Return, Size, and Age of Steelhead at the Besadny Anadromous Fisheries Facility, 2009

Steve Hogler and Steve Surendonk

ABSTRACT

An annual steelhead assessment project began 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 2009 began on March 30 when the ponds were sorted to look for steelhead with Chambers Creek and Ganaraska fin clips and continued through April 13. During this period 815 steelhead were handled at BAFF. The run consisted of 272 Chambers Creek strain steelhead, 219 Ganaraska, 32 Skamania and 292 unclipped, misclipped or strays from other streams or states.

The 2009 spring run total although above average, was only 51.5% of the 2008 spring run total. The increases observed in the most of the weight indices for steelhead captured during the 2009 spring run are likely due to a larger percentage of the run being age 4 as compared to the 2008 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 more abundant in past runs. Why older fish are absent from recent runs is unknown at this time but may be related to angler harvest, fish health, stocking location or poor survival of smolts.

The 109 steelhead handled at BAFF in the summer/fall of 2009 was the highest total since 1999 when 145 steelhead were captured. The summer/fall run continues to be much lower than historic runs of the early 1990's. The 2009 summer/fall run was also unlike earlier summer/fall runs in that earlier runs peaked in August or early September following late summer rains, while the 2009 peaked in mid-November. It is not known if the Skamania run has shifted toward the fall or if these are normal fall numbers without the early run component that was common in earlier years.

We continued to evaluate the relative magnitude of the smolt out-migration from the Kewaunee River in 2009. We captured few migrating trout and salmon in 2009 likely due to high river flows that induced out-migration before we began shocking. 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.

Gamete collections for the two spring strains of steelhead were good from BAFF in 2009 and should result in near normal numbers of Chambers Creek and Ganaraska being stocked in 2010. Adult Skamania to be used as brood fish were not collected from either

steelhead facility in 2009 due to VHS concerns which will result in no Skamania stocking in 2011 by Wisconsin unless gametes or fingerlings are obtained from another source.

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 2009 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 broke up and continued until egg quotas were reached. 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 as fish proceeded through BAFF, they 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 trucked downstream to be released. Fish that were not ripe, but having the appropriate fin clip were returned to a holding pond until they were ripe. All other fish were measured, weighed, revived, trucked downstream and released.

Fall operations began in early October when the pumps were turned on and continued until mid-November when the pumps were turned off. Steelhead were checked for fin clips, and a subsample were weighed and measured. With the onset of VHS, all steelhead returning to the weir in fall were harvested or trucked to the Kewaunee Harbor.

The data were analyzed using basic fishery statistics, such as average length and weight by sex and clip. Before steelhead smolts are stocked into the Kewaunee River, they are 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 assignment of 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 are 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, a single survey station below BAFF that was 350 meters in length was shocked. Stream electroshocking began immediately following the cessation of stocking and was scheduled to occur weekly until smolts were no longer captured. 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, measured to the nearest 1 mm and released back into stream. On survey dates, stream flow and stage information was collected from the USGS gauging site on the Highway F bridge just upstream of the survey site.

RESULTS

Spring-Adult Collection

Spring operations in 2009 began on March 30 when the ponds were sorted to look for steelhead with Chambers Creek and Ganaraska fin clips and continued through April 13 when the ponds were emptied. During this period, 815 steelhead were handled at BAFF. The run consisted of 272 Chambers Creek strain steelhead (33.4% of the run), 219 Ganaraska (26.9%), 32 Skamania (3.9%) and 292 (35.8%) unclipped, misclipped or strays from other streams or states (Table 1). The number of fish handled during the spring run in 2009 declined 48.5% from the 2008 total but still was more than the average run total from the previous eight springs of 617. The largest decline was in Ganaraska strain fish (60%) followed by Chambers Creek (45.5%) and non-broodstock steelhead (43.5%). Skamania strain steelhead increased by 52.3% over their 2008 total.

The Chambers Creek run peaked on March 30 while the Ganaraska run peaked on April 7 (Table 2). After egg collection was completed on April 13, the steelhead component of the facility was closed because the egg quota was reached and because of budget and staff shortfalls. It is likely more steelhead would have entered the facility if it had remained open.

Chambers Creek Strain

A total of 272 Chambers Creek strain steelhead were handled during the spring run of 2009 (Table 1; Table 2). They ranged in length from 440 mm to 832 mm and had an average length of 677 mm. Chambers Creek weight ranged from 0.90 kg to 5.62 kg and averaged 2.94 kg. The average length and average weight for Chambers Creek steelhead increased in 2009 from their 2008 levels and were near the 2000-2008 average length and weight.

Males comprised 46.0% of the run and averaged 671 mm in length and 2.78 kg in weight (Table 3). All three Chambers Creek fin clips were observed for male fish, with the left maxillary left ventral (LMLV) the most common. With the use of fin clips, returning fish can be assigned to age classes. In 2009, males returned at ages 2 through 7 (Table 4). Age 4 fish were the most common, and they averaged 697 mm in length and 3.05 kg in weight. Age 3 male Chambers Creek steelhead were also well represented in returning steelhead, with other age males much less abundant.

Females comprised 54.0% of the run averaging 681 mm in length and 3.07 kg in weight (Table 3). All three Chambers Creek fin clips were observed for female fish in 2009, with the LMLV the most common. With the use of fin clips, returning fish can be assigned to age classes. In 2009, females returned at ages 3 through 6 (Table 4). Age 4 fish were the most common, and averaged 685 mm in length and 3.09 kg in weight. Other age classes returned in substantially lower number.

Ganaraska strain

During spring operations a total of 219 Ganaraska were processed (Table 2). Ganaraska lengths ranged from 415 mm to 785 mm and averaged 636 mm (Table 1). Weights ranged from 0.72 kg to 4.90 kg and averaged 2.55 kg. Ganaraska average length and weight increased in 2009 from those measured in 2008, and were similar to the average length and weigh of captured Ganaraska from 2000 though 2008.

Males comprised 46.1% of the run in 2009 and had an average length of 620 mm and an average weight of 2.26 kg (Table 3). All three Ganaraska fin clips were observed for returning males in 2008 with the both ventral (BV) clip the most common. Based on fin clips, ages 2 through 5 male Ganaraska returned during the spring migration (Table 4). Age 4 fish were the most common, with substantially fewer fish of other ages captured. An average age 4 male was 656 mm in length and 2.53 kg in weight.

Females comprised 53.9% of the run and averaged 650 mm in length and 2.79 kg in weight (Table 3). All three clips were detected for female Ganaraska, with the BV clip the most common. Most of the returning females were age 4 and had an average length of 656 mm and an average weight of 2.85 kg (Table 4). Other age female Ganaraska were also present in returning fish but in substantially lower number than age 4 fish.

Skamania strain

During the spring 2009 run, thirty-two Skamania strain steelhead returned to BAFF and were processed during spring operations (Tables 1 and 2). Lengths ranged from 590 mm to 815 mm and averaged 679 mm (Table 1). Weights ranged from 1.78 kg to 4.40 kg and averaged 2.65 kg. Skamania average length and weight decreased in 2009 from those measured in 2008 and were the second smallest measured since 2001.

Males comprised 53.1% of the run in 2009 and had an average length of 688 mm and an average weight of 2.59 kg (Table 3). Two Skamania fin clips were observed for returning males in 2009 with the right maxillary-right ventral (RMRV) clip the most common. Based on fin clips, age 3 and age 4 male Skamania returned during the spring migration (Table 4). Age 4 fish were the most common and averaged 692 mm in length and 2.56 kg in weight.

Females comprised 46.9% of the run and averaged 670 mm in length and 2.72 kg in weight (Table 3). Two clips were detected for female Skamania, with the RMRV clip the most common. Ages 3 through 6 returned in 2009 with age 4 the most common and averaged 671 mm in length and 2.52 in weight (Table 4) Other aged Skamania returned in substantially lower number.

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 likely 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. Non-broodstock steelhead were processed during each day of operation, peaked on March 30 and accounted for 35.8% of the 2009 run (Table 2).

Smolt Out-migration

Stocking of trout and salmon, ten miles upstream of Lake Michigan (3 miles upstream of BAFF), started on March 13 and continued through May 11. A total of 31,308 Chambers Creek strain steelhead with an average length of 152 mm and an ALM clip and 15,095 Ganaraska with an average length of 152 mm and a BV clip were stocked into the Kewaunee River between April 10 and May 11. No Skamania were stocked in 2009. 36,559 seeforellen brown trout with an adipose –left pectoral (ALP) clip were stocked into the Kewaunee River between March 19 and March 30. The brown trout had an average length of 178 mm. 189,099 coho salmon with an average length of 158 mm were stocked between March 13 and April 2 and finally 76,609 Chinook salmon with an average length of 100 mm were stocked on May 11 into the Kewaunee River.

We shocked the study location below BAFF once a week between May 6 and May 19. After May 19, the decision was made to discontinue shocking because of low numbers of trout and salmon in our catch (Table 5). Daily totals of trout and salmon captured ranged

from 16 on May 19 to 19 on May 6 and 13. Stream flow, stage and temperature declined throughout the survey with the highest values on the first day of the survey and the lowest on the last day (Table 5).

Steelhead

During the 2009 out-migration survey, Chambers Creek strain was the most commonly captured steelhead. This number may be misleading because of the difference in the number of each strain that were stocked. If stocking number is considered, we captured each strain in the proportion in which they were stocked, 2.1 Chambers for each Ganaraska (Table 5). Steelhead catch varied little between the three survey dates with 13 captured on May 6 and 8 on May 19.

The length of captured steelhead was measured during each day of the survey. Steelhead were the smallest on the first date of survey and largest on the last day. The average length of each strain was similar to their average length at the time of stocking (Table 6). Although similar in size at the time of stocking, captured Chambers Creek steelhead were longer than Ganaraska steelhead on the last day of the survey.

Salmon

During the outmigration survey, we captured only one Chinook salmon fingerling eight days following stocking (Table 5). We did not capture any of the coho salmon that were stocked into the Kewaunee River during any shocking visit in 2009.

Brown Trout

Brown trout were captured during each day of this survey in nearly equal number (Table 5). Average length declined throughout the survey period and may indicate that smaller brown trout moved more slowly downstream past our survey location than larger fish (Table 6).

Summer/Fall Adult Collection

Summer/fall fish collections began on October 7 when the BAFF fish ladder began to operate. BAFF ponds were sorted six times during October and November to process migrating fish. One hundred seven steelhead were captured at BAFF during the summer/fall run of 2009 (Table 2). This was the highest total since 1999 when 145 steelhead were captured. Sixty-six of the one hundred-seven steelhead had an identifiable Skamania clip which was similar to the 2008 total catch of Skamania (Table 7). All steelhead captured on October 9 and October 13 were harvested while those captured during the remaining operational days were trucked to the harbor and released.

Skamania with a RMRV clip were the most commonly captured steelhead during the summer/fall run (Table 7). Other clipped Skamania and non-clipped steelhead were captured in substantially lower numbers. No Skamania were collected for broodstock production because of VHS concerns.

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 and return rate.

Timing and Abundance of the Run

Spring

Timing

Early (pre-1999) in Wisconsin's steelhead program, spring migratory runs were 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 (Hogler and Surendonk 2000). Recent runs (after 1999), however, have been markedly different in timing and abundance as compared to those earlier runs (Hogler and Surendonk 2006).

The spring 2009 run shared characteristics with pre and post 1999 runs. Like earlier runs, Chambers Creek strain steelhead were handled in highest number the first day of operation and then declined while Ganaraska strain fish increased in abundance before declining on the last day of operation. Like later runs, the total run time in 2009 was short. It is likely that the 2009 run would have been longer if operations were not ended to conserve resources. There is no clear explanation for the change in run timing or duration unless hatchery practices have compressed the duration of the spring run or river conditions such as flow and temperature have influenced spring run timing and length.

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 were comprised of several thousand steelhead, but from 2000 through 2008 run totals have averaged just 617 steelhead (Figure 1).

Although the 815 steelhead returned to BAFF in 2009 during the spring run were only 51.5% of the 2008 return number, it was still the second best spring run at BAFF since 2001 (Figure 1). There is no clear explanation for the decrease in run number observed in the spring steelhead runs since 1992 or the big increase observed in the spring of 2008 or the decline in number observed in 2009, although there are several possible causes.

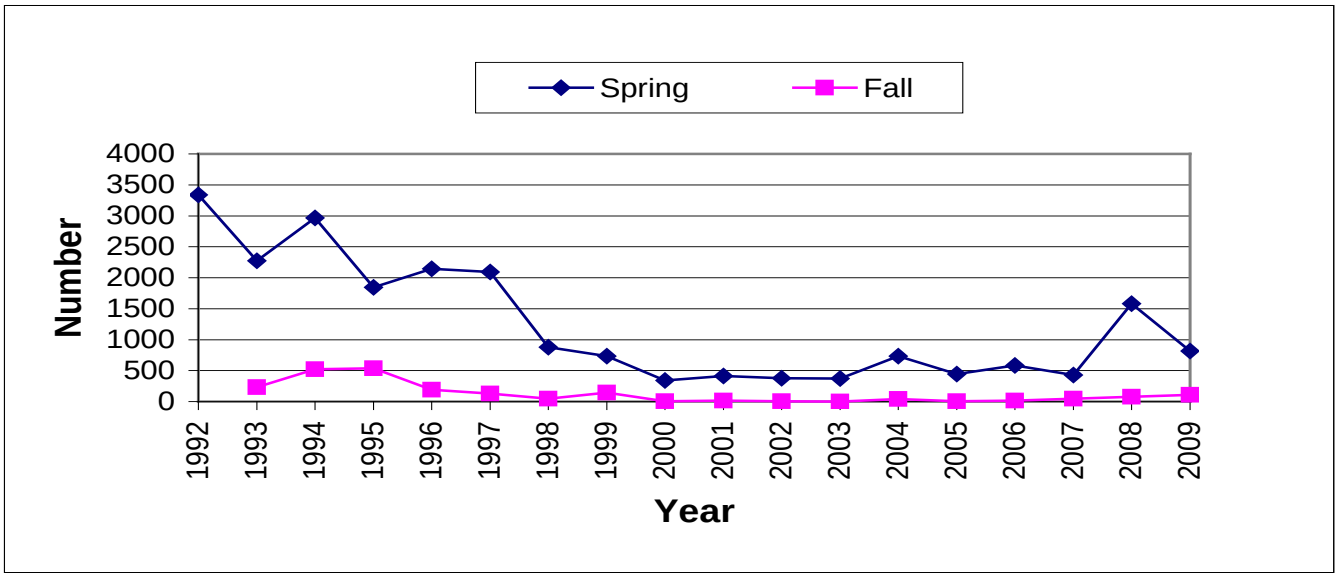


Figure 1. Return number to BAFF on the Kewaunee River for spring and summer/fall runs from 1992 through 2009.

Likely the good runs noted in 2008 and 2009 were due to a combination of factors. These factors could include, increased stocking levels the past 5 years, good river flows at the appropriate times (spring and fall), reduced lake harvest of adult steelhead or increased smolt survival.

Likewise the poor runs observed in spring runs from 2000 to 2007 were likely due to a combination of factors including, 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, poor water quality, poor survival of smolts, or high lake harvest of adult steelhead.

Stocking number does not appear to contribute significantly to the decline in run number observed from 1997 through 2007 or to the increase in run number seen in 2008 (Figure 2). Stocking number has remained 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 at near normal levels and in 2009 when only 50% of the Ganaraska quota was stocked because of a large manure spill in the headwaters of the Kewaunee River and no Skamania were stocked. The decline in stocking number in 2009 may substantially reduce future runs starting in the spring of 2011.

Spring 2009 river flow was sufficient for returning adult steelhead to reach BAFF as operations began in the spring. Both the volume of water in the river is the timing of the flow influence return rates of adult steelhead. In 2009, river flow decreased rapidly following ice-out. This rapid decrease in flow likely caused the decreasing number of steelhead captured at BAFF and shortened the run anglers saw in 2009.

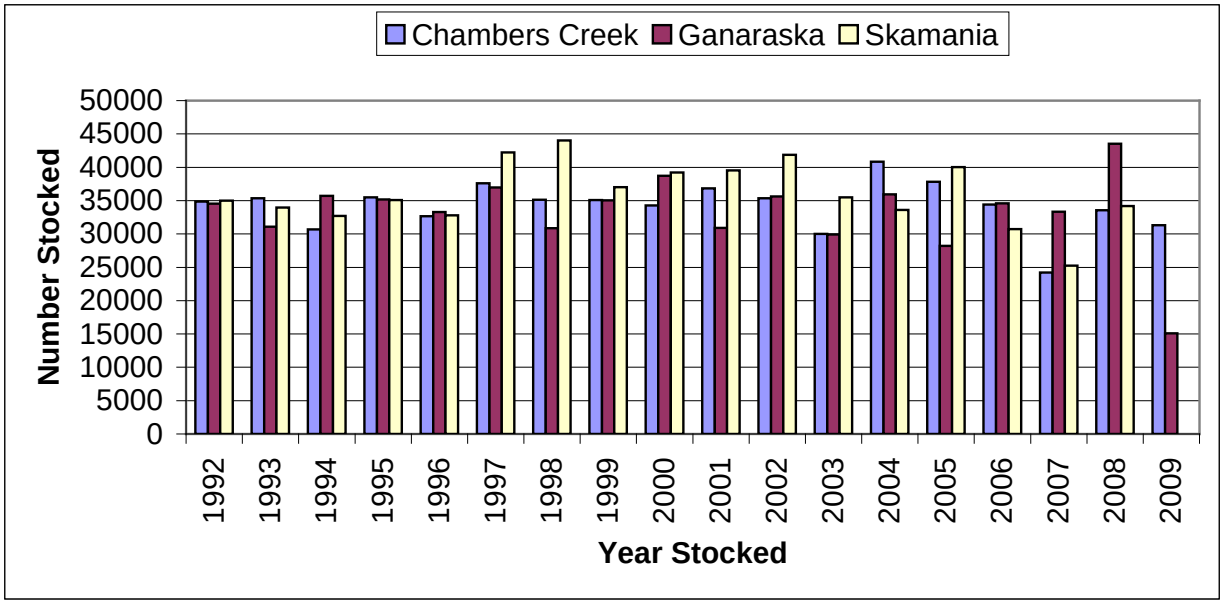


Figure 2. Stocking number by strain for steelhead stocked into the Kewaunee River from 1992 through 2009.

Lakewide angler harvest of adult fish may also affect the number of returning spawners to BAFF. The annual steelhead harvest in the early 1990's averaged just over 92,800 fish (Eggold 2009). From 1999 through 2003 steelhead harvest dropped to average 82,770 steelhead per year and in the last five years the average harvest has dropped to average 45,798 steelhead per year. The lag in time from the year of stocking to the year that steelhead are harvested coupled with steelhead stocking from other Lake Michigan agencies and natural reproduction in some streams make the relationship between harvest and return number difficult to understand. To illustrate this point, despite the marked reduction in harvest of steelhead from the Wisconsin waters of Lake Michigan from 1998 to 2007 the number of steelhead returning to BAFF did not increase but rather declined. It is likely that reductions in harvest from one jurisdiction may be balanced by increased harvest from anglers in other states, resulting in no net increase in the return to weir of Wisconsin stocked steelhead.

Mortality of smolts may also play an important role in determining the number adult steelhead that return to BAFF. Size at stocking has been shown to be an important factor in the survival of smolts (Seelbach 1985) and their ultimate contribution to the fishery (Bartron 2003). Research by Bartron (2003) indicated that the minimum size for substantial survival was 150 mm while Seelbach (1985) recommended a much larger stocking size at 200 mm. Size at stocking continues to be a concern. Since 2004, steelhead smolts continue to average 150 mm or less in length at the time of stocking (Hogler and Surendonk 2008). However, the benefit of larger size at stocking is not clear cut. For example, steelhead stocked in 2006 were of an average size (150 mm) when stocked. Based on stocking size one would predict average return numbers in 2008 but instead we

saw a large increase in return number. Smolt size likely does not fully explain return rate. Performance of the 2006 stocking year class should be followed to determine if the increased return continues throughout the time that year class is in the lake.

In addition to physical size, other factors, such as river flow, water quality, disease status, 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.

River flow at the time of stocking and during out migration may play a role in the survival of stocked smolts and perhaps in determining how well smolts imprint to the Kewaunee River. High flow may cause fast out migration and improve survival of smolts as they quickly pass through the predator gauntlet. However short residence time may lead to poorer imprinting which may result in lower returns as adults. Conversely, low flow may help imprinting but expose smolts for a longer period of time to predation by stream predators.

Stream flow, as measured by the USGS gauging station has been monitored during the out migration study indicates that flow has been variable throughout the past six years ranging from a low of 15 to 50 CFS in 2005 and 2007 to a high of 40 to 100 CFS in 2006 and 2008 (Hogler and Surendonk 2004, 2005, 2006, 2007). Return of adults by year class appears to be better in years with shorter stream residence times than in years with high flows as evidenced by good returns in 2008 and 2009 of the 2005 year class (stocked in 2006) when flow was high. Returns of fish stocked in lower flow conditions as found in 2005 and 2007 (as age 3 fish) have been lower than those of steelhead stocked in high flow years. It appears that the short river residence time following stocking may increase adult return rate. It is not known why the short time in the river improved return rate, but it could be linked to avoidance of predatory fish or avian predators or that by avoiding quickly warming river waters, smolts have a higher survival rate.

Water quality data collection during 2000 and 2004 suggest that in the Kewaunee River, runoff events may negatively impact water quality (Hogler 2001). In 2000, monitoring indicated that concentrations of dissolved oxygen dropped below the state standard of 5 mg/l frequently on the Kewaunee River due to runoff events. However, in 2004, monitoring indicated that water quality was generally good in the Kewaunee River. In 2009 a large manure spill that entered the headwaters of the Kewaunee River in early April threatened the survival of not only returning adults but recently stocked smolts. Although the manure stayed in the upper watershed and did not kill any trout or salmon, there are concerns about the effect of the spill on water chemistry which may affect imprinting and future returns of the 2009 stocked smolts. The possibility of a future spill that could cause a large fish kill that impacts egg collection of future broodstock or kills stocked smolts also remains a concern.

Fall

The 109 steelhead handled at BAFF during the summer/fall of 2009 run was the highest fall total since 1999 when 145 steelhead were captured (Figure 1). Recent summer/fall run totals continue to be much lower than those of 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. In addition, unlike earlier summer/fall runs that peaked in August or early September following late summer rains, the 2009 peaked in mid-November. It is not known if the Skamania run has shifted toward the fall or if these are normal fall numbers without the early run component common in earlier runs.

Strain Performance

Chambers Creek

The average length and all three weight indices increased in 2009 from 2008 levels for Chambers Creek steelhead (Table 1, Figure 3a). The increase in average length and weight is likely due to an increase in the number of age 4 fish that returned to the weir in 2009, as compared to 2008 when age 3 steelhead dominated the run. Standard and trophy weights also increased in 2009 from 2008 values suggesting that perhaps forage availability on Lake Michigan has increased (Figure 3a).

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 2009, 4-year-old Chambers Creek steelhead stocked in 2006 returned to BAFF at the highest rate since 2004 when 2001 stocked fish returned at 4.53 per thousand stocked (Table 8). Overall, the best return rates for Chambers Creek have been for fish stocked in 2006 followed by those stocked in 2001.

The return of 2007 stocked Chambers Creek steelhead has been better than the first two years of return from 2001 stocked steelhead but 2008 stocked fish have returned poorly (Table 8). It is hoped that the trend of improving returns of Chambers Creek steelhead continues.

Ganaraska

Ganaraska strain steelhead had more variation in yearly length and weight averages than Chambers Creek strain fish since 2001 (Table 1). In 2009, all three weight indices increased over the levels noted in 2008 and were near the averages for each weight category for the previous eight years (Table 1). Similar to the trend in the Chambers Creek run, average weight in 2009 increased likely due to a larger percentage of the run being age 4 (Figure 3b). Standard and trophy weights also increased in 2009 from 2008 values suggesting that perhaps forage availability on Lake Michigan has increased (Figure 3b).

The return of the 2005 Ganaraska year class (stocked in 2006) continues to dominate the Ganaraska return at BAFF. In 2008, they returned at the highest rate of any age 3 year class and in 2009 as the best returning age 4 year class of any cohort stocked since 1998 (Table 9). Despite returning in good number in 2008, the 2007 year class returned in average number in 2009 (Table 9). The 2005 and 2003 year classes continue to be the best returning year classes and the 1999 and 2002 the worst returning year classes

stocked since 1998. It is hoped that the 2005 year class will continue to return in good number in 2010 and that 2007 and 2008 year classes will also contribute to spring run in the future years.

Skamania

Skamania strain steelhead have been a small, but consistent portion of spring runs on the Kewaunee River (Table 1). In 2009, average and standard weights declined while trophy weight increased (Figure 3). However, since only thirty-two Skamania where handled during the 2009 spring run, weight information should be viewed cautiously.

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

Comparison of Strain Performance

All three strains had poorer returns to the weir in 2009 as compared to the 2008 run (Tables 1 and 7). Of the spring running strains since 1999, Chambers Creek strain steelhead returned to BAFF in greatest number. Survival based on return per thousand stocked indicates that Ganaraska had more consistent returns and a better overall return rate than Chambers Creek strain steelhead. The return rate of Skamania per thousand stocked is the lowest of the three strains of steelhead.

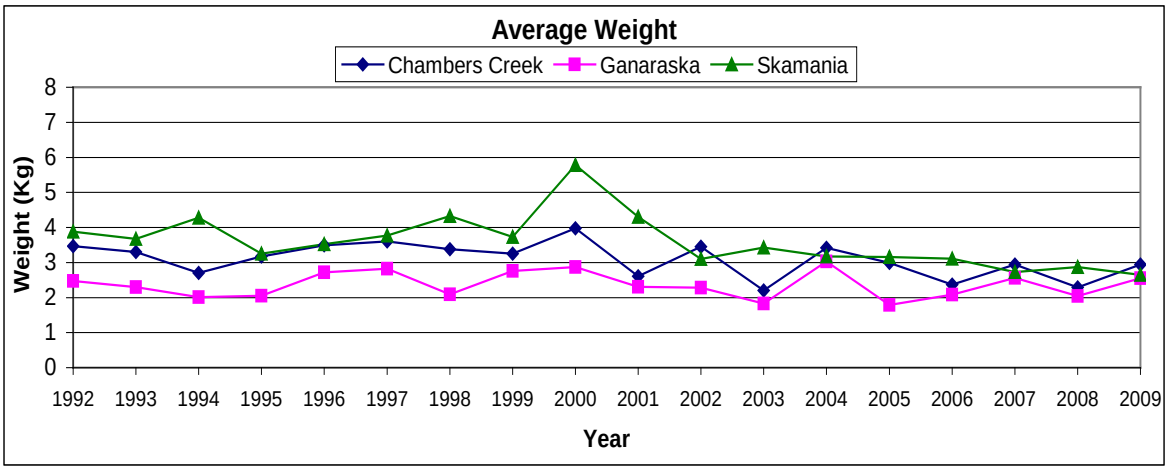
Based on measured size at BAFF, Chambers Creek are the largest steelhead followed by Skamania (Table 1). This result conflicts with results from the 1990's when Skamania were clearly the largest strain steelhead. Mixed results from the three weight trends may be the result of the low number of returning Skamania that have retuned at younger ages (Figure 3). Angler harvest of adult steelhead in some years may have also reduced the number of steelhead returning to BAFF.

Smolt Out-migration

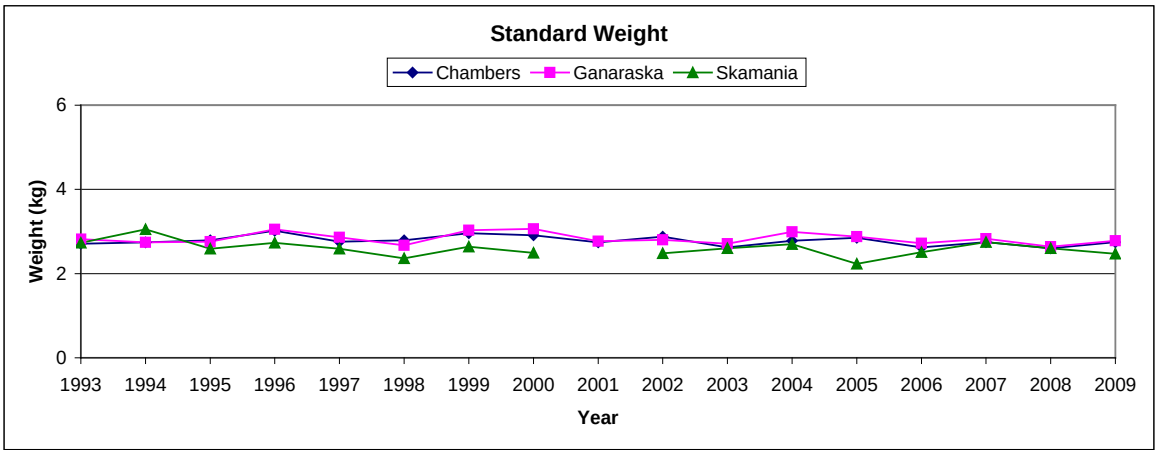
Our electroshocking surveys from 2004 through 2009 have documented that (1) smolts survive stocking and (2) that they are able to pass downstream of the dam at BAFF and make it to lower river sections on the way to Lake Michigan.

During the spring of 2009, heavy rainfall during stocking events just preceding our survey likely increased stream flow enough to push the stocked trout and salmon into the lower river past our downstream survey location. This resulted in very few trout and salmon being collected and limits our ability to discern the 2009 migration pattern.

A.



B.



C.

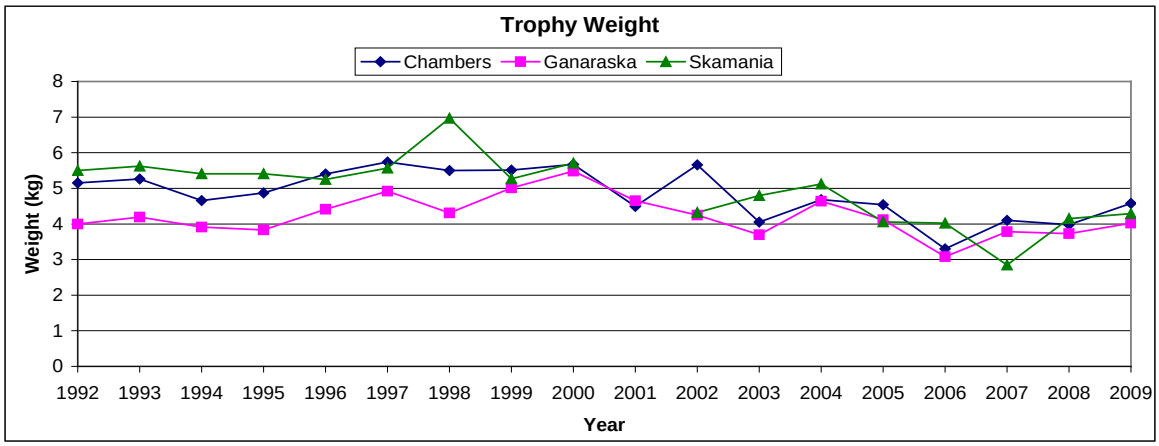


Figure 3. Weights trends for steelhead during spring migrations at BAFF, 1992-2009: (A) Average weight for each strain for that year, (B) Standard weight is based on the projected weight of a 660 mm steelhead, (C) Trophy weight for each strain based on the 95th percentile of weighed steelhead.

Although we collected a limited amount of data in 2009, it added to our knowledge of what happens to trout and salmon in the Kewaunee River post stocking. In general since 2004 we have learned that:

- Chinook and coho salmon spend little time in the river and appear to leave the Kewaunee River quickly following stocking.

- Steelhead appear to move downstream slower than salmon, although the actual rate is dependant on stream flow. Two distinctive patterns have been noted since 2004. Slow downstream movement, with steelhead remaining in the river for extended period was noted in 2004, 2005 and 2008. Fast downstream movement was noted in 2006, 2007 and perhaps in 2009. It appears from data collected during the 2008 and 2009 spring run, that the return of adult steelhead may increase when smolts are stocked into faster water and leave the river quickly as was the case in 2006. Additional research is needed to determine what out-migration strategy produces the greatest return as adults

- Brown trout appear to move downstream slower than steelhead and much slower than salmon based on the last five years of collected data.

SUMMARY

The 2009 spring run total although above average, was only 51.5% of the spring 2008 run total. The increases observed in most of the weight indices for steelhead captured during the 2009 spring run were likely due to a larger percentage of the run being age 4 compared to the 2008 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 2009 summer/fall steelhead run was the best run since the late 1990's, but still much less than historic runs. It is unknown how the very dry summer and fall in 2009 and low river levels limited the fall/summer run of Skamania into the Kewaunee River.

We continued to evaluate the relative magnitude of smolt out-migration from the Kewaunee River in 2009. Our catch was very low in 2009 and limited our ability to discern out-migration patterns. 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.

Gamete collections for the two spring strains of steelhead were good from BAFF in 2009 and should result in near normal numbers of Chambers Creek and Ganaraska being stocked in 2010. Adult Skamania to be used as brood fish were not collected from either

steelhead facility in 2009 due to VHS concerns which will result in no Skamania stocking in 2011 by Wisconsin unless gametes or fingerlings are obtained from another source.

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. 2009. Wisconsin's 2008 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. 2004. Return, Size, Age and Movement of Steelhead at the Besadny Anadromous Fisheries Facility, 2004. Wisconsin Department of Natural Resources. 25 p.

Hogler, S. and S. Surendonk. 2005. Return, Size, Age and Movement of Steelhead at the Besadny Anadromous Fisheries Facility, 2005. Wisconsin Department of Natural Resources. 25 p.

Hogler, S. and S. Surendonk. 2006. Return, Size, Age and Movement of Steelhead at the Besadny Anadromous Fisheries Facility, 2005. Wisconsin Department of Natural Resources. 25 p.

Hogler, S. and S. Surendonk. 2007. Return, Size, Age and Movement of Steelhead at the Besadny Anadromous Fisheries Facility, 2007. Wisconsin Department of Natural Resources. 24 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, 2001-2009.

Year	Strain	Number	Run %	Average Length (mm)	Length Range (mm)	Average Weight (kg)	Weight Range (kg)	Standard Weight (kg)*	Trophy Weight (kg)**
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							
2008	Chambers	499	31.5	627	400-840	2.29	0.60-4.74	2.60	3.98
	Ganaraska	545	34.5	595	372-815	2.04	0.58-4.64	2.64	3.73
	Skamania	21	1.3	689	420-820	2.87	0.62-4.42	2.60	4.15
	Other	517	32.7	--	--	--	--	--	--
	Total	1582							
2009	Chambers	272	33.4	677	440-832	2.94	0.90-5.62	2.75	4.58
	Ganaraska	219	26.9	636	415-785	2.55	0.72-4.90	2.78	4.02
	Skamania	32	3.9	679	590-815	2.65	1.78-4.40	2.47	4.29
	Other	292	35.8						
	Total	815							

* 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 2009 operations at BAFF, by strain of steelhead.

Spring Run Steelhead

Date	Chambers Creek	Ganaraska	Skamania	Other	Day Total
March 30	120	74	17	153	364
March 31				1	1
April 07	83	79	9	88	259
April 13	69	66	6	50	191
Total	272	219	32	292	815

Summer/Fall Run Steelhead

Date of Operation	Chambers Creek	Ganaraska	Skamania	Other	Day Total
October 9			6		6
October 13			5	1	6
October 27		1	8	1	10
November 3			47	27	74
November 10				8	8
November 17				3	3
Total		1	66	40	107

Table 3. Average length, weight and run number by strain, clip, and sex during the spring spawning run at BAFF, 2009.

	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)	703	3.17	76	685	3.09	124
Adipose, Left Maxillary (ALM)	537	1.64	4	765	4.12	2
Left Maxillary (LM)	629	2.22	45	652	2.81	21
Chambers Creek combined average	**671**	**2.78**		**681**	**3.07**	
Ganaraska						
Adipose, Left Ventral (ALV)	587	1.99	31	621	2.50	24
Adipose, Right Ventral (ARV)	491	1.37	9	680	3.02	8
Both Ventral (BV)	656	2.53	61	656	2.85	86
Ganaraska combined average	**620**	**2.26**		**650**	**2.79**	
Skamania						
Adipose, Right Maxillary (ARM)				645	2.64	1
Right Maxillary (RM)	668	2.70	3	675	3.26	4
Right Maxillary, Right Ventral (RMRV)	692	2.56	14	671	2.52	10
Skamania combined average	**688**	**2.59**		**670**	**2.72**	

Table 4. The age distribution, length, and weight of returning clipped steelhead by sex for the Kewaunee River spring 2009.

Chambers Creek

Age (Male)	2	3	4	5	7	Age (Female)	2	3	4	5	6
Measured	3	45	72	1	4	Measured		14	124	2	7
Average Length (mm)	454	629	697	786	809	Average Length (mm)	--	612	685	765	733
Range (mm)	440-470	485-710	583-785	--	770-832	Range	--	574-655	594-765	750-780	682-800
Weighed	3	45	72	1	4	Weighed	0	14	124	2	7
Average Weight (kg)	0.99	2.22	3.05	3.58	5.31	Average Weight (kg)	--	2.21	3.09	4.12	4.01
Range (kg)	0.90-1.16	1.30-3.12	1.70-4.38	--	5.10-5.62	Range (kg)	--	1.90-2.98	1.78-4.42	4.08-4.16	3.26-5.56

Ganaraska

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	7	31	61	2	0	Measured	0	19	86	8	5
Average Length (mm)	443	587	656	660	--	Average Length (mm)	--	592	656	680	730
Range (mm)	415-465	499-687	550-734	575-745	--	Range	--	557-677	560-730	618-785	708-750
Weighed	7	31	61	2	0	Weighed	0	19	86	8	5
Average Weight (kg)	0.98	1.99	2.53	2.74	--	Average Weight (kg)	--	2.10	2.85	3.02	4.00
Range (kg)	0.72-1.28	1.24-2.84	1.50-4.06	1.98-3.50	--	Range (kg)	--	1.46-2.78	1.44-4.24	2.02-4.36	3.42-4.90

Skamania

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	0	3	14	0	0	Measured		3	10	1	1
Average Length (mm)	--	668	692	--	--	Average Length (mm)	--	647	671	645	760
Range (mm)	--	625-710	607-815	--	--	Range	--	590-690	635-718	--	--
Weighed	0	3	14	0	0	Weighed	0	3	10	1	1
Average Weight (kg)	--	2.70	2.56	--	--	Average Weight (kg)	--	2.88	2.52	2.64	4.40
Range (kg)	--	2.24-3.18	1.78-4.18	--	--	Range (kg)	--	2.56-3.28	1.82-3.54	--	--

Table 5. Total trout and salmon captured by electroshocking during the 2009 out-migration study. The downstream site is below BAFF.

Downstream	CFS	Stage	Coho	Chinook	Brown	Chambers	Ganaraska	Skamania	Other	Total	Temp (C)
06-May	58	9.25	0	0	6	10	3	0	0	19	11.1
13-May	40	9.10	0	0	7	5	5	0	2	19	12.3
19-May	38	9.08	0	1	6	6	2	0	1	16	14.6
Total			0	1	19	21	10	0	3	54	

Table 6. Average lengths (mm) of trout and salmon captured during the out-migration study in 2009.

Strain	Stocking Length (mm)	Downstream		
		06 – May	13 - May	19 - May
Chambers Creek		146	158	170
Ganaraska		146	150	160
Skamania		--	--	
Chinook		--	--	100
Brown Trout		171	168	158

Table 7. Steelhead fin clip trends detected at BAFF during fall migrations, 2000-2009.

Strain and fin clip	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009
Skamania										
Adipose, Right Maxillary (ARM)	3				28			4	4	
Right Maxillary (RM)	1	8	1		4	2	1	14	1	6
Right Maxillary,Right Ventral (RMRV)	1					1			64	60
Total Skamania	5	8	1	0	32	3	1	18	69	66
Chambers Creek										
Left Maxillary (LM)										
Left Maxillary, Left Ventral (LMLV)							1	1		
Adipose, Left Maxillary (ALM)								1		
Total Chambers Creek	0	0	0	0	0	0	1	2		0
Ganaraska										
Adipose, Right Ventral (ARV)										
Adipose, Left Ventral (ALV)										1
Both Ventral (BV)										
Total Ganaraska	0	0	0	0	0	0	0	0		1
Unknown										
No Clips	2	5	2		3			5	9	29
Both Maxillary (LMRM)										
Adipose (?), Right Ventral (A?RV)										
Adipose (A)										
Other					5	3	13	25	1	11
Total Unknown	2	5	2	0	8	3	13	30	10	40
Total Fall Steelhead Run	**7**	**13**	**3**	**0**	**40**	**6**	**15**	**50**	**79**	**107**

Table 8. Return rates (number per thousand stocked) for Chambers Creek steelhead during spring migrations on the Kewaunee River, 2000-2009.

	Year Stocked									
Return Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2000	0.09	--	--	--	--	--	--	--	--	--
2001	1.51	0.00	--	--	--	--	--	--	--	--
2002	1.23	0.09	0.05	--	--	--	--	--	--	--
2003	0.11	0.15	1.79	0.17	--	--	--	--	--	--
2004	0.00	0.00	4.53	1.02	0.00	--	--	--	--	--
2005	0.06	0.00	0.62	0.48	0.20	0.20	--	--	--	--
2006	0.00	0.00	0.14	0.23	0.27	2.69	0.11	--	--	--
2007	0.00	0.00	0.00	0.00	0.17	2.69	0.82	0.52	--	--
2008	0.00	0.00	0.00	0.00	0.33	1.05	1.61	10.80	0.54	--
2009	0.00	0.00	0.00	0.00	0.13	0.17	0.08	5.69	2.44	0.09
Total	3.00	0.24	7.13	1.90	1.10	6.80	2.62	17.01	2.98	0.09

Table 9. Return rates (number per thousand stocked) for Ganaraska steelhead during spring migrations on the Kewaunee River, 2000-2009.

	Year Stocked									
Return Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2000	0.51	--	--	--	--	--	--	--	--	--
2001	3.08	0.08	--	--	--	--	--	--	--	--
2002	0.13	0.08	0.16	--	--	--	--	--	--	--
2003	0.17	0.00	1.49	0.45	--	--	--	--	--	--
2004	0.00	0.03	3.40	1.26	0.37	--	--	--	--	--
2005	0.00	0.00	0.58	0.73	0.67	1.72	--	--	--	--
2006	0.00	0.00	0.36	0.19	0.70	5.39	0.57	--	--	--
2007	0.00	0.00	0.00	0.00	0.13	2.36	0.74	0.52	--	--
2008	0.00	0.00	0.00	0.00	0.87	2.03	1.98	10.50	0.81	--
2009	0.00	0.00	0.00	0.00	0.00	0.14	0.35	4.25	1.50	0.16
Total	3.89	0.19	5.99	2.63	2.74	11.64	3.64	15.27	2.31	0.16

Table 10. Return rates (number per thousand stocked) for Skamania steelhead during spring migrations on the Kewaunee River, 2000-2009.

	Year Stocked									
Return Year	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
2000	0.12	--	--	--	--	--	--	--	--	--
2001	0.03	0.00	--	--	--	--	--	--	--	--
2002	0.43	0.03	0.00	--	--	--	--	--	--	--
2003	0.32	0.03	0.03	0.05	--	--	--	--	--	--
2004	0.11	0.03	0.53	0.12	0.00	--	--	--	--	--
2005	0.00	0.00	0.33	0.05	0.00	0.00	--	--	--	--
2006	0.00	0.00	.0.03	0.05	0.34	0.06	0.00	--	--	--
2007	0.00	0.00	.0.00	0.00	0.03	0.03	0.00	0.00	--	--
2008	0.00	0.00	0.00	0.00	0.00	0.30	0.25	0.00	0.04	--
2009	0.00	0.00	0.00	0.00	0.00	0.03	0.04	0.69	0.18	0.00
Total	1.01	0.09	0.92	0.27	0.37	0.42	0.29	0.69	0.22	0.00