Return, Size, and Age of Steelhead at the Besadny Anadromous Fisheries Facility, 2005

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ABSTRACT

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

Spring operations in 2005 began on April 6, and continued until April 20. During this period, 443 steelhead were handled at BAFF. The run consisted of 66 Chambers Creek strain steelhead (14.9% of the run), 125 Ganaraska (28.2%), 15 Skamania (3.4%), and 237 (53.5%) unclipped, misclipped or strays from other streams or states. The total number of fish handled during the spring run in 2005 declined from the 2004 total, but was similar to spring migrations of 2000 through 2003 in the number of steelhead processed. The spring 2005 run was very near the 5 year average run of 447 fish.

Summer/fall fish collections began in late September when the BAFF fish ladder began to operate. BAFF ponds were sorted seven days during September through November to process migrating fish. Six steelhead were captured at BAFF during October. Although the 2005 summer/fall migration of steelhead declined sharply from the run of 2004 it was similar to other summer/fall runs of the past five years. Fifty percent of the returning steelhead were Skamania with the majority having a right maxillary (RM) clip.

On April 25 we began to shock the study locations to monitor the out-migration of trout and salmon from the Kewaunee River. During this period we captured 663 trout and salmon above BAFF and 503 below BAFF. At the upstream site, daily totals ranged from 308 on April 25 to 26 trout and salmon on June 20. Daily totals of trout and salmon captured at the downstream site ranged from 33 to 90. Stream flow and stage were variable through the survey because of rainfall events, but generally showed a declining trend from April through June.

The 2005 spring run total declined substantially from what was observed during the 2004 spring run. The 2005 run was typical of the runs of the past five years, but 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, low lake level, high harvest of adult fish, or from mortality of recently stocked smolts.

Changes in the spring 2005 average, standard and trophy weights may be due to a larger percentage of the run being age 2 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 that were present in past runs. Why older fish are absent from the return is unknown at this time and may be related to angler harvest, fish health, stocking location or predation on smolts.

The summer/fall run of steelhead was poor in 2005 and was similar to those from 2000 through 2003. Although there was abundant late spring and late fall rain, river flow did not increase enough to trigger steelhead runs into the river, making 2005 a poor year for Skamania.

We continued to evaluate the relative magnitude of the smolt out-migration from the Kewaunee River in 2005. 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.

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 2005 migratory runs of adult steelhead at BAFF and smolt movement in the Kewaunee River.

METHODS

Adult Collection

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

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

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

Smolt Out-migration

To assess the movement of steelhead and other 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 resulting in an upstream site that was 910 meters in length and a lower site that was 350 meters in length. On survey dates, stream flow and stage information was collected from the USGS gauging site on the Highway F bridge just downstream of the lower survey site.

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 was used 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 2005 began on April 6, and continued until April 20. During this period, 443 steelhead were handled at BAFF. The run consisted of 66 Chambers Creek strain steelhead (14.9% of the run), 125 Ganaraska (28.2%), 15 Skamania (3.4%), and 237 (53.5%) unclipped, misclipped or strays from other streams or states. The total number of fish handled during the spring run in 2005 declined from the 2004 total, but was similar to spring migrations of 2000 through 2003 in the number of steelhead processed. The spring 2005 run was very near the 5 year average run of 447 fish.

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 6 (Table 2). The length of Chambers Creek steelhead ranged from 400 mm to 850 mm, with an average length of 675 mm (Table 1). Weight ranged from 0.68 kg to 5.12 kg and averaged 2.99 kg. The average length and average weight for Chambers Creek steelhead in 2005 decreased from 2004 levels and were among the lowest measured since 1997.

Males comprised 47.0 % of the run and averaged 630 mm in length and 2.45 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 2005, males returned at ages 2 through 5 and age 7 (Table 4). Age 4 fish were the most common, and averaged 711 mm in length and 3.12 kg in weight.

Females comprised 53.0% of the run and averaged 714 mm in length and 3.47 kg in weight (Table 3). LM and adipose-left maxillary (ALM) fin clips were observed on returning female Chamber Creek fish in 2005. ALM clipped fish were the most common, with an average length of 724 mm, an average weight of 3.63 kg and were judged to be age 5 (Table 4).

Handling mortality was 1.5% for Chambers Creek during the spring run (Table 5). This was less than what was observed in 2004 and but similar to the handling mortalities of years previous of 2004.

Ganaraska strain

Ganaraska were processed throughout spring operations (Table 2). Lengths ranged from 280 mm to 869 mm and averaged 537 mm. Weights ranged from 0.2 kg to 5.92 kg with an average weight of 1.79 kg (Table 1). The average length and weight in 2005 was the lowest measured since 1997, but likely reflects the large number of young males observed in the spring sample (Table 4).

Males dominated the run in 2005 (69.6%), and had an average length of 489 mm and weight of 1.34 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 5 returned during the spring migration (Table 4). Age 2 fish were the most common, with substantially fewer fish of other ages captured. Age 2 males averaged 408 mm in length and 0.7 kg in weight.

Females comprised 30.4% of the run and averaged 648 mm in length and 2.82 kg in weight (Table 3). Three clips were detected for female Ganaraska, with the ALV clip the most common. The majority of returning females were age 4 or age 5. Age 4 fish had an average length of 668 mm and average weight of 2.9 kg (Table 4). Age 5 females had an average length of 711 mm and an average weight of 3.64 kg.

Handling mortality was 3.2% for Ganaraska during the spring run (Table 5). 2005 handling mortality was greater than the five year average yearly mortality of 1.1% for Ganaraska.

Skamania strain

Skamania were handled throughout the spring run in 2005 (Table 2). Lengths ranged from 685 mm to 815 mm and averaged 732 mm. Weights ranged from 2.4 kg to 4.06 kg and averaged 3.16 kg (Table 1).

Males comprised 20% of the run, and had an average length of 766 mm and weight of 3.53 kg (Table 3). Two fin clips were observed for Skamania males, with the adipose-right maxillary clip (ARM) the most common. Based on fin clip and length, ages 4 and 5 returned during the spring migration (Table 4). Age 5 fish were the most common and averaged 781 mm in length and 3.66 kg in weight.

Females comprised 80% of the run and averaged 723 mm in length and 3.07 kg in weight (Table 3). Two clips were observed on returning females that corresponded to ages 4 and 5 (Table 4). The ARM fin clip was the most common clip observed. Age 5 females were the most common and averaged 723 mm in length and 3.07 kg in weight.

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

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. Members of this group were collected during each day of operation (Table 2), and were the largest single component of the spring run (Table 1).

Handling mortality for this group of steelhead was 0.4% which was slightly less than the five year average of 0.5% (Table 5).

Summer/Fall Adult Collection

Summer/fall fish collections began in late September when the BAFF fish ladder began to operate. BAFF ponds were sorted seven days during September through November to process migrating fish. Six steelhead were captured at BAFF during October (Table 2). Although the 2005 summer/fall migration of steelhead declined sharply from the run of 2004 it was similar to other summer/fall runs of the past five years (Table 6). Fifty percent of the

returning steelhead were Skamania with the majority those having a right maxillary (RM) clip. All steelhead captured during the fall 2005 run were returned to the Kewaunee River.

Smolt Out-migration

Steelhead were stocked seven miles upstream of Lake Michigan (3 miles upstream of BAFF) starting on April 11 and continuing through April 20. Stocking of other trout and salmon for the Lake Michigan program also began at this time and continued through May. A total of 37,815 Chamber Creek strain steelhead with an average length of 151 mm and a adipose-left maxillary clip, 28,233 Ganaraska with an average length of 138 mm and an adipose-right ventral clip and 40,009 Skamania with an average length of 142 mm and an adipose-right maxillary clip were stocked during this time into the Kewaunee River.

On April 25 we began to shock the study locations weekly though June 6, when we began to shock the sites biweekly as numbers of fish captured above BAFF decreased. At the upstream site daily totals ranged from 308 trout and salmon on April 25 to 26 fish on June 20 (Table 7). Daily totals of trout and salmon captured at the downstream site ranged from 33 to 90. Stream flow and stage were variable throughout the survey because of rainfall events, but generally showed a declining trend throughout the sampling period of April through June.

Steelhead

Ganaraska strain steelhead were the most commonly captured steelhead during the survey followed by Chambers Creek (Table 7). At the upstream location, all three strains of steelhead were captured in the highest number during April and May surveys and then declined to much lower numbers during surveys in 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 during each month of the survey. At the upstream location, average length was similar to average length at the time of stocking (Table 8). Average length declined for Chambers Creek and Ganaraska strain steelhead from April to May and then increased in June. Average length declined from April to June for Skamania steelhead. At the downstream site, average length declined from April to May for Chambers Creek and Skamania then increased in June. Ganaraska average length increased throughout the survey period.

Salmon

The 128,281 coho that were stocked through March 21 in the Kewaunee River were only captured early in our survey. At the upstream site, coho were captured on May 5 and not captured again. At the downstream location, coho were captured from April 25 through May 10 (Table 7). During the sampling period we captured 25 coho salmon, of which 21 were captured at the downstream site.

A total of 84,451 Chinook salmon were stocked into the Kewaunee River on May 18. Chinook salmon were captured only during June surveys. At the upstream location Chinook were captured during the June 2 and 6 sampling events. Downstream capture of Chinook was limited to the June 6 and June 20 survey events. Eighteen Chinook salmon were captured upstream of BAFF, with 12 captured downstream of the dam.

Brown Trout

A total of 36,533 brown trout were stocked into the river above the upstream site by April 7. Brown trout were captured at each survey site each day of the survey (Table 7). At the upstream site, we captured 68 brown trout with the majority captured during the April 25 shocking event. Following the April 25 sampling event, numbers declined sharply. At the downstream site, we captured a total of 104 brown trout with similar number seen each on each survey date.

DISCUSSION

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

Timing and Abundance of the Run

Spring

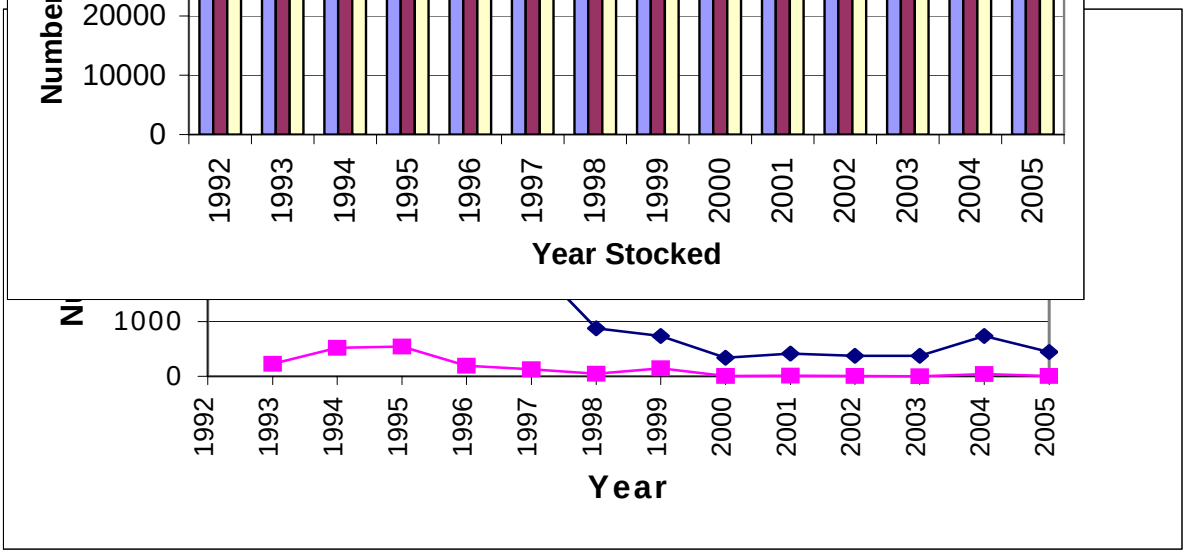
The past six springs, 1999 through 2005, steelhead runs at BAFF have been markedly different in timing and abundance as compared to previous years (Hogler and Surendonk 1997, 1998, 1999, 2000, 2001, 2002, 2003 and 2004). Spring migratory runs before 1999 had been predictable with large numbers of Chambers Creek returning to the weir with the onset of operations and then slowly declining in number through the end of April. As the Chambers Creek run dwindled in number, Ganaraska numbers increased rapidly, peaked in mid-April, and declined through early May. However, since 1999, run timing does not appear to be as distinct as was historically observed. In 2005, the run was limited to a two week period. There is no clear explanation for the change in run timing or duration.

Abundance of steelhead during the spring 2005 run declined sharply from what was observed in 2004, but in 2005 abundance was similar to what was observed from 2000 through 2003 (Figure 1). All components of the run (strain) decreased from their 2004 level, with the greatest decrease seen in Chambers Creek and unmarked steelhead abundances

(Table 1). The 2005 run abundance was near the five year average, but much lower than run size observed in the early 1990's.

There is no clear explanation for the decrease in run number in 2005. Likely it was the co and April. O uality, poor su

Fi mmer/fall



runs from 1992 through 2005.

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 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. In 2005, 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 Skamania (Figure 2). Chambers Creek and Ganaraska stocking numbers have varied from year to year but generally have remained above 30,000 for each strain.

Figure 2. Stocking number by strain for steelhead stocked into the Kewaunee River from 1992 through 2005.

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 diel concentrations of dissolved oxygen dropped below 5 mg/l regularly on the Kewaunee River (Hogler 2001). It is likely that the DO sags in 2000 were due to runoff events that delivered sediment and nutrients to the Kewaunee River allowing dense algal mats to form causing large diel swings in DO concentrations. 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 2005 (Chambers Creek-151 mm, Ganaraska-138 mm and Skamania-142 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 2005, only Chambers Creek strain fish were greater than 150 mm. Small size of recently stocked steelhead may be contributing to the decline in return number of steelhead.

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

Lakewide angler harvest of adult fish may also affect the number of returning spawners to BAFF. The annual steelhead harvest since the early 1990's has averaged just over 92,800 fish (Eggold 2005). Harvest during 1994, 1995 and 1998 exceeded 110,000 steelhead. However, the five year harvest average has declined to 58,558 and over the past two summers harvest has further declined 37% to 37,039. 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 6 steelhead handled at BAFF in the summer/fall of 2005 was less than the 40 fish handled in 2004 but similar to the previous four summer/fall runs (Figure 1). Low river flows caused by the lack of summer and fall rains have severely limited the run. However, other factors such as smolt mortality and lake harvest must have also impacted the return of these steelhead.

Strain Performance

Chambers Creek

Average length and weight of Chambers Creek steelhead declined in 2005 from 2004 levels and is the third lowest since 1997 (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 weight increased in 2005 from 2004 values, while trophy weight decreased (Figure 3). This suggests that younger (smaller) fish are contributing more to the run than in 2004, 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 return at age 4, we would expect to see the highest return rate of a year class occur three years after fish were stocked. In 2005, 4-year-old Chambers Creek steelhead stocked in 2002 returned at a lower rate than did 4-year-old fish in 2004 that were stocked in 2001 (Table 9). Overall, the best return rates have been for fish stocked in 1995, 1996 and 2001.

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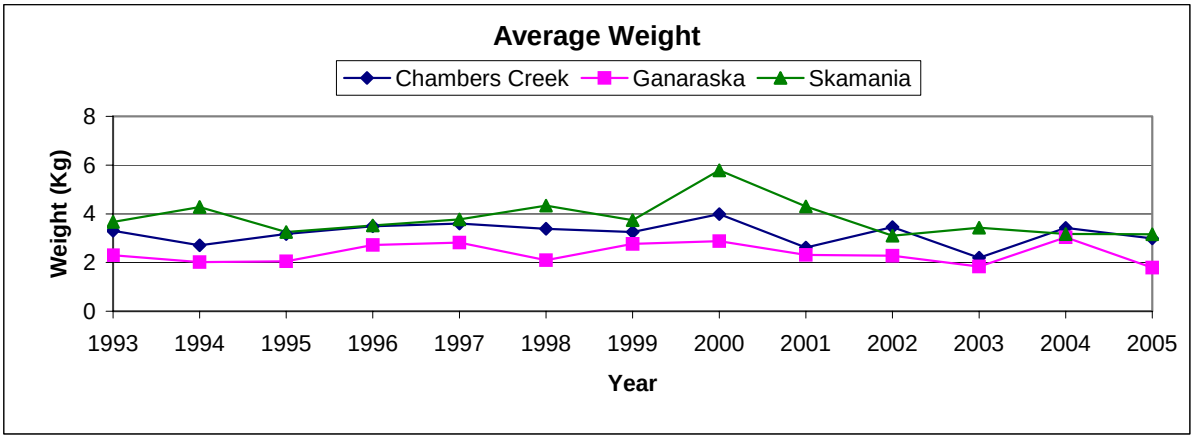

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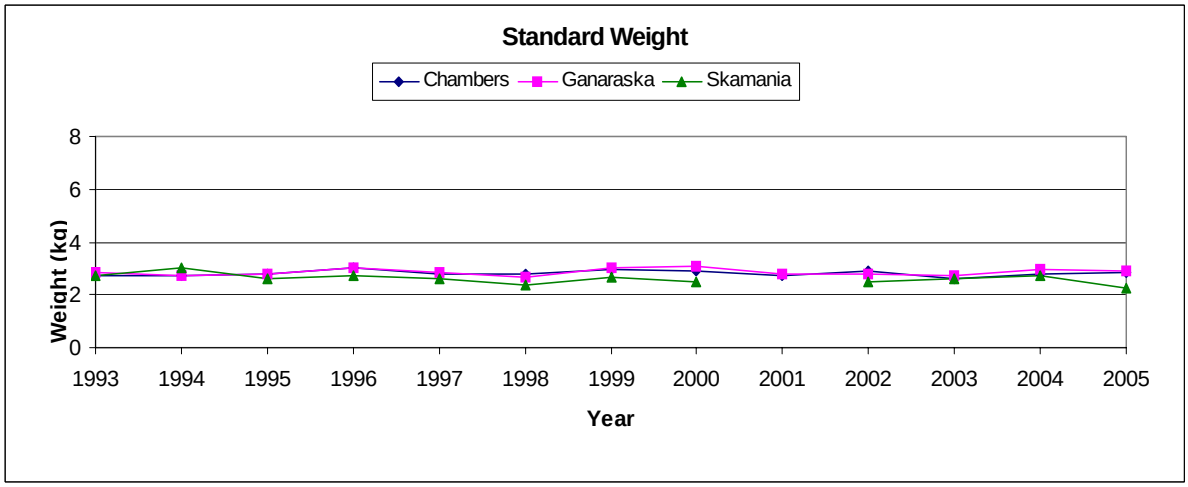

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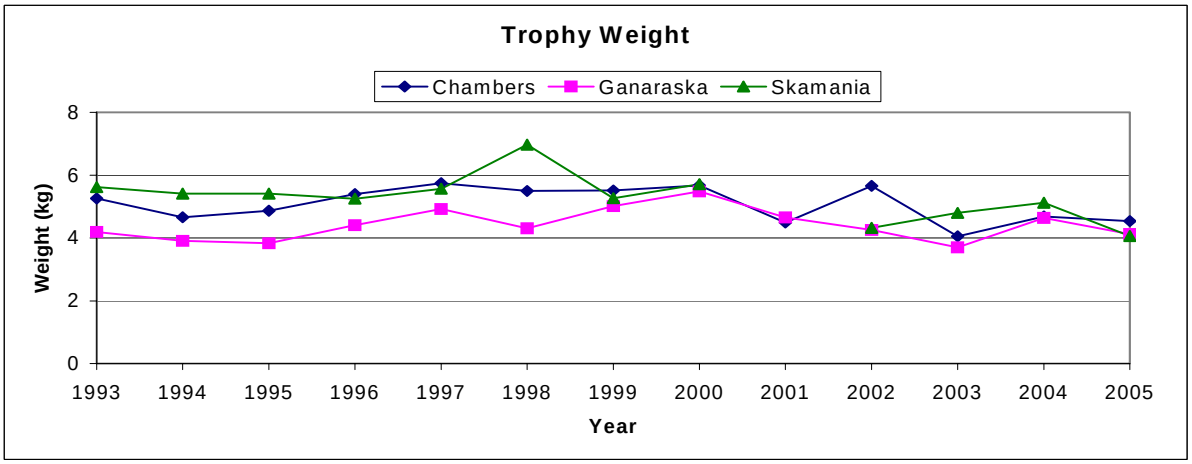

Figure 3. Weights trends for steelhead during spring migrations at BAFF, 1992-2005: (A) Average weight for each strain for that year, (B) Standard weight is based on the projected weight of a 660 mm steelhead, (C) Trophy weight for each strain based on the 95th. percentile of weighed steelhead.

Ganaraska

Ganaraska strain steelhead have had more variation in yearly average length and weight than Chambers Creek strain fish (Table 1). In 2005, average length and weight decreased to their lowest values since 1997. All three weight indices decreased in 2005 from 2004 levels, but it is likely the large number of age 2 fish have caused the decline in average weight and trophy weights (Figure 3). The decline in standard weight may be linked to forage levels on Lake Michigan.

The return rate of Ganaraska strain steelhead stocked in 2004 as age 2 fish was the highest for age 2 fish on record (Table 10). It is hoped that the 2003 year class of Ganaraska remains strong in order to improve the overall return of Ganaraska. Similar to the Chambers Creek strain, Ganaraska stocked in 1998 and 2000 have performed poorly, with improvements in return noted for those steelhead stocked in 1999, 2001 and 2002. 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 2005, average length increased over the 2004 level while average weight remained close to what was measured in 2004 (Table 1). Standard weight and trophy weights for 2005 declined from 2004 (Table 11). This may be due to the small number of fish handled during the spring 2005 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 2005 run was down from the 2004 run, but similar in number to other summer/fall runs since 2000 (Table 6). Lack of fall rain and high lake harvest may be responsible for the variation in run number and run timing.

Comparison of Strain Performance

All strains of steelhead had poorer returns to the weir in 2005 as compared to the 2004 run. Of the spring running strains since 1997, Chambers Creek has returned in greatest number despite a sharp decline in number during the past five spring migrations. 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, high harvest on adult fish by anglers on Lake Michigan and unhealthy fish from the hatchery. If returns continue to decline, each of these potential reasons must be examined to determine the cause of the decline.

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

Smolt Out-migration

During our electroshocking surveys in April, May and June we captured 663 trout and salmon above BAFF and 503 below. We documented that (1) smolts survive stocking and (2) that they are able to pass downstream of the dam at BAFF and make it to lower river sections on the way to Lake Michigan. Because the number of fish we captured was far less than 1% of the fish stocked and because we are not able to track fish all the way to Lake Michigan, we can not quantify with certainty how many fish survive stocking, downstream movement and ultimately make it to Lake Michigan.

We can however make general observations regarding the data collected in 2005. It appears that each species differs in movement pattern and on the duration of time spent in the river following stocking. Chinook and coho salmon were captured in our surveys shortly after stocking and then quickly moved downstream. Steelhead and brown trout moved downstream much more slowly and tended to remain at our downstream site throughout the survey period. By remaining in the river longer these species 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.

We were able to capture more Ganaraska strain steelhead than any other strain. This is surprising because only 28,233 Ganaraska were stocked as compared to 37,815 Chambers Creek and 40,009 Skamania. Perhaps since they had the smallest average size at stocking of the three strains, they remained in the river longer, making their capture more likely. Since we also captured more Ganaraska for a longer period of time at the downstream station, this explanation seems likely.

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

SUMMARY

The 2005 spring run total declined substantially from what was observed during the 2004 spring run. However, the 2005 run was typical of the runs of the past five years, but 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 2005 average, standard and trophy weights may be due to a larger percentage of the run being age 2 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 2005 and was similar to those from 2000 through 2003. Although there was abundant late spring and late fall rain, river flow did not increase enough to trigger steelhead runs into the river, making 2005 a poor year for Skamania.

We continued to evaluate the relative magnitude of the smolt out-migration from the Kewaunee River in 2005. While we were able to capture steelhead and other trout and salmon smolts, and make general statement regarding timing and downstream movements, many questions remain unanswered regarding survival of stocked fish. 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 2005, but should not affect the total number of steelhead stocked in 2006 because of the contribution of gametes from the Root River Steelhead Facility.

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Table 1. Summary of steelhead length and weight data collected during spring migratory runs at BAFF, on the Kewaunee River, 1997-2005.

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

* 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 2005 operations at BAFF, by strain of steelhead.

Spring Run Steelhead

Date	Chambers Creek	Ganaraska	Skamania	Other	Day Total
April 6	53	77	10	171	311
April 13	11	33	5	53	102
April 20	2	15	0	13	30
Total	66	125	15	237	443

Summer/Fall Run Steelhead

Date of Operation	Chambers Creek	Ganaraska	Skamania	Other	Day Total
September/ October					0
October 8				2	2
October 11					0
October 17			2		2
October 21			1		1
October 25				1	1
November 1					0
Total					6

Table 3. Average length, weight and run number by strain, clip, and sex during the spring spawning run at BAFF, 2005.

	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)	637	2.63	6	--	--	0
Adipose, Left Maxillary (ALM)	688	3.16	5	724	3.62	18
Left Maxillary (LM)	608	0.8	20	696	3.83	17
Chambers Creek combined average	**630**	**2.45**	**31**	**714**	**3.47**	**35**
Ganaraska						
Adipose, Left Ventral (ALV)	440	0.94	65	692	3.45	14
Adipose, Right Ventral (ARV)	688	2.95	13	668	2.90	13
Both Ventral (BV)	587	1.88	9	557	1.92	11
Ganaraska combined average	**489**	**1.34**	**87**	**648**	**2.82**	**38**
Skamania						
Adipose, Right Maxillary (ARM)	781	3.66	2	726	3.11	11
Right Maxillary (RM)	735	3.28	1	695	2.64	1
Right Maxillary, Right Ventral (RMRV)	--	--	0	--	--	0
Skamania combined average	**766**	**3.53**	**3**	**723**	**3.07**	**12**

Table 4. The age distribution, length, and weight of returning clipped steelhead by sex for the Kewaunee River spring 2005. In addition to the fish listed, one age 7 male and 1 age 7 female chambers creek steelhead were captured in 2005. The male was 810 mm in length and weighed 5.02 kg and the female was 780 mm in length and weighed 5.00 kg.

Chambers Creek

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	8	6	11	5	0	Measured	0	0	16	18	0
Average Length (mm)	436	637	711	758		Average Length (mm)			691	724	
Range (mm)	400-486	607-694	600-762	700-822		Range			632-745	650-778	
Weighed	8	6	11	5	0	Weighed	0	0	16	18	0
Average Weight (kg)	0.85	2.37	3.12	3.75		Average Weight (kg)			3.54	3.63	
Range (kg)	0.68-1.1	2.04-2.92	1.88-3.64	3.14-4.54		Range (kg)			2.28-4.24	2.2-4.06	

Ganaraska

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	61	9	13	4	0	Measured	1	11	13	13	0
Average Length (mm)	408	587	688	780		Average Length (mm)	454	557	668	711	
Range (mm)	280-485	540-628	535-795	713-869		Range	--	393-642	573-705	623-781	
Weighed	61	9	13	4	0	Weighed	1	11	13	13	0
Average Weight (kg)	0.7	1.88	2.95	4.57		Average Weight (kg)	0.9	1.92	2.9	3.64	
Range (kg)	0.2-1.08	1.14-2.24	1.44-4.26	3.4-5.92		Range (kg)	--	1.74-2.56	2.02=3.32	2.76-4.96	

Skamania

Age (Male)	2	3	4	5	6	Age (Female)	2	3	4	5	6
Measured	0	0	1	2	0	Measured	0	0	1	11	0
Average Length (mm)			735	775		Average Length (mm)			695	722	
Range (mm)			--	747-815		Range			--	685-785	
Weighed	0	0	1	2	0	Weighed	0	0	1	11	0
Average Weight (kg)			3.28	3.66		Average Weight (kg)			2.64	3.11	
Range (kg)			--	3.26-4.06		Range (kg)			--	2.4-4.06	

Table 5. Handling mortality by strain at BAFF during spring operations for the years 1997-2005.

Year	Strain	Number	Number Dead	Percent Mortality
1997	Chambers	610	4	0.6
	Ganaraska	364	7	1.8
	Skamania	288	0	0.0
	Other	829	5	0.6
	Total	**2,091**	**16**	**0.7**
1998	Chambers	236	5	2.1
	Ganaraska	241	1	0.4
	Skamania	74	0	0.0
	Other	325	4	1.2
	Total	**876**	**10**	**1.1**
1999	Chambers	220	1	0.5
	Ganaraska	237	1	0.4
	Skamania	23	0	0.0
	Other	252	0	0.0
	Total	**732**	**2**	**0.3**
2000	Chambers	69	0	0.0
	Ganaraska	84	0	0.0
	Skamania	40	0	0.0
	Other	147	0	0.0
	Total	**340**	**0**	**0.0**
2001	Chambers	66	1	1.5
	Ganaraska	136	1	0.7
	Skamania	2	0	0.0
	Other	209	0	0.0
	Total	**413**	**2**	**0.5**
2002	Chambers	51	3	5.9
	Ganaraska	61	3	4.9
	Skamania	17	0	0.0
	Other	247	3	1.2
	Total	**376**	**9**	**2.4**
2003	Chambers	81	0	0
	Ganaraska	68	0	0
	Skamania	16	0	0
	Other	206	0	0
	Total	**371**	**0**	**0**
2004	Chambers	203	14	6.9
	Ganaraska	162	0	0
	Skamania	31	0	0
	Other	339	1	0.3
	Total	**735**	**15**	**2.0**
2005	Chambers	66	1	1.5
	Ganaraska	125	4	3.2
	Skamania	15	0	0
	Other	237	1	0.4

	Total	**443**	**6**	**1.4**

Table 6. Steelhead fin clip trends detected at BAFF during fall migrations, 1997-2005.

Strain and fin clip	1997	1998	1999	2000	2001	2002	2003	2004	2005
Skamania									
Adipose, Right Maxillary (ARM)	57	8	8	3				28	
Right Maxillary (RM)	53	20	76	1	8	1		4	2
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
Chambers Creek									
Left Maxillary (LM)	1		1						
Left Maxillary, Left Ventral (LMLV)									
Adipose, Left Maxillary (ALM)									
Total Chambers Creek	1	0	1	0	0	0	0	0	0
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
Total Unknown	20	16	51	2	5	2	0	8	3
Total Fall Steelhead Run	**131**	**46**	**145**	**7**	**13**	**3**	**0**	**40**	**6**

Table 7. Total trout and salmon captured by electroshocking during the 2005 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 (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	261
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	

Table 8. Average length at stocking and average monthly lengths of steelhead captured during the out-migration study in 2005. Lengths are in mm.

Strain	Stocking Length	Upstream			Downstream		
		25-Apr	18-May	20-Jun	25-Apr	18-May	20-Jun
Chambers Creek	151	153	122	138	148	137	144
Ganaraska	138	132	125	149	141	144	154
Skamania	142	148	143	135	150	128	161

Table 9. Return rates (number per thousand stocked) for Chambers Creek steelhead during spring migrations on the Kewaunee River, 1996-2005.

	Year Stocked									
Return Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1996	1.10	--	--	--	--	--	--	--	--	--
1997	5.49	0.00	--	--	--	--	--	--	--	--
1998	4.99	0.85	0.11	--	--	--	--	--	--	--
1999	0.48	5.26	0.80	0.03	--	--	--	--	--	--
2000	0.08	1.16	0.93	0.11	0.09	--	--	--	--	--
2001	0.00	0.18	0.11	0.09	1.51	0.00	--	--	--	--
2002	0.00	0.00	0.00	0.03	1.23	0.09	0.05	--	--	--
2003	0.00	0.00	0.00	0.00	0.11	0.15	1.79	0.17	--	--
2004	0.00	0.00	0.00	0.00	0.00	0.00	4.53	1.02	0.00	--
2005	0.00	0.00	0.00	0.00	0.06	0.00	0.62	0.48	0.20	0.20
Total	12.14	7.45	1.95	0.26	3.00	0.24	6.99	1.67	0.20	0.20

Table 10. Return rates (number per thousand stocked) for Ganaraska steelhead during spring migrations on the Kewaunee River, 1996-2005.

	Year Stocked									
Return Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1996	0.94	--	--	--	--	--	--	--	--	--
1997	4.18	0.30	--	--	--	--	--	--	--	--
1998	2.67	3.57	0.35	--	--	--	--	--	--	--
1999	0.74	4.17	1.68	0.16	--	--	--	--	--	--
2000	0.14	0.57	0.57	0.58	0.51	--	--	--	--	--
2001	0.00	0.12	0.19	0.52	3.08	0.08	--	--	--	--
2002	0.00	0.00	0.00	0.16	0.13	0.08	0.16	--	--	--
2003	0.00	0.00	0.00	0.00	0.17	0.00	1.49	0.45	--	--
2004	0.00	0.00	0.00	0.00	0.00	0.03	3.40	1.26	0.37	--
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.58	0.73	0.67	1.72
Total	8.67	8.73	2.79	1.42	3.89	0.19	5.63	2.44	1.04	1.72

Table 11. Return rates (number per thousand stocked) for Skamania steelhead during spring migrations on the Kewaunee River, 1996-2005.

	Year Stocked									
Return Year	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1996	0.00	--	--	--	--	--	--	--	--	--
1997	0.03	0.03	--	--	--	--	--	--	--	--
1998	0.68	0.06	0.00	--	--	--	--	--	--	--
1999	0.37	0.30	0.00	0.00	--	--	--	--	--	--
2000	0.14	1.03	0.00	0.00	0.12	--	--	--	--	--
2001	0.00	0.00	0.00	0.02	0.03	0.00	--	--	--	--
2002	0.00	0.00	0.00	0.00	0.43	0.03	0.00	--	--	--
2003	0.00	0.00	0.00	0.00	0.32	0.03	0.03	0.05	--	--
2004	0.00	0.00	0.00	0.00	0.11	0.03	0.53	0.12	--	--
2005	0.00	0.00	0.00	0.00	0.00	0.00	0.33	0.05	--	--
Total	1.22	1.42	0.00	0.02	1.01	0.09	0.89	0.22	0.00	0.00