Return, Size, and Age of Steelhead at the Besadny Anadromous Fisheries Facility, 2007

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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. In 2004, a third component, monitoring the out-migration of trout and salmon from the Kewaunee River was added to the project.

Spring operations in 2007 began on April 2 when the ponds were sorted to look for steelhead with Chambers Creek and Ganaraska fin clips and continued through April 18 when the ponds were emptied. During this period, 431 steelhead were handled at BAFF. The run consisted of 163 Chambers Creek strain steelhead, 128 Ganaraska, 2 Skamania and 138 unclipped, misclipped or strays from other streams or states. The number of fish handled during the spring run in 2007 decreased from the 2006 total and was less than the average run total from the previous eight springs of 499. In 2007, the spring run was short with the majority of steelhead handled on the first two days of operation. The number of steelhead handled quickly declined after April 4th as river flow dropped.

The 2007 run was typical of the runs of the past five years and was far less 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 1998 and 2002. 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 Michigan level, high harvest of adult fish, or from mortality of recently stocked smolts.

Changes in the spring 2007 average, standard and trophy weights may be due to a larger percentage of the run being age 4 as compared to the 2006 run that was dominated by age 3 steelhead. Long term declines in weight trends were likely due to the absence of age 5 and older fish which were present in past runs. Why older fish were absent from recent runs remains unknown at this time and may be related to angler harvest, fish health, stocking location or predation on smolts.

We continued to evaluate the relative magnitude of the smolt out-migration from the Kewaunee River in 2007. While we were able to capture steelhead and other trout and salmon smolts and make general statement regarding timing and downstream movements, many questions remain unanswered regarding survival of stocked fish.

Summer/fall fish collections began on October 3 when the BAFF fish ladder began to operate. BAFF ponds were sorted thirteen times during October and November to process migrating fish. Fifty steelhead were captured at BAFF during the 2007 summer/fall run. This was the highest total since 1999 when 145 steelhead were captured. Eighteen of the

50 steelhead had identifiable Skamania clips which was the highest number seen since 2004.

The summer/fall run continues to be much lower in number than runs of the early 1990's. Poor river conditions, with low flow and warm water temperatures are likely responsible for some of the declines seen in fall runs since the late 1990's.

Gamete collections for the two spring strains of steelhead were good from BAFF in 2007 and should result in near normal numbers of Chambers Creek and Ganaraska being stocked in 2008. Adult Skamania used as brood fish were not collected from either steelhead facility in 2007 due to VHS concerns which will result in no Skamania stocking in 2009 by Wisconsin.

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 the 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 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 (3) since 2004, monitor the outmigration of steelhead and other trout and salmon smolts from the Kewaunee River. This report summarizes the data collected during the 2007 migratory runs of adult steelhead at BAFF and smolt movement in the Kewaunee River.

METHODS

Adult Collection

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

Fall operations began typically in July or August following rainfall events and continued sporadically until October when the facility was operated continuously until the river freezes in late November. Steelhead were checked for fin clips, and a subsample were weighed and measured. All returning steelhead were harvested in 2007 and none returned to the river because of VHS concerns.

The data were analyzed using basic fishery statistics, such as average length and weight by sex and clip. Before steelhead smolts were stocked into the Kewaunee River, they were marked with unique fin clips by strain. Chambers Creek strain steelhead were marked with left maxillary, adipose-left maxillary or left maxillary-left ventral clips. Ganaraska strain steelhead were marked with adipose-left ventral, adipose-right ventral or both ventral clips. Skamania were marked with right maxillary, adipose-right maxillary or right maxillary-right ventral clips. This allowed us to assign returning steelhead to year classes by fin clip and use of a length frequency table to estimate return rate by stocking year. A regression of length and weight for each strain was calculated to estimate standard weight. 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 were able to track recent weight trends in the population.

Smolt Out-migration

To assess the movement of steelhead and other salmonids downstream following stocking 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 upstream of the lower survey site.

Stream electroshocking began immediately following the cessation of stocking and was scheduled to occur weekly until smolts were not captured at the upstream site. Two electrical probes were used on the shocker and DC current was limited to an output of 4.5 amperes to sample migrating smolts. Following capture, smolts were identified to species, checked for clips and released back into stream. Once a month all smolts were measured to the nearest 1 mm before they were returned to the river.

RESULTS

Spring-Adult Collection

Spring operations in 2007 began on April 2 when the ponds were sorted to look for steelhead with Chambers Creek and Ganaraska fin clips and continued through April 18 when the ponds were emptied. During this period, 431 steelhead were handled at BAFF. The run consisted of 163 Chambers Creek strain steelhead (37.8% of the run), 128 Ganaraska (29.8%), 2 Skamania (0.5%) and 138 (31.9%) unclipped, misclipped or strays from other streams or states (Table 1). The number of fish handled during the spring run in 2007 decreased from the 2006 total and was less than the average run total from the previous eight springs of 499. In 2007, the spring run was short, with the majority of steelhead handled on the first two days of operation (Table 2). The number of steelhead handled quickly declined after April 4th as river flow dropped.

Chambers Creek Strain

Chambers Creek strain steelhead were the most common strain captured during the spring run (Table 2). They ranged in length from 405 mm to 810 mm, and had an average length of 679 mm (Table 1). Chambers Creek weight ranged from 0.56 kg to 4.76 kg and averaged 2.94 kg. The average length and average weight for Chambers Creek steelhead increased in 2007 from their 2006 levels and were near the 2001-2006 average length and weight.

Males comprised 46.9% of the run and averaged 701 mm in length and 2.56 kg in weight (Table 3). All three Chambers Creek fin clips were observed for male fish, with the left maxillary (LM) the most common. With the use of fin clips, returning fish can be assigned to age classes. In 2007, males returned at ages 2 through 5 (Table 4). Age 4 fish were the most common, and averaged 729 mm in length and 3.27 kg in weight. Age 2 and age 3 male Chambers Creek steelhead were also well represented in returning steelhead.

Females comprised 53.1% of the run and averaged 704 mm in length and 3.29 kg in weight (Table 3). All three Chambers Creek fin clips were observed for female fish in 2007 with the LM the most common. With the use of fin clips, returning fish can be assigned to age classes. In 2007, females returned at ages 3 through 5 (Table 4). Age 4 fish were the most common, and averaged 710 mm in length and 3.35 kg in weight. Other age classes returned in substantially lower number.

Ganaraska strain

Ganaraska were processed throughout spring operations (Table 2). Lengths ranged from 370 mm to 770 mm and averaged 629 mm. Weights ranged from 0.52 kg to 4.42 kg and averaged 2.56 kg (Table 1). Ganaraska average length and weight increased in 2007 from those measured in 2006, and were the longest and heaviest measured since 2004.

Males comprised 44.0% of the run in 2007 and had an average length of 600 mm and an average weight of 2.20 kg (Table 3). All three Ganaraska fin clips were observed for returning males in 2007, with the adipose-left ventral (ALV) clip the most common. Based on fin clips, ages 2 through 4 male Ganaraska returned during the spring migration (Table 4). Age 4 fish were the most common, with substantially fewer fish of other age captured. Age 4 males averaged 694 mm in length and 3.02 kg in weight.

Females comprised 56.0% of the run and averaged 656 mm in length and 2.87 kg in weight (Table 3). All three clips were detected for female Ganaraska, with the ALV clip the most common. Most of the returning females were age 4 and had an average length of 668 mm and an average weight of 3.02 kg (Table 4). Age 3 and Age 5 female Ganaraska were also present in returning fish but in substantially lower numbers.

Skamania strain

During the spring 2007 run only two Skamania strain steelhead that were identified by fin clips returned to BAFF (Table 1). It is unknown if additional Skamania were among the 99 non-spring spawning steelhead that were returned to the river on April 2 without fin clip and biological information being collected.

In 2007, both of the returning Skamania were female (Table 3). One female had a right maxillary (RM) clip and was Age 4. The other Skamania had a right maxillary-right ventral (RMRV) clip and was Age 5 (Table 4).

Non-broodstock steelhead

The final component of the spring run were 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. The 138 steelhead/rainbow trout which were in this category included the 99 steelhead sorted back to the river on April 2, and two Kamloops rainbow trout (Table 1).

Smolt Out-migration

Trout and salmon were stocked ten miles upstream of Lake Michigan (3 miles upstream of BAFF) between March 19 and May 11. A total of 24,193 Chamber Creek strain steelhead with an average length of 152 mm and a LM clip, 33,311 Ganaraska with an average length of 152 mm and a ALV clip and 25,245 Skamania with an average length of 152 mm and a RM clip were stocked. 31,384 seeforellen brown trout with an ALM clip were stocked into the Kewaunee River between April 9 and April 20. The brown trout had an average length of 185 mm. 152,000 coho salmon with an average length of 147 mm were stocked between March 19 and April 24, and finally 78,572 Chinook salmon with an average length of 100 mm were stocked on May 11 into the Kewaunee River.

On May 1, we began to shock the study locations on an alternate week basis and we continued to shock through June 13 (Table 5). On June 13, while we were electroshocking the downstream site an electrical problem with the stream shocker forced us to only shock 2/3 of the station and ended this study for the year. At the upstream site, daily totals ranged from 41 trout and salmon on May 1 to 13 on June 13. Daily totals of trout and salmon captured at the downstream site ranged from 46 on May 1 to 20 on June 13. Stream flow and stage were variable throughout the survey and were the highest on the first day of the survey and the lowest on the last day (Table 5). Stream temperature was the lowest on May 1 (8 C) and the highest on June 13 (19.2 C).

Steelhead

During the 2007 out-migration survey, Ganaraska strain steelhead were the most commonly captured steelhead followed by Skamania (Table 5). At the upstream location, Skamania and Chambers Creek steelhead were captured in the highest number during the May 1 survey and declined rapidly thereafter. Ganaraska were captured in greatest number on May 15 and then declined in number throughout the remainder of the survey. At the downstream location, Ganaraska and Skamania steelhead were captured in greatest number on May 1 and then declined in abundance while Chambers Creek steelhead were always captured in low number throughout the survey period.

Lengths of captured steelhead were measured during each day of the survey. At the upstream location during the first two shocking events, the average lengths of each strain were similar to their average length at the time of stocking (Table 6). Following two moderate rainfall events we surveyed the site again on May 30 and noted a decline in the average length of each strain. On the last day of survey the average length was similar to the previous survey date. At the downstream site, the average length of each strain varied little and was similar to stocking size.

Salmon

Chinook salmon were captured in very low numbers during the May 17 and May 30 surveys at the upstream location (Table 5). No Chinook salmon were captured downstream of BAFF. The size of captured Chinook salmon were similar to their stocking size (Table 6). We did not capture any of the coho salmon that were stocked into the Kewaunee River during any shocking visit in 2007.

Brown Trout

Brown trout were captured at each survey site each day of the survey and were the second most common captured trout at the upstream site and the most common at the downstream site (Table 5). Average length varied little throughout the survey period at each location (Table 6).

Summer/Fall Adult Collection

Summer/fall fish collections began October 3 when the BAFF fish ladder began to operate. BAFF ponds were sorted thirteen times during October and November to process migrating fish. Fifty steelhead were captured at BAFF during the summer/fall run of 2007 (Table 2). This was the highest total since 1999 when 145 steelhead were captured (Table 7). Eighteen of the 50 steelhead had identifiable Skamania clips which was the highest number seen since 2004. It is likely additional Skamania were among the other 32 steelhead captured but time constraints did not allow for clips to be identified. Skamania with a RM clip averaged 742 mm in length and 3.0 kg in weight. ALM clipped Skamania averaged 674 mm in length and 2.1 kg in weight.

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

Timing

Since 1999 steelhead runs at BAFF have been markedly different in timing and abundance as compared to those occurring before 1999 (Hogler and Surendonk 2006). Spring migratory runs before 1999 had been predictable with large numbers of Chambers Creek returning to the weir with the onset of operations in March followed by increasing Ganaraska numbers in April before the run ended in early May. However, since 1999, run timing does not appear to be as distinct as was historically observed. In 2007, as well as in the previous eight springs, the run has been limited to a two or three week period with the highest number of fish of all strains handled the first day of operation and sharply declining numbers thereafter. There is no clear explanation for the change in run timing or duration unless hatchery practices have compressed the duration of the spring run.

Abundance

Abundance of steelhead during spring runs has changed greatly during the pre and post 1999 period similar to run timing. Spring runs before 1999 consisted of several thousand steelhead, but since 1999 run totals have averaged just 499 steelhead (Figure 1). The 431 steelhead that returned to BAFF during the spring 2007 run was a decrease in number from what was observed in 2006. While Chambers Creek number increased slightly from 2006 to 2007, Ganaraska abundance declined nearly 50% from 2006 to 2007. The two Skamania that were captured in 2007 was the lowest number captured since 1992, although this number should be viewed with caution since Skamania are summer/fall run steelhead and perhaps many were returned to the river on April 2 without being held to collect biological data. In 2007, the unknown (other) component also declined in number from what was measured in 2006.

There is no clear explanation for the decrease in run number observed in the spring steelhead runs since 1992. Likely it was the combination of unseasonable weather (warm or cold), low Lake Michigan water levels making it difficult for fish to migrate upstream, low river flows due to poor spring runoff, a decline in stocking number, poor water quality, poor survival of smolts, or high lake harvest of adult steelhead.

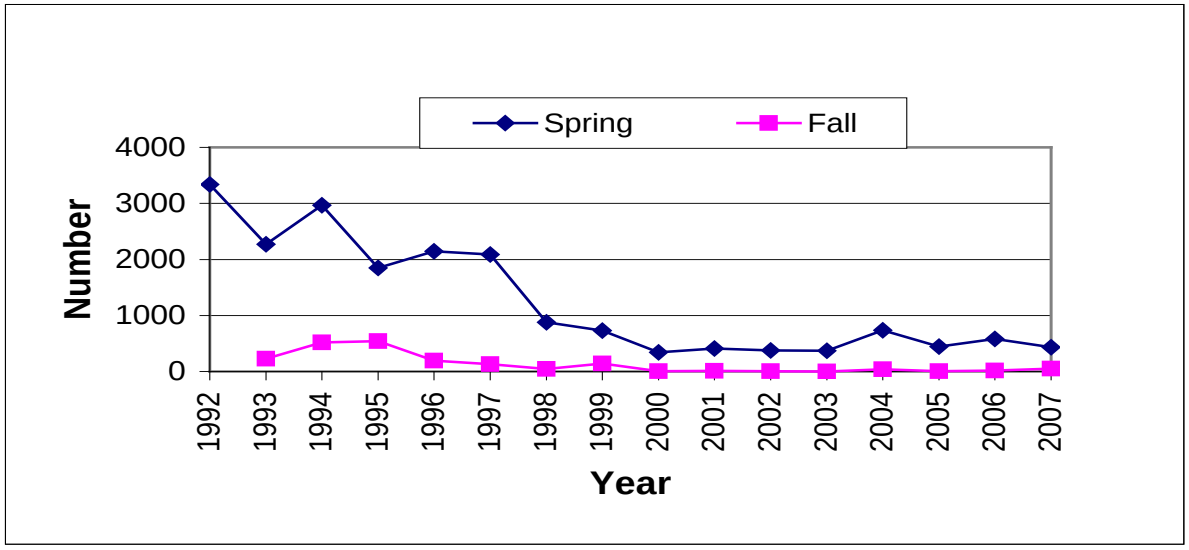

Figure 1. Return number to BAFF on the Kewaunee River for spring and summer/fall runs from 1992 through 2007.

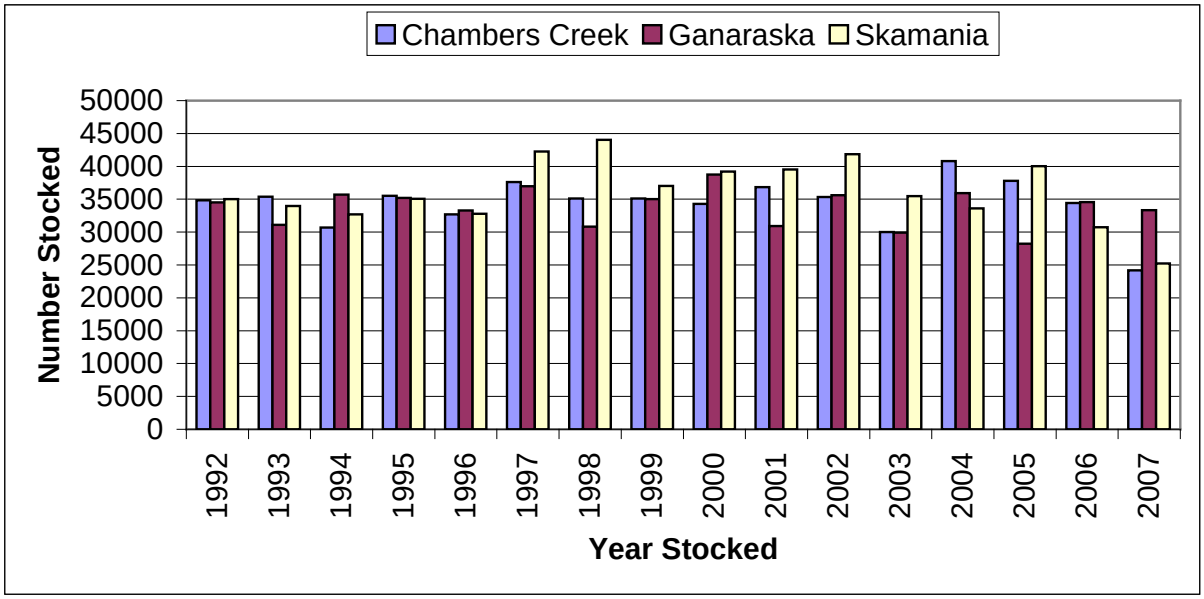

Figure 2. Stocking number by strain for steelhead stocked into the Kewaunee River from 1992 through 2007.

Low lake level and poor spring flows are related to less than normal winter snowfalls and when coupled with unusual spring weather may explain some of the decline in run number observed over the past eight years. Low water makes it difficult for large spawning steelhead to negotiate shallow stream sections and the lack of flow may inhibit upstream movement. These poor conditions may cause steelhead to attempt to spawn in lower sections of the Kewaunee River or drop back into Lake Michigan without spawning. In 2006 and 2007, early spring flows that appeared to be adequate to draw steelhead into the river, quickly decreased causing the run to dwindle out after the first week in April (Table 2).

Stocking number does not appear to be contributing to the decline in run number. Stocking number continues to remain relatively stable for all strains, although stocking numbers have varied from year to year, they have generally remained within 10-12% of the stocking goal of 35,000 for each strain except in 2007 when only Ganaraska were stocked in near normal number (Figure 2). The decline in stocking number in 2007 may reduce future runs substantially.

Water quality data collected during 2000 and 2004 suggest that in the Kewaunee River, runoff events may negatively impact water quality. In 2000, monitoring indicated that concentrations of dissolved oxygen dropped below the state standard of 5 mg/l regularly on the Kewaunee River due to runoff events (Hogler 2001). However, in 2004, monitoring indicated that water quality was generally good in the Kewaunee River. Unlike 2000, state standards for dissolved oxygen for warm water streams were never violated in 2004 (Hogler 2005). In 2007, visual inspection of the river and DO measurements did not any indicate water quality issues.

Mortality of smolts may also play an important role in the declining number of returning steelhead seen the past seven years. 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. 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 before 2007 were smaller in length than the 200 mm recommended by Seelbach (1985) and many were less than 150 mm. Bartron (2003) indicated that steelhead stocked at less than 150 mm in length survive poorly and contribute little to the fishery as adults. Recent drought conditions have reduced the amount of well water at Kettle Moraine Springs Fish Hatchery. Reduced water flow through the hatchery has impacted steelhead by reducing the number of smolts produced and has caused fish to be stocked earlier in the year at a smaller size which is reflected in stocking records. The small size of recently stocked steelhead may be contributing to the decline in return number of steelhead.

In addition to physical size, other factors, such as disease status or the amount of fat reserve, and predation by avian and fish predators 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 2006). Harvest during 1994, 1995 and 1998 exceeded 110,000 steelhead. However, the five year harvest average has declined to 48,900 and over the past three summers harvest has further declined to 40,631. Despite this marked reduction in harvest of steelhead from the Wisconsin waters of Lake Michigan the number of steelhead returning to BAFF has not increased. 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 the return to weir of Wisconsin stocked steelhead.

Fall

The 50 steelhead handled at BAFF in the summer/fall of 2007 was the highest total since 1999 when 145 steelhead were captured (Table 7). The summer/fall run continues to be much lower than historic runs of the early 1990's. Poor river conditions, with low flow and warm water temperatures are likely responsible for some of the declines seen in fall runs since the late 1990's.

Strain Performance

Chambers Creek

The average length and all three weight indices increased in 2007 from 2006 levels for Chambers Creek steelhead (Table 1, Figure 3). The increases in average length and weight are likely due to an increase in the number of age 4 fish that returned to the weir in 2007, as compared to 2006 when age 3 steelhead dominated the run. Standard and trophy weights also increased in 2007 from 2006 values (Figure 3). The 2007 standard weight was similar to the long term standard weight average, while trophy weight remained near the 15 year low. The lack of large, older steelhead in spring runs suggests that forage on Lake Michigan may be an issue, that anglers are harvesting large numbers of adult steelhead or that low river levels may be preventing large fish from reaching BAFF.

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 returned at age 4, we would expect to see the highest return rate of a year class occur three years after fish were stocked. In 2007, 4-year-old Chambers Creek steelhead stocked in 2004 returned to BAFF at the second highest rate since 2004 when 2001 stocked fish returned at 4.53 per thousand stocked (Table 8). Good water flow in 2004 likely contributed to the good return in 2007. Overall, the best Chamber Creek return rates have been for fish stocked in 1999, 2001 and 2004.

The return of 2005 stocked fish as age 3 steelhead was average in 2007 and age 2 fish returned at a better than the average rate so it is hoped that the 2008 run will improve over the 2007 run.

Ganaraska

Ganaraska strain steelhead have had more variation in yearly length and weight average than have Chambers Creek strain fish (Table 1). In 2007, average length and weight increased from 2006 levels, and were similar to 2004 averages. Although standard and trophy weights increased in 2007 from what was measured in 2006, they remain near the lowest levels measured since 1999. It is likely the lack of fish older than age 3 have caused

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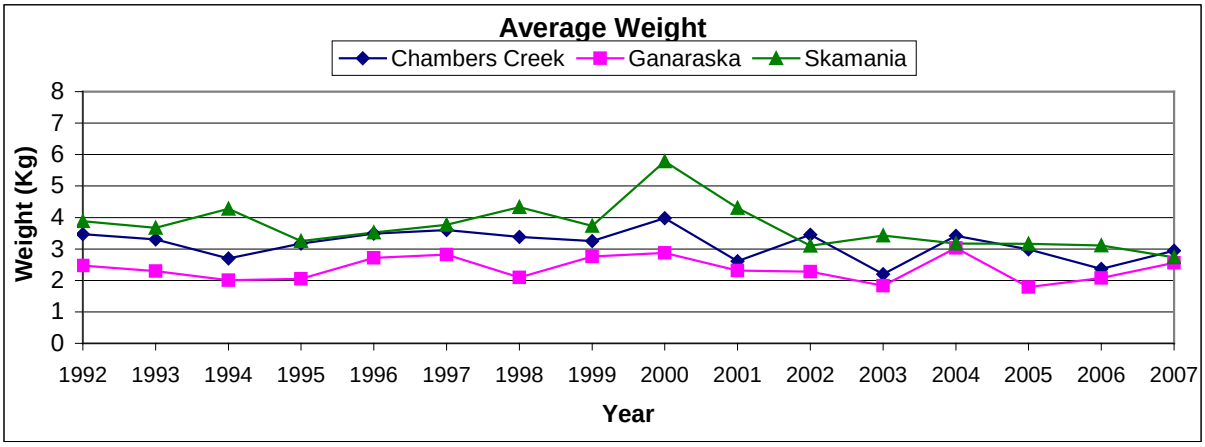

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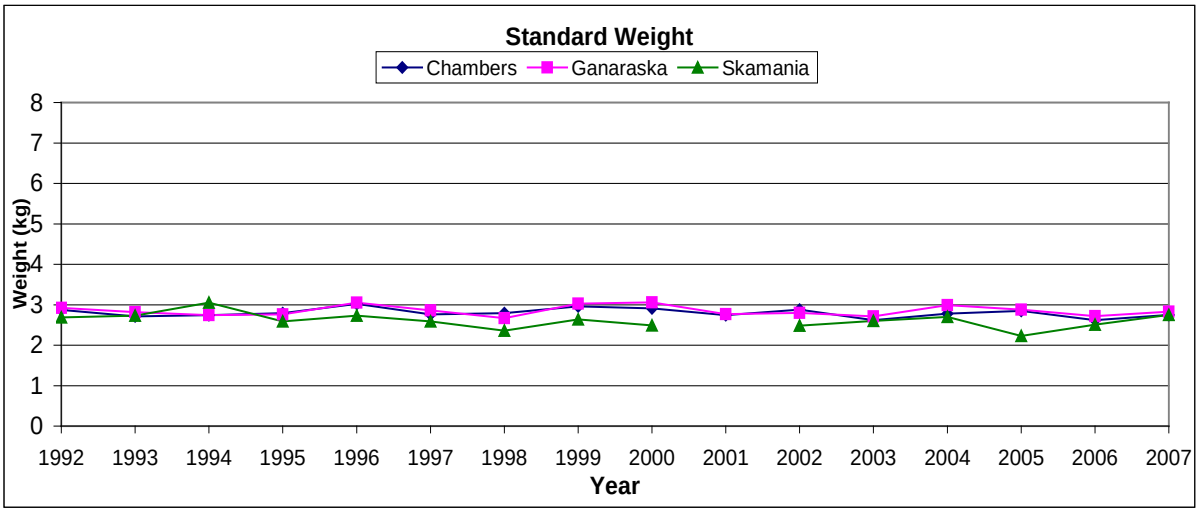

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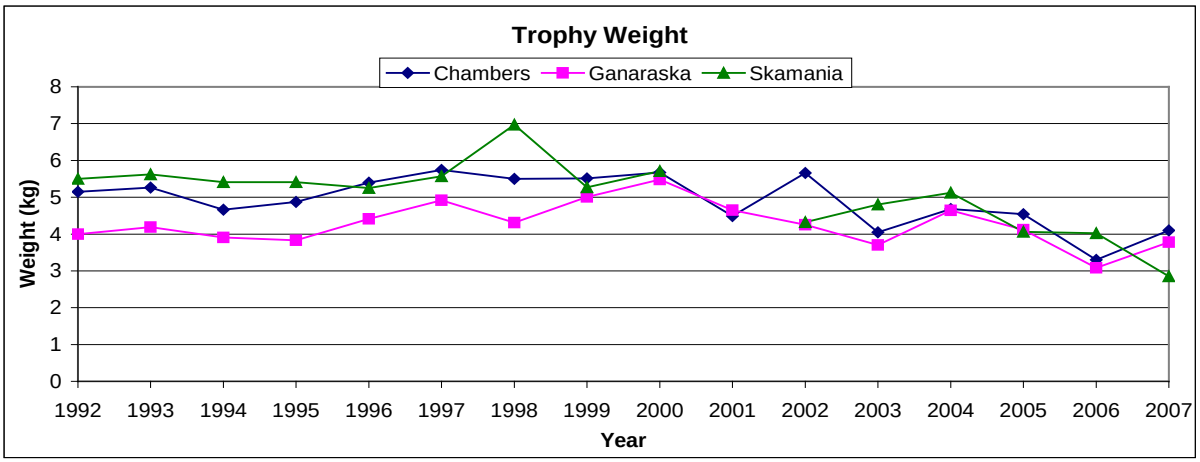

Figure 3. Weights trends for steelhead during spring migrations at BAFF, 1992-2007: (A) Average weight for each strain for that year, (B) Standard weight is based on the projected weight of a 660 mm steelhead, (C) Trophy weight for each strain based on the 95th percentile of weighed steelhead.

the decline in trophy weight, while the decline in standard weight may be linked to forage levels on Lake Michigan (Table 4).

The return rate of stocking year class 2004 Ganaraska, was the highest return of 4 year old fish since the 2001 stocking year class returned in 2004 (Table 9). The 2004 stocking year class continued to be the best returning year class since the 1997 year class. It is hoped that the 2004 year class of Ganaraska remains strong in order to improve the overall return of Ganaraska. Similar to the Chambers Creek strain, Ganaraska stocked in 1998, 2000 and 2003 have performed poorly, with improvements in return noted for those Ganaraska steelhead stocked in 2001 and 2004.

Skamania

Skamania were a small, but consistent portion of the spring run until 2007 when their abundance dropped substantially (Table 1). Average weight and trophy weight declined in 2007, while standard weight increased (Figure 3). But, since only two Skamania were handled during the 2007 spring run, average weight information should be viewed cautiously.

The number of Skamania collected during the fall run has varied greatly. Spring and fall return rates for the three most recent stocking years have been nearly zero and is indicative of the poor Skamania return to the Kewaunee River since 1999 (Table 10). Lack of fall rain and high lake harvest may be responsible for the variation in run number.

Comparison of Strain Performance

Chambers Creek steelhead had a better return to the weir in 2007 as compared to the 2006 run, while Ganaraska and Skamania numbers declined. Of the spring running strains since 1999, Ganaraska have returned to BAFF in greatest number. Survival based on return per thousand stocked indicates that Ganaraska has had more consistent returns and a slightly better overall return than has Chambers Creek strain steelhead. Summer-run Skamania have had reduced run numbers since the 1995 peak. The return rate of Skamania per thousand stocked 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 quality smolts, poor river water quality and high harvest of adult fish by anglers on Lake Michigan. If returns continue to decline, each of these potential reasons could be examined to determine the cause of the decline.

Based on measured size, Skamania continue to be the largest steelhead followed by Chambers Creek and then Ganaraska. Mixed results from the three weight trends may indicate forage problems on Lake Michigan, or be the result of greater numbers of younger

fish in the run because low water inhibited the upstream movement of larger steelhead. Angler harvest of adult steelhead may have also reduced the number of steelhead returning to BAFF.

Smolt Out-migration

During our electroshocking surveys in 2005, 2006 and 2007 we documented that (1) smolts survive stocking and (2) that they are able to pass downstream of the dam at BAFF and make it to lower river sections on the way to Lake Michigan. Because the number of fish we captured was far less than 1% of the fish stocked and because we are not able to track fish all the way to Lake Michigan, we can not quantify with certainty how many fish survive stocking, downstream movement and ultimately make it to Lake Michigan.

We can however make general observations regarding the data collected the since 2005.

Chinook and coho salmon appear to leave the Kewaunee River quickly following stocking. During the last three years of the survey, Chinook salmon have been collected once or twice at the upstream location shortly after stocking and then are not captured thereafter. Although coho salmon were not captured in 2007, collections the previous two years indicate they are captured early in the survey and move out of the area quickly.

Steelhead appeared to move downstream more slowly than do the salmon. Although in 2006 and 2007 the highest daily catch occurred on the first day shocking, the number captured throughout the remainder of the sampling period remained relatively constant. However, at the downstream station steelhead numbers declined quickly following the first survey day. This pattern of movement was the inverse of what was observed in 2005 and may be related to river flow. By remaining longer in upstream areas of the river it is hoped that steelhead imprint better to the river improving return in subsequent years, but by remaining in the river longer, steelhead may encounter greater mortality because of poor water quality, warming river temperatures or through being preyed upon by fish and bird predators. In Michigan tributary streams, Seelbach (1985) suggests that steelhead may spend two years in streams before entering Lake Michigan. While this is a normal condition in good trout water, it is likely that this trait, if widespread in Wisconsin waters could reduce the number of steelhead that migrate out of streams to Lake Michigan and ultimately return to spawn. Returns in future years should be monitored to determine if the 2005 or the 2006 -2007 out-migration pattern provides the greater return to weir.

Brown trout appear to move downstream slower than steelhead and much slower than salmon based on the last three years of collected data. Similar to steelhead, brown trout movement in 2007 was different than what was observed in 2005. In 2007, upstream numbers remained low throughout the survey period, while downstream numbers were much higher. Although this indicates that brown trout moved downstream over the BAFF dam shortly after stocking, they were slow to leave the survey area and migrate downstream to Lake Michigan.

SUMMARY

The 2007 spring run total decreased from what was observed during the 2006 spring run. Although the 2007 run was typical of the runs of the past five years, it was far less than those observed from 1991 through 1996. The reduction in return number is likely due to the poor return rate for several year classes that were stocked between 1998 and 2002. Poor survival of these year classes may be due to unusual weather conditions that resulted in poor flow on the Kewaunee River, high harvest of adult fish, or from mortality of recently stocked smolts.

Changes in the spring 2007 average, standard and trophy weights may be due to a larger percentage of the run being age 4 as compared to the 2006 run that was dominated by age 3 steelhead. Long term changes in weight trends are likely due to the absence of age 5 and older fish which were present in past runs. Why older fish are absent from recent runs is unknown at this time and may be related to angler harvest, fish health, stocking location or predation on smolts.

The summer/fall run of steelhead was fair in 2007 and was similar to the 2004 run, but still much less than historic runs. It is likely a very dry summer and fall in 2007 limited the fall/summer run of Skamania.

We continued to evaluate the relative magnitude of the smolt out-migration from the Kewaunee River in 2007. While we were able to capture steelhead and other trout and salmon smolts, and make general statements regarding timing and downstream movements, many questions remain unanswered regarding survival of stocked fish. 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.

Gamete collections for the two spring strains of steelhead were good from BAFF in 2007 and should result in near normal numbers of Chambers Creek and Ganaraska being stocked in 2008. Adult Skamania used as brood fish were not collected from either steelhead facility in 2007 due to VHS concerns which will result in no Skamania stocking in 2009 by Wisconsin.

REFERENCES

Baumgartner, M. 1995. Operational plan for the C.D. “Buzz” Besadny weir. Wisconsin Department of Natural Resources. Unpublished report. 23 p.

Bartron, M.L. 2003. Assessment of Historical and Contemporary Genetic Diversity of Steelhead (*Oncorhynchus mykiss*) in the Lake Michigan Basin. Doctorate Research, Michigan State University, Department of Fisheries and Wildlife. East Lansing, MI. 135 pages.

Daly, R. 1968. Chasing Rainbows. Wisconsin Conservation Bulletin. July-August 1968. 2 p.

Eggold, B. 2006. Wisconsin's 2005 open water sportfishing effort and harvest from Lake Michigan and Green Bay. Wisconsin Department of Natural Resources. 19 p.

Hogler, S. 2001.2000 Kewaunee River Baseline Monitoring Report. Wisconsin Department of Natural Resources. 58 p.

Hogler, S. and S. Surendonk. 2006. Return, size, Age and Movement of Steelhead at the Besadny Anadromous Fisheries Facility, 2006. Wisconsin Department of Natural Resources. 22 p.

Seelbach, P. 1985. Smolting success of hatchery raised steelhead planted in a tributary of Northern Lake Michigan. Michigan Department of Natural Resources. Fish. Res. Rep. No. 1934. 23 p.

Wisconsin Department of Natural Resources. 1988. Lake Michigan Steelhead Plan. Administrative Report #29. Bureau of Fisheries Management. December, 1988. Madison, Wisconsin. 18 p.

Table 1. Summary of steelhead length and weight data collected during spring migratory runs at BAFF, on the Kewaunee River, 1999-2007.

Year	Strain	Number	Run %	Average Length (mm)	Length Range (mm)	Average Weight (kg)	Weight Range (kg)	Standard Weight (kg)*	Trophy Weight (kg)**
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							
2005	Chambers	66	14.9	675	400-850	2.99	0.68-5.12	2.85	4.54
	Ganaraska	125	28.2	537	280-869	1.79	0.2-5.92	2.88	4.12
	Skamania	15	3.4	732	685-815	3.16	2.4-4.06	2.23	4.06
	Other	237	53.5	--	--	--	--	--	--
	Total	443							
2006	Chambers	135	23.2	633	435-762	2.37	0.60-4.12	2.62	3.30
	Ganaraska	249	42.8	588	397-794	2.08	0.40-5.32	2.72	3.08
	Skamania	17	2.9	704	630-795	3.11	2.02-4.02	2.51	4.02
	Other	181	31.1	--	--	--	--	--	--
	Total	582							
2007	Chambers	163	37.8	679	405-810	2.94	0.56-4.76	2.75	4.10
	Ganaraska	128	29.8	629	370-770	2.56	0.52-4.42	2.83	3.78
	Skamania	2	0.5	658	630-685	2.73	2.46-3.00	2.75	2.85
	Other	138***	31.9	--	--	--	--	--	--
	Total	431							

* Standard weight is a prediction based on a 660.4-mm steelhead.

** Trophy weight is based on the 95 percentile of weighed steelhead.

*** Includes 99 steelhead checked for fin clips and returned to the river.

Table 2. Daily totals during 2007 operations at BAFF, by strain of steelhead.

Spring Run Steelhead

Date	Chambers Creek	Ganaraska	Skamania	Other	Day Total
April 2	0	0	0	99	99
April 4	131	60	0	14	205
April 9	22	38	1	9	70
April 18	10	30	1	16	57
Total	163	128	2	138	431

Summer/Fall Run Steelhead

Date of Operation	Chambers Creek	Ganaraska	Skamania	Other	Day Total
October 6				1	1
October 17			2		2
October 18				1	1
October 19				15	15
October 22					0
October 23	2		16	5	23
October 25					0
October 31				1	1
November 6				5	5
November 13					0
November 20					0
November 26					0
November 29				2	2
Total	2	0	18	30	50

Table 3. Average length, weight and run number by strain, clip, and sex during the spring spawning run at BAFF, 2007.

	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)	491	1.22	18	756	4.1	3
Adipose, Left Maxillary (ALM)	648	2.40	20	645	2.67	11
Left Maxillary (LM)	729	3.27	38	710	3.35	72
Chambers Creek combined average	**701**	**2.56**	**76**	**704**	**3.29**	**86**
Ganaraska						
Adipose, Left Ventral (ALV)	687	2.96	32	667	3.01	52
Adipose, Right Ventral (ARV)	593	1.99	7	592	2.08	14
Both Ventral (BV)	429	0.80	16	753	3.69	4
Ganaraska combined average	**600**	**2.20**	**55**	**656**	**2.87**	**70**
Skamania						
Adipose, Right Maxillary (ARM)	--	--	0	--	--	0
Right Maxillary (RM)	--	--	0	630	2.46	1
Right Maxillary, Right Ventral (RMRV)	--	--	0	685	3.0	1
Skamania combined average	**--**	**--**	**--**	**658**	**2.73**	**2**

Table 4. The age distribution, length, and weight of returning clipped steelhead by sex for the Kewaunee River spring 2007.

Chambers Creek

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	16	20	38	2	0	Measured	0	11	72	3	0
Average Length (mm)	451	648	729	805	--	Average Length (mm)	--	645	710	756	--
Range (mm)	405-485	540-690	625-840	760-850	--	Range	--	525-700	580-810	740-770	--
Weighed	16	20	38	2	0	Weighed	0	11	72	3	0
Average Weight (kg)	0.84	2.40	3.27	4.30	--	Average Weight (kg)	--	2.67	3.35	4.09	--
Range (kg)	0.66-1.04	1.30-2.92	2.10-4.82	3.96-4.64	--	Range (kg)	--	2.20-3.12	1.78-4.76	3.50-4.50	--

Ganaraska

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	17	7	31	0	0	Measured	0	14	52	4	0
Average Length (mm)	431	593	694	--	--	Average Length (mm)	--	592	668	733	--
Range (mm)	370-470	540-632	585-775	--	--	Range	--	520-655	595-752	690-770	--
Weighed	17	7	31	0	0	Weighed	0	14	52	4	0
Average Weight (kg)	0.81	1.99	3.02	--	--	Average Weight (kg)	--	2.08	3.02	4.00	--
Range (kg)	0.52-1.04	1.46-2.84	2.18-4.22	--	--	Range (kg)	--	1.66=2.78	2.28-4.42	3.36-4.28	--

Skamania

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	0	0	0	0	0	Measured	0	0	1	1	0
Average Length (mm)	--	--	--	--	--	Average Length (mm)	--	--	630	685	--
Range (mm)	--	--	--	--	--	Range	--	--	--	--	--
Weighed	0	0	0	0	0	Weighed	0	0	1	1	0
Average Weight (kg)	--	--	--	--	--	Average Weight (kg)	--	--	2.46	3.00	--
Range (kg)	--	--	--	--	--	Range (kg)	--	--	--	--	--

Table 5. Total trout and salmon captured by electroshocking during the 2007 out-migration study. The upstream site is above BAFF and the downstream site is below BAFF.

Upstream	CFS	Stage	Coho	Chinook	Brown	Chambers	Ganaraska	Skamania	Other	Total	Temp (C)
1-May	57	9.28	0	0	9	9	12	10	1	**41**	8.0
17-May	30	9.07	0	8	2	4	16	3	2	**35**	13.0
30-May	24	8.95	0	2	8	0	7	3	0	**20**	19.1
13-June	15	8.85	0	0	4	4	1	4	0	**13**	19.2
Total			0	10	23	17	36	20	3	109	
Downstream	**CFS**	**Stage**	**Coho**	**Chinook**	**Brown**	**Chambers**	**Ganaraska**	**Skamania**	**other**	**Total**	**Temp. (C)**
1-May	57	9.28	0	0	23	3	14	6	0	**46**	8.0
17-May	30	9.07	0	0	38	0	9	1	0	**48**	13.0
30-May	24	8.95	0	0	21	2	1	0	0	**24**	19.1
***13-June**	15	8.85	0	0	15	1	3	1	0	**20**	19.2
Total			0	0	97	6	27	8	0	138	

*** During the June 13 survey of the downstream site, an electrical problem caused the survey to be ended after covering 2/3 of the station.**

Table 6. Average lengths (mm) of trout and salmon captured during the out-migration study in 2007.

Strain	Stocking Length (mm)	Upstream				Downstream			
		1-May	17-May	30-May	13-June	1-May	17-May	30-May	13-Jun
Chambers Creek	152	155	158	--	134	153	--	163	182
Ganaraska	152	159	156	134	146	174	160	149	160
Skamania	152	164	--	143	133	186	160	--	151
Chinook	100	--	87	101	127	--	--	--	--
Brown Trout	185	180	165	178	195	188	188	194	175

Table 7. Steelhead fin clip trends detected at BAFF during fall migrations, 1999-2007.

Strain and fin clip	1999	2000	2001	2002	2003	2004	2005	2006	2007
Skamania									
Adipose, Right Maxillary (ARM)	8	3				28			4
Right Maxillary (RM)	76	1	8	1		4	2	1	14
Right Maxillary,Right Ventral (RMRV)	9	1					1		
Total Skamania	93	5	8	1	0	32	3	1	18
Chambers Creek									
Left Maxillary (LM)	1								
Left Maxillary, Left Ventral (LMLV)								1	1
Adipose, Left Maxillary (ALM)									1
Total Chambers Creek	1	0	0	0	0	0	0	1	2
Ganaraska									
Adipose, Right Ventral (ARV)									
Adipose, Left Ventral (ALV)									
Both Ventral (BV)									
Total Ganaraska	0	0	0	0	0	0	0	0	0
Unknown									
No Clips	30	2	5	2		3			5
Both Maxillary (LMRM)									
Adipose (?), Right Ventral (A?RV)									
Adipose (A)	1								
Other	20					5	3	13	25
Total Unknown	51	2	5	2	0	8	3	13	30
Total Fall Steelhead Run	**145**	**7**	**13**	**3**	**0**	**40**	**6**	**15**	**50**

Table 8. Return rates (number per thousand stocked) for Chambers Creek steelhead during spring migrations on the Kewaunee River, 1998-2007.

	Year Stocked									
Return Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1998	0.11	--	--	--	--	--	--	--	--	--
1999	0.80	0.03	--	--	--	--	--	--	--	--
2000	0.93	0.11	0.09	--	--	--	--	--	--	--
2001	0.11	0.09	1.51	0.00	--	--	--	--	--	--
2002	0.00	0.03	1.23	0.09	0.05	--	--	--	--	--
2003	0.00	0.00	0.11	0.15	1.79	0.17	--	--	--	--
2004	0.00	0.00	0.00	0.00	4.53	1.02	0.00	--	--	--
2005	0.00	0.00	0.06	0.00	0.62	0.48	0.20	0.20	--	--
2006	0.00	0.00	0.00	0.00	0.14	0.23	0.27	2.69	0.11	--
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.17	2.69	0.82	0.52
Total	1.95	0.26	3.00	0.24	7.13	1.90	0.64	5.58	0.93	0.11

Table 9. Return rates (number per thousand stocked) for Ganaraska steelhead during spring migrations on the Kewaunee River, 1998-2007.

	Year Stocked									
Return Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1998	0.35	--	--	--	--	--	--	--	--	--
1999	1.68	0.16	--	--	--	--	--	--	--	--
2000	0.57	0.58	0.51	--	--	--	--	--	--	--
2001	0.19	0.52	3.08	0.08	--	--	--	--	--	--
2002	0.00	0.16	0.13	0.08	0.16	--	--	--	--	--
2003	0.00	0.00	0.17	0.00	1.49	0.45	--	--	--	--
2004	0.00	0.00	0.00	0.03	3.40	1.26	0.37	--	--	--
2005	0.00	0.00	0.00	0.00	0.58	0.73	0.67	1.72	--	--
2006	0.00	0.00	0.00	0.00	0.36	0.19	0.70	5.39	0.57	--
2007	0.00	0.00	0.00	0.00	0.00	0.00	0.13	2.36	0.74	0.52
Total	2.79	1.42	3.89	0.19	5.99	2.63	1.87	9.47	1.31	0.52

Table 10. Return rates (number per thousand stocked) for Skamania steelhead during spring migrations on the Kewaunee River, 1997-2007.

	Year Stocked									
Return Year	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
1998	0.00	--	--	--	--	--	--	--	--	--
1999	0.00	0.00	--	--	--	--	--	--	--	--
2000	0.00	0.00	0.12	--	--	--	--	--	--	--
2001	0.00	0.02	0.03	0.00	--	--	--	--	--	--
2002	0.00	0.00	0.43	0.03	0.00	--	--	--	--	--
2003	0.00	0.00	0.32	0.03	0.03	0.05	--	--	--	--
2004	0.00	0.00	0.11	0.03	0.53	0.12	0.00	--	--	--
2005	0.00	0.00	0.00	0.00	0.33	0.05	0.00	0.00	--	--
2006	0.00	0.00	0.00	0.00	.0.03	0.05	0.34	0.06	0.00	--
2007	0.00	0.00	0.00	0.00	.0.00	0.00	0.03	0.03	0.00	0.00
Total	0.00	0.02	1.01	0.09	0.92	0.27	0.37	0.09	0.00	0.00