Return, Size, and Age of Steelhead at BAFF, 2008

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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 2008 began on April 3 when the ponds were sorted to look for steelhead with Chambers Creek and Ganaraska fin clips and continued through April 22. During this period, 1,582 steelhead were handled at BAFF. The run consisted of 499 Chambers Creek strain steelhead, 545 Ganaraska, 21 Skamania and 517 unclipped, misclipped or strays from other streams or states.

The 2008 spring run total more than tripled the run total of 2007 making it the best spring run at BAFF since 1998. Decreases observed in most of the weight indices for steelhead captured during the 2008 spring run were likely due to a larger percentage of the run being age 3 as compared to the 2007 run that was dominated by age 4 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 but have been absent in recent runs. Why older fish are absent from recent runs is unknown at this time and may be related to angler harvest, fish health or predation on smolts.

Summer/fall fish collections began on September 29 when the fish ladder began to operate. Ponds were sorted eight times during October and November to process migrating fish. Seventy nine steelhead were captured at BAFF during the 2008 summer/fall run. This was the highest total since 1999 when 145 steelhead were captured. Sixty-nine of the 79 captured steelhead had identifiable Skamania clips which was the highest number seen since 1999. Although 2008 fall run was much better than recent runs, it was much lower than historic runs. It is likely that dry summers and falls have resulted in low river levels which have limited the fall/summer run of Skamania.

We continued to evaluate the relative magnitude of the smolt out-migration from the Kewaunee River in 2008. 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 2008 and should result in near normal numbers of Chambers Creek and Ganaraska being stocked in 2010. Adult Skamania used as brood fish were not collected from either steelhead facility in 2008 due to VHS concerns which will result in no Skamania stocking in 2010 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 2008 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 April 22. 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. All other fish were measured, weighed, revived, trucked downstream and released.

Fall operations begin on September 29 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 and not passed back to the river.

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. These clips allowed us to assign returning steelhead to year classes by fin clip and use length frequency tables to estimate return rate by stocking year. A regression of length and weight for each strain was calculated to predicate the standard weight of returning by strain. 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 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 were 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 2008 began on April 3 when the ponds were sorted to look for steelhead with Chambers Creek and Ganaraska fin clips and continued through April 22 when the ponds were emptied. During this period, 1,582 steelhead were handled at BAFF. The run consisted of 499 Chambers Creek strain steelhead (31.5% of the run), 545 Ganaraska (34.4%), 21 Skamania (1.3%) and 517 (32.6%) unclipped, misclipped or strays from other streams or states (Table 1). The number of fish handled during the spring run in 2008 tripled the 2007 total and was more than the average run total from the previous eight springs of 461. Although both the Chambers Creek and Ganaraska run peaked on April 11, Chambers Creek steelhead returned slightly earlier than the Ganaraska strain did (Table 2). After April 15 as river flow dropped, the number of steelhead handled quickly declined.

The 2008 spring run was more typical of runs seen in the 1990's with an extended return period rather than what was observed the past several years when processing day totals peaked on the first day and declined thereafter.

Chambers Creek Strain

A total of 499 Chambers Creek strain steelhead were handled during the spring run of 2008 (Table 1). They ranged in length from 400 mm to 840 mm, and had an average length of 627 mm. Chambers Creek weight ranged from 0.60 kg to 4.74 kg and averaged 2.60 kg. The average length and average weight for Chambers Creek steelhead decreased in 2008 from their 2007 levels and were slightly less than the 2000-2007 average length and weight.

Males comprised 61.1% of the run and averaged 618 mm in length and 2.13 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 2008, males returned at ages 2 through 6 (Table 4). Age 3 fish were the most common, and they averaged 612 mm in length and 2.04 kg in weight. Age 4 male Chambers Creek steelhead were also well represented in returning steelhead, with other age males much less abundant.

Females comprised 38.9% of the run and averaged 640 mm in length and 2.54 kg in weight (Table 3). All three Chambers Creek fin clips were observed for female fish in 2008, with the LMLV the most common. With the use of fin clips, returning fish can be assigned to age classes. In 2008, females returned at ages 3 through 6 (Table 4). Age 3 fish were the most common, and averaged 603 mm in length and 2.14 kg in weight. Other age classes returned in substantially lower number.

Ganaraska strain

Ganaraska were processed throughout spring operations and were the most abundant known strain fish handled (Table 2). Lengths ranged from 372 mm to 815 mm and averaged 595 mm. Weights ranged from 0.58 kg to 4.64 kg and averaged 2.04 kg in weight (Table 1). Ganaraska average length and weight decreased in 2008 from those measured in 2007, and were similar to those measured since 2000.

Males comprised 49.0% of the run in 2008 and had an average length of 576 mm and an average weight of 1.72 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 6 male Ganaraska returned during the spring migration (Table 4). Age 3 fish were the most common, with substantially fewer fish of other ages captured. Age 3 males averaged 574 mm in length and 1.74 kg in weight.

Females comprised 51.0% of the run and averaged 613 mm in length and 2.28 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 3 and had an average length of 579 mm and an average weight of 1.91 kg (Table 4). Age 4 and age 5 female Ganaraska were also present in returning fish but in substantially lower numbers than age 3 females.

Skamania strain

During the spring 2008 run, twenty-one Skamania strain steelhead returned to BAFF and were processed throughout spring operations (Tables 1 and 2). Lengths ranged from 420 mm to 820 mm and averaged 689 mm (Table 1). Weights ranged from 0.62 kg to 4.42 kg with an average weight of 2.87 kg. Skamania average length and weight decreased in 2008 from those measured in 2007 and were the smallest measured since 2000.

Males comprised 33.3% of the run in 2008 and had an average length of 675 mm and an average weight of 2.75 kg (Table 3). Two Skamania fin clips were observed for returning males in 2008 with the adipose right maxillary (ARM) clip the most common. Based on fin clips, age 2, 4 and 5 male Skamania returned during the spring migration (Table 4). Age 4 fish were the most common, with fewer fish of other ages captured. Age 4 males averaged 698 mm in length and 2.85 kg in weight.

Females comprised 66.7% of the run and averaged 696 mm in length and 2.93 kg in weight (Table 3). Two clips were detected for female Skamania, with the right maxillary (RM) clip the most common. Most of the returning females were age 5 and had an average length of 708 mm and an average weight of 3.03 kg (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. During the 2008 spring run we counted 517 (32.7% of the run) steelhead/rainbow trout which were in this category (Table 1). Similar to known strain steelhead, they were processed during each day of operation and peaked on April 11 (Table 2).

Smolt Out-migration

Stocking of trout and salmon occurred ten miles upstream of Lake Michigan (3 miles upstream of BAFF) between March 18 and May 16. A total of 33,341 Chamber Creek strain steelhead with an average length of 149 mm and an ALM clip, 43,510 Ganaraska with an average length of 152 mm and a ARV clip and 34,186 Skamania with an average length of 165 mm and an ARM clip were stocked into the Kewaunee River between March 21 and April 22. 24,773 seeforellen brown trout with an ALV clip were stocked into the Kewaunee River between April 7 and May 13. The brown trout had an average length of 181 mm. 54,389 coho salmon with an average length of 127 mm were stocked on March 18 and finally 75,637 Chinook salmon with an average length of 100 mm were stocked on May 16 into the Kewaunee River.

On April 30 we began to shock the study locations on an alternate week basis that continued through May 28. After May 28, the decision was made to discontinue shocking early because of high river flow, low steelhead numbers and crew scheduling difficulty

(Table 5). At the upstream site, daily totals ranged from four trout and salmon on April 30 to 38 on May 28. Daily totals of trout and salmon captured at the downstream site ranged from zero on April 30 to 31 fish on May 28. Stream flow and stage were variable but declining throughout the survey and were the highest on the first day of the survey and the lowest on the last day, although flow and stage increased sharply in June after heavy rainfall (Table 5). Stream temperature was the lowest on April 30 (8 C) and the highest on May 14 (14.4 C).

Steelhead

During the 2008 out-migration survey, Ganaraska strain were the most commonly captured steelhead followed by Chambers Creek (Table 5). At the upstream location, Ganaraska strain steelhead were captured in the highest number although in 2008 the overall capture rate was very low for all strains. Most steelhead were captured during the May 28 shocking run with few captured earlier in the survey. High river flow during late April and early May made shocking difficult and was likely responsible for the low catch rates during the first two shocking runs. At the downstream location, only seven steelhead were captured during the survey, with Ganaraska steelhead the most common. High river flow made shocking very difficult at this location.

The lengths of captured steelhead were measured during each day of the survey. At the upstream location during the first shocking event, the average length of each strain was similar to their average length at the time of stocking (Table 6). Average length decreased during the second survey event and then increased on May 28. It is likely that between April 30 and May14, larger steelhead smolted and left the area during high flow leaving smaller, yet to smolt, steelhead in the survey section. At the downstream site, the average length of each strain varied little and was similar to stocking size, but because of low capture number, it is not possible to discern any trends although steelhead at the downstream site appeared to be larger than upstream steelhead measured on the same date.

Salmon

During the shocking event on May 28, we captured 19 Chinook salmon at the upriver site and two at the lower site (Table 5). The size of captured Chinook salmon was similar to their size at stocking (Table 6). We did not capture any of the coho salmon that were stocked into the Kewaunee River during any shocking visit in 2008.

Brown Trout

Brown trout were the most common salmonid captured during this survey (Table 5). Although they were not captured on April 30, they were captured on the other survey dates at both survey locations in nearly equal number. Average lengths varied little throughout the survey period and were similar to their size at stocking (Table 6).

Summer/Fall Adult Collection

Summer/fall fish collections began on September 29 when the BAFF fish ladder began to operate. BAFF ponds were sorted at least eight times during October and November to process migrating fish. Seventy-nine steelhead were captured at BAFF during the summer/fall run of 2008 (Table 2). This was the highest total since 1999 when 145 steelhead were captured. Seventy of seventy-nine steelhead had identifiable Skamania clips which was the highest number seen since 1999 (Table 7). Additionally, many steelhead were seen in the public viewing window during July and August that could not enter the facility and likely dropped back to the lower river or the lake because of warm stream water temperatures (Mike Baumgartner, BAFF manager, personal communication).

Skamania with a RMRV clip were the most commonly captured steelhead during the summer/fall run (Table 7). They averaged 685 mm in length and 2.57 kg in weight. Other clipped Skamania and non-clipped steelhead were captured in substantially lower numbers. No Skamania were collected for broodstock production because of VHS concerns and all returning steelhead were harvested.

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 in Wisconsin's steelhead program spring migratory runs 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 (Hogler and Surendonk 2000). However, 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). Since 1999, run timing does not appear to be as distinct as was historically observed. From 1999 through 2007, the run was 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. The spring 2008 run although not entirely like pre-1999 runs, did share several distinct characteristics with those earlier runs. First, the number of steelhead handled increased over time from the first processing date and then declined in numbers rather than peaking on the first date of operation then sharply declining like recent runs (Table 2). Secondly, in 2008, there was a one to two week difference in the run timing of Chambers Creek and Ganaraska strains unlike recent runs when there has been little, if any, difference in run time of the spring strains. Finally,

the length of the run increased from over what has been observed the last several springs. 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 consisted of several thousand steelhead, but from 1999 through 2007 run totals have averaged just 499 steelhead (Figure 1).

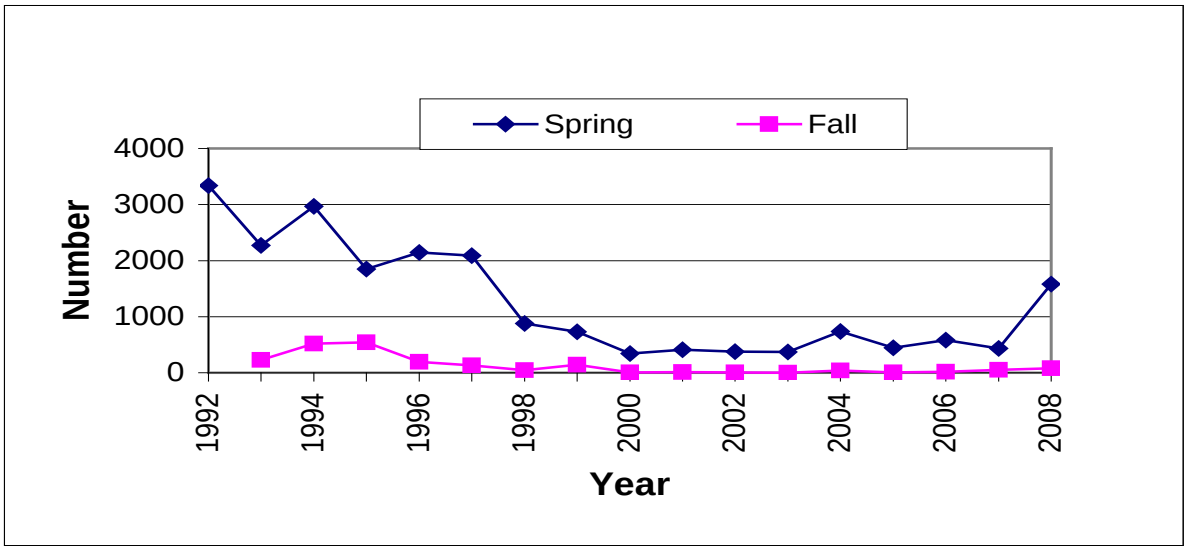


Figure 1. Return number to BAFF on the Kewaunee River for spring and summer/fall runs from 1992 through 2008.

The 1,582 steelhead that returned to BAFF during the spring 2008 run tripled the return number from what was observed in 2007 and was the highest number of steelhead handled since the spring of 1997 (Figure 1). Every category of steelhead increased in 2008 over what had been seen in 2007 (Table 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.

Likely the decreases observed in spring runs since 1997 were 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.

Likewise the increase noted in 2008 is likely 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.

Kewaunee River stocking numbers do not appear to contribute significantly to the decline in run size observed from 1997 through 2007 or to the increase in run size seen in 2008 (Figure 2). Stocking numbers have 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 in near normal number. The decline in stocking number in 2007 may substantially reduce future runs starting in the spring of 2009.

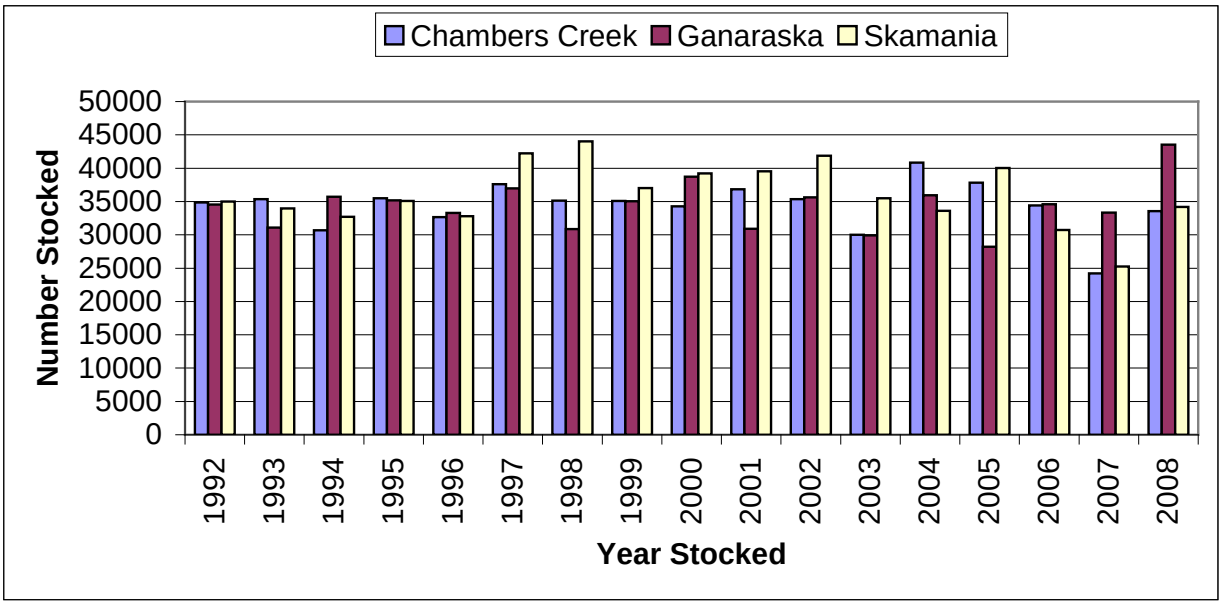


Figure 2. Stocking number by strain for steelhead stocked into the Kewaunee River from 1992 through 2008.

Spring 2008 river flow was sufficient for returning adult steelhead to reach BAFF. As important as the volume of water in the river is the timing of the flow. During the previous 5 years, we have experienced unusual spring conditions with snow melt, rain and the river being ice free in February. It is likely many mature steelhead missed this early pulse of water and had difficulty navigating upstream when day length and maturity level reached critical levels because of low river flow. The spring of 2008 returned to a more “normal” pattern with spring melt and ice break-up in early March, although river flow quickly began to drop by mid-April.

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 2007). Harvest during 1994, 1995 and 1998 exceeded 110,000 steelhead. However, recently the annual harvest has declined to average 46,647 for the past five

years (2003-2007), although average harvest the past three years (2005-2007) has increased to 53,044. 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 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 by other states, resulting in no net increase in the return to weir of Wisconsin stocked steelhead. Furthermore, the harvest of steelhead has increased the past several years and in 2008 we observed an increase in steelhead return number to BAFF (Table 1; Figure 1).

Mortality of smolts may also play an important role in determining the number of adult steelhead returning to BAFF. 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.

Size at stocking continues to be a concern. Since 2004, stocked steelhead continue to average less than 150 mm in length, with the average length at the time of stocking at 146 mm for Chambers Creek steelhead, 140 mm for Ganaraska and 143 mm for Skamania (Hogler and Surendonk 2004, 2005, 2006, 2007). Since stocked steelhead in 2006 were of an average size when stocked, the large increase in return number in 2008 can not be explained by a larger smolt size and suggests other factors are also important in determining survival of stocked steelhead.

In addition to physical size, other factors, such as river flow, water quality, disease status, the amount of fat reserves, 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, measured by the USGS gauging station has been monitored during the out migration study indicates that flow has been variable throughout the past 5 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). 2006 flow was near the high end of the range and suggests that a higher flow rate at the time of stocking may correspond with increased adult return seen three years later. Additionally, we have noted that in the Kewaunee River steelhead either out migrate quickly such as was observed in 2006 and 2007 or slowly as in 2005. 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 runs of migratory fish or avian predators or that by avoiding quickly warming river waters the 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 regularly on the Kewaunee River due to runoff events. However, in 2004, monitoring indicated that water quality was generally good in the Kewaunee River. In 2008, visual inspection of the river and DO measurements did not indicate any water quality issues.

Other potential issues that affect smolt survival such as disease status, fat reserves and predation on stocked steelhead have not been studied to develop relationships with adult return number.

Fall

The 79 steelhead handled at BAFF in the summer/fall of 2008 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.

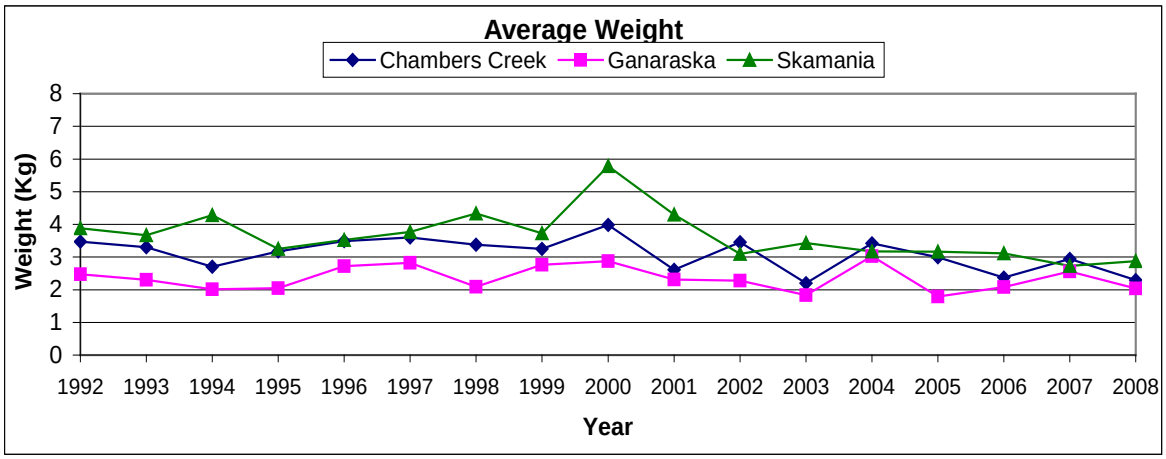
Strain Performance

Chambers Creek

The average length and all three weight indices decreased in 2008 from 2007 levels for Chambers Creek steelhead (Table 1, Figure 3). The decrease in average length and weight is likely due to an increase in the number of age 3 fish that returned to the weir in 2008, as compared to 2007 when age 4 steelhead dominated the run. Standard and trophy weights also decreased in 2008 from 2007 values (Figure 3). The 2008 standard weight was lowest measured since 2000 and the trophy weight was the second lowest during the same period. 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 2008, 4-year-old Chambers Creek steelhead stocked in 2005 returned to BAFF at the second highest rate since 2004 when 2001 stocked fish returned at 4.53 per

A.



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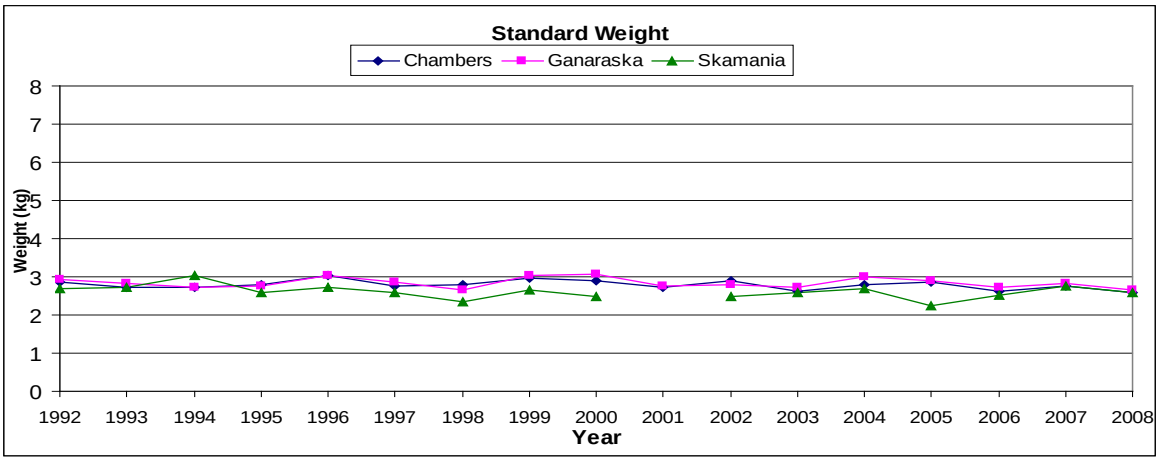

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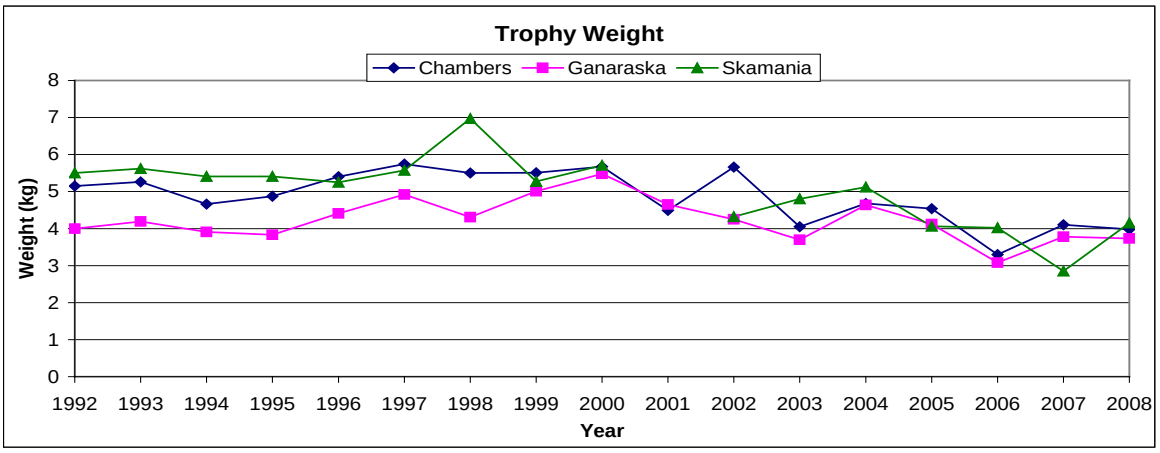

Figure 3. Weights trends for steelhead during spring migrations at BAFF, 1992-2008: (A) Average weight for each strain for that year, (B) Standard weight is based on the projected weight of a 660 mm steelhead, (C) Trophy weight for each strain based on the 95th percentile of weighed steelhead.

thousand stocked (Table 8). Overall, the best return rates for age 4 Chambers Creek have been for fish stocked in 2001 and 2004.

The overall return of steelhead stocked in 2006 was the highest seen since the 2001 stocking year class. Steelhead stocked in 2007 also returned well in 2008 (Table 8). It is hoped that the trend of increasing returns since the 2004 stocking year class fish continues.

Ganaraska

Ganaraska strain steelhead have had more variation in yearly length and weight average than have Chambers Creek strain fish (Table 1). In 2008, all three weight indices decreased and were the lowest or near the lowest levels measured since 2000 (Table 1). It is likely the lack of fish older than age 3 have caused 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 the 2005 stocking year class of Ganaraska, was the second 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, although the 2006 year class has returned at a similar rate in its first two years in the lake. Because of the strong return of the 2006 stocking class in 2008, it is hoped that this year class will continue to return to BAFF the next several years and improve the overall return of Ganaraska. Similar to the Chambers Creek strain, Ganaraska stocked in 2001, 2004 and 2006 have returned well, while other year classes had poorer return rates.

Skamania

Skamania strain steelhead have been a small, but consistent portion of spring runs on the Kewaunee River (Table 1). Average weight and trophy weight increased in 2008, while standard weight decreased (Figure 3). Since only twenty-one Skamania where handled during the 2008 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 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). Lack of fall rain may be responsible for the variation in run number.

Comparison of Strain Performance

All three strains had better returns to the weir in 2008 as compared to the 2007 run (Tables 1 and 7). 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 rate than has 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, Skamania continue to be the largest steelhead followed by Chambers Creek and then Ganaraska (Table 1). 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 or from poor survival of earlier stocked year classes (Figure 3). Angler harvest of adult steelhead in some years may have also reduced the number of steelhead returning to BAFF.

Smolt Out-migration

During our electroshocking surveys from 2004 through 2008, we 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. 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 make general observations regarding the data collected the since 2004.

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 2008, collections during previous years indicate they are captured early in the survey and move out of the area quickly.

Steelhead appear 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 in 2008 was the highest on the last survey date (Table 5). It is likely that high river flows that made stream shocking difficult and reduced our capture efficiency was responsible for this unusual trend.

During 2008 very few steelhead were collected at either location indicating either that steelhead moved out of the river quickly or remained near the stocking site upriver of our shocking locations. It is unknown which occurred, although an unrelated electrofishing survey in July captured juvenile steelhead between our two out-migration sites perhaps indicating the later pattern. Slow downstream movement is similar to what was observed in 2005 and the inverse of what was measured in 2006 and 2007.

It appears from data collected during the 2008 spring run, the return of adult steelhead may increase when smolts are stocked into faster water resulting in faster transportation out of the river as was the case in 2006. Additional research is needed to determine if fast movement out of the river improves return by reducing smolt mortality. Smolts may avoid predators and unfavorable river conditions. Alternatively, slow movement may improve returns because steelhead imprint better to the river and leave the river with a higher level of fitness as some research suggests (Seelbach 1985). Returns in future years should be

monitored to determine if the 2005 or 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 five years of collected data. Like steelhead, brown trout movement in 2008 was similar to what was observed in 2005. In 2008, 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 2008 spring run total more than tripled the run total of 2007 making it the best spring run at BAFF since 1998. Decreases observed in the most of the weight indices for steelhead captured during the 2008 spring run are likely due to a larger percentage of the run being age 3 as compared to the 2007 run that was dominated by age 4 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 2008 summer/fall steelhead run was the best run since the late 1990's, but still much less than historic runs.

We continued to evaluate the relative magnitude of the smolt out-migration from the Kewaunee River in 2008. 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 2008 and should result in near normal numbers of Chambers Creek and Ganaraska being stocked in 2008. Adult Skamania to be used as brood fish were not collected from either steelhead facility in 2008 due to VHS concerns which will result in no Skamania stocking in 2010 by Wisconsin unless gametes or fingerlings are obtained from another source.

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Table 1. Summary of steelhead length and weight data collected during spring migratory runs at BAFF, on the Kewaunee River, 2000-2008.

Year	Strain	Number	Run %	Average Length (mm)	Length Range (mm)	Average Weight (kg)	Weight Range (kg)	Standard Weight (kg)*	Trophy Weight (kg)**
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							
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							

* 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 2008 operations at BAFF, by strain of steelhead.

Spring Run Steelhead

Date	Chambers Creek	Ganaraska	Skamania	Other	Day Total
April 3	69	22	5	85	181
April 9	121	139	5	117	382
April 11	191	195	4	167	557
April 15	81	123	6	104	314
April 17	12	8	0	16	36
April 22	25	58	1	28	112
Total	499	545	21	517	1582

Summer/Fall Run Steelhead

Date of Operation	Chambers Creek	Ganaraska	Skamania	Other	Day Total
October 4			29	5	34
October 8			10	1	11
October 10			14	4	18
October 15			7		7
October 23			4		4
October 27			1		1
November 3			2		2
November 13			2		2
Total			70	9	79

Table 3. Average length, weight and run number by strain, clip, and sex during the spring spawning run at BAFF, 2008.

	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)	612	2.04	255	610	2.21	127
Adipose, Left Maxillary (ALM)	734	3.33	25	703	3.10	36
Left Maxillary (LM)	561	1.82	25	693	3.19	31
Chambers Creek combined average	**618**	**2.13**	**305**	**640**	**2.54**	**194**
Ganaraska						
Adipose, Left Ventral (ALV)	515	1.42	43	678	2.97	57
Adipose, Right Ventral (ARV)	663	2.62	18	654	2.76	38
Both Ventral (BV)	581	1.80	206	584	1.95	183
Ganaraska combined average	**576**	**1.72**	**267**	**613**	**2.28**	**278**
Skamania						
Adipose, Right Maxillary (ARM)	698	2.85	4	680	2.80	6
Right Maxillary (RM)	644	2.61	3	708	3.03	8
Right Maxillary, Right Ventral (RMRV)	--	--	--	--	--	--
Skamania combined average	**675**	**2.75**	**7**	**696**	**2.93**	**14**

Table 4. The age distribution, length, and weight of returning clipped steelhead by sex for the Kewaunee River spring 2008.

Chambers Creek

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	13	254	25	12	1	Measured	0	118	36	31	9
Average Length (mm)	432	612	734	700	749	Average Length (mm)	--	603	703	693	703
Range (mm)	400-480	475-686	425-808	598-840	--	Range	--	543-642	605-760	580-780	651-768
Weighed	13	254	25	12	1	Weighed	0	118	36	31	9
Average Weight (kg)	0.78	2.04	3.33	2.94	4.40	Average Weight (kg)	--	2.14	3.10	3.19	3.08
Range (kg)	0.60-1.08	1.14-2.93	0.70-4.74	1.78-4.46	--	Range (kg)	--	1.54-2.88	1.88-3.90	1.80-4.32	2.28-4.26

Ganaraska

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	27	186	18	16	20	Measured	0	177	38	57	6
Average Length (mm)	436	574	663	648	642	Average Length (mm)	--	579	654	678	711
Range (mm)	372-483	408-665	560-776	505-815	625-684	Range	--	504-660	554-790	578-798	630-792
Weighed	27	186	18	16	20	Weighed	0	177	38	57	6
Average Weight (kg)	0.80	1.74	2.65	2.46	2.37	Average Weight (kg)	--	1.91	2.76	2.97	3.29
Range (kg)	0.58-1.06	0.74-2.58	1.52-4.32	1.66-4.64	2.16-2.65	Range (kg)	--	1.14-2.84	1.86-4.02	1.82-4.10	2.40-4.30

Skamania

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	1	0	4	2	0	Measured	0	0	6	8	0
Average Length (mm)	420	--	698	756	--	Average Length (mm)	--	--	680	708	--
Range (mm)	--	--	651-730	691-820	--	Range	--	--	644-737	620-790	--
Weighed	1	0	4	2	0	Weighed	0	0	6	8	0
Average Weight (kg)	0.62	--	2.85	3.61	--	Average Weight (kg)	--	--	2.80	3.03	--
Range (kg)	--	--	2.48-3.04	2.80-4.42	--	Range (kg)	--	--	2.36-3.66	1.95-3.88	--

Table 5. Total trout and salmon captured by electroshocking during the 2008 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)
30-April	100	9.55	0	0	0	1	3	0	0	**4**	8.0
14-May	61	9.31	0	0	1	1	7	2	1	**12**	14.4
28-May	40	9.15	0	19	1	4	13	0	1	**38**	11.5
Total			0	19	2	6	23	2	2	54	

Downstream	CFS	Stage	Coho	Chinook	Brown	Chambers	Ganaraska	Skamania	Other	Total	Temp (C)
30-April	100	9.55	0	0	0	0	0	0	0	0	8.0
14-May	61	9.31	0	0	26	0	1	0	0	27	14.4
28-May	40	9.15	0	2	22	1	4	1	1	31	11.5
Total			0	2	48	1	5	1	1	58	

Table 6. Average lengths (mm) of trout and salmon captured during the out-migration study in 2008.

Strain	Stocking Length (mm)	Upstream			Downstream		
		30 - April	15May	28-May	30 - April	15May	28-May
Chambers Creek		162	109	143	--	--	150
Ganaraska		143	133	156	--	154	161
Skamania		--	153	--	--	--	144
Chinook		--	--	108	--	--	98
Brown Trout		--	180	170	--	191	187

Table 7. Steelhead fin clip trends detected at BAFF during fall migrations, 2000-2008.

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

Table 8. Return rates (number per thousand stocked) for Chambers Creek steelhead during spring migrations on the Kewaunee River, 1999-2008.

	Year Stocked									
Return Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1999	0.03	--	--	--	--	--	--	--	--	--
2000	0.11	0.09	--	--	--	--	--	--	--	
2001	0.09	1.51	0.00	--	--	--	--	--	--	
2002	0.03	1.23	0.09	0.05	--	--	--	--	--	
2003	0.00	0.11	0.15	1.79	0.17	--	--	--	--	
2004	0.00	0.00	0.00	4.53	1.02	0.00	--	--	--	
2005	0.00	0.06	0.00	0.62	0.48	0.20	0.20	--	--	
2006	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	0.17	2.69	0.82	0.52	
2008	0.00	0.00	0.00	0.00	0.00	0.33	1.05	1.61	10.80	0.54
Total	0.26	3.00	0.24	7.13	1.90	0.97	6.63	2.54	11.32	0.54

Table 9. Return rates (number per thousand stocked) for Ganaraska steelhead during spring migrations on the Kewaunee River, 1999-2008.

	Year Stocked									
Return Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1999	0.16	--	--	--	--	--	--	--	--	--
2000	0.58	0.51	--	--	--	--	--	--	--	
2001	0.52	3.08	0.08	--	--	--	--	--	--	
2002	0.16	0.13	0.08	0.16	--	--	--	--	--	
2003	0.00	0.17	0.00	1.49	0.45	--	--	--	--	
2004	0.00	0.00	0.03	3.40	1.26	0.37	--	--	--	
2005	0.00	0.00	0.00	0.58	0.73	0.67	1.72	--	--	
2006	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	0.13	2.36	0.74	0.52	
2008	0.00	0.00	0.00	0.00	0.00	0.87	2.03	1.98	10.50	0.81
Total	1.42	3.89	0.19	5.99	2.63	2.74	11.50	3.29	11.02	0.81

Table 10. Return rates (number per thousand stocked) for Skamania steelhead during spring migrations on the Kewaunee River, 1999-2008.

	Year Stocked									
Return Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
1999	0.00	--	--	--	--	--	--	--	--	--
2000	0.00	0.12	--	--	--	--	--	--	--	
2001	0.02	0.03	0.00	--	--	--	--	--	--	
2002	0.00	0.43	0.03	0.00	--	--	--	--	--	
2003	0.00	0.32	0.03	0.03	0.05	--	--	--	--	
2004	0.00	0.11	0.03	0.53	0.12	0.00	--	--	--	
2005	0.00	0.00	0.00	0.33	0.05	0.00	0.00	--	--	
2006	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	0.03	0.03	0.00	0.00	
2008	0.00	0.00	0.00	0.00	0.00	0.00	0.30	0.25	0.00	0.04
Total	0.02	1.01	0.09	0.92	0.27	0.37	0.39	0.25	0.00	0.04