# Return, Size, and Age of Steelhead at the Besadny Anadromous Fisheries Facility, 2006

Steve Hogler and Steve Surendonk


## ABSTRACT

An annual steelhead assessment project was begun in 1992 at the Besadny Anadromous Fisheries Facility (BAFF) to (1) assess the return of the three steelhead strains to BAFF and (2) collect basic biological information on each strain. In 2004, a third component, monitoring the out-migration trout and salmon from the Kewaunee River was added to the project.

Spring operations in 2006 began on April 5 and continued until April 17. During this period, 582 steelhead were handled at BAFF. The run consisted of 135 Chambers Creek strain steelhead, 249 Ganaraska, 17 Skamania, and 181 unclipped, misclipped or stray from other streams or states. The 2006 spring run was short, with the majority of steelhead handled on the first day of processing.

The 2006 spring run total increased from what was observed during the 2005 spring run and was the second best run since 2000. Improved run number was likely due to good return of steelhead stocked in 2004 and to improved spring flows that were noted in 2006. This spring run was typical of the runs of the past five years, but was far less than those observed from 1991 through 1996.

Changes in the spring 2006 average, standard and trophy weights may be due to a larger percentage of the run being age 3 as compared to the 2005 run that was dominated by age 4 steelhead.

On April 27, we began to shock the out-migration study locations weekly except when weather and stream conditions prevented the survey from being completed. At the upstream site, daily totals ranged from 220 trout and salmon on April 27 to 80 fish on June 20. Daily totals of trout and salmon captured at the downstream site ranged from 7 to 209.

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.

Summer/fall fish collections began October 2 when the BAFF fish ladder began to operate. BAFF ponds were sorted nine days during October and November to process migrating fish. Fourteen steelhead were captured at BAFF during October and one steelhead was captured in November. Only one steelhead was positively identified as a Skamania. All steelhead captured during the fall 2006 run were returned to the Kewaunee River.

The summer/fall run of steelhead was poor in 2006 and was similar to those since 2000. Although there was abundant late spring and late fall rain, river flow did not increase enough to trigger steelhead runs into the river, making 2006 a poor year for Skamania.

Gamete collections for all three strains of steelhead were spotty at BAFF in 2006, but should not affect the total number of steelhead stocked in 2007 because of the contribution of additional gametes from the Root River Steelhead Facility.

# 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 2006.

# METHODS

## Adult Collection

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

Fall operations began typically in July or August following rainfall events and continued sporadically until October when the facility was operated continuously until the river froze in late November. Summer/early fall collection procedures differed from spring procedures because of warm water conditions which may increase mortality of the handled steelhead. To maximize survival, fish were handled as little as possible. Steelhead were checked for fin clips, and sexed. Fish with target fin clips were sent to the Kettle Moraine Springs Fish Hatchery (KMSFH) and held until spawned. All other steelhead were passed upstream.

The data were analyzed using basic fishery statistics, such as average length and weight by sex and clip. Before steelhead smolts were stocked into the Kewaunee River, they were marked with unique fin clips by strain. Chambers Creek strain steelhead were marked with left maxillary, adipose-left maxillary or left maxillary-left ventral clips. Ganaraska strain steelhead were marked with adipose-left ventral, adipose-right ventral or both ventral clips. Skamania were marked with right maxillary, adipose-right maxillary or right maxillary-right ventral clips. This allowed us to assign returning steelhead to year classes by fin clip and use of a length frequency table to estimate return rate by stocking year. A regression of length and weight for each strain was calculated to estimate standard weight. By using standard weight and trophy weight, which is the measure of the weight of a 660 mm steelhead and the weight of the 95th percentile of steelhead respectively, we were able to track recent weight trends in the population. Handling mortality was estimated from the number of caudal fin clipped dead fish that were found in holding ponds, recovery tanks, and around the river release site. Catch numbers per day of weir operation were plotted to examine the timing of spring migratory runs.

### 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 is 35 times the stream width at that location resulted in an upstream site that was 910 meters in length and a lower site that was 350 meters in length. On survey dates, stream flow and stage information was collected from the USGS gauging site on the Highway F bridge just downstream of the lower survey site.

Stream electroshocking began immediately following the cessation of stocking and would 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 2006 began on April 5, and continued until April 17. During this period, 582 steelhead were handled at BAFF. The run consisted of 135 Chambers Creek strain steelhead (23.2% of the run), 249 Ganaraska (42.8%), 17 Skamania (2.9%), and 181 (31.1%) unclipped, misclipped or strays from other streams or states (Table 1). The total number of fish handled during the spring run in 2006 increased from the 2005 total and was the fourth best run in the last nine years. The spring 2006 run was 24% greater than the 5 year average run of 468 fish. In 2006, the spring run was short, with the majority of steelhead handled on the first day of processing (Table 2). The number of steelhead handled declined quickly thereafter.

## Chambers Creek Strain

Chambers Creek strain steelhead were processed during each day of operation this spring, with the majority of Chambers Creek handled on April 5 (Table 2). Chambers Creek steelhead ranged in length from 435 mm to 762 mm, and had an average length of 633 mm (Table 1). Weight ranged from 0.60 kg to 4.12 kg and averaged 2.37 kg. The average length and average weight for Chambers Creek steelhead in 2006 decreased from 2005 levels and were among the smallest average lengths and weights measured since 1998.

Males comprised 60.0% of the run and averaged 633 mm in length and 2.31 kg in weight (Table 3). All three Chambers Creek fin clips were observed for male fish, with the left maxillary (LM) the most common. With the use of fin clips, returning fish can be assigned to age classes. In 2006, males returned at ages 2 through 6 (Table 4). Age 3 fish were the most common, and averaged 638 mm in length and 2.31 kg in weight. Other age male Chambers Creek steelhead returned in much lower numbers.

Females comprised 40.0% of the run and averaged 633 mm in length and 2.46 kg in weight (Table 3). All three Chambers Creek fin clips were observed for female fish in 2006, with the LM the most common. With the use of fin clips, returning fish can be assigned to age classes. In 2006, females returned at ages 3 through 6 (Table 4). Age 3 fish were the most common and averaged 614 mm in length and 2.27 kg in weight.

## Ganaraska strain

Ganaraska were processed throughout spring operations (Table 2). Lengths ranged from 397 mm to 794 mm and averaged 588 mm. Weights ranged from 0.40 kg to 5.32 kg with an average weight of 2.08 kg (Table 1). The average length and weight in 2006 increased from those measured in 2005, but still were the third smallest since 1998.

Males comprised 48.2% of the run in 2006 and had an average length of 575 mm and weight of 1.88 kg (Table 3). Three fin clips were observed for Ganaraska males, with the adipose-left ventral (ALV) clip the most common. Based on fin clip, age 2 through age 6 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 578 mm in length and 1.87 kg in weight.

Females comprised 51.8% of the run and averaged 600 mm in length and 2.27 kg in weight (Table 3). Three clips were detected for female Ganaraska, with the ALV clip the most common. Most of the returning females were age 3 with an average length of 584 mm and an average weight of 2.11 kg (Table 4). Other ages were present in substantially lower number.

### Skamania strain

Skamania were handled throughout the spring run in 2006 although numbers were low (Table 2). Lengths ranged from 630 mm to 795 mm and averaged 704 mm. Weights ranged from 2.02 kg to 4.02 kg and averaged 3.11 kg (Table 1). The spring 2006 Skamania run was similar to those in the previous three springs.

Males comprised 29.4% of the run and averaged 721 mm in length and 3.04 kg in weight (Table 3). Three fin clips were observed for Skamania males, with the right maxillary- right ventral clip (RMRV) the most common clip observed. Based on fin clip and length, age 4 through age 6 male Skamania returned during the spring migration (Table 4). Age 4 fish were the most common and averaged 747 mm in length and 3.44 kg in weight.

Females comprised 70.6% of the run and averaged 697 mm in length and 3.13 kg in weight (Table 3). Two clips were observed on returning females that corresponded to ages 3, 4 and 5 (Table 4). The RMRV fin clip was the most common clip observed. Age 4 females were the most common and averaged 704 mm in length and 3.29 kg in weight.

### Non-broodstock steelhead

The final component of the spring run were those steelhead not used for broodstock collection. Although the majority of these fish were Chambers Creek, Ganaraska, or Skamania strain steelhead, they were unclipped, misclipped, or were study fish from another stream. Clipped or unclipped fish from other states were also part of this category. The 181fish in this group captured in the spring 2006 run were handled during each day of operation (Table 2).

## Smolt Out-migration

Trout and salmon were stocked ten miles upstream of Lake Michigan (3 miles upstream of BAFF) starting on March 23 and continuing through May 11. A total of 34,430 Chambers Creek strain steelhead with an average length of 163 mm and a LMLV clip, 34,585 Ganaraska with an average length of 140 mm and a BV clip and 30,731 Skamania with an average length of 127 mm and a RMRV clip were stocked into the Kewaunee River between March 31 and April 25. 38,328 seeforellen brown trout with an ARV clip were stocked into the Kewaunee River between March 23 and April 24. The brown trout had an average length of 173 mm. 78,456 coho salmon with an average length of 160 mm were stocked between March 21 and 23, and finally 59,904 Chinook salmon with an average length of 86 mm were stocked on May 11 into the Kewaunee River.

On April 27, we began to shock the study locations weekly though June 20, except for the weeks of May 8-12, May 15-19, May 29- June 2 and June 12-16 when weather and stream conditions prevented the survey to be completed (Table 5). At the upstream site, daily totals ranged from 220 trout and salmon on April 27 to 80 fish on June 20. Daily totals of trout and salmon captured at the downstream site ranged from 7 to 209. Stream flow and stage were variable throughout the survey because of rainfall events with low flows and low stage early and late in the survey, with higher flow and stage levels in late May and early June.

### Steelhead

Chambers Creek strain steelhead were the most commonly captured steelhead during the survey followed by Ganaraska (Table 5). At the upstream location, all three strains of steelhead were captured in the highest number during April and then declined to lower numbers during surveys in May and June. At the downstream location, Chambers Creek and Skamania steelhead declined from April through June, while Ganaraska steelhead remained relatively stable in number throughout the entire period.

Length was measured once during each month of the survey. At the upstream location, average length was similar to average length at the time of stocking (Table 6). The average length measured each month declined for Chambers Creek, increased for Ganaraska strain steelhead and varied little for Skamania strain fish at the upstream location. At the downstream site, average length declined from April to June for Chambers Creek. Average length in June decreased for Skamania and Ganaraska following an increase in May.

### Salmon

Coho salmon were only captured early in our survey. At the upstream site, coho were captured on May 4 and not captured again. At the downstream location, coho were captured from April 27 through May 4 (Table 5). During the sampling period we captured 17 coho salmon, of which 16 were captured at the downstream site.

Chinook salmon were captured in very low number during May 24 and June 5 surveys (Table 5). All six Chinook salmon that were captured during our 2006 survey were caught upstream of BAFF.

### Brown Trout

Brown trout were captured at each survey site each day of the survey (Table 5). The highest catch of brown trout occurred on the first day of sampling at both the upstream and downstream sites and then declined throughout the remainder of the survey.

## Summer/Fall Adult Collection

Summer/fall fish collections began October 2 when the BAFF fish ladder began to operate. BAFF ponds were sorted nine times days during October through November to process migrating fish. Fourteen steelhead were captured at BAFF during October and one steelhead was captured in November (Table 2). Although the 2006 summer/fall migration of steelhead improved from the 2005 run, it was still less than the 2004 run and much less than runs in the 1990’s (Table 7). Only one steelhead was positively identified as a

Skamania. However, because of salmon spawning activities, it was not always possible to check for finclips so it is likely many of the steelhead captured early in the run were Skamania strain steelhead. All steelhead captured during the fall 2006 run were returned to the Kewaunee River.

## DISCUSSION

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

### Timing and Abundance of the Run

### Spring

Timing

Since 1999, steelhead runs at BAFF have been markedly different in timing and abundance as compared to those occurring before 1999 (Hogler and Surendonk 1997, 1998, 1999, and 2006). Spring migratory runs before 1999 were predictable with large numbers of Chambers Creek returning to the weir with the onset of operations and then slowly declining in number through the end of April. As the Chambers Creek run dwindled in number, Ganaraska numbers increased rapidly, peaking in mid-April, and declining through early May. However, since 1999, run timing does not appear to be as distinct as was historically observed. In 2006, as well as in the previous seven springs, 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. There is no clear explanation for the change in run timing or duration unless hatchery practices have compressed the duration of the spring run.

Abundance

Abundance of steelhead in the spring 2006 run increased from what was observed in the 2005 run (Figure 1). Each of the three known strain components of the run increased in 2006 from their 2005 level, with Chambers Creek and Ganaraska nearly doubling in abundance. The unknown (other) component declined in number in 2006 from 2005 levels. The 2006 run abundance was near the five year average, but much lower than run sizes observed in the early 1990’s.

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

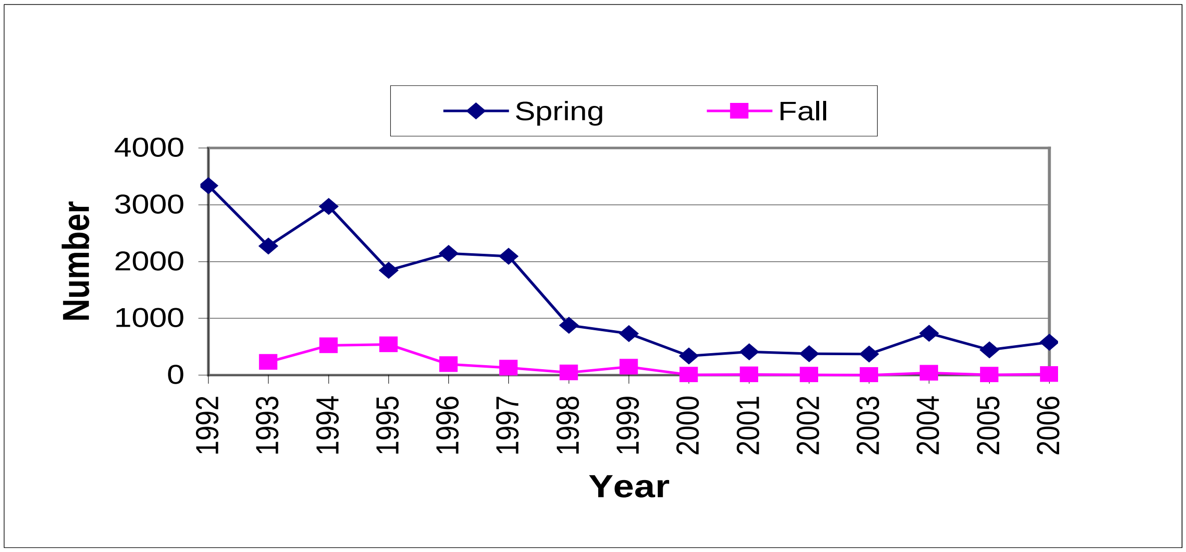



**Figure 1. Return number to BAFF on the Kewaunee River for spring and summer/fall runs from 1992 through 2006.**

Unfavorable spring weather may explain some of the decline in run number observed over the past seven years with unpredictable spring weather bringing either early river warm-ups before fish are ready to spawn or late river warm-ups too late for steelhead spawning. Coupled with a lack of precipitation or precipitation at the wrong time, spring weather may be partly responsible for the poor runs. These poor conditions may have caused steelhead to attempt to spawn in lower sections of the Kewaunee River or drop back into Lake Michigan without spawning. In 2006, early spring flows appeared to be adequate to draw steelhead into the river, but cold weather and rapidly decreasing flow may have slowed fish movement and caused several reaches of the river to become extremely shallow making upstream passage difficult for large fish. The number of younger, smaller fish observed this spring and the lack of larger, older fish appeared to support low water level as a partial reason for declining returns.

Stocking number does not appear to be contributing to the decline in run number. Stocking number continues to remain relatively stable for all strains (Figure 2). 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.

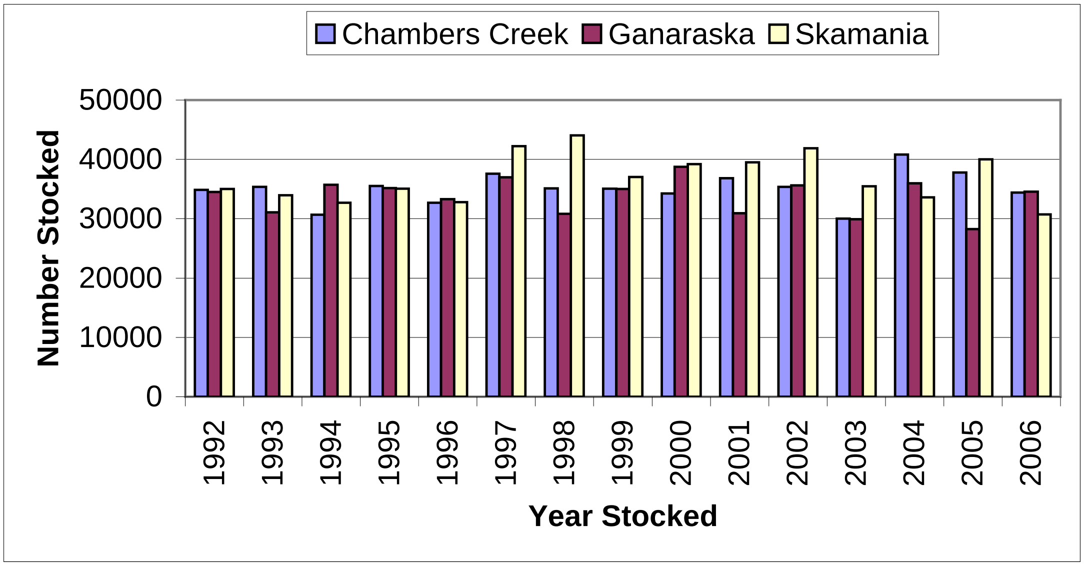



**Figure 2. Stocking number by strain for steelhead stocked into the Kewaunee River from 1992 through 2006.**

Water quality data collected during 2000 and 2004 suggest that in the Kewaunee River, runoff events may negatively impact water quality. In 2000, monitoring indicated that concentrations of dissolved oxygen dropped below the state standard of 5 mg/l for warmwater streams regularly due to runoff events (Hogler 2001). However, in 2004, monitoring indicated that water quality was generally good in the Kewaunee River. Unlike 2000, state standards for dissolved oxygen for warm water streams were never violated in 2004 (Hogler 2005).

Mortality of smolts may also play an important role in the declining number of returning steelhead seen the past seven years. Low flow in the Kewaunee River following smolt stocking may have increased smolt mortality and ultimately reduced the number of adults returning to the river. Size at stocking has been shown to be an important factor in the survival of smolts and their ultimate contribution to the fishery (Seelbach 1985). Smolts stocked in 2006 (Chambers Creek-163 mm, Ganaraska-140 mm and Skamania-127 mm) were similar in length to smolts stocked in recent years, but smaller in length than the 200 mm recommended by Seelbach (1985). Bartron (2003) indicated that steelhead stocked at less than 150 mm in length survive poorly and contribute little to the fishery as adults. In 2006, only Chambers Creek strain fish were greater than 150 mm. Recent drought conditions have reduced the amount of well water at Kettle Moraine Springs Fish Hatchery. Reduced water flow through the hatchery has impacted steelhead by reducing the production of smolts and causing fish to be stocked earlier at smaller size. The small size of recently stocked steelhead may be contributing to the decline in return number of steelhead.

In addition to physical size, other factors, such as disease status or the amount of fat reserve and predation by avian and fish predators on recently stocked steelhead may influence the number of smolts that survive and return as adults. These factors have not been researched for Kewaunee River steelhead making their impact on return number unknown.

Lakewide angler harvest of adult fish may also affect the number of returning spawners to BAFF. The annual steelhead harvest since the early 1990's has averaged just over 92,800 fish (Eggold 2006). Harvest during 1994, 1995 and 1998 exceeded 110,000 steelhead. Recently however, harvest has declined and now averages 58,558 over the past five years and further declined 37% to average 37,010 the past two years. Despite this marked reduction in harvest of steelhead from the Wisconsin waters of Lake Michigan the number of steelhead returning to BAFF has not increased. However, results from our tagging studies (Hogler and Surendonk 1997 and 1998) indicate that steelhead have lakewide movement patterns. Reductions in harvest from one jurisdiction may be balanced by increased harvest from anglers by other states, resulting in no net increase in the return to weir of Wisconsin stocked steelhead.

## Fall

The 15 steelhead handled at BAFF in the summer/fall of 2006 was more than the 6 fish handled in 2005 but similar to the previous four summer/fall runs (Figure 1). Improved river flow because of timely fall rains was likely responsible for the improved run. It is not known at this time why despite good river flow, the Skamania run in 2006 and those of the previous six years are much lower than historic runs on the Kewaunee River.

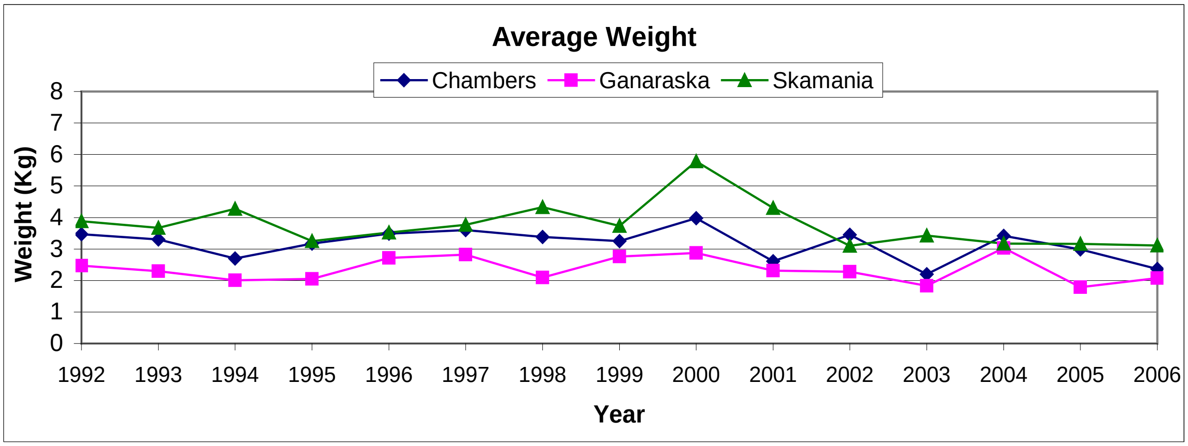
## Strain Performance

### Chambers Creek

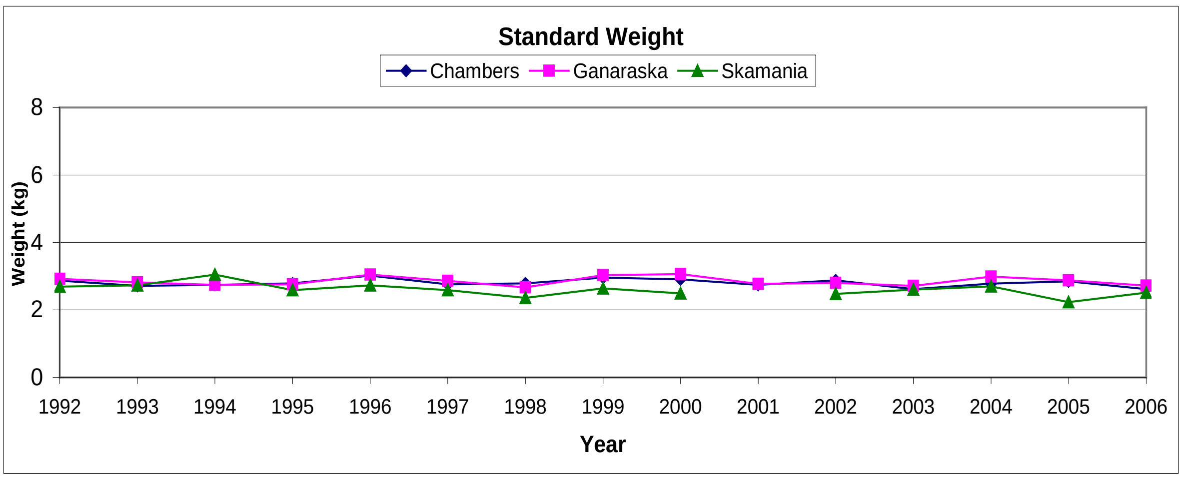
Average length and weight of Chambers Creek steelhead declined in 2006 from 2005 levels and is the second lowest since 1998 (Table 1). The decrease in average length and weight may be due to an increase in the number of younger fish returning to the weir or may be due to forage conditions in Lake Michigan. Standard and trophy weights decreased in 2006 from 2005 values and are the lowest on record (Figure 2 and 3). This change suggests that younger (smaller) fish are contributing more to the run than in other years, but also may indicate forage may be an issue because of the lack of large fish in the run.

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 to occur three years after the fish were stocked. In 2006, 4-year-old Chambers Creel steelhead stocked in 2003 returned at a lower rate than did 4-year-old fish in any year except for those stocked in 1998 and 2000 (Table 8). Overall, the best return rates have been for fish stocked in 1995, 1996 and 2001, it is hoped that the good return of Chambers Creek stocked in 2004 that we observed in 2006 will continue and improve the overall return of Chambers Creek steelhead to BAFF.

A.




B.




C.

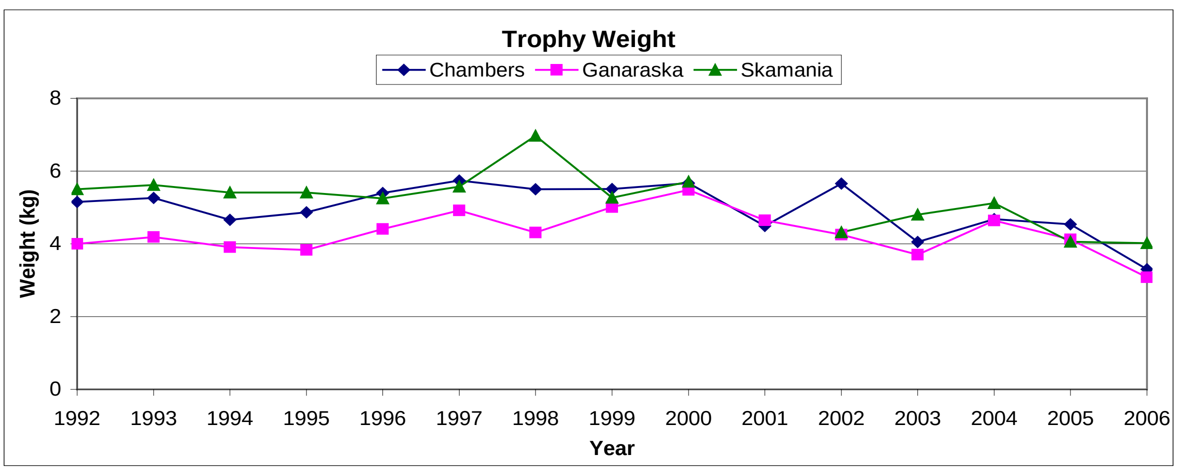



**Figure 3. Weights trends for steelhead during spring migrations at BAFF, 1992-2006: (A) Average weight for each strain for that year, (B) Standard weight is based on the projected weight of a 660 mm steelhead, (C) Trophy weight for each strain based on the 95$^{th}$. percentile of weighed steelhead.**

## Ganaraska

Ganaraska strain steelhead have had more variation in yearly length and weight averages than have Chambers Creek strain fish (Table 1). In 2006, average length and weight increased from 2005 levels, but still remain near their lowest values since 1998. While average weight increased in 2006, the other two weight indices declined. 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 3).

The return rate of Ganaraska stocked in 2004 was the highest return of 3 year old fish since 1996 stocking year class returned in 1998 (Table 10). The 2004 stocking year class continued to be one of the best returning year classes since the 1996 cohort. It is hoped that the 2004 year class of Ganaraska remains strong and improves the overall Ganaraska return to BAFF. Additionally, since the return of stocking year class 2005 had the second best return rate for age 2 fish, it is hoped that future returns of this year class will continue. Similar to the Chambers Creek strain, Ganaraska stocked in 1998, 2000 and 2003 have performed poorly, with improvements in returns noted for those steelhead stocked in 2001 and 2004. Overall, return rate indicates that fish stocked in 1996 returned at a higher rate than those stocked in later years.

## Skamania

Skamania had been a small, but consistent portion of the spring run until 2001 when their abundance dropped substantially. In 2006, the total number of Skamania handled was similar to 2005, however, average length and weight decreased slightly while standard weight and trophy weights increased from 2005 levels (Table 1). This variation may be due to the small number of Skamania handled during the spring 2006 run. However, since this strain normally migrates upriver in late summer and fall, return rates during the spring are expected to be low.

The number of Skamania collected during the fall run has varied greatly. The 2006 run was similar in number to other summer/fall runs since 2000 (Table 7). The lack of fall rain and high lake harvest may be responsible for the variation in run number and run timing that Skamania has experienced since 1997.

## Comparison of Strain Performance

All strains of steelhead had better returns to the weir in 2006 as compared to the 2005 run. Of the spring running strains since 1998, Ganaraska have returned to BAFF in greatest number, although Chambers Creek have returned in near equal number. Survival based on return per thousand stocked indicates that Ganaraska has had more consistent returns and a slightly better overall return than has Chambers Creek strain steelhead. Summer-run Skamania have had reduced run numbers since the 1995 peak. The return rate of Skamania per thousand stocked is the lowest of the three strains of steelhead.

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

Skamania continue to be the largest steelhead followed by Chambers Creek and Ganaraska. Mixed results from the three weight trends may indicate forage problems on Lake Michigan. Decreasing return number may continue to influence weight trends if smaller fish (younger in age) continue to dominate the run.

## Smolt Out-migration

During our electroshocking surveys in April, May and June we captured 588 trout and salmon above BAFF and 370 below (Table 5). Catch at both locations was less in 2006 than in 2005. In 2006, we documented that (1) smolts survive stocking and (2) that they are able to pass downstream of the dam at BAFF and make it to lower river sections on the way to Lake Michigan. Because the number of fish we captured was far less than 1% of the fish stocked and because we are not able to track fish all the way to Lake Michigan, we cannot quantify with certainty how many fish survive stocking, downstream movement and ultimately make it to Lake Michigan.

We can however make general observations regarding the data collected in 2006. It appears that each species differs in movement pattern and on the duration of time spent in the river following stocking.

Few Chinook and coho salmon were captured in our surveys and it appears that they leave the Kewaunee River quickly following stocking. This observation is similar to what was identified in 2005.

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

Similar to steelhead, brown trout movement in 2006 was different than what was observed in 2005. Like steelhead, the number of brown trout captured at the upstream station remained stable throughout the survey period indicating slow downstream movement.

Additional years of data are needed to better understand survival and movement following stocking.

## SUMMARY

The 2006 spring run total increased from what was observed during the 2005 spring run and was the second best run since 2000. Improved run number was likely due to good return of steelhead stocked in 2004 and to improved spring flows noted in 2006. However, although the 2006 run number was typical of the runs of the past five years, it was far less than those observed in 1991 through 1996. The reduction in return number is likely due to the poor return rate for several year classes that were stocked between 1998 and 2002. Poor survival of these year classes may be due to unusual weather conditions that resulted in poor flow on the Kewaunee River and low lake level, high harvest of adult fish, or from mortality of recently stocked smolts.

Changes in the spring 2006 average, standard and trophy weights may be due to a larger percentage of the run being age 3 as compared to the 2004 run that was dominated by age 4 steelhead. Long term declines in weight trends are likely due to the absence of age 5 and older fish which were present in past runs. Why older fish are absent from recent runs is unknown at this time and may be related to angler harvest, fish health, stocking location or predation on smolts.

The summer/fall run of steelhead was poor in 2006 and was similar to those since 2000. Although there was abundant late spring and late fall rain, river flow did not increase enough to trigger steelhead runs into the river, making 2006 a poor year for Skamania.

We continued to evaluate the relative magnitude of the smolt out-migration from the Kewaunee River in 2006. 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 all three strains of steelhead were spotty from BAFF in 2006, but should not affect the total number of steelhead stocked in 2007 because of the contribution of gametes from the Root River Steelhead Facility.

## REFERENCES


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

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

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

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

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

Hogler, S. and S. Surendonk. 1997. Return, size, Age and Movement of Steelhead at the Besadny Anadromous Fisheries Facility, 1992-1995. Wisconsin Department of Natural Resources. 52 p.

Hogler, S. and S. Surendonk. 1998. Return, size, Age and Movement of Steelhead at the Besadny Anadromous Fisheries Facility, 1997. Wisconsin Department of Natural Resources. 34 p.

Hogler, S. and S. Surendonk. 1999. Return, size, Age and Movement of Steelhead at the Besadny Anadromous Fisheries Facility, 1998. 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. 22 p.

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

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

**Table 1. Summary of steelhead length and weight data collected during spring migratory runs at BAFF, on the Kewaunee River, 1998-2006.**

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

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

**Table 2. Daily totals during 2006 operations at BAFF, by strain of steelhead.**

**Spring Run Steelhead**

| Date | Chambers Creek | Ganaraska | Skamania | Other | Day Total |
|---|---|---|---|---|---|
| **April 5** | 107 | 172 | 13 | 128 | 420 |
| **April 11** | 18 | 31 | 1 | 22 | 72 |
| **April 17** | 10 | 46 | 3 | 31 | 90 |
| **Total** | 135 | 249 | 17 | 181 | 582 |

**Summer/Fall Run Steelhead**

| Date of Operation | Chambers Creek | Ganaraska | Skamania | Unknown | Day Total |
|---|---|---|---|---|---|
| **October 7** | | | | 0 | 0 |
| **October 10** | | | | 10 | 10 |
| **October 16** | | | | 1 | 1 |
| **October 20** | | | | 1 | 1 |
| **October 23** | | | | 1 | 1 |
| **October 31** | | | 1 | | 1 |
| **November 8** | | | | | 0 |
| **November 15** | | | | | 0 |
| **November 16** | 1 | | | | 1 |
| **Total** | 1 | 0 | 1 | 13 | 15 |

**Table 3. Average length, weight and run number by strain, clip, and sex during the spring spawning run at BAFF, 2006.**

| | **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) | 705 | 2.46 | 1 | 682 | 2.78 | 7 |
| Adipose, Left Maxillary (ALM) | 491 | 1.26 | 6 | 683 | 3.15 | 3 |
| Left Maxillary (LM) | 643 | 2.40 | 74 | 622 | 2.36 | 44 |
| **Chambers Creek combined average** | **633** | **2.31** | **81** | **633** | **2.46** | **54** |
| **Ganaraska** | | | | | | |
| Adipose, Left Ventral (ALV) | 585 | 1.94 | 95 | 586 | 2.14 | 110 |
| Adipose, Right Ventral (ARV) | 463 | 1.09 | 16 | 726 | 3.61 | 7 |
| Both Ventral (BV) | 668 | 2.67 | 9 | 651 | 2.69 | 12 |
| **Ganaraska combined average** | **575** | **1.88** | **120** | **600** | **2.27** | **129** |
| **Skamania** | | | | | | |
| Adipose, Right Maxillary (ARM) | 630 | 2.02 | 1 | -- | -- | 0 |
| Right Maxillary (RM) | 734 | 2.86 | 1 | 676 | 2.66 | 3 |
| Right Maxillary, Right Ventral (RMRV) | 747 | 3.44 | 3 | 704 | 3.29 | 9 |
| **Skamania combined average** | **721** | **3.04** | **5** | **697** | **3.13** | **12** |

**Table 4. The age distribution, length, and weight of returning clipped steelhead by sex for the Kewaunee River spring 2006.**

**Chambers Creek**

| Age (Male) | 2 | 3 | 4 | 5 | 6 | Age (Female) | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Measured | 4 | 69 | 1 | 5 | 2 | Measured | 0 | 41 | 7 | 3 | 3 |
| Average Length (mm) | 443 | 638 | 705 | 719 | 588 | Average Length (mm) | -- | 614 | 682 | 724 | 683 |
| Range (mm) | 435-455 | 505-695 | -- | 705-734 | 556-620 | Range | -- | 564-655 | 660-715 | 700-762 | 630-755 |
| Weighed | 4 | 69 | 1 | 5 | 2 | Weighed | 0 | 41 | 7 | 3 | 3 |
| Average Weight (kg) | 0.84 | 2.31 | 2.46 | 3.53 | 2.09 | Average Weight (kg) | -- | 2.27 | 2.78 | 3.61 | 3.15 |
| Range (kg) | 0.60-0.98 | 1.16-2.96 | -- | 3.06-4.02 | 1.96-2.22 | Range (kg) | -- | 0.80-2.92 | 2.30-3.14 | 3.26-4.08 | 2.62-4.12 |

**Ganaraska**

| Age (Male) | 2 | 3 | 4 | 5 | 6 | Age (Female) | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Measured | 15 | 87 | 9 | 1 | 8 | Measured | 1 | 107 | 12 | 6 | 3 |
| Average Length (mm) | 446 | 578 | 668 | 705 | 664 | Average Length (mm) | 590 | 584 | 651 | 745 | 671 |
| Range (mm) | 420-570 | 465-652 | 605-724 | -- | 642-745 | Range | -- | 397-710 | 590-710 | 680-794 | 642-720 |
| Weighed | 15 | 87 | 9 | 1 | 8 | Weighed | 1 | 107 | 12 | 6 | 3 |
| Average Weight (kg) | 0.93 | 1.87 | 2.67 | 3.44 | 2.75 | Average Weight (kg) | 1.92 | 2.11 | 2.69 | 3.89 | 3.00 |
| Range (kg) | 0.54-1.90 | 0.88-2.72 | 1.94-3.06 | -- | 2.48-3.56 | Range (kg) | -- | 0.40-3.06 | 1.42-3.98 | 2.94-5.32 | 2.66-3.48 |

**Skamania**

| Age (Male) | 2 | 3 | 4 | 5 | 6 | Age (Female) | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Measured | 0 | 0 | 3 | 1 | 1 | Measured | 0 | 2 | 9 | 1 | 0 |
| Average Length (mm) | -- | -- | 747 | 734 | 630 | Average Length (mm) | -- | 661 | 704 | 705 | -- |
| Range (mm) | -- | -- | 715-795 | -- | -- | Range | -- | 642-675 | 658-730 | -- | -- |
| Weighed | 0 | 0 | 3 | 1 | 1 | Weighed | 0 | 2 | 9 | 1 | 0 |
| Average Weight (kg) | -- | -- | 3.44 | 2.86 | 2.02 | Average Weight (kg) | -- | 2.04 | 3.29 | 3.90 | -- |
| Range (kg) | -- | -- | 2.90-4.02 | -- | -- | Range (kg) | -- | 2.04-2.04 | 2.30-3.96 | -- | -- |

**Table 5. Total trout and salmon captured by electroshocking during the 2005 and 2006 out-migration study. The upstream site is above BAFF and the downstream site is below BAFF.**

**2005**

| Upstream | CFS | Stage | Coho | Chinook | Brown | Chambers | Ganaraska | Skamania | Other | Total | Temp (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **25-Apr** | 50 | 9.20 | 0 | 0 | 33 | 114 | 120 | 32 | 7 | **306** | |
| **05-May** | 37 | 9.05 | 4 | 0 | 9 | 31 | 46 | 35 | 2 | **127** | |
| **10-May** | 37 | 9.05 | 0 | 0 | 1 | 18 | 9 | 17 | 1 | **46** | |
| **18-May** | 37 | 9.07 | 0 | 0 | 7 | 15 | 17 | 5 | 3 | **47** | |
| **23-May** | 48 | 9.15 | 0 | 0 | 5 | 10 | 13 | 3 | 1 | **32** | 62 |
| **02-Jun** | 25 | 8.94 | 0 | 2 | 6 | 12 | 14 | 4 | 2 | **40** | 64 |
| **06-Jun** | 30 | 8.99 | 0 | 16 | 3 | 3 | 5 | 8 | 4 | **39** | 68 |
| **20-Jun** | 20 | 8.90 | 0 | 0 | 4 | 8 | 3 | 7 | 4 | **26** | 67 |
| **Total** | | | 4 | 18 | 68 | 211 | 227 | 111 | 24 | 663 | |

| Downstream | CFS | Stage | Coho | Chinook | Brown | Chambers | Ganaraska | Skamania | other | Total | Temp. (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **25-Apr** | 50 | 9.20 | 16 | 0 | 18 | 21 | 26 | 9 | 0 | **90** | |
| **05-May** | 37 | 9.05 | 3 | 0 | 4 | 21 | 29 | 29 | 1 | **87** | |
| **10-May** | 37 | 9.05 | 2 | 0 | 15 | 12 | 19 | 9 | 1 | **58** | |
| **18-May** | 37 | 9.07 | 0 | 0 | 15 | 12 | 30 | 16 | 1 | **74** | |
| **23-May** | 48 | 9.15 | 0 | 0 | 10 | 4 | 14 | 5 | 0 | **33** | |
| **02-Jun** | 25 | 8.94 | 0 | 0 | 10 | 4 | 13 | 4 | 3 | **34** | |
| **06-Jun** | 30 | 8.99 | 0 | 10 | 9 | 1 | 12 | 7 | 1 | **40** | |
| **20-Jun** | 20 | 8.90 | 0 | 2 | 23 | 4 | 42 | 13 | 3 | **87** | 74 |
| **Total** | | | 21 | 12 | 104 | 79 | 185 | 92 | 10 | 503 | |

**2006***

| Upstream | CFS | Stage | Coho | Chinook | Brown | Chambers | Ganaraska | Skamania | Other | Total | Temp (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **27-Apr** | 44 | 9.21 | 0 | 0 | 71 | 89 | 27 | 32 | 1 | **220** | 52 |
| **04-May** | 65 | 9.35 | 1 | 0 | 33 | 51 | 12 | 21 | 2 | **120** | 56 |
| **24-May** | 101 | 9.5 | 0 | 1 | 22 | 11 | 20 | 14 | 1 | **69** | 56 |
| **05-Jun** | 88 | 9.5 | 0 | 5 | 13 | 19 | 37 | 15 | 10 | **99** | 60 |
| **20-Jun** | 46 | 9.18 | 0 | 0 | 11 | 19 | 31 | 14 | 5 | **80** | 66 |
| **Total** | | | 1 | 6 | 150 | 189 | 127 | 96 | 19 | 588 | |

| Downstream | CFS | Stage | Coho | Chinook | Brown | Chambers | Ganaraska | Skamania | other | Total | Temp. (F) |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **27-Apr** | 44 | 9.21 | 11 | 0 | 91 | 51 | 34 | 19 | 3 | **209** | 54 |
| **04-May** | 65 | 9.35 | 5 | 0 | 17 | 21 | 18 | 6 | 1 | **68** | 60 |
| **24-May** | 101 | 9.5 | 0 | 0 | 1 | 8 | 28 | 3 | 8 | **48** | 56 |
| **05-Jun** | 88 | 9.5 | 0 | 0 | 1 | 1 | 4 | 0 | 1 | **7** | 62 |
| **20-Jun** | 46 | 9.18 | 0 | 0 | 4 | 5 | 20 | 3 | 6 | **38** | 68 |
| **Total** | | | 16 | 0 | 114 | 86 | 104 | 31 | 19 | 370 | |

*** Heavy rain or high flow prevented electroshocking during the weeks of May 8-19 and May 29-June 3.**

**Table 6. Total trout and salmon captured by electroshocking during the 2005 and 2006 out-migration study. The upstream site is above BAFF and the downstream site is below BAFF.**

**2005**

| | Upstream | | | Downstream | | |
|---|---|---|---|---|---|---|
| **Strain** | 25-Apr | 18-May | 20-Jun | 25-Apr | 18-May | 20-Jun |
| **Chambers Creek** | 153 | 122 | 138 | 148 | 137 | 144 |
| **Ganaraska** | 132 | 125 | 149 | 141 | 144 | 154 |
| **Skamania** | 148 | 143 | 135 | 150 | 128 | 161 |

**2006**

| | Upstream | | | Downstream | | |
|---|---|---|---|---|---|---|
| **Strain** | 27-Apr | 24-May | 20-Jun | 27-Apr | 24-May | 20-Jun |
| **Chambers Creek** | 162 | 157 | 155 | 175 | 165 | 150 |
| **Ganaraska** | 129 | 138 | 144 | 165 | 157 | 165 |
| **Skamania** | 137 | 129 | 134 | 163 | 184 | 131 |

**Table 7. Steelhead fin clip trends detected at BAFF during fall migrations, 1997-2006.**

| Strain and fin clip | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 | 2006 |
|---|---|---|---|---|---|---|---|---|---|---|
| Skamania | | | | | | | | | | |
| Adipose, Right Maxillary (ARM) | 57 | 8 | 8 | 3 | | | | 28 | | |
| Right Maxillary (RM) | 53 | 20 | 76 | 1 | 8 | 1 | | 4 | 2 | 1 |
| Right Maxillary,Right Ventral (RMRV) | | | 8 | 1 | | | | | 1 | |
| Right Maxillary,Left Pectoral (RMLP) | | | 1 | | | | | | | |
| Right Pectoral, Left Ventral (RPLV) | | 2 | | | | | | | | |
| Left Maxillary, Left Ventral (LMLV) | | | | | | | | | | |
| Total Skamania | 110 | 30 | 93 | 5 | 8 | 1 | 0 | 32 | 3 | 1 |
| Chambers Creek | | | | | | | | | | |
| Left Maxillary (LM) | 1 | | 1 | | | | | | | |
| Left Maxillary, Left Ventral (LMLV) | | | | | | | | | | 1 |
| Adipose, Left Maxillary (ALM) | | | | | | | | | | |
| Total Chambers Creek | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 1 |
| Ganaraska | | | | | | | | | | |
| Adipose, Right Ventral (ARV) | | | | | | | | | | |
| Adipose, Left Ventral (ALV) | | | | | | | | | | |
| Both Ventral (BV) | | | | | | | | | | |
| Total Ganaraska | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Unknown | | | | | | | | | | |
| No Clips | 17 | 15 | 30 | 2 | 5 | 2 | | 3 | | |
| Both Maxillary (LMRM) | | | | | | | | | | |
| Adipose (?), Right Ventral (A?RV) | | | | | | | | | | |
| Adipose (A) | 1 | | 1 | | | | | | | |
| Other | 2 | 1 | 20 | | | | | 5 | 3 | 13 |
| Total Unknown | 20 | 16 | 51 | 2 | 5 | 2 | 0 | 8 | 3 | 13 |
| **Total Fall Steelhead Run** | **131** | **46** | **145** | **7** | **13** | **3** | **0** | **40** | **6** | **15** |

**Table 8. Return rates (number per thousand stocked) for Chambers Creek steelhead during spring migrations on the Kewaunee River, 1997-2006.**

| | Year Stocked | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Return Year | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
| 1997 | 0.00 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 1998 | 0.85 | 0.11 | -- | -- | -- | -- | -- | -- | -- | -- |
| 1999 | 5.26 | 0.80 | 0.03 | -- | -- | -- | -- | -- | -- | -- |
| 2000 | 1.16 | 0.93 | 0.11 | 0.09 | -- | -- | -- | -- | -- | -- |
| 2001 | 0.18 | 0.11 | 0.09 | 1.51 | 0.00 | -- | -- | -- | -- | -- |
| 2002 | 0.00 | 0.00 | 0.03 | 1.23 | 0.09 | 0.05 | -- | -- | -- | -- |
| 2003 | 0.00 | 0.00 | 0.00 | 0.11 | 0.15 | 1.79 | 0.17 | -- | -- | -- |
| 2004 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 4.53 | 1.02 | 0.00 | -- | -- |
| 2005 | 0.00 | 0.00 | 0.00 | 0.06 | 0.00 | 0.62 | 0.48 | 0.20 | 0.20 | -- |
| 2006 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.14 | 0.23 | 0.27 | 2.69 | 0.11 |
| Total | 7.45 | 1.95 | 0.26 | 3.00 | 0.24 | 7.13 | 1.90 | 0.47 | 2.89 | 0.11 |

**Table 9. Return rates (number per thousand stocked) for Ganaraska steelhead during spring migrations on the Kewaunee River, 1997-2006.**

| | Year Stocked | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Return Year | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
| 1997 | 0.30 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 1998 | 3.57 | 0.35 | -- | -- | -- | -- | -- | -- | -- | -- |
| 1999 | 4.17 | 1.68 | 0.16 | -- | -- | -- | -- | -- | -- | -- |
| 2000 | 0.57 | 0.57 | 0.58 | 0.51 | -- | -- | -- | -- | -- | -- |
| 2001 | 0.12 | 0.19 | 0.52 | 3.08 | 0.08 | -- | -- | -- | -- | -- |
| 2002 | 0.00 | 0.00 | 0.16 | 0.13 | 0.08 | 0.16 | -- | -- | -- | -- |
| 2003 | 0.00 | 0.00 | 0.00 | 0.17 | 0.00 | 1.49 | 0.45 | -- | -- | -- |
| 2004 | 0.00 | 0.00 | 0.00 | 0.00 | 0.03 | 3.40 | 1.26 | 0.37 | -- | -- |
| 2005 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.58 | 0.73 | 0.67 | 1.72 | -- |
| 2006 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.36 | 0.19 | 0.70 | 5.39 | 0.57 |
| Total | 8.73 | 2.79 | 1.42 | 3.89 | 0.19 | 5.99 | 2.63 | 1.74 | 7.11 | 0.57 |

**Table 10. Return rates (number per thousand stocked) for Skamania steelhead during spring migrations on the Kewaunee River, 1997-2006.**

| | Year Stocked | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Return Year | 1996 | 1997 | 1998 | 1999 | 2000 | 2001 | 2002 | 2003 | 2004 | 2005 |
| 1997 | 0.03 | -- | -- | -- | -- | -- | -- | -- | -- | -- |
| 1998 | 0.06 | 0.00 | -- | -- | -- | -- | -- | -- | -- | -- |
| 1999 | 0.30 | 0.00 | 0.00 | -- | -- | -- | -- | -- | -- | -- |
| 2000 | 1.03 | 0.00 | 0.00 | 0.12 | -- | -- | -- | -- | -- | -- |
| 2001 | 0.00 | 0.00 | 0.02 | 0.03 | 0.00 | -- | -- | -- | -- | -- |
| 2002 | 0.00 | 0.00 | 0.00 | 0.43 | 0.03 | 0.00 | -- | -- | -- | -- |
| 2003 | 0.00 | 0.00 | 0.00 | 0.32 | 0.03 | 0.03 | 0.05 | -- | -- | -- |
| 2004 | 0.00 | 0.00 | 0.00 | 0.11 | 0.03 | 0.53 | 0.12 | 0.00 | -- | -- |
| 2005 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | 0.33 | 0.05 | 0.00 | 0.00 | -- |
| 2006 | 0.00 | 0.00 | 0.00 | 0.00 | 0.00 | .0.03 | 0.05 | 0.34 | 0.06 | 0.00 |
| Total | 1.42 | 0.00 | 0.02 | 1.01 | 0.09 | 0.92 | 0.27 | 0.34 | 0.06 | 0.00 |