drought conditions can impact streams and low flow conditions may result in conditions that are marginal or unsuitable for trout. Small streams tend to be most affected by drought, however, larger streams can also be affected. To the extent possible, scheduling changes are made, , to ensure waters receive their established trout allocations. In the spring of 2002, when drought conditions prevailed, the pre-season stocking schedule was rearranged so small streams were stocking just prior to opening day.

In the fall of 2005, stocking was cancelled on one stream, curtailed on others, and trout (partial or full allocations) were redirected to other waters.

Floods – A severe rain event can cause high flow conditions in streams rendering them temporarily unsuitable for stocking. If necessary, stream stocking is re-scheduled (later in the week, if possible) after the floodwaters subside. Flooding generally does not create a stocking problem on ponds or lakes unless a dam breach occurs. If a significant portion of a lake's surface is lost, rendering the lake unsuitable for trout or for fishing, then the trout will be re-directed to other waters.

Freezing weather – Hatchery trucks are equipped with ice picks, to use as needed to create open water. Lakes in northern portion of the state that are frozen are re-scheduled if possible.

Lake restorations – Periodically, ponds and lakes undergoing dredging or rehabilitation projects are drained and projects may not be completed prior to the onset of trout stocking. Trout allocated for these waters are re-distributed to the remaining trout-stocked waters.

Allocation Methodology for Cultured Trout

Overview

Considerable effort was expended in developing a methodology to allocate cultured trout that was both resource and user-based, yet maintained existing, desirable allocation patterns. In 1990, following public input on the new "Trout Stocking Improvement Plan," (which included the allocation methodology and several regulatory changes) the Fish and Game Council approved the methodology and regulatory changes. The allocation methodology uses a combination of biological, physical, and social factors to equitable allocate trout over a 10-week period to all trout-stocked waters. A computerized database containing data for each stream, lake, and pond is used in conjunction with formulae to calculate individual weekly allotments. The database is annually reviewed and updated by biologists, who receive input from a variety of sources.

Background

Prior to 1990 the statewide allocation of trout to nearly 200 waters was based upon an entrenched tradition that relied heavily upon political boundaries. The trout-stocked waters in each of the state's 21 counties had an assigned quantity of trout. Each year these "quotas" would be reviewed by members of the Fish and Game Council who, in consultation with county representatives from the NJ State Federation of Sportsmen, had the discretionary power to allocate and redirect spring-stocked trout. If waters or stocking points were added or dropped from a particular county, the trout would typically be redistributed among the remaining trout-stocked waters within that county. In the absence of defined allocation guidelines, haggling for trout inevitably occurred and over time resulted in noticeable inequities that were difficult to change. Variable production and quality of trout reared at the aging Hackettstown Hatchery further complicated this annual allocation process. When the Pequest Trout Hatchery became operational in the mid-1980's, the production of brook, brown, and rainbow trout shifted from the Hackettstown Hatchery to Pequest. The modern facility at Pequest provided New Jersey anglers with a dependable supply of quality, catchable-sized trout. In response to a more stable supply of cultured trout, efforts to develop a means to more equitably distribute trout statewide intensified.

Efforts to devise a trout stocking formula to correct deficiencies in the apportioning of trout in New Jersey began as early as the 1970's with a review of the stocking procedures developed by other states. Those procedures generally included a variety of physical, biological, and social factors that were used in conjunction with management objectives and formulas to derive waterbody allocations. Some factors that were common to both streams and lakes included size, suitability to support trout, and social factors (human population density and recreational potential). Stream procedures tended to be more complex by relying upon additional physical and biological stream characteristics (i.e. trout biomass, food supply, pool depth, shelter, food availability, and vegetated stream margin). Each component used was typically assigned a value or rating and established

stocking rates (based upon the sizes of cultured trout available for stocking) were applied in conjunction with a formula to derive the number to be stocked.

The early attempts to develop trout stocking procedures for New Jersey focused on the collection of data similar to what was in use by other states. Waterbody size and capacity to hold trout were integral components for both streams and lakes. Additional stream data was collected and included flow, width, and a habitat component (percent of water over one foot, and percent cover). Because of the complexity of the stream formula, coupled with difficulties associated with data manipulation and computations (without benefit of personal computers) the development of a formula languished.

Interest and effort to develop a formula resumed in the 1980's, coinciding with the construction of a new trout hatchery and three major water-supply reservoirs. Formal allocation procedures were needed that would allow the DFW to take advantage of the anticipated stable supply of cultured trout, and facilitate allocations of trout to new waters. The following concepts were central to the development of an allocation methodology:

(1) Trout allocations would be based upon an established, baseline number of catchable-size trout available each spring from the Pequest Trout Hatchery.
(2) Trout would be equitably allocated, using procedures that relied upon a combination of resource and user characteristics.
(3) Trout allocations would be adjusted annually as a result of program and resource/user changes, thereby providing incentives to improve existing conditions (such as access).

The difficult task of data manipulation and testing of formula eased considerably when personal computers and database software became readily available in the mid 1980's. Additional data for streams and lakes was collected with the assistance of staff fisheries biologists and conservation officers. Stream variables that were evaluated included flow, stream length, width, trout supporting capability, percent pool/cover, vegetative cover, and stocking frequency. Lake variables included surface area, trout supporting capability, angler access, human population density, and proximity to other trout-stocked waters. A variety of formulae and combinations of variables and criteria were evaluated and a suitable allocation methodology was tentatively selected that utilized some of the variables that were investigated. In 1989 a public forum was held to solicit input on the "Trout Stocking Improvement Plan" which included the allocation methodology and several tentative regulatory changes (creation of the *Wild Trout Stream and Trout Conservation Area* regulations). This plan was accepted by NJ Fish and Game Council (with modifications to the regulations) and implemented by the DFW in 1990.

Database Variables

The trout allocation methodology utilizes three factors – physical, biological and social – to characterize the resource and recreational use of the resource. Variables are assigned to each of these factors and are used in a formula to derive the weekly trout allocations

for individual waters. Variables for the physical and social factors differ for streams and lakes, while the biological factor relies upon one variable common to both types of waters. The variables associated with each factor are described below and summarized in Table 6 (streams) and Table 7 (lakes).

Physical Factor

The physical size of a trout-stocked water plays a major role in determining the number of trout allocated. Because of differences in the character of streams and lakes (flowing versus standing water) different variables were used to describe each type. Data collected for the physical criteria were used to develop separate size categories for streams and lakes/ponds.

Streams The physical factor for streams is characterized using two variables - flow and length. Flow and length variables provide a reasonable assessment of available space for cultured trout and are relatively easy to obtain compared to more precise habitat assessments (pool features, cover, etc.).

- Flow Streams are assigned to one of the following six size categories (A-F) based upon the mean stream flow for March and April (obtained from USGS gauging stations, if available, or through field measurement).
  - (A) 100 cfs or more,
  - (B) 40 – 99 cfs,
  - (C) 20 – 39 cfs,
  - (D) 8 – 19 cfs,
  - (E) 4 – 8 cfs, and
  - (F) 1-3 cfs

  When indicated by flow data, major streams were divided into sections and assigned to appropriate size categories. Stream width (measured in the field) may be used as an aid in determining the appropriate size category.
- Length Length is used to linearly quantify the amount of stockable water. The miles of stream that are stocked are determined by assigning 0.5 miles to each stocking point (0.25 mile upstream and downstream), discounting overlap between stocking points and in-stream physical barriers to upstream fish movement (i.e. dams).

Lakes & Ponds

- Surface area Lakes are assigned to one of the following three size categories:
  - (A) 1- 5 acres
  - (B) 6 – 30 acres, and
  - (C) 31 acres or more.

Biological Factor

The ability to support trout and maintain a trout fishery is the biological criterion used for all trout-stocked waters. The fishery is characterized as either seasonal or year round. If a trout-stocked water does not support (or sporadically supports) trout year round, the trout fishery is termed seasonal. In a seasonal trout fishery, spring-stocked trout that are not caught within the first few months following release generally do not survive through the summer months because of high water temperatures. A year round designation indicates

that the water supports trout year round and is managed to provide a year round fishery. Summer water temperatures, in combination with dissolved oxygen, do not exceed trout tolerances and trout that are not caught within the first few months consistently survive ("holdover") through the summer and may grow appreciably (particularly in lakes). Angling for trout is a year round activity on these trout-stocked waters. When differences in trout supporting capabilities occurred over the length of a stream, the stream was further divided into sections to accommodate for these changes.

Social Factor

The social factor involves a multi-faceted characterization of the opportunity to fish for trout. As with the physical factor, different variables are used for streams and lakes since the conditions, which enhance or limit angling opportunities, vary.

Streams A combination of three variables (ownership, availability of parking, and angler interest) is used to characterize the recreational use potential (RUP) on a scale of 1 (lowest) to 5 (highest).

- Ownership In New Jersey the owner(s) of the stream bank and stream bottom controls foot access to the stream. Trout are stocked in publicly and privately owned streams provided the owner allows unrestricted public access. Publicly owned streams generally have a higher profile with the angling public than privately owned waters and tend to be more heavily fished. The amount of stream that is in public ownership is expressed as a percent of the total distance stocked.
- Parking The availability of parking for stream anglers can be quite variable and may be limiting, particularly on the opening day of the trout season. Anglers may be relegated to parking some distance away or on road shoulders, or roadside pull-offs or parking lots may be in close proximity. Parking is rated as good adequate, or poor.
- Interest Angler interest is also rated (high, moderate, low) as a means to acknowledge highly popular waters, however, it is acknowledged that stocking densities may play a role in the level of interest.

Lakes & Ponds Three variables (human population density, angler access, and opportunity) were used to characterize the social factor for lakes.

- Human population density Trout are stocked in lakes in and near urban areas to provide a readily accessible, seasonal fishery to a potentially large number of people. The population density of the municipality having a trout-stocked water was used as an indication of the extent of this opportunity.
- Access Trout-stocked lakes are, for the most part, publicly owned and have ample parking for recreationalists. Consequently, parking is not considered a factor that limits participation. However, the percentage of shoreline that can be fished and the opportunity to boat (on lakes over 10 acres) is quantified as a means of rating accessibility.
- Proximity of trout-stocked waters Trout-stocked lakes and ponds not having (or having few) trout-stocked waters nearby provide not only a local, but also a more regional opportunity trout fishing opportunity. The number of trout-

stocked waters within a ten-mile radius of a trout-stocked lake is determined and used as an indication of trout fishing availability in the area.

Database

A computerized database is used to manage the data associated with the physical, biological and social factors related to each trout-stocked water. The database is annually reviewed and updated prior to calculating the spring allocations by the regional fishery biologists, who receive input from conservation officers, stocking crews, the NJ Fish & Game Council, and the general public. Feedback on resource changes is strongly encouraged so those factors affecting the individual allocations for waters can be appropriately adjusted. The data is organized and manipulated using DBase III+ software. The database used to calculate the 2003 spring allocations appears in Appendix G.

Allocation Procedure

A three-step process (Table 8) is used to calculate individual weekly allocations for the ten-week spring stocking period using the trout-stocked waters database. First, the pre-season and in-season allocations for streams are approximated using the database in conjunction with established stocking rates and formulae. An individual allocation that falls below 100 trout is increased to 100 to make the stocking effort worthwhile (in terms of manpower). Next, the same is done for lakes and ponds. The third step finalizes the nearly 1,000 individual allocations generated by the first two steps. Programs written using DBase III+ software are used in this three-step process. The procedures used in the three-step process are more fully explained below.

Step 1 Calculation of weekly individual unadjusted allocations for streams

A stream's initial allocation is first computed for the pre-season period by multiplying the stocking rate (number of trout per mile) established for the stream's size category by the stream mileage. The resulting product is then adjusted upward or downward according to the variables associated with the biological and social factors. Streams that provide a year round fishery are rewarded with a 10 percent increase in trout. If the recreational use potential is excellent or outstanding then the initial allocation is further increased by 10 or 20 percent. If it is fair or poor then a 10 or 20 percent decrease in the allocation occurs. These incremental adjustments to the initial allocation (which also affect the in-season allocations) are subject to change annually when warranted by changes in the field. This provides an incentive to improve existing situations as well as recognizing when conditions have deteriorated. The unadjusted in-season stocking allocations are based upon the pre-season allocation and determined using the stocking frequency chart for streams. The number of trout per allocation, and the number of in-season allocations, generally decreases as the season progresses. This stocking pattern recognizes that angler effort decreases after opening day waters and fewer trout are stocked as the season progresses.

Step 2 Calculation of weekly individual unadjusted allocations for ponds/lakes

A pond/lake's initial allocation is first computed for the pre-season period using a sliding scale stocking formula. This was deemed necessary because if large lakes were stocked at the same rate as small lakes and ponds then the large lakes would absorb a considerable portion of the hatchery production. The sliding scale stocking rate applies a 75 trout per acre stocking rate to the first five acres of an impoundment. The next 25 acres are stocked at a reduced rate (five trout per acre), and any acres in excess of 30 are stocked at a rate of one per acre. The resulting allocation figure is then adjusted upward or downward according to the variables associated with the biological and social factors. As with streams, lakes that provide a year round fishery are rewarded with a 10 percent increase in trout. If the human population density is 1,000 people per square mile or greater, then the initial allocation is increased by 10 or 20 percent. Angler access limitations, in terms of shoreline and boating access, result in allocation reductions of 20 or 40 percent. If few or no trout angling opportunities are available within ten miles then the allocation is boosted by 10 or 30 percent. These incremental adjustments also affect the in-season allocations) and are subject to change annually when warranted by changes in the field. This provides an incentive to improve existing situations as well as recognizing when conditions have changed. The unadjusted in-season stocking allocations are based upon the pre-season allocation and determined using the stocking frequency chart for lakes. The number of trout per allocation decreases in-season except on those waters having year round trout fisheries. Certain waters have been designated to receive only one stocking (pre-season) are not assigned in-season allocations. When the pond/lake formula was first developed it was necessary to make a minor adjustment to all the lake allocations (the 0.95 multiplier) in order to balance the stream and lake allocations to achieve the spring baseline.

Step 3 Calculation of final individual allocations for streams, lakes, and ponds

First the undajusted allocations calculated in Steps 1 and 2 are summed. When this total is less than or greater than the established spring baseline of 575,00 trout, all allocations must be proportionally adjusted using a calculated constant (C) in order to achieve the baseline figure (Table 9). This unadjusted total has consistently exceeded the spring baseline and allocations have been adjusted downward one or two percent since inception. The final procedure involves rounding all the allocations to the nearest multiple of ten, to simplify the loading of fish onto the hatchery trucks. This last procedure inevitably results in a final total that differs from the target baseline figure by as much as several hundred trout, but is an acceptable margin of error.

Opportunity – Antiquated software (Dbase III+) is used to maintain the database and derive the spring trout allocations and conversion to a modern software set-up is desirable.

TABLE 6.— Factors and Associated Criteria used to Determine Spring Trout Allocations for New Jersey Trout-Stocked Streams.

<table>
<tr><td rowspan="2">Physical</td><td>Flow - Each stream is assigned to a size category (A-F) based on stream discharge (flow) and width. Discharge is the mean discharge in cfs (ft^3/sec) for April – May (USGS gauging station or field measurement data used). Width is the mean width midway in the stream reach.
<table>
<tr><td>A</td><td>discharge: ≥ 100 cfs</td><td>width: 40 – 150 ft</td></tr>
<tr><td>B</td><td>discharge: 40 - 99 cfs</td><td>width: 19 – 68 ft</td></tr>
<tr><td>C</td><td>discharge: 20 - 39 cfs</td><td>width: 15 – 54 ft</td></tr>
<tr><td>D</td><td>discharge: 8 – 19 cfs</td><td>width: 10 – 33 ft</td></tr>
<tr><td>E</td><td>discharge: 4 -7 cfs</td><td>width: 7 – 30 ft</td></tr>
<tr><td>F</td><td>discharge: 1 – 3 cfs</td><td>width: 5 – 21 ft</td></tr>
</table></td></tr>
<tr><td>Length – Each stocking point is assigned a distance of 0.5 miles (¼ mile above and below each point). Mileage overlap between stocking points (those within 0.5 miles of each other) is not counted and mileage assigned to a stocking point is reduced if a barrier restricts fish movement (e.g. dam). The sum of the distances assigned to the stocking points for an individual stream equals the stream mileage. If a stream section is regulated as a Year Round Trout Conservation Area, the mileage for the special regulation section is noted.</td></tr>
<tr><td>Biological</td><td>Fishery Type The ability of a water to support trout determines the fishery type.
Seasonal (S) - Trout survival beyond the spring is not expected (or survival through the summer is intermittent) and the trout are not expected to grow significantly before they are caught (put-and-take).
Year-round (Y) - Trout survival year-round is expected and the trout may or may not grow significantly before they are caught Immediate harvest (put-and-take) and/or delayed harvest (put-grow-take) is possible.</td></tr>
<tr><td>Social</td><td>Recreational Use Potential (RUP) Three variables (parking availability, land ownership, angler interest) are used in combination to rate the recreational use potential of a stream on a scale of to 5 (high) to 1 (low).
Ownership – The percentage of stocked water in public ownership (public ownership may be on only one side of the stream, not both).
Parking – Parking availability is rated Good (G), Adequate (A), or Poor (P).
Interest – Angler interest is rated High (H), Moderate (M), and Low (L).
<table>
<tr><th>RUP</th><th>OWN</th><th>PARK</th><th>INT</th></tr>
<tr><td>5</td><td>50-100</td><td rowspan="3">G</td><td rowspan="3">H</td></tr>
<tr><td rowspan="2">4</td><td>15-49</td></tr>
<tr><td>1-14</td></tr>
<tr><td></td><td>0</td><td></td><td></td></tr>
</table>
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<tr><th>RUP</th><th>OWN</th><th>PARK</th><th>INT</th></tr>
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<tr><td rowspan="2">3</td><td>15-49</td></tr>
<tr><td>1-14</td></tr>
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<tr><td rowspan="2">3</td><td>15-49</td></tr>
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<tr><td rowspan="2">2</td><td>15-49</td></tr>
<tr><td>1-14</td></tr>
<tr><td></td><td>1</td><td>0</td><td></td></tr>
</table></td></tr>
</table>

TABLE 7.— Factors and Associated Criteria used to Determine Spring Trout Allocations for New Jersey Trout-Stocked Lakes and Ponds.

Physical	Surface area Each lake/pond is assigned to a size category (A-C) based upon surface area (acres)	G	0 – 5 acres
		H	6 – 30 acres
		I	> 30 acres
Biological	Fishery Type The ability of a water to support trout determines the fishery type. Seasonal (S) - Trout survival beyond the spring is not expected (or survival through the summer is intermittent) and the trout are not expected to grow significantly before they are caught (put-and-take). Year-round (Y) - Trout survival year-round is expected and the trout may or may not grow significantly before they are caught Immediate harvest (put-and-take) and/or delayed harvest (put-grow-take) is possible.		
Social	Human population density - The population density of the municipality bordering the lake is obtained from recent government census figures and expressed as the number of people per square mile. If more than one municipality borders the lake then the weighted mean is used.		
	Angler access - Accessibility is evaluated for shoreline and boat fishing. Shoreline access is limiting ("S") if less than 25% of the shoreline is accessible to the general public. For lakes over 10 acres, boating access is considered limiting ("B") if a boat launch (cartop or ramp) is absent or if boating is not allowed.		
	Angling opportunity (proximity of trout stocked waters) - For each trout-stocked lake or pond the number of trout stocked waters within a 10-mile radius is counted.		

TABLE 8.— Calculation of individual trout allocations – a 3 step process.

STEP 1 of 3

Calculate the Unadjusted Weekly Allocations for Each Stream Using the Following Formula:

Q * M * [1 + F + R] * K

Stocking Rate (Q)	Category A	Q = 485 trout/mile
	Category B	Q = 395 trout/mile
	Category C	Q = 260 trout/mile
	Category D	Q = 210 trout/mile
	Categories E & F	Q = 135 trout/mile
Mileage (M)	-	M = number of miles stocked[1]
Fishery Type (F)	Seasonal	F = 0.0 (no change)
	Year-round	F = 0.1 (10% increase)
Recreational Potential (R)	RP = 5 (outstanding)	R = 0.2 (20% increase)
	RP = 4 (excellent)	R = 0.1 (10% increase)
	RP = 3 (good)	R = 0.0 (no change)
	RP = 2 (fair)	R = –0.1 (10% decrease)
	RP = 1 (poor)	R = –0.2 (20% decrease)
Frequency Factor (K)	Consult table below for value assigned to K	

Stocking Frequency and Value Assigned to K for Streams

Stream Characteristics		**Weekly stocking frequency and value assigned to K**							
Size Category	***Conditions*** *(mutually exclusive and applied in order of appearance)*	***Pre-Season***	***In-season stocking period*** [1]						
			Week 1	*Week 2*	*Week 3*	*Week 4*	*Week 5*	*Week 6*	*Week 7*
A, B, & C	Closed in-season stocking dates	1.0	0.45	0.4	0.4	0.4	0.4	0.25	0.25
A & B	No closed in-season stocking dates; year round fishery or D&R Feeder Canal	1.0	0	0.4	0.4	0.4	0.4	0.25	0.25
	No closed in-season stocking dates; seasonal fishery	1.0	0	0.4	0.4	0.4	0.4	0	0
C	No closed in-season stocking dates; year round fishery	1.0	0	0.4	0.4	0.4	0.4	0.25	0
	No closed in-season stocking dates; seasonal fishery	1.0	0	0.4	0.4	0.4	0.4	0	0
D	RUP = 3, 4, or 5 — Year-round fishery	1.0	0	0.4	0.4	0.4	0.4	0.25	
	RUP = 3, 4, or 5 — Seasonal fishery	1.0	0	0.4	0.4	0.4	0	0	0
	RUP = 1 or 2	1.0	0	0.4	0	0.4	0	0	0
E	year round fishery	1.0	0	1.0	0	1.0	0	0	0
	seasonal fishery	1.0	0	1.0	1.0	0	0	0	0
F	None (all inclusive)	1.0	0	0	1.0	0	0	0	0

[1] A Year Round Trout Conservation Area (YTCA) stretch is not stocked as frequently as the rest of the stream. Prior to 2004, a YTCA stretch was stocked during the pre-season period and two times during the in-season stocking period (Weeks 3 & 7). In 2004, another in-season stocking was added (Week 6). If the mileage for a YTCA section is included in the overall stream mileage, then YTCA mileage must be subtracted from the stream mileage before calculating the stream's in-season allotments for those weeks when the YTCA is not stocked.

TABLE 8 (continued).— Calculation of individual trout allocations – a 3 step process.

STEP 2 of 3

Calculate the Unadjusted Weekly Allocations for Each Pond & Lake Using the Following Formula:

Q * [1 + F + D + L + P] * 0.95 * K

Stocking Rate Subformula (Q)	Surface area (A) is 1 to 5 acres	Q = [75 * A]
	Surface area (A) is 6 to 30 acres	Q = [5 * (A – 5)] + 375
	Surface area (A) is over 30 acres	Q = [1 * (A – 30)] + 500
Fishery Type (F)	seasonal	F = 0.0 (no change)
	year-round	F = 0.1 (10% increase)
Human Population Density (D)	at least 5,000 people/sq. mile	D = 0.2 (20% increase)
	1,000 – 4,999 people/sq. mile	D = 0.1 (10% increase)
	less than 1,000 people/sq. mile	D = 0.0 (no change)
Angler Access (L)	lake > 10 acres and no boating access	L = –0.2 (20% decrease)
	shoreline < 25% accessible	L = –0.2 (20% decrease)
	both shoreline & boat access limiting	L = –0.4 (40% decrease)
Angling Opportunity (P)	No TSW within a 10 mile radius	P = 0.3 (30% increase)
	1 – 5 TSW within a 10 mile radius	P = 0.1 (10% increase)
	more than 5 TSW within a 10 mile radius	P = 0.0 (no change)
Frequency Factor (K)	Consult table below for value assigned to K	

Stocking Frequency and Value Assigned to K for Ponds/Lakes

Pond/Lake Characteristics		**Weekly stocking frequency and value assigned to K**							
Fishery Type	***Conditions (mutually exclusive and applied in order of appearance)***	***Pre-Season***	***In-season stocking period*** [1]						
			Week 1	***Week 2***	***Week 3***	***Week 4***	***Week 5***	***Week 6***	***Week 7***
Year Round	None (all inclusive)	1.0	0	1.0	0	1.0	0	1.0	0
Seasonal[1]	Stocked pre-season only	1.0	0	0	0	0	0	0	0
	Human population density 5,000+ people/ sq. mile **OR** no trout-stocked waters within a 10 mile radius	1.0	0	0.75	0.75	0.75	0.75	0	0
	All others	1.0	0	0.75	0.75	0.75	0	0	0

[1] In 2005 the in-season stocking schedule for these waters was shifted one week earlier (i.e. in-season stockings commenced Week 1 and ended on Week 3 or 4).

TABLE 8 (continued) — Calculation of individual trout allocations – a 3 step process.

STEP 3 of 3 Calculation of Final Allocations for Streams, Ponds, & Lakes	
A	Any individual allotments that are 1 - 99 are increased to 100.
B	Calculate the adjustment constant (C) to achieve the spring baseline by dividing the spring baseline by the sum of all the unadjusted pre-season and in-season stream and pond/lake allotments calculated in Steps 1 & 2
C	Multiply each unadjusted pre-season and in-season allotment by the adjustment constant (C) to obtain the adjusted pre-season and in-season allotments.
D	Obtain the final allotments by rounding each adjusted pre-season and in-season allotment to the nearest multiple of 10 and adjusting individual allotments that are 1 - 99 to 100.
E	Calculate the spring trout allocation for each waterbody by summing the rounded pre-season and in-season allotments. Note: Due to the rounding process the season total of all in-season and pre-season allotments may be slightly greater or less than the spring baseline.

TABLE 9.— Annual spring baseline and constant used to adjust individual raw pre-season and in-season trout allotments in order to achieve the spring baseline figure.

Year	Target spring baseline (number of trout)	Adjustment constant (C)
1990	560,000	0.99462
1991	575,000	0.98471
1992	575,000	0.98823
1993	575,000	0.98866
1994	575,000	0.98543
1995	575,000	0.98130
1996	575,000	0.98478
1997	575,000	0.97922
1998	575,000	0.98039
1999	575,000	0.97748
2000	575,000	0.97960
2001	575,000	0.97849
2002	575,000	0.98056
2003	575,000	0.97458