Return, Size, and Age of Steelhead at the Besadny Anadromous Fisheries Facility, 2004

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ABSTRACT

An annual steelhead assessment project was begun in 1992 at the Besadny Anadromous Fisheries Facility (BAFF) to (1) assess the return of the three steelhead strains to BAFF, and (2) collect basic biological information on each strain.

Spring operations in 2004 began on March 24, and continued until April 15. During this time period 735 steelhead were handled (Table 1). The run consisted of 203 Chambers Creek strain steelhead (27.6% of the run), 162 Ganaraska (22.0%), 31 Skamania (4.2%), and 339 (46.1%) unclipped, misclipped or strays from other streams or states. The total number of fish handled during the spring of 2004 nearly doubled the 2003 total and was the most steelhead handled since 1998. The spring 2004 run was well above the 5 year average run of 446 fish.

The summer/fall run began in July and continued through November. A total of 40 steelhead were captured at BAFF of which 32 were Skamania strain. Twenty-four Skamania were sent to Kettle Moraine Springs Hatchery to be spawned as broodstock, with the remainder passed upstream.

The 2004 spring run total was highest total since 1998. Return of each of the three strains stocked increased from 2003 levels and generally was the best return of marked steelhead since 1999. However, the 2004 run total was still substantially lower than those observed in 1991 through 1996. The reduction in return number is likely due to the poor return rate for several year classes that were stocked between 1997 and 2000. Poor survival of these year classes may be due to unusual weather conditions that resulted in poor flow on the Kewaunee River and low lake level, high harvest of adult fish, or from mortality of recently stocked smolts.

Changes in the 2004 average, standard and trophy weights may be due to a larger percentage of the run being age 4 as compared to the 2003 run being dominated by age 3. Long term declines in weight trends is likely due to the absence of age 5 and older fish that were common in the past. Why older fish are absent from the return is unknown at this time and may be related to angler harvest, fish health, stocking location or predation on smolts.

Gamete collections for all three strains of steelhead were spotty from BAFF in 2004, but should not affect the total number of steelhead stocked in 2005.

The summer/fall run of steelhead was improved in 2004, but still much lower than historical runs. Although there was abundant late spring and late fall rain, river flow did not increase enough to trigger steelhead runs into the river, making 2004 a fair year for Skamania.

We began to evaluate the magnitude of the smolt out-migration from the Kewaunee River in 2004. While we were able to capture some steelhead smolts, heavy rainfall limited our ability to sample the river as planned and thus limits our ability to make tentative conclusions from the data. It appears that steelhead are surviving stocking and are moving downstream as they smolt. In Wisconsin rivers it appears that steelhead move out quickly following stocking unlike what has been found in Michigan by Seelbach (1985) which indicates many stocked steelhead spend an additional year in streams before moving out into Lake Michigan. Water quality does not appear to be affecting survival during out-migration. Additional work needs to be done to assess the affect of the low head dam, shallow river runs and fish condition on the survival of stocked steelhead.

INTRODUCTION

Wisconsin began its Lake Michigan rainbow/steelhead trout fishery in 1963 when rainbow trout were stocked in a Door County stream (Daly 1968). During the years following the original stocking, many changes in the fishery occurred including changes in the strains and age of fish stocked. Since 1988, Wisconsin has stocked three steelhead strains, Skamania, Chambers Creek, and Ganaraska for its Lake Michigan steelhead program. Although similar in appearance, each strain has unique characteristics that make each important to the overall steelhead program. We hoped that these strains would provide a good return to the creel and provide more fishing opportunities throughout the year for anglers in tributary streams.

To further enhance the steelhead fishery and continue the time series of biological information collected during earlier studies, an annual steelhead assessment project was initiated by Fisheries Management at the C.D. Besadny Anadromous Fishery Facility (BAFF) weir in 1992. The goals of this project are to (1) assess the return of the three steelhead strains to BAFF, (2) to collect basic biological information on each strain, and in past years (3) to floy tag adult fish to determine: handling mortalities from the spawning operation, angler return rate and movement of these fish in the Kewaunee River and in Lake Michigan. New to this project in 2004 was an attempt to monitor the outmigration of steelhead smolts with the use of electroshocking gear and to use a continuous temperature and dissolved oxygen monitor to determine if water quality could be affecting smolt survival. This report summarizes the data collected during the 2004 migratory runs of steelhead at BAFF.

METHODS

Adult Collection

BAFF operations begin during early spring when ice on the Kewaunee River starts to break up and continues until ice up during early winter (Baumgartner 1995). Water is passed through the collection ponds and down the fish ladder, attracting migrating steelhead up the ladder and into the ponds. Ponds are sorted at least once a week and fish are passed upstream, spawned and passed, or held, depending on clip and ripeness. During spring migrations as fish proceed through the BAFF, the fish are checked for clips, sex and ripeness. Steelhead are measured to the nearest 1 mm and weighed to the nearest 0.01 kg. All fish receive a caudal fin clip to denote that data had been collected on that fish. Ripe fish with the appropriate strain fin clip are spawned, allowed to recover, and then passed upstream. Fish that are not ripe, but have the appropriate fin clip are returned to a holding pond. All other fish are measured, weighed, revived, and then passed upstream.

Late summer/early fall collection procedures differ from spring procedures because of warm water conditions, which may increase mortality of the handled steelhead. To maximize survival, fish are handled as little as possible. Steelhead are checked for fin clips,

and sexed. Fish with target fin clips are sent to the Kettle Moraine Springs Fish Hatchery (KMSFH) and held until spawned. All other steelhead are passed upstream.

Annually data is analyzed using basic fishery statistics, such as average length and weight by sex and clip. A regression of length and weight for each strain is calculated. By using standard weight and trophy weight, which is the measure of the weight of a 660 mm steelhead and the weight of the 95th percentile of steelhead respectively, we are able to track recent weight trends in the population. Handling mortality is estimated from the number of caudal fin clipped dead fish that are found in holding ponds, recovery tanks, and around the river release site. Catch numbers per day of weir operation are plotted to examine the timing of spring migratory runs.

Smolt Out-migration

To assess the movement of steelhead and other stocked salmonids downstream and past the lowhead dam at BAFF, two survey stations, one located just upstream of BAFF and the other downstream of BAFF were established. Each station was 35 times the stream width at that location resulting in an upstream site that was 910 meters in length and a lower site that was 350 meters in length. On survey dates, stream flow and stage information was collected from the USGS gauging site on the Highway F bridge just downstream of the lower survey site.

Shocking would begin following the cessation of stocking and would occur weekly until smolts were not captured. Stream electroshocking gear using DC current was used to sample migrating smolts. Following capture, smolts were identified to species, checked for clips and measured to the nearest 1 mm and released back into stream.

Continuous Chemistry Monitor

A YSI Sondes continuous chemistry monitor was placed upstream of BAFF one week before steelhead stocking for 2004. The monitor collected hourly dissolved oxygen (DO) and temperature readings throughout the survey period until field sampling of smolts ended.

RESULTS

Spring-Adult Collection

Spring operations in 2004 began on March 24, and continued until April 15. During this time period a total of 735 steelhead were handled (Table 1). The run consisted of 203 Chambers Creek strain steelhead (27.6% of the run), 162 Ganaraska (22.0%), 31 Skamania (4.2%), and 339 (46.1%) unclipped, misclipped or strays from other streams or states. The total number of fish handled during the spring of 2004 nearly doubled the 2003 total and was the most steelhead handled since 1998. The spring 2004 run was well above the 5 year average run of 446 fish.

Chambers Creek strain

Chambers Creek strain steelhead were processed during each day of operation this spring (Table 2). The length of Chambers Creek steelhead ranged from 440 mm to 845 mm, with an average length of 713 mm (Table 1). Weight ranged from 0.94 kg to 5.32 kg and averaged 3.42 kg. The average length and average weight for Chambers Creek steelhead in 2004 increased from 2003 levels and were similar to those measured in 2002.

Males comprised 42.9% of the run and averaged 724 mm in length and 2.99 kg in weight (Table 3). Two different Chambers Creek fin clips were observed for male fish, with the adipose-left maxillary (ALM) the most common. With the use of fin clips, returning fish can be assigned to age classes. In 2004, males returned at ages 3 and 4 (Table 4). Age 4 fish were the most common, and averaged 758 mm in length and 3.81 kg in weight. With 61 of the 87 returning males age 4, the 2004 run was essentially a run of a single age class of male fish, which is not unexpected since the 2003 male Chambers Creek run was dominated by age 3 males.

Females comprised 56.1% of the run, averaged 705 mm in length and 3.44 kg in weight, (Table 3). Similar to males, two fin clips were observed, with the ALM clip the most common. Females returned at ages 3 and 4 (Table 4). Age 4 females returned in the greatest number, and averaged 713 mm in length and 3.52 kg in weight. With 106 of 116 females age 4, the 2004 run of females was dominated by a single year class.

Handling mortality was 6.9% for Chambers Creek during the spring run (Table 5). This was similar to mortality seen in 2002 and much greater than the 2003 level. The average handling mortality for Chambers Creek steelhead since 1996 has been 1.6%.

Ganaraska strain

Ganaraska were processed throughout spring operations (Table 2). Lengths ranged from 250 mm to 810 mm and averaged 663 mm. Weights ranged from 0.18 kg to 5.1 kg with an average of 3.03 kg (Table 1).

Males comprised 54.3% of the run, and had an average length of 662 mm and weight of 2.99 kg (Table 3). A total of three fin clips were observed for Ganaraska males, with the adipose, left ventral (ALV) clip the most common. Based on fin clip, ages 2, 3 and 4 returned during the spring migration (Table 4). Age 4 fish were the most common, with substantially fewer age 2 and age 3 fish captured. Age 4 males averaged 728 mm in length and 3.71 kg in weight.

Females comprised 45.7% of the run and averaged 664 mm in length and 3.06 kg in weight (Table 3). Three clips were detected for female Ganaraska, with the ALV clip the most common. The majority of returning females were age 4 and had an average length of 682

mm and average weight of 3.31 kg (Table 4). Substantially fewer age 3 and age 5 female Ganaraska were captured.

Handling mortality was 0.0% for Ganaraska during the spring run (Table 5). This mortality rate was less than the eight year average of 0.8% for Ganaraska.

Skamania strain

Skamania were handled throughout the spring run in 2004 (Table 2). Lengths ranged from 540 mm to 894 mm and averaged 709 mm. Weights ranged from 1.46 kg to 5.32 kg and averaged 3.17 kg (Table 1).

Males comprised 45.2% of the run, and had an average length of 743 mm and weight of 3.43 kg (Table 3). Two fin clips were observed for Skamania males, with the adipose, right maxillary clip (ARM) the most common. Based on fin clip and length, ages 3, 4 and 6 returned during the spring migration (Table 4). Age 4 fish were the most common and averaged 717 mm in length and 3.05 kg in weight.

Females comprised 54.8% of the run and averaged 681 mm in length and 2.96 kg in weight (Table 3). Three clips were observed on returning females that corresponded to ages 3, 4 and 5 (Table 4). The ARM fin clip was the most common clip observed. Age 4 female Skamania averaged 684 mm in length and 2.92 kg in weight.

Handling mortality was 0.0% for Skamania for the eighth consecutive spring run (Table 5).

Non-broodstock steelhead

The final component of the spring run was those steelhead not used for broodstock collection. Although the majority of these fish were Chambers Creek, Ganaraska, or Skamania strain steelhead, they were unclipped, misclipped, or were study fish from another stream. Clipped or unclipped fish from other states were also part of this category. Members of this group were collected during each day of operation (Table 2), and were the largest single component of the spring run (Table 1).

Handling mortality for this group of steelhead was 0.3% which was slightly less than the eight year average of 0.9% (Table 5).

Summer/Fall Adult Collection

The 2004 summer/fall migration of steelhead was highest since 1999 when 145 steelhead returned to BAFF (Table 6). BAFF was operated eleven days during July through November to process migrating fish (Table 2). Most of the returning steelhead were Skamania (32 of 40) with the majority having an adipose right maxillary (ARM) clip. The

remainder of the steelhead were unclipped. A total of 24 Skamania were sent to Kettle Moraine Springs Fish Hatchery to be held until ripe for spawning with the remaining steelhead passed upstream.

Smolt Out-migration

Steelhead were stocked seven miles upstream of Lake Michigan and 3 miles upstream of BAFF starting on April 12 and continuing through April 22. A total of 40,824 Chamber Creek strain steelhead with an average length of 135 mm and a left maxillary clip, 35,950 ganaraska with an average length of 128 mm and an adipose, left ventral clip and 33,590 skamania with an average length of 150 mm and a right maxillary clip were stocked during this time period.

On May 7 we shocked the survey site upstream of BAFF. We shocked the 910 meter long survey site in 21 minutes and captured 119 steelhead and 166 coho salmon. Stream flow was 60 cubic feet per second (CFS) and stage was 8.9 feet. With the use of fin clips, we determined that we caught 29 Chambers Creek steelhead, 74 Ganaraska, 15 Skamania and 1 steelhead was unclipped. The average length of captured smolts were 146 mm for Chambers Creek, 146 mm for Ganaraska, 157 mm for Skamania and 155 mm for coho salmon.

On the same date we attempted to shock the survey site below BAFF, but after a short distance we were forced to abandon the attempt because of numerous white sucker, which made shocking and netting impossible. We did not capture or see any salmonid smolts during the 5 minutes we shocked, however smolts were observed downstream of Highway F.

Rainfall following our May 7 survey caused river flow and stage to increase to a level that did not allow us to walk the stream until May 19. On this date, we only surveyed the upstream site. In 25 minutes of shocking, we collected 18 steelhead and 1 coho salmon. Stream flow was 75 CFS and river stage was 9.4 feet. The steelhead catch was divided into 2 Chambers Creek, 15 Ganaraska and 1 Skamania. Average length of each strain was similar to those on May 7. Once again due the presence of a large number of white sucker we were unable to shock the lower survey site.

Following the second day of surveying, heavy rainfall resulting in stream flows of greater than 2,000 CFS and stage levels above flood stage, forced us to halt smolt sampling.

Continuous Chemistry Monitor

The continuous chemistry monitor was in place from April 7 through June 14 on the Kewaunee River above BAFF. During this time, water quality values were judged good.

Dissolved oxygen values ranged from 5.2 to 18.5 mg/l with a mean of 9.6 mg/l (Figure 1). Normal daily fluctuations occurred with oxygen being the lowest in early morning hours and

highest during daylight photosynthesis. During the highest water period (from about May 21 to June 14 Th.) dissolved oxygen concentration tended to stabilize. In-stream photosynthesis and respiration does not influence the oxygen concentration in the river during these large runoff events like it does during normal flows. However, dissolved oxygen concentrations never dropped below the 5 mg/l state standard for warm water streams during sampling. During the sample period, water temperature ranged from 3.4 to 22.9 degrees C with a mean of 12.3 degrees C. There was a gradual warming trend with the warmest temperatures in June, as expected.

pH ranged from 7.6 to 8.7 with a mean of 8.2, which is well within the normal range. pH values fluctuated the most during the highest stream flows between May 21 and June 14th.

Specific conductivity ranged from 308 to 707 uS/cm but was normally in the 600's. The mean was 616 uS/cm. As indicated in Figure 1, specific conductivity values dropped significantly because of dilution during the highest runoff, then recovered as the water level receded.

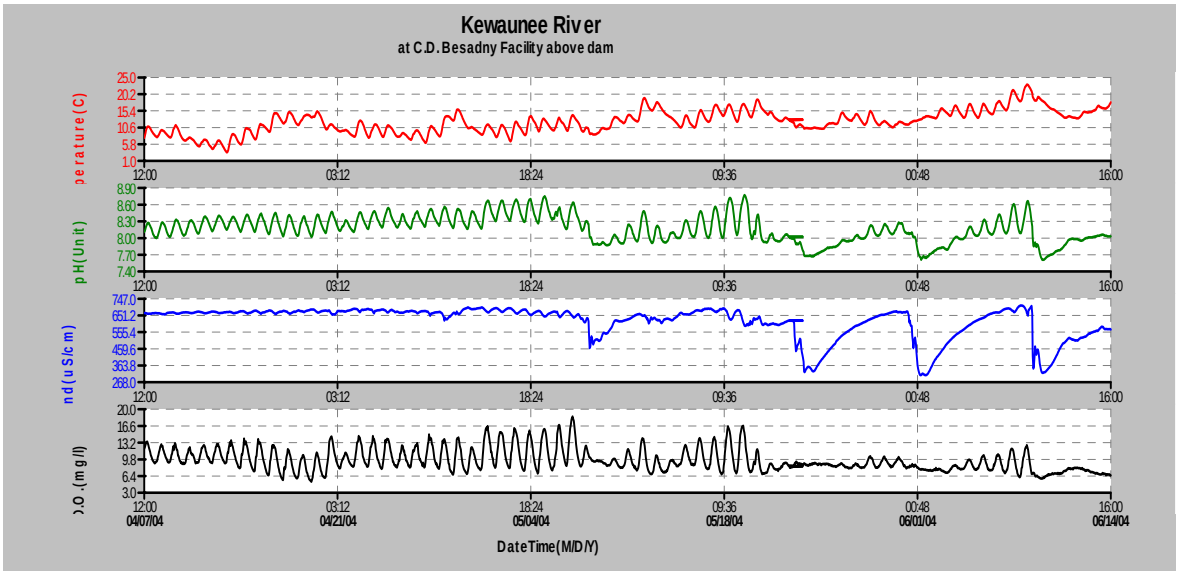

Figure 1. Results from the continuous monitor located on the Kewaunee River above BAFF. From top to bottom, temperature, pH, specific conductance and D.O curves indicate good water quality at this location during the sample period.

DISCUSSION

Since 1992, we have been monitoring trends of several factors associated with the annual steelhead spawning migrations up the Kewaunee River to BAFF. They include abundance and run timing for each strain, length and weight, return rate, and handling mortality.

Timing and Abundance of the Run

Spring

The past six springs, 1999 through 2004, steelhead runs at BAFF have been markedly different in timing and abundance as compared to previous years (Hogler and Surendonk 1997, 1998, 1999, 2000, 2001, 2002 and 2003). Spring migratory runs before 1999 had been predictable with large numbers of Chambers Creek returning to the weir with the onset of operations and then slowly declining in number through the end of April. As the Chambers Creek run dwindled in number, Ganaraska numbers increased rapidly, peaked in mid-April, and declined through early May. However, since 1999, water level and flow have been very low during normal migration times. Instead of the typical pulses of steelhead, the fish that have returned, move in for a short period of time and then leave the Kewaunee River reducing the duration of the run.

The 2004 spring run was the best run in abundance observed since 1998 and nearly doubled the 2003 run (Figure 2). All components of the run (strain) increased from their 2003 level, with the greatest increase seen in Chambers Creek abundance (Table 1). Although the run number sharply increased in 2004, it was still below the seven year average run size of 996 and well bellow the 1996 peak run of 2,144. This year's run total was just 34.3% of the 1996 run.

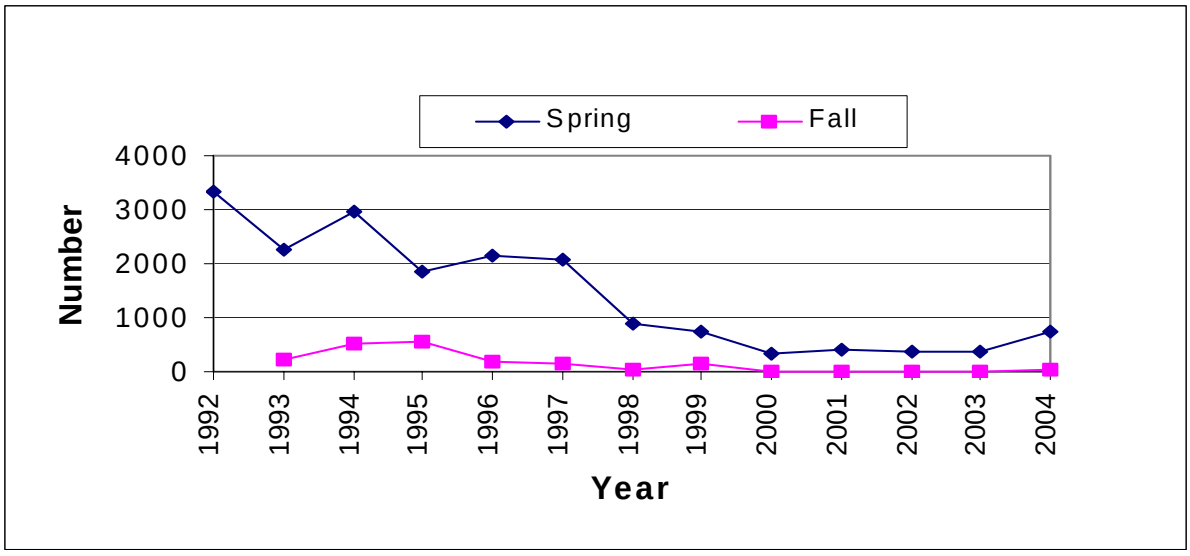

Figure 2. Steelhead return to BAFF during spring and fall runs, 1992-2004.

It is likely that improved spring flows and reduced lake harvest the previous two summers are responsible for the increased run total. However, despite the improved run in 2004, run totals have dropped substantially since the mid-1990's. The reason for the decline is not clear and may be attributable to a combination of several factors including stocking number,

poor river flow or poor water quality, poor survival of smolts, or high lake harvest of adult steelhead.

Stocking number continues to remain relatively stable for Chambers Creek and Ganaraska, although Skamania numbers have varied from year to year (Figure 3). Since 1992, the WDNR has stocked at least 30,000 steelhead of each strain into the Kewaunee River. Stocking of Chambers Creek strain smolts in 2004 exceeded 40,000 and was the most stocked in the recent past.

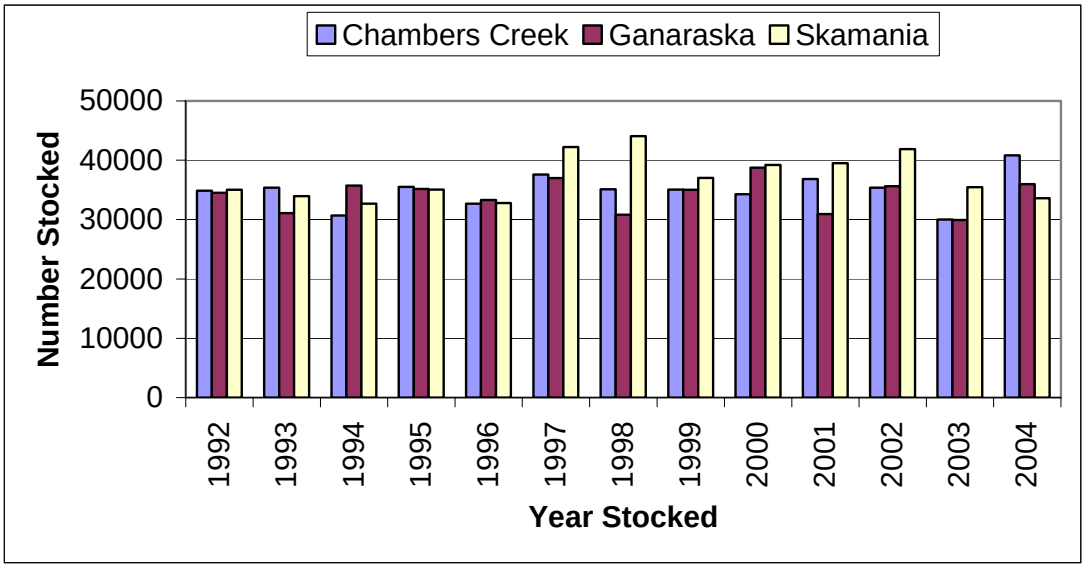

Figure 3. Stocking number by strain for steelhead stocked into the Kewaunee River from 1992 through 2004.

Unfavorable weather may explain some of the decline in run number observed over the past decade with warm weather and a lack of precipitation or precipitation at the wrong time responsible for the poor runs. Early ice-out before the fish were ready to migrate followed by quickly dropping flows may have caused steelhead to attempt to spawn in lower sections of the Kewaunee River or drop back into Lake Michigan and reabsorb their eggs instead of continuing to migrate upstream. In 2004 spring flows appeared to be adequate to draw steelhead into the river, but low Lake Michigan water levels caused several reaches of the river to be extremely shallow making upstream passage difficult for largest fish (Age 5 and greater). The number of younger, smaller fish observed this spring and the lack of larger, older fish appeared to support low water level as a partial reason for declining returns.

Data collected with the use of a continuous chemistry monitor during the spring and early summer of 2004, indicate that water quality is generally good. State standards for dissolved oxygen in warm water streams was never violated. This result is different than was observed in 2000 when diel concentrations of dissolved oxygen dropped below 5 mg/l regularly on the Kewaunee River (Hogler 2001). It is likely that the DO sags in 2000 were

due to run off events that delivered sediment and nutrients to the Kewaunee River allowing dense algal mats to form causing large diel swings in DO concentrations. Also, warm summer waters are less able to hold oxygen. However, the huge runoff events that did occur during the sampling period in 2004 did not seem to negatively impact the water quality of the Kewaunee River because of cool water temperatures and limited aglal production.

Mortality of smolts may also play an important role in the declining number of returning steelhead seen the past decade. Low flow in the Kewaunee River following smolt stocking may have increased smolt mortality and ultimately reduced the number of adults returning to the river. Changes in stocking location to the lower river did not appear to increase the number of returning steelhead to BAFF (Hogler and Surendonk 2003). Size at stocking has been shown to be an important factor in the survival of smolts and their ultimate contribution to the fishery (Seelbach 1985). Smolts stocked in 2004 (Chambers Creek-142 mm, Ganaraska-130 mm and Skamania-150 mm) were similar in length to smolts stocked in previous years, but smaller in length then the 200 mm recommended by Seelbach (1985). In addition to physical size, condition factors, such as disease status or fat reserves, and predation on recently stocked steelhead may influence the number of smolts that survive and return as adults. These factors have not been researched for Kewaunee River steelhead making their impact on return number unknown.

Lakewide angler harvest of adult fish may also affect the number of returning spawners to BAFF. The annual steelhead harvest since the early 1990's has averaged just over 92,800 fish (Eggold 2004). Harvest during 1994, 1995 and 1998 exceeded 110,000 steelhead which likely reduced the number of steelhead able to return to BAFF. However, the average yearly harvest of steelhead since 2000 has declined to 72,900 which is 20% below the ten-year average harvest. The reduction in harvest of steelhead from the Wisconsin waters of Lake Michigan has not increased the number of steelhead returning to BAFF. However, results from our tagging studies (Hogler and Surendonk 1997 and 1998) indicate that steelhead have lakewide movement patterns. Reductions in harvest from one jurisdiction may be balanced by increased harvest from anglers by other states, resulting in no net increase in survival of Wisconsin stocked steelhead.

Fall

The 40 steelhead handled at BAFF in the summer/fall of 2004 was greater than the number handled the past several summers, but substantially lower than the 540 fish captured in 1995 (Figure 1). Low flow, despite late spring and summer rainfall and low lake water levels have severely limited the run. However, other factors such as smolt mortality and lake harvest must have also impacted the return of these steelhead.

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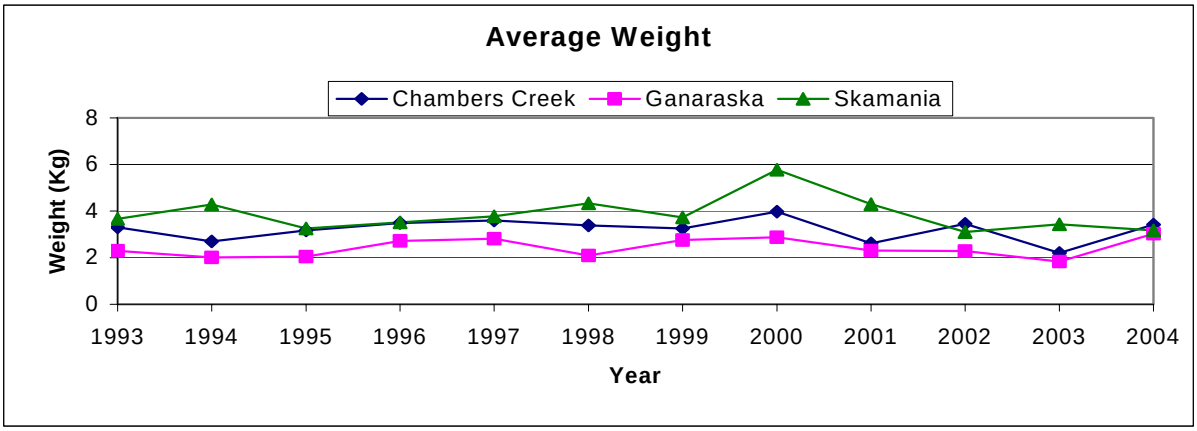

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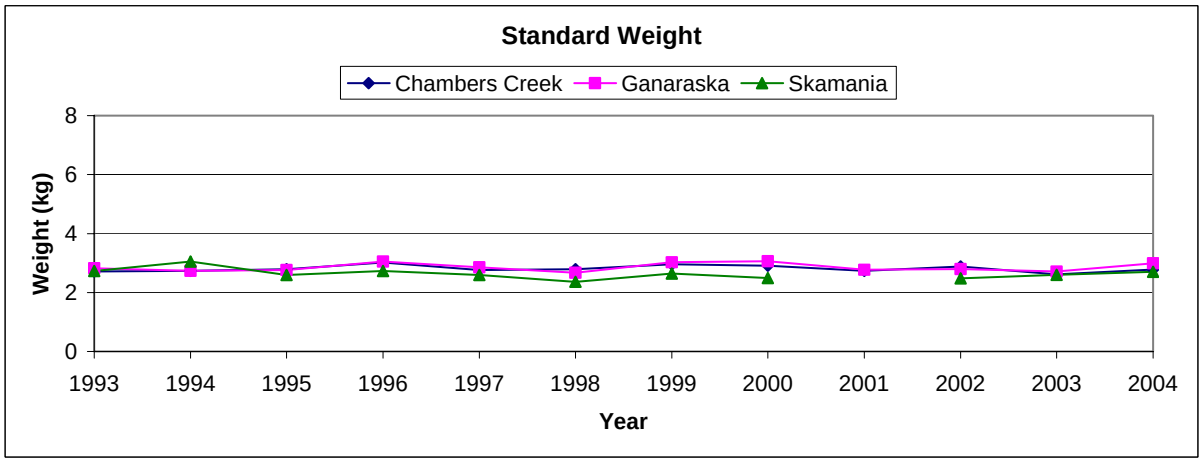

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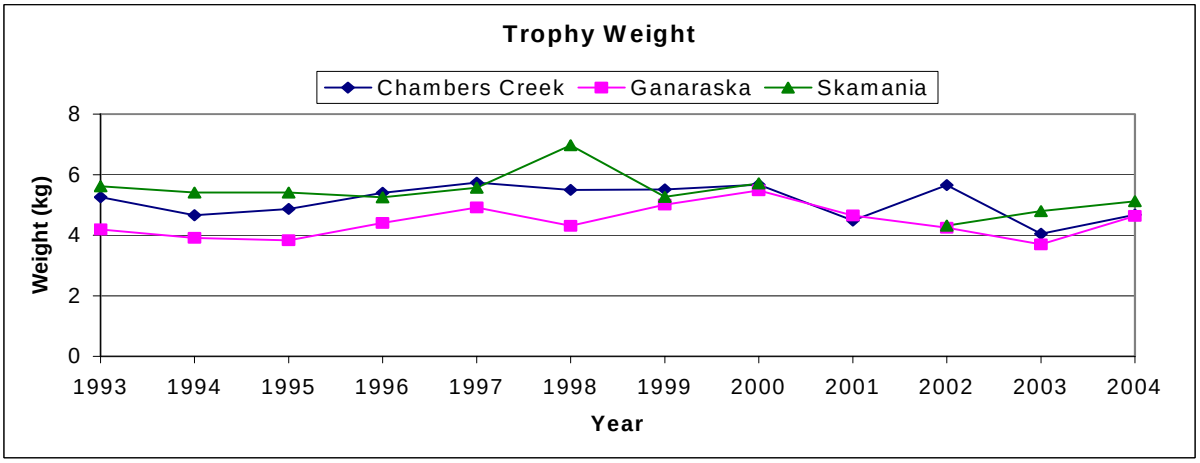

Figure 4. Weights trends for steelhead during spring migrations at BAFF, 1992-2004: (A) Average weight for each strain for that year, (B) Standard weight is based on the projected weight of a 660 mm steelhead, (C) Trophy weight for each strain based on the 95th. percentile of weighed steelhead.

Strain Performance

Chambers Creek

Average length and weight of Chambers Creek steelhead increased in 2004 from 2003 levels and is similar to 2002 averages (Table 1). The increase in average length and weight may be due to the number of 4 year old fish returning to the weir (Table 4). Age 4 fish (2000 year class) dominated the Chambers Creek return in 2004, while 3 year old fish were more common the previous two springs. Improved flow and higher lake levels may have allowed larger fish to migrate upstream without obstruction this past spring thus increasing the number of 4 year fish in the run. Standard and trophy weight indices also increased in 2004 from 2003 values (Figure 4). However, since 1993, the three weight trend indices have varied little for Chambers Creek steelhead.

Return rates from an individual year of stocking can also be evaluated by the use of fin clips. Since the majority of Chambers Creek fish traditionally return at age 4, we would expect to see the highest return rate of a year class occur three years after fish were stocked. In 2004, 4-year-old Chambers Creek steelhead stocked in 2001 returned at a much higher rate than did 4-year-old fish stocked in 1997 (Table 7). Overall, 2001 stocked fish returned at a rate similar to those steelhead stocked in 1996 and earlier and much better than fish stocked in 1997 through 2000.

Ganaraska

Ganaraska strain steelhead have had more variation in yearly average length and weight than Chambers Creek strain fish (Table 1). All three weight indices increased in 2004 from 2003 levels and are the highest since 2000 (Figure 4). Similar to Chambers Creek, more 4 year old fish contributed to the 2004 run than they did for the past several years resulting in increased weight. Long-term trends for each of the three weight indices indicate that Ganaraska weights have been relatively stable since 1993.

The return rate of Ganaraska strain steelhead stocked in 2001 was the highest since 1996, which resulted in a good return in 2004 for Ganaraska (Table 8). This reverses the trend of declining returns observed for Ganaraska over the previous three years. Similar to the Chambers Creek strain, Ganaraska stocked in 1998 and 2000 have performed poorly, with improvements in return noted for those steelhead stocked in 1999 and 2001. Overall, return rate indicates that fish stocked in 1996 returned at a higher rate than those stocked in later years.

Skamania

Skamania had been a small, but consistent portion of the spring run until 2001 when their abundance dropped substantially. Average length and weight increased in 2004 from 2003 levels and was similar to those measured in 2001. Standard weight and trophy weights for

2004 were also similar to those in 2001 (Table 1). However, since this strain normally migrates upriver in late summer and fall, return rates during the spring are expected to be low (Table 9).

The number of Skamania collected during the fall run has varied greatly. The 2004 run was the best fall run since 1999. Improved flow rates in early fall and late fall rain may have aided the run in 2004. However, fall run totals are still substantially lower than those in the mid-1990's. High lake harvest and poor river conditions may be responsible for the variation in run number and run timing.

Comparison of Strain Performance

All strains of steelhead had improved returns to the weir in 2004 as compared to the 2003 run, although all strains still have shown a decreasing return to the weir since the early 1990's. Of the spring running strains since 1993, Chambers Creek has returned in greatest number despite a sharp decline in number during the past four spring migrations. Survival based on return per thousand stocked also indicates Chambers Creek, in general, return at a higher rate than does Ganaraska strain steelhead, although this trend may be reversing, based on the return rates of the last four springs. Summer-run Skamania have had reduced run numbers since the 1995 peak. The return rate of Skamania is the lowest of the three strains of steelhead.

The exact reason(s) for these substantially lower return rates are unknown. Certainly low water has hurt return number but can't explain the entire decline in run number. Other potential reasons for the decline include poor imprinting to the river by smolts, predation on newly stocked steelhead by birds and other fish, entrapment behind the dam at BAFF under low flow conditions, poor river water quality, high harvest on adult fish by anglers on Lake Michigan and unhealthy fish from the hatchery. If returns continue to decline, each of these potential reasons must be examined to determine the cause of the decline.

Skamania continue to be the largest steelhead followed by Chambers Creek and Ganaraska. Mixed results from the three weight trends may indicate forage problems on Lake Michigan or that younger (smaller) fish are more common during spawning runs because of the reduced return rate for fish stocked in 1995-1998. However, decreasing return number may influence the trends of each weight index if smaller fish (younger in age) continue to dominate the run.

Smolt Out-migration

Heavy rainfall limited the number of stream shocking runs that could be made to assess the out-migration of smolts following stocking. From the limited amount of data that we collected, it was clear that steelhead (and coho salmon) had moved downstream from their stocking location. Because we could not assess smolt abundance below BAFF we can not estimate the number of fish that successfully navigated the low head dam, but from observation, smolts did survive the trip over the dam.

Of the steelhead smolts we captured, most were Ganaraska strain steelhead followed by Chambers Creek. Few Skamania strain steelhead were captured and we also captured many coho salmon. Based on the number of fish stocked, we should have captured more Chambers Creek than Ganaraska than Skamania. It is unknown why we caught so few Chambers Creek or Skamania steelhead.

Water quality did not appear to limit steelhead during the period following stocking in 2004. This differs from summer water quality data collected in 2000 when low DO may have limited trout and salmon survival. This could indicate if stocked fish smolt, and leave the system quickly, they survive well and if they don't leave quickly survival could be reduced from the combination of low flows, warming water temperatures and low DO.

Additional work will be attempted in 2005 to better assess the movement of steelhead in the Kewaunee River following stocking.

SUMMARY

The 2004 spring run total was the highest total since 1998. Return of each of the three strains stocked increased from 2003 levels and generally was the best return of marked steelhead since 1999. However, the 2004 run total was still substantially lower than those observed in 1991 through 1996. The reduction in return number is likely due to the poor return rate for several year classes that were stocked between 1997 and 2000. Poor survival of these year classes may be due to unusual weather conditions that resulted in poor flow on the Kewaunee River and low lake level, high harvest of adult fish, or from mortality of recently stocked smolts.

Changes in the 2004 average, standard and trophy weights may be due to a larger percentage of the run being age 4 as compared to the 2003 run being dominated by age 3. Long term declines in weight trends is likely due to the absence of age 5 and older fish that were common in the past. Why older fish are absent from the return is unknown at this time and may be related to angler harvest, fish health, stocking location or predation on smolts.

Gamete collections for all three strains of steelhead were spotty from BAFF in 2004, but should not affect the total number of steelhead stocked in 2005 because of the contribution of gametes from the Root River Steelhead Facility.

The summer/fall run of steelhead improved in 2004, but still was much lower than historical runs. Although there was abundant late spring and late fall rain, river flow did not increase enough to trigger steelhead runs into the river, making 2004 a fair year for Skamania.

We began to evaluate the relative magnitude of the smolt out-migration from the Kewaunee River in 2004. While we were able to capture some steelhead smolts, heavy rainfall limited our ability to sample the river. It appears that once steelhead are stocked, they move downstream as they smolt and enter Lake Michigan soon after stocking. Water quality does

not appear to be affecting survival during out-migration. Additional work needs to be done to assess the affect of the low head dam, shallow river runs and fish condition on the survival of stocked steelhead.

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Table 1. Summary of steelhead length and weight data collected during spring migratory runs at BAFF, on the Kewaunee River, 1996-2004.

Year	Strain	Number	Run %	Average Length (mm)	Length Range (mm)	Average Weight (kg)	Weight Range (kg)	Standard Weight (kg)*	Trophy Weight (kg)**
1996	Chambers	731	34.1	699	390-950	3.49	0.6-8.2	3.02	5.40
	Ganaraska	414	19.3	630	341-865	2.72	0.4-6.1	3.05	4.41
	Skamania	175	8.2	734	436-907	3.52	0.8-6.9	2.73	5.25
	Other	824	38.4	--	--	--	--	--	--
	Total	2,144							
1997	Chambers	610	29.2	721	471-915	3.60	1.1-7.3	2.76	5.74
	Ganaraska	364	17.4	657	365-812	2.82	0.5-7.4	2.86	4.92
	Skamania	288	13.8	757	420-934	3.77	0.7-6.6	2.59	5.57
	Other	829	39.6	--	--	--	--	--	--
	Total	2,091							
1998	Chambers	236	26.9	706	394-900	3.38	0.6-6.9	2.79	5.50
	Ganaraska	241	27.5	593	270-795	2.09	0.5-5.1	2.67	4.31
	Skamania	74	8.4	795	540-953	4.33	1.7-7.4	2.36	6.97
	Other	325	37.1	--	--	--	--	--	--
	Total	876							
1999	Chambers	220	30.1	683	386-890	3.25	0.7-7.0	2.96	5.51
	Ganaraska	237	32.4	633	269-815	2.76	0.3-6.2	3.03	5.01
	Skamania	23	3.1	759	571-903	3.73	1.9-5.7	2.64	5.27
	Other	252	34.4	--	--	--	--	--	--
	Total	732							
2000	Chambers	69	20.3	750	475-865	3.98	0.9-5.8	2.91	5.67
	Ganaraska	84	24.7	637	370-832	2.87	0.4-5.7	3.06	5.48
	Skamania	40	11.8	761	635-894	5.78	1.4-5.8	2.49	5.71
	Other	147	43.2	--	--	--	--	--	--
	Total	340							
2001	Chambers	66	16.0	650	549-809	2.61	1.4-4.8	2.74	4.49
	Ganaraska	136	33.0	621	421-830	2.31	0.6-5.3	2.77	4.65
	Skamania	2	0.4	756	711-800	4.30	3.7-4.8	--	--
	Other	209	50.6	--	--	--	--	--	--
	Total	413							
2002	Chambers	51	13.6	716	440-860	3.45	0.6-5.7	2.88	5.66
	Ganaraska	61	16.2	662	375-870	2.82	0.4-4.7	2.80	4.25
	Skamania	17	4.5	718	586-788	3.10	1.6-4.3	2.48	4.32
	Other	247	65.7	--	--	--	--	--	--
	Total	376							
2003	Chambers	81	21.8	617	425-800	2.20	0.8-4.5	2.62	4.05
	Ganaraska	68	18.3	556	360-732	1.83	0.6-3.9	2.71	3.70
	Skamania	16	4.3	741	572-842	3.43	1.9-4.8	2.60	4.80
	Other	206	55.5						
	Total	371							
2004	Chambers	203	27.6	713	440-845	3.42	0.94-5.32	2.78	4.68
	Ganaraska	162	22.0	663	250-810	3.03	0.18-5.10	2.99	4.64
	Skamania	31	4.2	709	540-894	3.17	1.46-5.32	2.70	5.12
	Other	339	46.1						
	Total	735							

* Standard weight is a prediction based on a 660.4-mm steelhead.
** Trophy weight is based on the 95 percentile of weighed steelhead.

Table 2. Daily totals during 2004 operations at BAFF, by strain of steelhead.

Spring Run Steelhead

Date	Chambers Creek	Ganaraska	Skamania	Other	Day Total
March 24	58	9	7	80	154
March 29	78	61	13	118	270
April 1	41	42	8	74	165
April 7	13	25	2	45	85
April 15	13	25	1	22	61
Total	203	162	31	339	735

Summer/Fall Run Steelhead

Date of Operation	Chambers Creek	Ganaraska	Skamania	Other	Day Total
July 22			14	5	19
July 27			7		7
August 5			3		3
September 9			4	3	7
October 13					0
October 21					0
October 26			1		1
October 28					0
November 1			2		2
November 3			1		1
November 9					0
Total	0	0	32	8	40

Table 3. Average length, weight and run number by strain, clip, and sex during the spring spawning run at BAFF, 2004.

	Male			Female		
Strain and Clip	**Average Length (mm)**	**Average Weight (kg)**	**Run Number**	**Average Length (mm)**	**Average Weight (kg)**	**Run Number**
Chambers Creek						
Left Maxillary, Left Ventral (LMLV)	-	-	0	-	-	0
Adipose, Left Maxillary (ALM)	758	3.81	61	713	3.52	106
Left Maxillary (LM)	643	2.41	26	621	2.50	10
Chambers Creek combined average	**724**	**3.39**	**87**	**705**	**3.44**	**116**
Ganaraska						
Adipose, Left Ventral (ALV)	728	3.71	53	682	3.31	52
Adipose, Right Ventral (ARV)	629	2.4	24	618	2.44	21
Both Ventral (BV)	423	0.83	11	680	3.1	1
Ganaraska combined average	662	2.99	88	664	3.06	74
Skamania						
Adipose, Right Maxillary (ARM)	717	3.05	8	684	2.92	13
Right Maxillary (RM)	779	3.96	6	652	3.01	3
Right Maxillary, Right Ventral (RMRV)	-	-	0	742	3.48	1
Skamania combined average	743	3.43	14	681	2.96	17

Table 4. The age distribution, length, and weight of returning clipped steelhead by sex for the Kewaunee River spring 2004.

Chambers Creek

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	=	26	61	0	0	Measured	0	10	106	0	0
Average Length (mm)	-	643	758	-	-	Average Length (mm)	-	621	713	-	-
Range (mm)	-	440-730	690-845	-	-	Range	-	567-743	655-805	-	-
Weighed	0	26	61	0	0	Weighed	0	10	106	0	0
Average Weight (kg)	-	2.41	3.81	-	-	Average Weight (kg)	-	2.50	3.52	-	-
Range (kg)	-	0.94-3.34	2.4-5.32	-	-	Range (kg)	-	1.82-4.12	1.76-5.18	-	-

Ganaraska

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	11	24	53	0	0	Measured	0	21	52	1	0
Average Length (mm)	423	629	728	-	-	Average Length (mm)	-	618	682	680	-
Range (mm)	250-480	490-705	590-810	-	-	Range	-	525-765	605-792	-	-
Weighed	11	24	53	0	0	Weighed	0	21	52	1	0
Average Weight (kg)	0.83	2.40	3.71	-	-	Average Weight (kg)	-	2.44	3.31	3.10	-
Range (kg)	0.18-1.06	122-3.30	2.32-5.10	-	-	Range (kg)	-	1.46-4.42	1.62-4.12	-	-

Skamania

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	0	2	8	0	4	Measured	0	3	13	1	0
Average Length (mm)	-	660	717	-	838	Average Length (mm)	-	652	684	742	-
Range (mm)	-	625-695	540-847	-	740-814	Range	-	645-660	625-715	-	-
Weighed	0	2	8	0	4	Weighed	0	3	13	1	0
Average Weight (kg)	-	2.57	3.05	-	4.63	Average Weight (kg)	-	3.01	2.92	3.48	-
Range (kg)	-	2.30-2.84	1.46-4.412	-	4.02-5.32	Range (kg)	-	2.86-3.16	1.76-3.32	-	-

Table 5. Handling mortality by strain at BAFF during spring operations for the years 1994-2004.

Year	Strain	Number	Number Dead	Percent Mortality
1996	Chambers	731	41	5.6
	Ganaraska	414	7	1.7
	Skamania	175	3	1.7
	Other	824	7	0.9
	Total	**2,144**	**58**	**2.7**
1997	Chambers	610	4	0.6
	Ganaraska	364	7	1.8
	Skamania	288	0	0.0
	Other	829	5	0.6
	Total	**2,091**	**16**	**0.7**
1998	Chambers	236	5	2.1
	Ganaraska	241	1	0.4
	Skamania	74	0	0.0
	Other	325	4	1.2
	Total	**876**	**10**	**1.1**
1999	Chambers	220	1	0.5
	Ganaraska	237	1	0.4
	Skamania	23	0	0.0
	Other	252	0	0.0
	Total	**732**	**2**	**0.3**
2000	Chambers	69	0	0.0
	Ganaraska	84	0	0.0
	Skamania	40	0	0.0
	Other	147	0	0.0
	Total	**340**	**0**	**0.0**
2001	Chambers	66	1	1.5
	Ganaraska	136	1	0.7
	Skamania	2	0	0.0
	Other	209	0	0.0
	Total	**413**	**2**	**0.5**
2002	Chambers	51	3	5.9
	Ganaraska	61	3	4.9
	Skamania	17	0	0.0
	Other	247	3	1.2
	Total	**376**	**9**	**2.4**
2003	Chambers	81	0	0
	Ganaraska	68	0	0
	Skamania	16	0	0
	Other	206	0	0
	Total	**371**	**0**	**0**
2004	Chambers	203	14	6.9
	Ganaraska	162	0	0
	Skamania	31	0	0
	Other	339	1	0.3

	Total	**735**	**15**	**2.0**

Table 6. Steelhead fin clip trends detected at BAFF during fall migrations, 1994-2004.

Strain and fin clip	1996	1997	1998	1999	2000	2001	2002	2003	2004
Skamania									
Adipose, Right Maxillary (ARM)	97	57	8	8	3				28
Right Maxillary (RM)	63	53	20	76	1	8	1		4
Right Maxillary,Right Ventral (RMRV)				8	1				
Right Maxillary,Left Pectoral (RMLP)				1					
Right Pectoral, Left Ventral (RPLV)	1		2						
Left Maxillary, Left Ventral (LMLV)	2								
Total Skamania	163	110	30	93	5	8	1	0	32
Chambers Creek									
Left Maxillary (LM)	4	1		1					
Left Maxillary, Left Ventral (LMLV)	1								
Adipose, Left Maxillary (ALM)									
Total Chambers Creek	5	1		1				0	0
Ganaraska									
Adipose, Right Ventral (ARV)									
Adipose, Left Ventral (ALV)									
Both Ventral (BV)									
Total Ganaraska								0	0
Unknown									
No Clips	20	17	15	30	2	5	2		3
Both Maxillary (LMRM)	1								
Adipose (?), Right Ventral (A?RV)	4								
Adipose (A)		1		1					
Other		2	1	20					5
Total Unknown	25	20	16	51	2	5	2	0	8
Total Fall Steelhead Run	**193**	**131**	**46**	**145**	**7**	**13**	**3**	**0**	**40**

Table 7. Return rates (number per thousand stocked) for Chambers Creek steelhead during spring migrations on the Kewaunee River, 1996-2004.

	Year Stocked								
Return Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
1996	1.10	--	--	--	--	--	--	--	--
1997	5.49	0.00	--	--	--	--	--	--	--
1998	4.99	0.85	0.11	--	--	--	--	--	--
1999	0.48	5.26	0.80	0.03	--	--	--	--	--
2000	0.08	1.16	0.93	0.11	0.09	--	--	--	--
2001	0.00	0.18	0.11	0.09	1.51	0.00	--	--	--
2002	0.00	0.00	0.00	0.03	1.23	0.09	0.05	--	--
2003	0.00	0.00	0.00	0.00	0.11	0.15	1.79	0.17	--
2004	0.00	0.00	0.00	0.00	0.00	0.00	4.53	1.02	0.00
Total	12.14	7.45	1.95	0.26	2.94	0.24	6.37	1.19	0.00

Table 8. Return rates (number per thousand stocked) for Ganaraska steelhead during spring migrations on the Kewaunee River, 1996-2004.

	Year Stocked								
Return Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
1996	0.94	--	--	--	--	--	--	--	--
1997	4.18	0.30	--	--	--	--	--	--	--
1998	2.67	3.57	0.35	--	--	--	--	--	--
1999	0.74	4.17	1.68	0.16	--	--	--	--	--
2000	0.14	0.57	0.57	0.58	0.51	--	--	--	--
2001	0.00	0.12	0.19	0.52	3.08	0.08	--	--	--
2002	0.00	0.00	0.00	0.16	0.13	0.08	0.16	--	--
2003	0.00	0.00	0.00	0.00	0.17	0.00	1.49	0.45	--
2004	0.00	0.00	0.00	0.00	0.00	0.03	3.40	1.26	0.37

Total	8.67	8.73	2.79	1.42	3.89	0.19	5.05	1.71	0.37

Table 9. Return rates (number per thousand stocked) for Skamania steelhead during spring migrations on the Kewaunee River, 1996-2004.

	Year Stocked								
Return Year	1995	1996	1997	1998	1999	2000	2001	2002	2003
1996	0.00	--	--	--	--	--	--	--	--
1997	0.03	0.03	--	--	--	--	--	--	--
1998	0.68	0.06	0.00	--	--	--	--	--	--
1999	0.37	0.30	0.00	0.00	--	--	--	--	--
2000	0.14	1.03	0.00	0.00	0.12	--	--	--	--
2001	0.00	0.00	0.00	0.02	0.03	0.00	--	--	--
2002	0.00	0.00	0.00	0.00	0.43	0.03	0.00	--	--
2003	0.00	0.00	0.00	0.00	0.32	0.03	0.03	0.05	--
2004	0.00	0.00	0.00	0.00	0.11	0.03	0.53	0.12	--
Total	1.22	1.42	0.00	0.02	1.01	0.09	0.56	0.17	0.00