This draft report was provided to the Brule River Sportsmen's Club by Bill Blust of the Wisconsin Department of Natural Resources.

BRULE RIVER WILD STEELHEAD STOCKING EXPERIMENT

INTRODUCTION

The steelhead or migratory rainbow trout (*Oncorhynchus mykiss*) was first introduced into the Bois Brule River in 1896, when 20,000 fry hatched from eggs collected directly from the Klamath River basin in Northern California were hatched at the Federal hatchery in Duluth, Minnesota by the U.S Fish Commission. Stocking efforts utilizing this strain continued for several years (~100,000 fish total) before being replaced with fish originating from Oregon's Rogue River basin. Beginning in 1910, captive brood stock reared within the state hatchery system provided a more reliable source for the stocking (fry and eventually other age strategies) and were used off and on until the early 1980's. The genetic makeup of this source was derived from numerous strains, including non-migrating rainbows with a documented total of 2,015,707 stocked (see stocking table), but it is believed the earliest stocking of wild fry directly from the west coast was responsible for the establishment of the Brule fishery. Interestingly a non-migrating strain of rainbow collected from hatchery reared brood originating from the Sacramento River (Shasta strain) in California were first stocked as fry in the very upper portion of the Brule by private citizen Nick Lucius Jr. of Solon Springs six years earlier in 1890. Those fish were shipped to him by rail from the Wisconsin Fish Commission hatchery in Southern Wisconsin.

The present "Brule River" strain has both a fall and spring run component and supports the largest self sustaining population within the US portion of the Lake Superior basin. Like other wild steelhead populations, annual run size and year class strengths fluctuate considerably, being highly affected by extreme flow/temperature regimes and lake conditions (water temps, predator/prey abundance) after the smolt leaves the river. In particular, newly emergent fry (< 2") are very susceptible to measureable increases in stream discharge from storm events occurring during the window of late spring to mid-summer.

The fishery has been intensively studied dating back to the 1940's. Three anadromous population assessments were carried out in the early 1940's, 1961-64 and 1978-80 which utilized mechanical weirs placed across the entire stream to capture and count ascending fall and spring spawning migrations. During the 1960's and 70's studies a DC boom shocker was also employed to capture fresh migrants in the estuarine portion of the lower river. The weirs were placed at three locations including; just upstream of the current Ranger Station Campground canoe landing in the 1940's, downstream of Hwy 2 for the 1960's and 70's studies and Winneboujou during the first year of the 1960's survey. Weir catches were very poor during the first two studies, numbering less than 100 in each year from 1962-64. In 1979, which was the only full year of sampling for that study, a total of 1,791 adults were captured, but no population estimate was attained. From 1987-1991, an extensive steelhead production evaluation was conducted throughout the entire watershed, as well as, a smolt assessment at the newly constructed lamprey barrier/fishway on the lower river. Early life history data collected during these studies provided invaluable insight towards understanding the dynamics of the fishery. In 1986, the reconstruction of the original lamprey barrier included an underwater observation window which provided the ability to estimate annual adult spawning migrations using a randomized observation schedule. In the summer of 1988 electricity was supplied to the barrier/fishway and a time lapse VHS recording system was installed which proved to be an invaluable fisheries tool. This system is in use yet today and provides very accurate counts of not only steelhead, but all salmonids ascending the river to spawn. From the time period 1986-2009 annual wild steelhead runs have fluctuated between 3,005 and 8,759 fish.

The history of management strategies included periodic tightening of bag and length limits for both the stream and lake fisheries, establishment of several seasonal refuges within the river and sporadic stocking of domesticated rainbows and summer run steelhead through the early 1980's. In 1993, the latest and most restrictive regulation was put into place for the river fishery which set the daily bag limit at one fish with a minimum size of 26". This regulation change provided protection for nearly all adult fish to spawn at least once and resulted in a more stable/quality fishery. In 2000, the same restrictions were applied to the Lake Superior fishery which had a more restrictive regulation previously enacted which included a daily bag of 1 and minimum length limit of 28".

During the mid 1970's to mid 1980's, prior to the installation of the lamprey barrier/fishway, anglers raised concern about a perceived declining steelhead population. After careful deliberation by state and concerned citizens a stocking program utilizing Brule River strain fish was instituted. The initial stocking strategy was modeled after recent successful west coast wild rehabilitation programs, Wisconsin's and Michigan's Lake Michigan's steelhead plan and a Cornell University genetics evaluation conducted on numerous steelhead populations inhabiting the western end of Lake Superior. Its initial strategy called for a 5 year project which included annual stocking of 50,000 wild yearlings larger than 7" in length reared at the Brule River hatchery/rearing station and released in downstream reaches prior to smolting. Due to many unforeseen limitations within the hatchery system in rearing wild trout, the project included near annual adjustments to improve quality of the product and evolved into a lengthy experiment. Three different life history strategies were used (2 yr olds, fingerlings and yearlings respectfully) to improve adult return rates, encompassing fourteen year classes and twenty years of evaluation. This paper will outline hatchery strategies employed and evaluation of the experimental program.

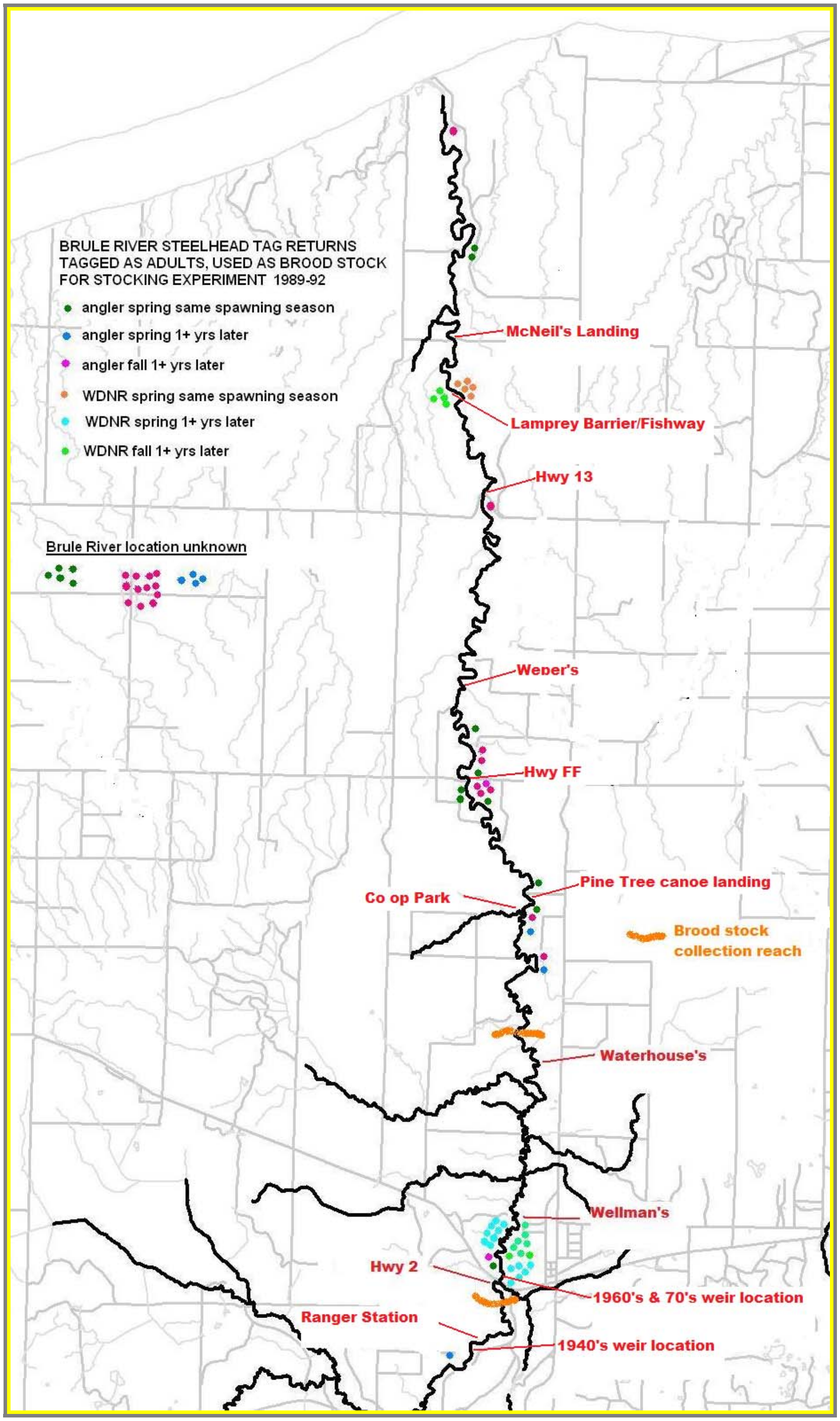
METHODS

A panel of fisheries biologists and technicians from the State of Wisconsin, as well as members of the Brule River Ad Hoc committee (outside partners) met numerous times in the mid 1980's to discuss strategies to improve a depressed Brule River steelhead fishery. One main component of their plan included development of an effective enhancement program. Much of the criteria used to guide this endeavor were acquired from successful stocking programs carried out by management agencies in Wisconsin, Michigan, Washington and British Columbia. Of utmost importance was conservation of the genetic diversity of the existing fishery and to produce a product that would provide the best chance of success. To adhere to these guidelines only Brule River adults were used for gametes and the offspring were raised in an environment that would minimize the amount of human interaction so their inherent wild characteristics would be maintained to the highest extent possible. Research studies evaluating returns of steelhead supplementation projects in Lake Michigan and the west coast stressed the importance of releasing pre-smolts no less than seven inches in length to obtain the highest return rate of adults. After the first year of the project growth rates were far inferior to the objective, so it was determined to rear the fish for an additional year to attain an end product that had the best chance of success. All fish were marked with a left ventral and/or adipose clip so they could be identified as they migrated upstream past the lamprey barrier/fishway observation window.

The capture of adult fish the first year was accomplished by using several 240 volt DC electrofishing barges in late April at the Winneboujou and Ranger Station spawning grounds while the fish were in the act of spawning. The requested quota of eggs was accomplished (~75,000), but this technique proved to be very difficult, time consuming and the public perception of gathering fish within the spawning grounds was highly controversial, so it was discontinued and replaced with a more efficient procedure. For the remainder of the experiment a 240 volt DC mini shocker boat was used to collect pre-spawn fish during the month of March in the section of river from US Hwy 2 to nearly a mile below the "Box Car hole" or approximately six miles of stream. This reach is locally known as the "woods" and "meadows", named for the riparian habitat it flows through. It is a low gradient, meandering segment of the river which typically harbors good numbers of over-wintering fish from the previous fall run. All attempts were made to capture each year's sample before any significant runoff (>CFS, turbidity) occurred to maximize efficiency and beat any substantial upstream movement to spawning grounds. To achieve the yearly quota of eggs, approximately 200 adults were needed which typically took two to four separate shocking runs. Each run was separated by several or more days to allow new fish to move upstream and occupy the previously shocked section. The objective was to capture an equal sex ratio, but this was never achieved because by the time we were able to get into the river a large portion of the males that over wintered in this reach had already migrated to upstream spawning sites. In a typical year females dominated the catch by a 2 to 1 ratio. A downstream shocking pass was used to capture the fish and they were placed in an onboard holding tank. When necessary a 12 volt aerator was used to keep the tank well oxygenated, which was especially beneficial during warm days or long runs. Three access sites along the shocking route were used to off- load the fish, which were transferred to hatchery trucks for transport back to the Brule fish hatchery. These sites were: old Hwy 2 bridge, Wellman's (1mile downstream) and Waterhouse's (~ 5 miles downstream) (see fig.1), with the latter two being private residences. During years of deep snow cover only the upper two locations were accessible.

Ripe females from the first year of the experiment were immediately stripped and the eggs fertilized. The remaining "green" fish were transferred to a cage placed in the Little Brule River immediately downstream of the hatchery outflow and held until ripe. In subsequent years all steelhead captured were brought to the Brule River hatchery and held within one of its earthen ponds to ripen which typically required an additional one to four weeks. During the first two years, fish were placed in 3 to 4 (4'x 4' x 8') pens held within the pond to keep sexes separated and ease recapture. The remaining eleven years, fish were released directly into the ponds and allowed to swim freely. This proved to be most successful and efficient in achieving our quota of eggs while minimizing injuries. Cages used early on served their purpose, but constant bumping into the screen material resulted in the development of open wounds around the snout region exposing the individual fish to numerous water borne diseases such as bacterial cold water disease. Biweekly inspections were made to evaluate female ripeness and ripe fish were processed if numbers were adequate. A dry fertilization procedure was used with a ratio of two males to one female. Total number of eggs collected during the respective life history strategies were: two year olds = 75,000-125,000, fingerlings = 250,000-325,000, yearlings = 175,000-225,000. Photoperiod and water temperature had the most influence in the timing of female fish becoming ripe.

In a typical year thirty individuals were sacrificed for mandatory health inspections with the remaining lot released back into the river. A portion of those released during the years 1989-92 were tagged to monitor movement and angler harvest. After release at the Ranger Station canoe landing, numerous fish were sighted spawning near the Winneboujou Bridge several days later. Anglers caught a high percentage in both the river and Lake Superior up to three years after release and we encountered them during subsequent brood stock electrofishing runs (fig. 1). Also, holding the fish for an extended period for ripening, some up to one month, provided an excellent opportunity to evaluate latent electrofishing mortality. Most years we observed a mortality rate in the one to two percent range and experienced as high as five percent one year.



BRULE RIVER STEELHEAD TAG RETURNS
TAGGED AS ADULTS, USED AS BROOD STOCK
FOR STOCKING EXPERIMENT 1989-92
angler spring same spawning season
angler spring 1+ yrs later
angler fall 1+ yrs later
WDNR spring same spawning season
WDNR spring 1+ yrs later
WDNR fall 1+ yrs later
Brule River location unknown
McNeil's Landing
Lamprey Barrier/Fishway
Hwy 13
Weber's
Hwy FF
Pine Tree canoe landing
Co op Park
Brood stock
collection reach
Waterhouse's
Wellman's
Hwy 2
1960's & 70's weir location
Ranger Station
1940's weir location

Figure 1

TWO YEAR OLDS

The 1988 year class was the first for the supplementation program and was to consist of 50,000, seven-plus-inch, pre-smolt yearlings to be stocked out in the spring of the following year. This strategy was chosen because recent enhancement projects on Lake Michigan tributaries and west coast streams found stocking fish greater than seven inches greatly improved survival and return rates. The fish were to be raised entirely at the Brule River hatchery, but it wasn't too far into the first year when we realized rearing wild fish in a confined environment and unsuitable cold hatchery temperatures (especially during winter) wouldn't allow the fish to reach the length we desired. So the first of many modifications to the program was made when it was decided to raise them for an additional year. This strategy of rearing two year olds lasted for five years and was one of constant change as the hatchery system constantly strived to improve upon rearing techniques to produce the highest quality and largest fish possible.

The first two years (1988 & 89 year classes) were hatched and reared entirely in Brule. Well water was used exclusively on the eggs and fry of the 1988 lot, where as, creek water (when its temperature was above 49 F) was used to temper the well water on the eggs and fry of the 1989 year class to speed up hatching and growth of the young fry. During both years fry were kept in holding tanks until a majority reached 2" in length and then transferred to concrete raceways in early August for the remaining twenty two months. In an effort to retain the fish's innate wild characteristics, human contact was kept to a minimum by enclosing the raceways with a plastic green house type structure called the "hoop house". It was funded by the Brule River Sportsman's Club specifically for this project. The fish were fed a moist pellet diet via automatic feeders much of the time. Both year classes experienced an outbreak of gill disease which was immediately treated with "Diquat". Ice and cold water conditions during the winter months curtailed growth and made feeding difficult.

Length obtained during the first two years was less than anticipated when compared to growth in the wild and averaged 5.8" and 6.9" for the 1988 and 1989 year classes respectively. Coincidently, 35% of the 1988 year class and 71% of the 1989 year class exhibited characteristics of smolting at time of release, with a direct relationship between average size and percent smolted. A total of 50,738 fish from the 1988 year class were stocked at eight locations in the lower river in the spring of 1990. All fish were finclipped, with the largest fish (> 6.0") receiving a LVAD clip (n = 18,966) and the remaining allotment receiving a LV clip prior to stocking. A total of 44,164 fish from the 1989 year class was stocked at two locations (Hwy 13, McNeil's landing) in the spring of 1991. All fish were given a LVAD finclip prior to stocking with 28.8% exceeding seven inches compared to 14.8% for the 1988 year class. Assessment of downstream movement after stocking was monitored in conjunction with a wild smolt study being carried out by the fisheries research unit at the lamprey/barrier fishway. The inclined-screen smolt trap catch indicated a surge in downstream movement for the first month after stocking, with much reduced levels as the summer progressed. Average size caught in the smolt trap was 7.2" with a range of 5.0"-9.4". Residualism (those that did not migrate to Lake Superior due to small size or inherent traits) was evaluated for the 1988 year class in the fall of 1990 and early spring of 1991 at Hwy FF with a 240 volt DC stream electrofishing barge. Of the yearlings captured during the fall survey, 65.3% (n = 75) were of hatchery origin, whereas, the spring electrofishing run one year later revealed a 42.3% hatchery composition. Average size for both wild and hatchery fish in the spring sample was nearly identical at 6.5", although, most wild fish were one year younger. Wild juvenile steelhead densities fluctuate greatly in the lower river (Hwy 2 to mouth) due to of ill timed spring/summer flood events after emergence and rarely fill the vast available habitat. Because of this, it was determined the residual population had no negative impact on the existing wild population.

Rearing strategies for the 1990 year class were adjusted to improve growth rates and size at stocking. The Bayfield hatchery hatched and reared the fish on well water for over a year before fish were transferred back to Brule in late June of the following year. Water temperature there exceeded those at Bayfield. They were again raised within the enclosed concrete raceways for the remaining eleven months. On October 31, 1991 a large snow storm severely damaged the structure and integrity of the hoop house enclosure which had to be taken down and was not used for the remainder of the project. A total of 48,799 were stocked at three locations (Hwy FF, Hwy 13, and McNeil's) in early May of the following year. The juveniles attained an average length of 7.8" at stocking, which was much improved over the previous two year classes. We found 80.3% of the allotment exhibiting morphological characteristics of smolting and those that did averaged 8.3". A diet of moist pellets was exclusively used during their time in the hatchery and was dispersed by automatic feeders on a regular basis. All fish were given a LVAD fin clip prior to stocking.

Due to an outbreak BKD (Bacteria Kidney Disease) within the 1991 year class (3/60 yearlings) while being reared at Bayfield Hatchery it was recommended the class remain there for the second year to reduce the risk of spreading the disease to inland bound trout being held at the Brule hatchery, as well as the Brule River watershed itself. The fish were again hatched and reared the first full year on well water within the hatchery and then moved outside to an effluent pond for the second summer. This change in strategy was intended to take advantage of higher water temperatures typically found within the ponds to improve growth. Again, a moist food diet was used exclusively and a LVAD clip given to all fish. Growth far exceeded previous year classes, but higher than expected mortality while in the fry stage and inefficiencies in removal from the ponds resulted in substantially fewer fish than the requested quota of 50,000 fish. A total of 32,167 fish averaging 9.48" in length were stocked at McNeil's landing in early May, 1993. A very high percentage of fish had smolted prior to stocking, raising concerns over imprinting and its effect on future return rates.

The 1992 year class was again hatched and reared exclusively at the Bayfield Hatchery. They were raised similarly to the previous year class for the first year of captivity, then transferred to large indoor raceways the second summer which were supplied with well water. The fish were then transferred to the Brule hatchery in the winter of 1993 (Jan-Feb) for acclimation and imprinting for several months before stocking. Higher than expected mortality due to gill disease while at the Bayfield hatchery resulted in fewer fish than requested. A total of 31,316, averaging 7.8" were stocked at McNeil's landing in May of 1994. A moist diet was used exclusively and all fish were given a LVAD clip.

In 1993, rearing strategies were adjusted again. Soon after hatching at the Bayfield Hatchery sack fry were transferred to the Brule Hatchery and were to be reared there for the remaining two years. When the sack fry arrived they were placed in troughs supplied with creek water which was fed by an electric pump situated in one of the upper head boxes. During the first summer, two power outages along with an outbreak of gill disease caused very high mortality. The following spring there was only 3,550 yearlings remaining so it was decided to stock them at that time. All fish were stocked in the lower river in late May averaging 3.3", with none receiving fin clips. They were exclusively fed a moist diet during their stay in the hatchery.
Hatchery space limitations and problems with costs associated with rearing fish for two years led to the abandonment of the project in favor of alternative life history strategies.

ADVANCED FINGERLINGS

In the winter of 1994 it was decided to discontinue the two-year-old, pre-smolt program due to poorer than anticipated return rates and a shortage of propagation rearing space in favor of an experimental advanced fingerlings program. This new strategy was chosen because it drastically shortened rearing time for the wild fish, in addition to taking advantage of the Brule's productive waters which typically was far below carry capacity most years. The objective was to rear three year classes with a quota of 150,000-200,000 two inch fingerlings to be stocked out in early August. The two inch threshold was chosen because recent fisheries research conducted on the Brule concluded this was a critical length for a young steelhead to attain in order to survive most ill timed flood events. Eggs were again taken in Brule, transported to Bayfield and raised in the "well house" on artesian water. During second year (1995) to accelerate growth, an industrial gas water heater purchased by Lake Superior Steelhead Association was installed in the "well house" for the purpose of increasing the supplied well water temperature (49F) to a more desirable temperature for steelhead growth. Water temperatures in the mid to upper fifties were achieved and resulted in accelerated growth, but an outbreak of gill disease prior to stocking resulted in sick fish being released. No heated water was used on the 1996 year class because of fear of another gill disease outbreak and other complications with the boiler system. All year classes were fed a moist diet and no fin clips were given due to their small size. The 1994 year class (n=137,000), averaged 1.3" and was scatter planted by motorized Jon boat from Stone's Bridge to Jerseth Creek in early August. A cattle tank supplied with a constant flow of bottled oxygen was used during transport to keep the fish healthy. Average size of the 1995 year class was larger (1.75") so it was decided to scatter plant the 133,344 by motorized Jon boat from Hwy 2 to ½ mile downstream of the Box Car hole (~6 mi.). Several large coolers supplied with bottled oxygen were used to keep the fish alive during transport downstream. In mid August of 1996, the fingerlings averaged 1.3" in length and were again scatter planted in the upper river and tributaries. A total of 262,140 fingerlings were stocked. Locations included: all upper river tributaries, Stone's bridge, Nebagamon Creek, Lt Brule River, Sandy Run Creek and from Big Lake to Winneboujou (Hwy B). For remote tributary locations the fingerlings were brought to streamside in oxygen packs. Stocking from Big Lake to Winneboujou Bridge was accomplished by canoe with fingerlings stored in oxygen packs and placed in coolers supplied with bottled oxygen prior to stocking.

YEARLINGS

Beginning in 1997 the supplementation project was again revamped, this time in favor of yearlings because we felt they best fit the hatchery and the fish itself. This five year program used the knowledge acquired during the past nine years of wild fish culture to improve upon the quality of fish produced, minimizing the amount of time in the captive environment, while relying on the natural river environment to grow the fish until they decided to leave the river environment. The vast majority of Brule River wild steelhead smolt and down migrate to Lake Superior during the spring and early summer of their third year of life (age=2+), averaging 8.4". As stated earlier, because natural occurrences (i.e., flood flows) typically limits annual recruitment within the lower 20 miles of the Brule, it was felt plenty of space was available to grow the parr for their final year or so before leaving to the lake. It was also assumed the additional year of river inhabitance would improve survival, help enhance imprinting, and maintain wild characteristics which may improve adult returns rates. Additionally, by stocking yearlings instead of two year olds space would be freed up at the two hatcheries resulting in a considerable cost savings. A quota of 100,000 was requested to be stocked in late May of each year.   During the duration of this project, the Bayfield facility utilized well water to hatch the eggs and rear the fingerlings in start tanks for nine to twelve months. They were then transferred to Brule depending on size and weather conditions no later than March of the following year. In Brule, they were kept in concrete raceways which were sparsely covered with sheets of plywood to minimize human contact and fed a moist diet mostly by hand. Automatic feeders were used during weekends. The 1997 year class was given a LV clip with the remaining four years receiving only an AD clip well before stocking. The AD clip was requested because it was far superior to the LV clip when it came to identification at the fishway's observation window and was less harmful to the fish. Only in one of the five years was the quota met (1997), but the remaining years only fell short by a few thousand fish. Stocking occurred in mid May at nine locations in the lower river from the Ranger Station campground to Hwy 13. Additionally, a small number was also released in Nebagamon Creek at Afterhours Road each year. Surplus yearlings from the 1998-2001 year classes were stocked in North Fish Creek at the Keystone Dump rd. to supplement its fishery. Total numbers for each year class stocked in the Brule and average size are as follows: 1997 = 98,876 (4.1"), 1998 = 103,194 (3.9"), 1999 = 109,203 (3.6"), 2000 = 106,514 (4.2"), 2001 = 106454 (3.8"). Total numbers for each year class stocked in North Fish Creek for the years 1999-2002 was 29,850, 61,770, 16,559 and 10,577 respectfully, and averaged the same size as corresponding year classes stocked in the Brule River.

An outbreak of Bacterial Coldwater Disease occurred in1999, 2000 & 01 several weeks after fin clipping and required immediate attention to avoid significant mortality. Occurrence of this disease is common when wild strain fish are raised in a hatchery environment because stress is typically the precursor. The cranial tissue and area around the fresh adipose clip was particularly susceptible to infection. During an outbreak of the disease in the spring of 2000 it spread in epidemic fashion causing substantial mortality before being controlled. Treatments consisted of a peroxide bath introduced immediately below the head boxes of each race way along with a salt block immediately after first detection. To alleviate potential infections a salt block was placed in the head end of each race way throughout the fin clipping process to minimize stress.

RESULTS

TWO YEAR OLDS

Evaluation of maiden and repeat spawning return rates for the five years in which the two year olds were stocked was derived by applying a representative scale sample collected annually to the corresponding length frequency of identifiable marked fish passing upstream through the Brule River lamprey barrier/fishway. Scale samples were collected each year from the "woods" and "meadows" section of the river immediately after closure of the extended fall fishing season, and during brood stock collection in the spring of the year using a 240 volt DC mini boom shocker. The number of scale samples collected annually ranged from 39-94 during years when most life histories were represented. When no or very few scale samples were collected for a particular life history and/or length frequency, an age and appropriate number were applied through thorough evaluation of growth data collected from the corresponding sample. The number and corresponding length frequency of stocked fish passing upstream through the lamprey barrier/fishway for a particular year was very sound, with estimates only made during periods of dirty water or power outages. Upstream movement was recorded on a time lapse VHS recorder and reviewed at a later date. When reviewing the tapes all marked fish were freeze framed and length was attained using a calibrated measuring device. Identification of fin clips was typically straight forward, but was more difficult if fin regeneration occurred, when water clarity was limited, when passage of fish at high speeds or the side profile was such that it did allow for complete viewing of the left side. Fish from the 1988 year class, which only had a left ventral fin clip (LV), presented the most challenge in identification. However, with the addition of an adipose clip (LVAD) for the remaining year classes (1989-1991) accuracy was vastly enhanced. It must be noted that because of these inherent problems associated with not actually handling each fish return rates are a minimum of what actually passed by the observation window.

The total maiden return rate for all five years combined (n = 4,130) was 2.0% out of the 207,184 fish stocked. Return rates ranged from a high of 2.6% for the 1988 year class to a low of 1.6% for the 1990 year class (fig. 2). The three remaining year classes were very comparable with return rates of 1.7%, 1.9% and 2.3% for the 1989, 1991 and 1992 year classes respectively. The 1988 year class also contributed the highest number of maiden spawners to the fishery totaling 1,329 out of the 50,738 stocked. Four year maidens estimates from the 1988 year class (n = 866) were also significantly higher than all other ages or years estimated. The life history break down for this age group was mostly comprised of fish exhibiting a 2 stream, 2 lake (2.2) make up (n = 672) with a unusually high frequency (n = 194) of 3 stream,1lake (3.1) fish. As stated earlier, there was documentation of substantial residualism of stocked fish from the 1988 year class due to their small size at stocking. Many remained in the river an additional year and over-wintered before migrating to Lake Superior which accounted for a higher percent of 3 year stream fish in the adult portion than is commonly seen in the wild Brule stock. River survival for those fish must have been substantial to make this contribution.

Fig. 2. MAIDEN RETURNS

year class	# stocked	fin clip	3 YR maiden	4 YR maiden	5 YR maiden	6 YR maiden	7 YR maiden	total	% return
1988	50,738	LR	300	866	121	42		1,329	2.6
1989	44,164	LRAD	256	363	65	47	12	743	1.7
1990	48,799	LRAD	266	214	183	92		755	1.6
1991	32,167	LRAD	47	291	197	60		595	1.9
1992	31,316	LRAD	203	180	228	97		708	2.3

The 1988 year class was the only year when returning maidens of hatchery origin out numbered their corresponding wild cohort. Returns for that year class was comprised of 59.1% (n = 1,329) hatchery origin stock compared to 40.9% (n = 921) for wild returnees (fig. 3). Poor wild juvenile production throughout the Brule that year (~100,000 YOY) played a significant role in these observations made. Similarly, maiden returns from the 1991 year class was extremely poor due to a combination of poor fingerling production (est. ~64,000 YOY) and reduced lake survival resulting in a significant contribution of stocked fish which comprised 45.5% of all maiden returns (712 vs. 595). Conversely, a large wild year class produced in 1992 resulted in a maiden return of 2,752 adults compared to 708 for stocked fish or 20.5%. The other two years, 1989 and 1990, stocked fish contributed 25.7% (n = 743) and 41.5% (n = 755) of their corresponding year classes. Contribution of stocked fish to the total estimated adult maiden return of 11,732 for the five year period was 35.2% or 4,130 fish.

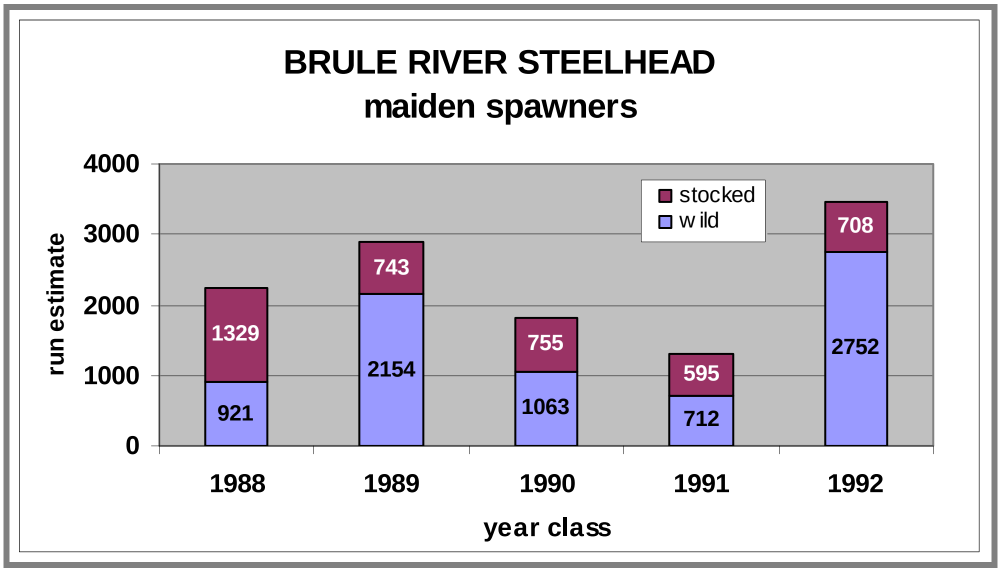


Fig. 3.

Steelhead have the ability to repeat spawn with some fish returning five or more times as validated from Brule River scales samples. A restrictive harvest regulation enacted on the river in 1991 (1 fish daily over 26") helped protect first time spawners from harvest and increased the number of repeat spawners for both wild and stocked fish. Both natural mortality (after age six) and angler harvest once they become legal size significantly impacts the size of the year class as it ages and passes through the fishery. Because of this, obtaining a representative scale sample of older fish often times becomes difficult. So, repeat spawning for each year class is a rough estimate, but does indicate how valuable they are to the fishery. Most wild Brule River steelhead begin spawning at ages 3-6 with the peak at 4 years of age. Ages of first time spawners and repeats of stocked fish were found to be very similar to the wild fish. The number of repeat spawners typically peaks at ages 5 and 6 with a significant decrease through age 10 (fig. 4). The total number of repeats from four out of the five stocked years exceeded the total number of maiden spawners from the corresponding year class. This is typically observed in the wild population with only the 1988 year class being an anomaly. It is unknown if the high percentage of 3 stream fish in the maiden estimates had any bearing on these results. When comparing total numbers of first time spawners and repeats for all two year olds stocked the estimates were very similar (4,130 maidens vs. 3,933 repeats).

Fig. 4. REPEAT SPAWNING

Year class	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	Age 10	repeat	maiden	total
1988	217	142	145	60	95	0	0	659	1,329	1,988
1989	43	209	307	179	3	11	0	752	743	1,495
1990	144	399	194	23	75	33	10	878	755	1,633
1991	78	235	150	94	148	16	0	721	595	1,316
1992	77	176	284	248	120	18	0	923	708	1,631
								3,933	4,130	8,063

Contribution of stocked fish to annual spawning runs peaked in 1995 (fig. 5). The stocked portion of the 1995 spawning year totaled 1,567 fish (29.5%) out of the 5,313 estimated. Slightly fewer stocked fish contributed to the 1996 spawning year with 1,261 (24.4%) out of 5,165 estimated. A significant number of four year old fish from the 1988 year class contributed to a premature peak of 1,339 stocked fish in 1992 and accounted for 17.6% of that year's fishery.

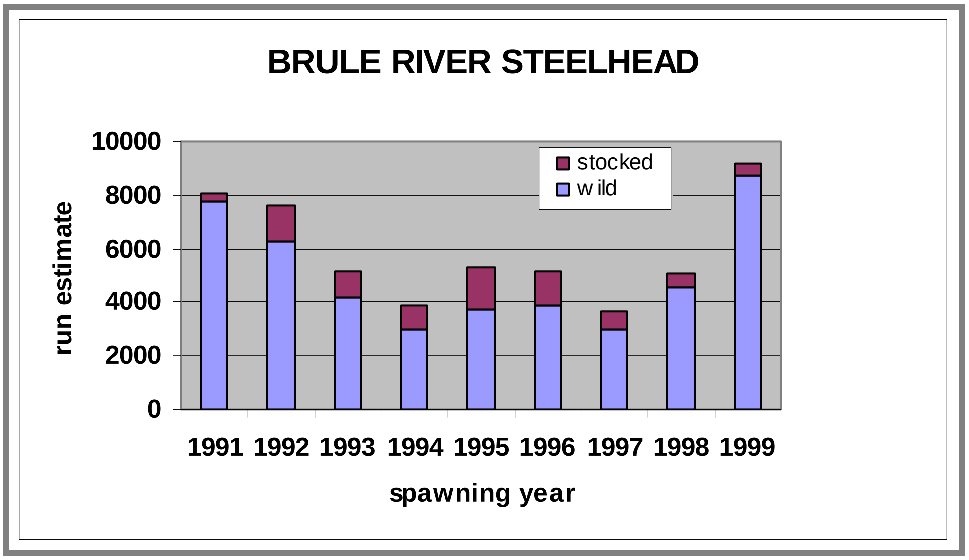


Fig. 5.

Wild steelhead growth was slightly better than that of stocked fish of similar life histories. Maiden 2 stream,1 lake (2.1) wild fish averaged 15.3 inches, where as, stocked fish average 14.7 inches. Maiden 2 stream, 2 lake (2.2) wild fish averaged 21.4" compared to 20.4" for stocked fish. For older returning first time spawners it was more difficult to compare growth rates due to a lack a representative scale sample for the stocked portion but, in general they also appeared to be slightly smaller. The difference in growth rates was likely due to the stocked fish being much smaller at time of release than their wild year class counterparts. It is possible that the amount of time necessary for acclimation to their new environment after release may have also slowed growth, but not as probable as the size differential between the two at time of stocking. Growth within the lake environment was likely comparable, which is determined by water temperatures and forage availability.

A significant amount of adult straying was documented into neighboring rivers, especially during years of increased stream discharge. Most notable was a significant spring angling fishery which developed on the Middle River downstream of the Hwy 13 lamprey barrier. Nearly all fish caught, which lasted for numerous years, were of hatchery origin and stocked in the nearby Brule several years earlier. Clipped fish that were originally stocked in the Brule River were also caught in the Iron and Amnicon Rivers during the spring spawning season but to a lesser degree. Straying of these stocked fish appeared to be higher than typically observed in the wild and was likely a result of rearing the fish for two years in the Bayfield hatchery where a significant amount of smolting occurred prior to stocking. Conversely, imprinting to the Brule hatchery was significant as observations of fin clipped adults returning to spawn downstream of the facility was significant for the first three year classes reared there.

ADVANCED FINGERLINGS

To evaluate fingerling stocking success from the 1996 year class we used first run catch data obtained from two index stations located near or within release locations. We found catch rates of YOY steelhead from the Little Brule station (15,000 scatter planted upstream of station) five weeks after stocking were much higher than the average of twelve prior sampling seasons (avg = 28) (range 5-90). The catch of 87 YOY, with an estimated make up of 22 wild progeny and 65 hatchery progeny, was three times greater than comparable years and was only exceeded by the 1992 year class (n = 90). Estimation of the hatchery component was derived from an obvious size difference between wild and hatchery stock sampled, with hatchery origin fish being considerably smaller. Throughout the watershed steelhead reproduction in 1996 was comparable to year classes produced in 1988 and 1991 when a total of 4 and 19 were sampled. The estimated addition of 65 hatchery fish increased abundance within the index station four fold over what would have been produced naturally (22 vs 87) and over comparable corresponding year classes.

When comparing pre and post wild year classes at the Winneboujou Club index station to the 1996 year class when 50,000 YOY were scatter planted upstream showed a significant increase of YOY steelhead post stocking. Pre-stocking years (1987-1990) averaged 62 wild YOY and in 1997 (1 year post) only 12 were captured. In 1996, seven weeks after stocking, a total of 290 YOY were sampled consisting of an estimated 244 hatchery progeny. The 1988 wild year class was considered comparable (through river wide index monitoring) to the wild year class produced in 1996 when 37 and an estimated 44 were captured respectively. The estimated hatchery component (n = 244) sampled in 1996 increased the population within the index station by over five fold (44 vs 288) and eight fold over the comparable year class.

Fingerlings stocked during this experiment were too small to fin clip so their contribution to the adult fishery couldn't be assessed at the fishway observation window. Although, it was speculated the fish stocked in 1994 and 1996 may have had a positive impact on the fishery. As noted earlier, large floods and/or sustained high water during late spring and early summer within the lower river can have detrimental effects on year class production. In 1994, a very large flood in late April had the potential to negatively impact egg survival (redd leveling and sedimentation), but the number of maiden spawners returning from that year class was average (n = 2,169) when compared to returns from 1988-2000.

Supplementation of fingerlings in 1996 may have provided a more significant contribution to the adult fishery. Lower river discharge during the entire spring and summer period was above average which nearly always results in a substantial reduction in year class size as documented in 1991 which experienced similar flow regimes and resulting poor system wide production. Maiden returns originating from the 1996 year class was above average (n = 2,538) and significantly greater than the 1991 year class which produced only 712 maiden spawners. Initial survival of young entering the lake can play a significant role in the number of maidens returning, but it is unlikely it would have that big of an impact for the 1991 year class so it could be assumed the above average year class was the result of stocking fingerling in the upper river.

The 1995 year class scatter planted downstream of Hwy 2 were not very fit at time of stocking due to gill disease (columnaris), so their contribution to the fishery was likely insignificant. Also, stream conditions in the lower river were ideal for wild fry survival and growth which probably resulted in an above average year class and made evaluation of stocking success difficult.

YEARLINGS

Assessment of maiden and repeat spawner returns for the five yearling year classes was accomplished using the same techniques used to evaluate the two year old program. Annually each fall after closure of the extended fishing season a representative scale sample of the adult wild and hatchery components of the fishery were collected from the "woods/meadows" area of the river using a 240 volt mini boom shocker. These scale samples were then applied to the entire length frequency of steelhead counted and measured (wild & stocked) as they passed upstream through the lamprey barrier/fishway. The data collected was very accurate and only estimated when a power outage occurred or viewing was hindered due to dirty water. The number of scale samples collected annually for the stocked portion ranged from 34-81 during years when most life histories were represented. When no or very few scale samples were collected for a particular life history and/or length frequency, an age and appropriate number were applied through thorough evaluation of growth data collected from the corresponding sample.

The maiden return rate for all five years combined was 1.00% (n = 5,255) out of the 524,241 fish stocked. Return rates ranged from a high of 1.3% for the 2001 year class to a low of 0.7% for the 1998 year class (fig. 6). The other three year classes had return rates of 0.9%, 1.2% and 1.0% for the 1997, 1999 and 2000 year classes respectively. Number of fish stocked for each year was very similar, so the total number of maiden spawners returning mirrored the percent return. The 2001 year class contributed a total of 1,339 maidens followed by 1,317 (1999), 1,037 (2000), 864 (1997) and 698 from 1997. Percent maidens by age for all years combined was not significantly different than the wild component for the corresponding five year stocking period. The percentage for ages 3-5, which make up the majority of maidens each year, was represented by 28%, 44% and 20% respectfully.

Fig. 6. MAIDEN RETURNS

year class	# stocked	fin clip	2 YR maiden	3 YR maiden	4 YR maiden	5YR maiden	6 YR maiden	total	% return
1997	98,876	LR	10	287	340	163	64	864	0.9
1998	103,194	AD	1	240	188	226	43	698	0.7
1999	109,203	AD	100	464	599	106	48	1317	1.2
2000	106,514	AD	57	255	549	123	53	1037	1.0
2001	106,454	AD	24	228	667	314	106	1339	1.3

Percent contribution of hatchery maidens to the total maiden return from the 1997-2001 year classes ranged from a high of 37.6% (1,317/3,501) in 1999 to 19.7% (1,037/5,261) for the 1998 year class (fig. 7). The remaining three years had a hatchery component of 21.5% (n = 864), 20.3% (n = 698) and 27.0% (n = 1339) for the years 1997, 1998 and 2001 respectively. The

1,339 maidens produced from the 2001 year class was the highest of the five years, but the 1,317 returning from the 1999 year class had the greatest impact to the fishery due to very poor recruitment of its corresponding wild year class which produced only 2,185 maidens. Contribution of stocked fish to the total estimated adult maiden return for the five year period was 24.8% or 5,255 out of 21,172 estimated. Wild maiden returns during this time period were considerably higher than any consecutive five year period of the previous ten years, so the percent contribution of stocked fish to their respective year class was less than if normal year classes were produced.

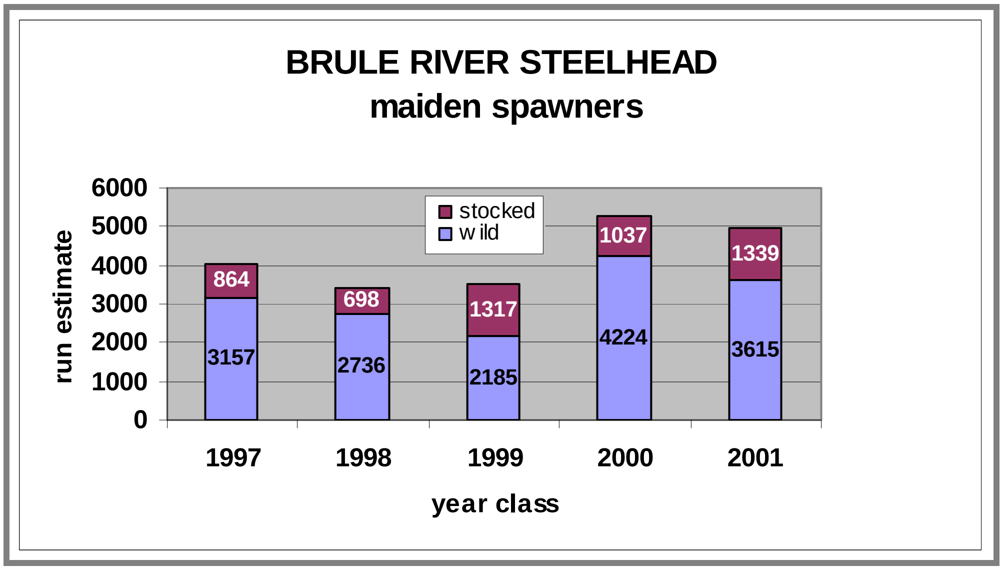


Fig. 7.

The percent of repeat spawning in a steelhead fishery is used by managers to evaluate its current health, with most considering 50% an objective. Since enactment of the one bag and 26" minimum size limit, repeat spawning increased substantially and resulted in appreciable increases in annual run size along with greater stability to the fishery. An estimated total of 10,565 spawning adults (fig. 8) returned from the yearlings stocked in1997-2001, of which, 5,310 (50%) were repeat spawners. All years except 1998 had repeat to maiden spawning ratios near 1:1, except for the 1998 year class which may have been a result of collection of a non representative scale sample due to a low maiden return rate. The number of repeat spawning fish peaked at ages five and six and was part of the fishery up to age nine. Estimated returns for corresponding wild year classes totaled 38,242 fish which were made up of 22,325 repeats (58.4%) and 15,917 maiden spawners.

Fig. 8. REPEAT SPAWNING

year class	Age 3	Age 4	Age 5	Age 6	Age 7	Age 8	Age 9	repeat	maiden	total
1997	16	132	148	399	108	108	91	1,002	864	1,866
1998	0	66	187	92	71	49	4	469	698	1,167
1999	38	230	655	218	107	35	53	1,336	1,317	2,653
2000	0	244	263	270	260	107	40	1,184	1,037	2,221
2001	0	200	607	305	117	60	30	1,319	1,339	2,658
*estimated								5,310	5,255	10,565

Contribution of stocked fish to annual spawning runs (fig. 9) peaked during the spawning years of 2003-06 when the majority of fish recruited to the fishery. The stocked portion of the 2002-03 run totaled 1,985 (20.9%) out of the 9,482 counted. Slightly more stocked fish (n = 2,026) comprised the 2003-04 run and accounted for 19.8% of the 10,248 steelhead returning that year. By 2008, when the youngest stocked fish present in the fishery were seven years old, only 278 were counted, accounting for 3.7% of the total run. The last stocked fish will likely be out of the fishery after the 2010-11 spawning run. Seventy five were estimated during the fall of 2009.

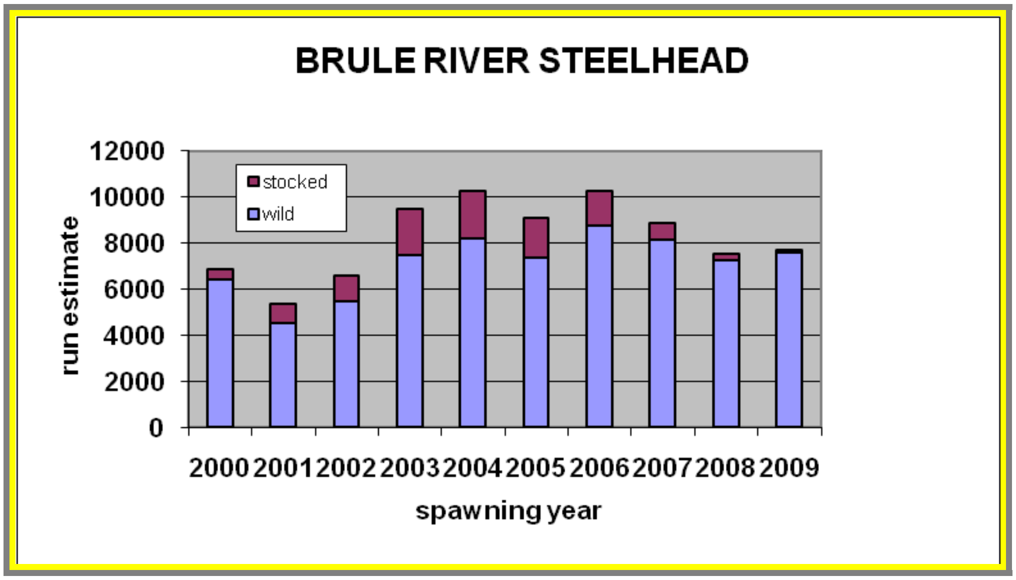


Fig. 9.

Growth rates for maiden stocked fish were nearly identical to wild fish with the same life history. This isn't surprising considering size at stocking was similar to yearlings found in the wild and they appeared to adapt to the wild environment well after stocking. Average length for a first time returning stocked adult with a 2 stream, 1 lake (2.1) life history was 15.2" compared to 15.6" for a similar wild fish. Maiden 2 stream, 2 lake (2.2) stocked fish averaged 21.7", where as, wild fish averaged 21.5". 2 stream, 3 lake (2.3) maiden hatchery spawners averaged 24.6" compared to 24.7" for wild fish.

There was no assessment done to evaluate adult returns from the four years of stocking North Fish Creek (1999-2002), although all fish stocked did have adipose clips. The only indication of their success, after release, was observed during a stream electro fishing survey completed in August of 2003 at the stocking site (Keystone Dump Rd.). Results from the survey found several year classes of Brule strain fish (age1+ & 2+), but were at much lower densities than the wild fish present. Of the 89 age 1+ rainbows sampled 8 (9%) were of hatchery origin.

DISCUSSION

From the very onset, this stocking program which was initially instituted to supplement a depressed wild fishery was one of constant change and evolved into an experiment to evaluate three different life history stocking strategies extending over three decades.

Collection of brood and eggs was perfected early on, but obtaining a quality product of desired size was a real challenge. What was originally thought to be a simple task turned into one of many adversities, resulting in dozens of adjustments made over the first eight years of the experiment in both the hatching and rearing process. Cold water temperatures was the primary cause for these adjustments which lead to slower than desired growth and contributed to disease out breaks. In the end, a combination of both the Brule and Bayfield hatcheries were used on each of the year classes to improve growth potential by maximizing seasonal temperature regimes at both sites and simplified the transition between the three different life history strategies used in the experiment.

Gill disease (columnaris) was nearly an annual occurrence in both the fry and small fingerling stages and if diagnosed or treated too late significant mortality often occurred. Failure to reach the requested quota four out of the first five years of the program resulted from it, as well as an almost complete year class failure in 1993. By the time the yearling program was instituted, the hatchery component of the program was perfected, although an outbreak of bacteria cold water disease from 1999-2001 required immediate attention to avoid significant mortality.

Human contact was kept at a minimum throughout the rearing process to maintain the fish's wild characteristics. Lights were only used occasionally on the fry in Bayfield and scattered raceway covers provided enough protection/shelter during daylight hours for the larger fish in Brule. The hoop house didn't provide any advantage over plywood raceway covers used after its collapse. Automatic feeders were utilized occasionally when hatchery personnel were absent, but weren't necessary on a daily basis as hand feeding proved to be very effective if done from a distance. The use of moist pellets of the appropriate size was a necessity.

The monitoring system at the Brule lamprey barrier/fishway provided a very accurate assessment of marked adults returning to spawn. If another stocking program is taken up in the future it is recommended an adipose clip be used on all fish to aide in identification.

TWO YEAR OLDS

The five year program, because it was new to the hatchery system, required a great deal of work and ingenuity from both hatchery and management personnel to make it as successful as it was. Much was learned and provided a good blueprint for the remaining eight years of the stocking experiment and for potential projects of this sort in the future.

Maiden return rates of 1.6% to 2.6% (average = 2.0%) were much less than originally expected when compared to return rates of similar sized steelhead per-smolts stocked in Lake Michigan streams (~10%), as well as, past salmonid stocking by the WDNR in Lake Superior. But, after evaluation of more current WDNR and MDNR stocking programs in Lake Superior during the same time period they were comparable. In the late 1980's, the smelt population in western Lake Superior experienced a dramatic decline, resulting in reduced lake survival of both wild and hatchery fish.

Contribution of maiden spawners from stocking was most significant for the 1988 and 1991 year classes when wild recruitment was poor and comprised 59% and 45.5% of first time spawners from the respective year classes. Conversely, during years of above average wild reproduction/lake survival stocked maidens only made up 25.6% and 20.5% of the returning first time spawners for the 1989 and 1992 year classes respectively. Overall, during the five year project hatchery maidens comprised 35.2% of all first time spawners and significantly improved year class strength. Coincidently, the best return rate (1988) occurred when the largest number was stocked on top of a very small wild year class, helping to more than double maiden run size for that year class.

Environmental and climatic conditions affecting stream conditions after spawning and fry emergence play a significant role in determining year class strength, which can fluctuate considerably on an annual basis. When exposed to consecutive seasons of poor stream conditions future returns can become depressed and may be slow to recover due to a “stock recruitment” relationship. For the Brule River, the minimum annual escapement of female spawners is unknown, but were at lowest levels observed in the mid 1990’s and may have been approaching critical levels. For example, during the 1995 spawning run an estimated 1,357 wild females (4+ years old) deposited an estimated 5,158,500 eggs (ave. = 3,800) compared to an estimated 10,172,600 in 1992. Stocked females for the corresponding year enhanced egg deposition by 50.2% for a total of 7,750,100. For the 1996 spawning year, stocked females increased egg deposition by 41.6% for a total of 8,162,400. During years of highest stocked fish abundance (1992-97) egg deposition was increased by an average of 27.7%.

Implementation of the 26” minimum size limit for steelhead in 1991 was instrumental in stabilizing the fishery by protecting nearly all first time spawners and allowing more a chance to repeat spawn. The regulation change had a positive impact on the stocked fish as well, as it was instituted when most of the earlier year classes were maturing. The number of repeat spawners from the five year classes stocked doubled their contribution to the fishery by increasing the 4,130 maidens to a total of 8,063 returning. The impact was even greater to the fishermen as these fish were caught and released numerous times adding immeasurable enjoyment to an outing. Total contribution of all stocked spawners during peak abundance (1992-98) ranged from 11% to 29.5%, with the 1995 spawning year having the highest percentage.

Implications associated with this two year old pre-smolt program included: measurable straying to neighboring streams for spawning, residualism due to small size at stocking for the first few year classes, and the need for additional hatchery space for two year classes instead of the customary one normally found in the hatchery system, thereby adding expense.

Looking back, much was learned in all aspects of the 2 year old program and helped pave the way for subsequent experiments. Larger size at stocking didn’t necessarily result in higher return rates because so many other variables affected survival including lake conditions, forage abundance, where and when they smolted, etc. It succeeded in providing supplementation to several poor wild year classes and may have helped rejuvenate the depressed fishery faster than if nothing was done, but would be the least preferred strategy to enhance a future steelhead population.

ADVANCED FINGERLINGS

No mark was given to the fingerlings before release so evaluation of their success in enhancing the adult fishery is speculative at best. However, based on two electrofishing surveys in 1996 at an established index station when 262,140 were scatter planted in a nearby habitat, we documented a significant increase in YOY several months after their introductions. This observed enhancement also appeared to pay off as adult returns from what appeared to be a very poor wild year class was beyond expectations with 2,538 maidens returning compared to 921 and 712 from comparable sized wild year classes observed in 1988 and 1991 respectfully. Of course, many other variables within the river and lake environments after stocking could have affected year class success. A comprehensive system wide salmonid evaluation in the late 1980's and early 1990's concluded high wild YOY recruitment to be in the neighborhood of 300,000 fish and poor years roughly 100,000. So, introducing 200,000+ healthy fish on top of the wild production undoubtedly enhances year class strength if carry capacity isn't limited.

Introductions of advanced fingerlings appear to be most successful in upper river and tributary habitats because of more stable flow conditions which improves survival after stocking. Upper river introductions appeared to be very sucessful at the time because of a lack of quality spawning habitat throughout the reach which undoubtedly limited recruitment. Since this experiment, an extensive spawning habitat enhancement project was carried out throughout the entire upper river mainstem and tributaries where over two million pounds of washed gravel was added to selected stream reaches. Additionally, 5.8 miles of tributary spawning habitat was restored as part of a focused habitat improvement initiative. So, fingerling stocking in this portion of the river may no longer be as beneficial due to increased and stable wild recruitment. The use of fingerlings to enhance year class strength within the lower river is more of a gamble due to flashy river flows, but is a viable option and should be considered if there is a down turn in the adult population.

There are many advantages to using advanced fingerlings over other life history stocking strategies including: inexpensive to rear, better adaptation to river environment, less domestication and the ability to substantially increase year class strength if done in low wild recruitment years and at appropriate locations.

Disadvantages include: smaller than wild cohorts at time of stocking, must have fish on hand when poor year classes are produced, inability to mark fish for later identification, low survival if stocked in lower river habitat prior to flood event.

This life history strategy is also a viable option for other south shore tributaries if enhancement is viewed necessary, but similarly to the Brule they should be introduced to stream habitats where survival stands the best chance. If habitat space isn't limited they adapt to the natural environment very well and would be best utilized in headwater reaches of the main stem or smaller tributaries where flood flows are less frequent.

YEARLINGS

By the time yearlings were used to evaluate their effectiveness in enhancing the Brule's steelhead fishery, incubation and rearing techniques were drastically improved to deliver a quality product over earlier life history strategies. During this five year project the requested quota of 100,000 fish was reached in all years except 1997 when it fell short by only 1,200 fish. In the four years when quotas were met and surplus fish were available they were stocked into North Fish Creek to supplement its steelhead fishery. Overall, they fit the hatchery system very well and by utilizing the Bayfield facility for their first nine months (because of better overall water temperatures), growth was maximized. Then transferring them to the Brule hatchery early the next spring provided the ability to acclimate to a more natural environment and take advantage of warming water temperatures prior to stocking. We found scatter planting in the lower river limited the amount of competition with wild fish and provided the best chance of survival. Very seldom does wild recruitment fill all available living space within this reach, leaving plenty of habitat available for their introduction. They appeared to adapt very well to the wild environment as their condition factor by summers end resembled that of wild fish and the extent of residualism didn't appear to be noticeably different from that found in the wild stock. Survival to smolting wasn't evaluated, but observations from anglers and during electrofishing runs (adult assessment and brood stock collection) indicated a good proportion of hatchery fish present.

Maiden return rates ranged from 0.7% to 1.3% and averaged1.0%, which was in the range of what was anticipated. A cumulative total of 5,255 maidens returned from the five year classes compared to an estimated 15,917 wild fish from corresponding year classes or 24.8% of the total maiden return. Wild returns during this time period were very healthy so contribution of hatchery fish wasn't as significant, but helped increase yearly run estimates to some of the highest numbers observed. When combined with the repeat component they together helped push total annual returns over the 10,000 fish threshold for the first time since monitoring began at the lamprey barrier/fishway in 1986. A total of 5,275 repeat spawners were estimated from the stocking compared to 22,325 returning from the wild. Together hatchery origin maidens and repeats totaled 10,530 fish and the corresponding wild segment of the run combined for a total of 38,241 fish. The contribution of hatchery fish to the fishery was greatest during the spawning years of 2003 and 2004 when they contributed 20.9% and 19.8% to the respective years.

Contribution of hatchery origin fish to the adult fishery had a much greater impact on angling success than on wild recruitment. When stocked adults were at their highest abundance, the wild portion of the fishery was also at very healthy levels, so the additional egg deposition by hatchery spawners likely had very little impact on annual production, unlike what was observed with the 2 yr old stocking program when a period of low wild egg deposition was positively enhanced by the additional eggs deposited by hatchery origin fish. Wild adults, four years of age and older, of the 2003-06 spawning runs accounted for egg deposition of 10,805,300 to 13,482,400 (~ 3,800/fish) which was more than sufficient to maximize potential recruitment. Hatchery origin fish during this period increased egg deposition by 23.2% to 30% or an average of 3,178,700 per year.

Life history makeup of returning hatchery adults replicated that of wild fish during the same time period, as well as having similar growth rates. There wasn't any significant observation of straying to nearby streams as witnessed during the two year old program, and a significant number of hatchery origin adults were documented spawning downstream of the Brule Fish Hatchery on newly created and restored habitat indicating strong imprinting. The use of yearlings to supplement a depressed steelhead fishery on one of the south shore streams has merit and is probably the best option if validation of return rates is preferred. However, there is no guarantee they will perform the same due to a changing Lake Superior predator/prey makeup. They fit the pre-VHS era hatchery system well and the strategy seems to benefit both the fish and resource. The recent documentation of VHS within the Lake Superior watershed will definitely complicate initiation of a new program as will other diseases that find their way here.

STOCKING HISTORY

Location	Year	species	size	recorded
Bois Brule River	1890	Rainbow	fry	25,000
Bois Brule River	1892	Rainbow	fry	30,000
Bois Brule River	1890-94			55,000
Bois Brule River	1896	Steelhead	Fry	20,000
Bois Brule River	1897	Steelhead	Fry	10,000
Bois Brule River	1898	Steelhead	Fry	5,000
Bois Brule River	1895-99			94,500
Bois Brule River	1900	Steelhead	Fry	15,000
Bois Brule River	1900-04			45,250
Bois Brule River	1905-09			47,500
Bois Brule River	1910-14			126,000
Bois Brule River	1916	Rainbow	Fingerling	4,800
Bois Brule River	1917	Rainbow	Fry	43,200
Bois Brule River	1917	Rainbow	Fingerling	2,400
Bois Brule River	1917	Rainbow	Fingerling	2,400
Wilson Creek	1917	Rainbow	Fry	9,000
Bois Brule River	1918	Rainbow	Fry	57,600
Bois Brule River	1918	Rainbow	Fingerling	4,800
Little Brule River	1918	Rainbow	Fry	7,200
Sandy Run	1918	Rainbow	Fry	7,200
Bois Brule River	1919	Rainbow	Fry	16,200
Bois Brule River	1919	Rainbow	Fry	7,200
Bois Brule River	1919	Rainbow	Fry	18,000
Bois Brule River	1919	Rainbow	Fry	9,000
Bois Brule River	1919	Rainbow	Fry	18,000
Little Brule River	1919	Rainbow	Fry	3,600
Nebagamon Creek	1919	Rainbow	Fry	12,600
Rocky Run Creek	1919	Rainbow	Fry	3,600
Bois Brule River	1915-19			232,200
Bois Brule River	1921	Rainbow	Fry	21,600
Bois Brule River	1921	Rainbow	Fry	19,800
Rocky Run Creek	1921	Rainbow	Fry	5,400
Bois Brule River	1922	Rainbow	Fingerling	18,000
Bois Brule River	1920-24			77,400
Bois Brule River	1929	Rainbow	Fingerling	205
Bois Brule River	1925-29			205
Bois Brule River	1930	Rainbow	Yearlings	183
Bois Brule River	1930-34			13,455
Blueberry Creek	1935	Rainbow	Fingerling	6,400
Bois Brule River	1935	Rainbow	Fingerling	79,272

Bois Brule River	1935	Rainbow	Yearlings	4000
Bois Brule River	1936	Rainbow	Fingerling	20,000
Bois Brule River	1935-37			119,442
Bois Brule River	1938	Rainbow	Yearlings	225
Bois Brule River	1939	Rainbow	Fingerling	87,312
Bois Brule River	1939	Rainbow	Yearlings	6,880
Bois Brule River	1939	Rainbow	Adults	617
Trask Creek	1939	Rainbow	Yearlings	2500
Bois Brule River	1940	Rainbow	Fingerling	222,128
Bois Brule River	1940	Rainbow	Yearlings	44,514
Bois Brule River	1940	Rainbow	Adults	298
Trask Creek	1940	Rainbow	Fingerling	40,000
Bois Brule River	1941	Rainbow	Fingerling	123,000
Trask Creek	1941	Rainbow	Fingerling	18,000
Bois Brule River	1942	Rainbow	Fingerling	17,882
Bois Brule River	1942	Rainbow	Adults	83
Bois Brule River	1943	Rainbow	Adults	1,192
Little Brule River	1952	Rainbow	Yearlings	1,000
Bois Brule River	1953	Rainbow	Yearlings	37
Little Brule River	1954	Rainbow	Yearlings	6,494
Bois Brule River	1955	Rainbow	Yearlings	4,000
Bois Brule River	1956	Rainbow	Yearlings	6,000
Bois Brule River	1957	Rainbow	Yearlings	7,500
Bois Brule River	1958	Rainbow	Fry	35,000
Bois Brule River	1958	Rainbow	Yearlings	5,000
Little Brule River	1958	Rainbow	Adults	7
Bois Brule River	1959	Rainbow	Yearlings	4,000
Bois Brule River	1960	Rainbow	Yearlings	4,000
Bois Brule River	1961	Rainbow	Yearlings	4,000
Bois Brule River	1962	Kamloop	Yearlings	5,136
Bois Brule River	1962	Rainbow	Yearlings	4,000
Bois Brule River	1963	Rainbow	Yearlings	4,000
Bois Brule River	1964	Rainbow	Yearlings	4,000
Bois Brule River	1965	Rainbow	Yearlings	4,000
Bois Brule River	1966	Rainbow	Yearlings	4,000
Bois Brule River	1967	Rainbow	Yearlings	4,000
Little Brule River	1967	Rainbow	Yearlings	4,000
Little Brule River	1967	Rainbow	Adults	28
Bois Brule River	1968	Spring Spawners	Yearlings	43,913
Little Brule River	1968	Rainbow	Yearlings	2,000
Bois Brule River	1969	Spring Spawners	Fingerling	26,000
Little Brule River	1969	Rainbow	Fingerling	12,150
Little Brule River	1969	Rainbow	Fingerling	13,050
Little Brule River	1969	Rainbow	Yearlings	4,000
Bois Brule River	1970	Summer Steelhead	Yearlings	20,286
Bois Brule River	1970	Rainbow	Yearlings	4,000
Bois Brule River	1971	Rainbow	Yearlings	4,000
Bois Brule River	1971	Summer Steelhead	Adults	1,325
Bois Brule River	1972	Rainbow	Yearlings	4,000

Bois Brule River	1972	Spr Spawning Rb	Fingerling	50,000
Bois Brule River	1973	Spr Spawning Rb	Fingerling	10,000
Bois Brule River	1973	Spr Spawning Rb	Yearlings	10,000
Bois Brule River	1973	Summer Stlhead	Adults	753
Bois Brule River	1974	Rainbow	Yearlings	4,000
Bois Brule River	1975	Rainbow	Yearlings	3,500
Bois Brule River	1976	Spr Spawning Rb	Fingerling	168,500
Bois Brule River	1976	Rainbow	Yearlings	3,500
Little Brule River	1978	Spr Spawning Rb	Yearlings	30,000
Little Brule River	1979	Spr Spawning Rb	Yearlings	30,000
Bois Brule River	1980	Rainbow	Yearlings	30,000
Little Brule River	1983	Summer Stlhead	Yearlings	4,740
Brule Watershed	1990	Wild Steelhead	Two Year	50,738
Brule Watershed	1991	Wild Steelhead	Two Year	44,164
Brule Watershed	1992	Wild Steelhead	Two Year	48,799
Brule Watershed	1993	Wild Steelhead	Two Year	32,167
Brule Watershed	1994	Wild Steelhead	Two Year	31,316
Brule Watershed	1994	Wild Steelhead	Fry	137,000
Brule Watershed	1995	Wild Steelhead	Fry	133,344
Brule Watershed	1996	Wild Steelhead	Fry	262,140
Brule Watershed	1997	Wild Steelhead	Yearlings	98,876
Brule Watershed	1998	Wild Steelhead	Yearlings	103,194
Brule Watershed	1999	Wild Steelhead	Yearlings	109,203
Brule Watershed	2000	Wild Steelhead	Yearlings	106,514
Brule Watershed	2001	Wild Steelhead	Yearlings	106,454