1994 MCNARY DAM AND LOWER MONUMENTAL DAM SMOLT MONITORING PROGRAM

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1994 MCNARY DAM AND LOWER MONUMENTAL DAM SMOLT MONITORING PROGRAM ANNUAL REPORT

AND

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ANNUAL REPORT

Prepared by:

Paul Wagner

Washington Department of Fish and Wildlife

July 1995

1.0 INTRODUCTION

The Washington Department of Fisheries (WDF) assumed responsibility for the Smolt Monitoring Program at McNary Dam on the Columbia River in 1990 and at the new juvenile collection facility at Lower Monumental Dam on the Snake River in 1993. This report summarizes the 1994 Smolt Monitoring work at both sites.

Construction of the new McNary juvenile collection facility resulted in approximately a one week delay in the start of monitoring activities at the McNary site in 1994. Collection and sampling began on April 8 at McNary Dam and on April 6 at Lower Monumental Dam. Monitoring operations were conducted through December 6 at McNary Dam and through November 1 at Lower Monumental Dam. Sampling and monitoring activities were interrupted on several occasions at the McNary site due to mechanical failures within the new bypass system. In addition, all monitoring activities were canceled from July 17 through July 28 when the entire McNary facility was unwatered during an emergency action resulting from a massive thermal stress induced subyearling chinook fish kill. All passage information, including mark recoveries from the PIT tag passive interrogation system, were lost during this time period.

A total of 374,724 and 181,021 juvenile salmonids were anesthetized, individually counted, and examined for scale loss and brands by WDFW Smolt Monitoring personnel in 1994 at McNary Dam and Lower Monumental Dam, respectively.

2.0 SUMMARY OF ANESTHETIC PRACTICES

2.1 ANESTHETIZATION OF SAMPLE FISH

The anesthetic practices used at McNary Dam in 1994 were similar to those used in past years but were modified sightly in response to the operation of a new sampling system. The new McNary anesthetic system is virtually identical to the Lower Monumental anesthetic system and the general procedures used at the Lower Monumental site were also used at the new McNary site. These included:

1) Documentation of the concentration of MS222 used in the re-circulating anesthetic system.

2) Documentation of the concentration of benzocaine used in the pre-anesthetic system.

3) Documentation of the time that fish were held in the pre-anesthetic (induction time). The maximum time that fish were held in the re-circulating anesthetic (MS222) was not documented in 1994 at the new McNary site. For the first time, complete post handling mortality counts were available under the new system and the true post handling mortality rate was used as the best overall reference of the effect of the sampling and anesthetic system (see 5).

4) Documentation of total daily sample tank mortality. This information is normally included as part of the daily data summary.

5) Documentation of post handling mortality. In the past, processed sample fish were sent either to the bypass control tank or to raceway 1 to be transported at McNary Dam. Complete counts of

mortalities from raceway 1 were not available at McNary Dam because this raceway was not swept for debris and many of the mortalities were lost during transportation vehicle loading. A raceway 1 mortality index was calculated based upon the number of mortalities recovered from the tailscreens. In 1994, all sample fish were sent either to raceways 9 east, 9 west, or 5 and complete mortality counts were obtained from these locations at the new McNary facility. Therefore a complete post handling mortality rate was obtained from the McNary site this year. The procedures pertaining to post-handled sample fish in 1994 were identical to those used in 1993 at Lower Monumental Dam. All sample fish were sent directly to raceway 1 except late in the season when they were loaded directly onto minitankers after sample processing. All raceway 1 mortalities were recovered during transportation vehicle loading and a complete raceway 1 mortality rate was calculated at Lower Monumental Dam in 1994.

6) At McNary Dam, a portion of the sample fish were marked for the NBS and a subsample of these were held for 48 hour delayed mortality evaluation. The 48 hour delayed mortality rate for marked fish was documented.

2.2 CONCENTRATIONS

Pre-anesthetic System - McNary Dam

WDFW staff participated in a cooperative evaluation of the new McNary facility prior to the start of the 1994 season and were able to identify the need to modify the McNary pre-anesthetic gate design to prevent leaking prior to the start of the 1994 monitoring season. The original design for the new McNary facility pre-anesthetic system and chamber gates was very similar to that originally installed at the Lower Monumental site at the start of the 1993 season. This problem was identified and corrected at the McNary site prior to the start of 1994 operations. Therefore, the pre-anesthetic chamber gates did not leak at the new McNary facility in 1994 as they did at the Lower Monumental facility in 1993.

The pre-anesthetic stock solution used at the McNary site was 300 grams of benzocaine per gallon of ethyl alcohol at the start of the season similar to what had been the standard at the old McNary facility in past years. However, due to the larger capacity (54 gallons, 1994 versus 20 gallons, 1993) of the new pre-anesthetic chambers, the stock solution concentration was increased to 450 grams of benzocaine per gallon of alcohol. This was identical to what was used at the Lower Monumental site in 1994 (see next section). The pre-anesthetic concentration averaged 45.6ppm in 1994 at the McNary site and ranged from 35ppm to 58ppm. This was similar to but slightly in excess of the 20ppm to 50ppm pre-anesthetic concentration range recommended by the USFWS (NBS). The concentration average (45.6ppm) was slightly higher than that used in past years (42ppm) due to the larger capacity system (see summary section).

Pre-anesthetic System - Lower Monumental Dam

A stock solution of 600 grams of benzocaine per gallon of alcohol was used early in the 1994 season (through April 24) at Lower Monumental Dam. However, after April 24 the stock solution concentration was reduced to 450 grams of benzocaine per gallon of alcohol similar to what was in use at the McNary site. The anesthetic concentrations ranged from 21ppm to 49ppm and averaged 44ppm for the season at Lower Monumental. This was similar to the concentrations used at the

McNary site and within the USFWS (NBS) recommended guidelines.

Re-circulation System - McNary Dam

At McNary Dam, the MS222 concentrations in the re-circulating anesthetic system were recorded daily (Appendix Table 1). Starting concentrations ranged from 0ppm to 33.1ppm and averaged 18.7ppm. This is generally within the USFWS (NBS) recommended re-circulating anesthetic concentration range of 10ppm to 30ppm.

Appendix Table 1 also shows anesthetic periodically added to the re-circulation system. This was necessary due to two problems associated with the shallow slope of the pre-anesthetic delivery line.

1)The shallow slope of the delivery line resulted in fish becoming stranded on the wedgewire water elimination screen and additional water had to be passed through this system to flush fish across the screen and into the sorting trough (re-circulation system). This resulted in dilution of the re-circulation system.

2) In addition, a portion of the water from the re-circulating flush outlet located just downstream of the wedgewire water elimination screen drained back through the screen and was lost when this system was operated. More water and anesthetic had to be added to the re-circulation system to compensate for this loss.

Anesthetic was also added to the re-circulation system to compensate for anesthetic removed from the water by thousands of sample fish during the course of large sample days. Therefore, MS222 was added to the re-circulation system at McNary Dam on several occasions, but this was done simply to compensate for dilution or the removal of anesthetic by fish during processing. The actual concentration of anesthetic that fish were exposed to at the McNary site was within the 10ppm to 30ppm guidelines recommended by the USFWS (NBS).

Re-circulation System - Lower Monumental Dam

A higher concentration of MS222 was used at Lower Monumental Dam than at McNary Dam. This was due to generally larger fish present in the Lower Monumental sample. Starting concentrations ranged from 31.2ppm to 34.1ppm and averaged 33.6ppm (Appendix Table 2). Anesthetic was also occasionally added to the Lower Monumental re-circulation system to compensate for the removal of anesthetic by large numbers of sample fish.

2.3 INDUCTION AND EXPOSURE TIMES

Sample fish are exposed to anesthetic in two phases at McNary and Lower Monumental Dams.

Phase 1: An allotment of fish is crowded into the pre-anesthetic tank and anesthetized with benzocaine. All fish in each allotment experience the same period of exposure to benzocaine because all fish are removed at the same time from the tank and are then passed to the sorting trough.

Phase 2: Fish are removed from the sorting trough individually and therefore individual fish are exposed to MS222 for varying periods of time.

Time In The Pre-anesthetic System - McNary Dam

The total time (induction time) that fish were held in pre-anesthetic during the 1994 season ranged from 2.9 minutes to 5.5 minutes and averaged 4.1 minutes overall (Appendix Table 3), which is consistent with the USFWS (NBS) recommendation of an induction time of not less than one minute. The USFWS (NBS) also recommended an induction time of not less than two minutes when water temperatures exceed 60 degrees fahrenheit. Facility water temperatures exceeded 60 degrees from June 18 through October 16, and during this period the induction times ranged from 2.9 to 5.5 minutes with an average time of 3.9 minutes.

The 4.1 minute average induction time needed to pre-anesthetize sample fish in 1994 under the new system was more than double that required in 1993 (1.7 minutes) under the old pre-anesthetic system. However, the anesthetic concentrations used in 1993 (42.0ppm) and 1994 (45.6ppm) were very similar. The change in induction time is mostly likely associated with the larger capacity chambers used in 1994.

Time In The Pre-anesthetic System - Lower Monumental Dam

Induction time ranged from 2.5 minutes to 5.5 minutes with an average of 4.0 minutes (Appendix Table 4). Facility water temperatures exceeded 60 degrees from June 9 through October 27, and during this period the induction times ranged from 2.6 to 4.5 minutes with an average time of 3.9 minutes.

2.4 POST HANDLING MORTALITY

McNary Dam

The overall post handling mortality rate under the new system was at least comparable to and most likely much lower than that for all past years under the old system. Unfortunately, post handling mortality statistics are not directly comparable for the old versus the new system because not all mortalities were recovered from raceway 1 in the old system and only a mortality index was available. This index should be considered a minimum estimate of the actual mortality rate of post handled sample fish designated for transport. The other post handling statistic available under the old system was from the bypass/control tank and was presumed to be based upon a complete mortality count. The 1994 post handling mortality rate equalled 0.4% which is based upon complete mortality counts from raceways 9 east and 9 west. As a general reference, the 1993 raceway 1 mortality index was 0.8% and the 1993 bypass/control tank mortality rate was 0.4%.

The sample tank mortality rate is based primarily on pre-handling mortality but is related to the sampling program. The 1994 sample tank mortality rate averaged 3.0% in the new system compared to 2.1% in 1993 under the old system. Both of these are based upon complete mortality counts. One factor which contributed to the increase in 1994 sample tank mortality was the stranding of fish in the delivery line between the pre-anesthetic chambers and the sorting trough. This was related to the shallow slope of the line and was eventually corrected operationally through a modification to the flushing procedure.

Because most of the mortalities included in the sample tank mortality counts die prior to handling,

factors which influence the overall system mortality rate have a strong corresponding influence on the sample tank mortality rate. System mortality did show an increase in 1994 (1.5%) over that of 1993 (1.3%). This would suggest that in general the mortality rate was up in 1994. In addition, of the 11,084 mortalities extracted from the sample tank in 1994, 2,728 were counted on a single day (July 16). This was the onset of a massive thermal stress induced fish kill which resulted in the complete unwatering of the juvenile facility and the emergency release of all fish from the raceways. Most of the raceway mortalities were bypassed to the river and were not counted and are not reflected in the system mortality rate. Therefore, the slight increase in the 1994 system mortality rate over that of 1993 does indicate that passage conditions through the new McNary bypass system were more adverse in 1994 than in 1993. However, this measurable increase does not truly reflect the actual increase in the mortality rates between the two years because the 1994 mortality counts are incomplete. The sample tank mortality counts are complete through 0700 hours on July 16 and are therefore more representative. Finally, an increase in overall ambient river temperatures has been shown to increase both system and sample tank mortality rates. In 1994, river temperatures averaged 62.9 degrees (F) and ranged to 73.0 degrees (F) compared to the 1993 average of 61.0 degrees (F) and the 1993 maximum of 71.0 degrees (F).

Lower Monumental Dam

The only measure of the post-handling mortality rate is the recovery of mortalities from raceway 1. All mortalities are recovered from raceway 1 at Lower Monumental Dam and a complete mortality count and mortality rate is therefore available. In 1994, the raceway 1 mortality rate was 0.6% compared to 0.3% in 1993. Sample tank mortality also showed a slight increase in 1994 (0.8%) compared to 1993 (0.7%) as did the overall system mortality rate (0.1% - 1993, 0.4% - 1994). Two factors contributed to the general increase in mortality associated with the sampling system in 1994:

1) Warmer Water - River temperatures averaged 63.7 degrees (F) and ranged to 69.5 degrees (F) in 1994 compared to the 1993 average of 62.1 degrees (F) and maximum of 69.2 degrees (F).

2) More Fish Handled - In 1994 a total of 181,021 fish were sampled compared to only 39,388 in 1993. The increase in the number of fish sampled in 1994 was to accommodate research marking programs. This four to five fold increase in the number of fish sampled and the corresponding increase in workload placed a heavy burden on the 1994 Lower Monumental Smolt Monitoring Program and the personnel working at this site. In addition, it created problems within the sampling system which were not encountered in 1993. For example, jumping of fish out of the sample tank upstream of the crowder was not a problem in 1993 after the 24 hour sample had been crowded to the downstream end of the tank. However, in 1994, the sample rate was frequently changed within a 24 hour period. Each time this occurred, fish sampled at the original rate had to be re-crowded and segregated from fish sampled at the new rate. Usually this was done to increase the sample rate to provide more fish for the marking programs. In this situation, large numbers of fish quickly arrived upstream of the crowder and a few of these fish would occasionally be found dead outside the tank near the inflow on the walkway grate. This problem was eventually corrected by the installation of netting at this location.

Procedure Note - At the Lower Monumental site, as at the McNary site, the normal operating

procedure is to send all "live" sample fish to a retention raceway after anesthetization and examination. Sample mortalities are removed from the sample tank prior to this and counted separately. "Live" sample fish include all fish even those which enter the sampling system severely injured and obviously dying. Severe injuries on fish entering the sampling system occur possibly as a result of passage through the bypass system or more likely as a result of passage through the turbines or spillways of projects located upstream. Therefore, a portion of the live sample fish which are processed and passed to the retention raceway include fish which were severely injured prior to sample processing and most likely die only a few hours after being handled. These fish are included in the post-handling mortality counts but are not truly reflective of the effect of the sampling program.

Fish that had an increased likelihood of mortality were not used in the marking programs (i.e., dying or descaled fish were not marked) but were sent to raceway 1. Therefore, while the marking programs were in progress, the only fish that were sent to raceway 1 were: A) previously marked fish, B) non-target species, and C) descaled or D) severely injured dying target species. The raceway 1 population was composed of a higher proportion of C and D type fish in 1994 than in 1993 and this certainly contributed to the higher 1994 mortality rate.

2.5 SUMMARY

The anesthetic procedures used by McNary SMP personnel in 1994 at the new facility were similar to those used in 1993 at the old facility and similar to those procedures used in 1994 at the Lower Monumental site. These procedures were generally consistent with the USFWS recommended anesthetic guidelines. The low post-handling mortality rates observed at both sites in 1994 would generally suggest that these procedures did not unduly compromise fish condition.

The most interesting aspect relative to the change in facility anesthetic systems at the McNary site was the change in pre-anesthetic induction time. The induction time, or time needed to render fish unconscious, in the old pre-anesthetic system at McNary Dam was typically 1.5 to 2.0 minutes (i.e., 1.7 minutes in 1993). Under the new McNary system, the 1994 induction time increased to better than double (4.1 minutes) that required with the old system and was nearly identical to the induction time required at the Lower Monumental site (4.0 minutes). Yet the anesthetic concentrations used at all three locations were virtually identical. The obvious change was the increase in water capacity in the new McNary pre-anesthetic system (54 gallons) over that of the old system (20 gallons). The new McNary system in terms of both capacity and design is virtually identical to that used at the Lower Monumental site. There are at least three possible explanations for the change in induction time at the McNary site and the similarity in induction time between the new McNary and the Lower Monumental systems.

1) Dilution Time

The 54 gallon capacity of the new pre-anesthetic system at McNary may simply require a greater mixing time for the same concentration of anesthetic than was required with the old 20 gallon system. This situation would be identical to that at the Lower Monumental site.

2) Loss of Anesthetic

Under the new McNary pre-anesthetic system, the water level in each pre-anesthetic chamber is regulated by a standpipe as opposed to a floor drain used in the old system. The procedure used in the new system is this:

Step 1. Fish are crowded into the pre-anesthetic chamber with the chamber water level equal to that of the holding (sample) tank.

Step 2. The standpipe valve is opened and the water level allowed to drain down to the top of the standpipe.

Step 3. Pre-anesthetic stock solution is added to approximately 1 gallon of water and mixed in a bucket. This anesthetic mixture is then poured into the pre-anesthetic chamber.

Step 4. The fish are anesthetized and released through a floor drain and delivered to the wet lab via gravity flow.

Step 3 results in an increase in the pre-anesthetic water level above the elevation of the standpipe and drainage of approximately one gallon of water back over the pipe. If the pre-anesthetic remains in the surface layers before mixing with the rest of the water in the pre-anesthetic chamber, a disproportionate amount will drain out the standpipe. This would mean that the actual concentration of anesthetic in the pre-anesthetic chamber is less than calculated which would undoubtedly result in a much longer induction time. This situation is inherent to the new pre-anesthetic system design and is identical to that used at the Lower Monumental site.

3) Dissolved Oxygen

The number of fish that are crowded into each pre-anesthetic chamber allotment is dependent upon the processing capability of the SMP sorting crew. Fish density in the pre-anesthetic chambers has generally not been a consideration in this process. The smaller capacity of the old McNary pre-anesthetic system may have created a situation in which fish were briefly exposed to a reduced level of dissolved oxygen while undergoing pre-anesthetization. This could have resulted in both the shorter observed induction time and the higher post-handling mortality rate. The dissolved oxygen levels in the pre-anesthetic chambers have never been measured at either the McNary or the Lower Monumental sites.

3.0 SPECIAL DATA COLLECTION

3.1 ELASTOMER VISIBLE IMPLANT MARKED YEARLING CHINOOK

For the second time in as many years, yearling chinook from the Lyons Ferry Hatchery program were marked with a visible implant (VI) elastomer in the adipose eyelid tissue. Two implant colors (red and yellow) were used for 1994 outmigrants as opposed to only one color (red) in 1993. The fish were marked to distinguish Snake River chinook from other stocks of fish and to continue evaluation of the mark including the new color (yellow). All of the fish released from the 1994 Lyons Ferry program were VI marked on either the left or the right side with one of the two colors. None of the marked fish were transported by barge below Ice Harbor Dam as was the case for a portion of the 1993 yearling release. Most (597,398) of the 1994 VI marked outmigrants were yearling fall chinook

from Lyons Ferry Hatchery although some (140,725) were spring chinook from the Tucannon River satellite facility. A portion (32, 182 - Right Red, 25,134 - Left Red) of the marked spring chinook were released into the Tucannon River as zero age fish in the fall of 1993. A summary of the specific recovery rates and arrival timing for each VI mark category is presented for fish recovered at McNary Dam in Table 1 and for fish recovered at Lower Monumental Dam in Table 2.

Visible implant marked fish were recovered at both the Lower Monumental and McNary sites (Tables 1 and 2). Overall, the VI marked fish were 7mm smaller when they passed the Lower Monumental

Table 1. Summary of elastomer visible implant yearling chinook recovered at McNary Dam in 1994.

Category	Right Red	Left Red	Right Yellow	Left Yellow	Total
Recovery Data					
Released	32,182	333,488	47,133	325,320	738,123
Sampled (Rate)	177 (0.5%)	1,414 (0.4%)	6 (0.0%)	422 (0.1%)	2,019 (0.3%)
Collected (Rate)	4,760 (14.8%)	54,845 (16.4%)	227 (0.5%)	18,042 (5.5%)	77,874 (10.6%)
P.Index (Rate)	5,571 (17.3%)	61,189 (18.3%)	260 (0.6%)	19,985 (6.1%)	87,005 (11.8%)
Arrival Timing					
10th Percentile	May 23	May 3	May 11	May 4	May 3
50th Percentile	June 10	May 11	May 12	May 10	May 11
90th Percentile	June 15	May 19	May 21	May 18	May 23

Table 2. Summary of elastomer visible implant yearling chinook recovered at Lower Monumental Dam in 1994.

Category	Right Red	Left Red	Right Yellow	Left Yellow	Total
Recovery Data					
Released (Rate)	32,182	333,488	47,133	325,320	738,123
Sampled (Rate)	46 (0.1%)	7,871 (2.4%)	178 (0.4%)	7,875 (2.4%)	15,970 (2.2%)
Collected (Rate)	597 (1.9%)	122,131 (36.6%)	3,098 (6.6%)	109,531 (33.7%)	235,357 (31.9%)
P. Index (Rate)	618 (1.9%)	123,870 (37.1%)	3,117 (6.6%)	111,698 (34.3%)	239,303 (32.4%)
Arrival Timing					
10th Percentile	April 24	April 24	April 25	April 26	April 25
50th Percentile	May 8	April 28	May 6	April 30	April 29
90th Percentile	May 12	May 11	May 10	May 12	May 11

site (163.2mm) than when they passed the McNary site (170.2mm) one to two weeks later. Virtually none (0.8%)of the fish sample at the Lower Monumental site were found to be descaled but the descaling rate rose considerably (6.2%) by the time the fish entered the McNary system. This rise in the descaling rate observed at McNary Dam is almost certainly due to the cumulative effect of passage through the turbines or spillways of the two projects upstream (Ice Harbor Dam, Lower Monumental Dam) and/or possibly the result of passage through the as yet unevaluated Ice Harbor bypass system. Both the new McNary and Lower Monumental bypass systems have been evaluated and passage through these systems has been determined to result in minimal scale loss.

Fish marked with a red elastomer on the left side were recovered at the highest rates at both projects. Most (308,354) of these were yearling fall chinook released in the spring of 1994 from Lyons Ferry Hatchery although a relatively small number (25,134) were spring chinook released into the Tucannon River in the fall of 1993.

Right red VI fish were composed entirely of spring chinook released in the fall of 1993. This group of fish was recovered at a fairly high rate at the McNary site compared to the Lower Monumental site. However, this could simply have been the result of a color distinction error at the McNary site as right yellow VI fish were almost absent from the reported McNary recoveries.

In general, the red mark appeared superior to the yellow mark. To some extent, both marks appeared to have fragmented into smaller barely visible particles which undoubtedly resulted in some marked fish being missed and may have also hindered color distinction. In addition, the yellow mark was fairly similar to the general color of the adipose eyelid tissue and it is therefore also likely that a higher proportion of the yellow marks were missed by the SMP fish handlers. Therefore, the reported recovery rates for all VI fish may have been biased low as a result of some marked fish being missed and the greatest likelihood of this type of error would have been for fish marked with the yellow elastomer. In addition, the recovery rates of each of the four mark groups of fish may be skewed as a result of color distinction error.

3.2 GAS BUBBLE TRAUMA

Prior to the start of 1994 field operations, Smolt Monitoring Program supervisors attended a single day training seminar pertaining to the examination of juvenile salmonids for symptoms of gas bubble trauma at the NBS/USFWS field station located in Cook, Washington. Examination of all sample fish for external signs of gas bubble trauma began at the onset of the smolt monitoring season at both the McNary and Lower Monumental sites. Due to increased levels of spill, the examination format was intensified to include external sampling of yearling chinook and steelhead and internal sampling of steelhead removed just prior to entry into the separator (referred to as "separator samples" periodically throughout this section). McNary and Lower Monumental staff received an additional day of field training with NBS pathologists relative to the internal examinations. The additional external and internal sampling occurred twice per day (morning and evening) three days per week at both sites. The additional effort was not part of the original 1994 SMP contract and required the acquisition and training of additional technicians to perform a portion of the work. The results of all GBT monitoring at both the McNary and Lower Monumental sites are included in Tables 3 and 4. The criteria used for the 1994 external examinations were:

Category	Criterion
1)	No Evidence
2)	Bubbles in less than 50% of surface area of a single fin
3)	Bubbles in greater than 50% of surface area of a single fin
4)	Bubbles in two or more fins
5)	Bubbles in one or more fins and the head

Internal examination criteria consisted of observed presence of gas bubbles:
1) externally on the lateral line
2) internally on the lateral line
3) in the gill filaments
4) elsewhere internally (i.e., distended air bladder, bubbles on the headkidney)

Generally, external examinations of all sample fish for gas bubble symptoms had little program impact because fish are closely examined for marks and descaling as part of the normal processing procedure. However, the internal and external examinations of fish removed just prior to entering the separator presented special problems. Because of the 12 hour separation between morning and evening samples, supervisory biologists were not present during all examinations. In addition, external gas bubble symptoms were rare and fish with symptoms were not available for use as training aids for temporary personnel. Therefore personnel inexperienced in observing gas bubble symptoms were placed in a position where they could easily misidentify external symptoms of gas bubble trauma during unsupervised examinations. This appeared to be the case at the Lower Monumental site during the first 6 days of external sampling of fish removed from the separator (May 19-24). During this time period a total of 19 fish were identified as having the presence of one or two bubbles in the caudal fin. Because of the complete lack of symptoms observed in the daily sample during the same time period, it was suspected that the external symptoms observed from the separator samples were erroneous. On May 25, all technicians conducting the external examinations of fish from the separator were instructed to hold fish suspected as exhibiting GBT symptoms in a live trough for verification by a supervisory biologist. The following day, two fish were re-examined and determined to have parasites in the caudal fin which had been mistaken for gas bubbles. External symptoms of gas bubble trauma were not observed in fish removed from the separator from that time on.

In addition, yearling chinook and steelhead sampling from the separator began near the end of the spring outmigration when fish abundance was declining and continued well into June when numbers of fish were low. Therefore, obtaining an adequate sample size in a reasonable time period became a progressively more difficult task. Sampling periods in excess of 8 hours with the morning sampling period overlapping into the evening sampling period were required to obtain adequate numbers of fish late in the spring outmigration season. This obviously eliminated the possibility of collecting two distinct morning and evening samples of fish with a 12 hour separation between sampling periods.

Internal symptoms of gas bubble trauma were observed at a high (34.3%) rate throughout the sampling period at Lower Monumental Dam (Table 4). Virtually all of the observed internal symptoms consisted of bubbles in the gill filaments and/or head kidney or a distended air bladder. The general lack of observed external symptoms during the same time period called into question the validity of the internal sampling procedure. This was particularly so because fish known to be GBT free were

Table 3. Summary of 1994 gas bubble trauma sampling results from McNary Dam.

Category	Ch-1	Ch-0	Sh-H	Sh-W	Coho	Sock-H	Sock-W	Total
Full Sample (External) Number Sampled (4/23-12/5)	38,811	133,201	9,906	2,051	4,721	418	6,663	195,771
# with Symptoms	0	0	5	0	0	0	0	5
% with Symptoms	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Separator (External) Number Sampled (5/20-6/20)	3,080	0	2,699	224	0	0	0	6,003
# with Symptoms	1	0	6	1	0	0	0	8
% with Symptoms	0.0	---	0.2	0.4	---	---	---	0.1
Separator (Internal) Number Sampled (5/13-6/21)	0	0	585	0	0	0	0	585
# with Symptoms	0	0	4	0	0	0	0	4
% with Symptoms	---	---	0.7	0	0	0	0	0.7

Table 4. Summary of 1994 gas bubble trauma sampling results from Lower Monumental Dam.

Category	Ch-1H	Ch-1W	Ch-0H	Ch-0W	Sh-H	Sh-W	Sock	Total
Full Sample (External) Number Sampled (4/21-10/30)	34,154	4,896	0	951	24,406	4,410	413	69,230
# with Symptoms	48	0	0	0	4	1	1	54
% with Symptoms	0.1	0.0	---	0.0	0.0	0.0	0.2	0.1
Separator (External) Number Sampled (5/19-6/20)	1,525	257	0	0	1,901	141	0	3,824
# with Symptoms	6	0	0	0	12	1	0	19
% with Symptoms	0.4	0.0	---	---	0.6	0.7	---	0.5
Separator (Internal) Number Sampled (5/19-6/20)	0	0	0	0	417	0	0	417
# with Symptoms	0	0	0	0	143	0	0	143
% with Symptoms	---	---	---	0	34.3	0	0	34.3

not used as a control group in the internal examination procedure. On July 29 and July 30, 44 days after spill had ceased at the Little Goose project, the same technician crew who had conducted the internal examinations during the spring were again called in and requested to perform internal examinations of an additional 30 hatchery steelhead as a control group. Seven of the 30 fish were once again observed to have internal GBT symptoms (Table 5). This strongly suggests that the entire internal examination procedure used at the Lower Monumental site earlier in the spring was flawed and the results probably contained a high level of error.

Table 5. Summary of internal gas bubble symptom control sampling at Lower Monumental Dam on July 29 and July 30, 1994.

Category	Ch-1H	Ch-1W	Ch-0H	Ch-0W	Sh-H	Sh-W	Sock	Total
Separator (Internal) Number Sampled (7/29-7/30)	0	0	0	0	30	0	0	30
# with Symptoms	0	0	0	0	7	0	0	7
% with Symptoms	---	---	---	0	23.3	0	0	23.3

In summary, the rates of observable GBT symptoms reported by the McNary and Lower Monumental SMP personnel this past spring are likely overestimates of the actual GBT rates. The most accurate estimates are probably those derived from the daily sample when supervisory biologists were always present to verify the observations. The most inaccurate rates are probably those derived from the internal examinations due to some unknown aspect of the examination procedure.

4.0 RESEARCH

4.1 MARKING PROGRAMS AT MCNARY DAM

In 1994, Smolt Monitoring Program personnel participated in the final year of a cooperative WDFW/NBS zero age chinook marking program at McNary Dam. For this program, subyearling chinook were freeze branded, coded wire tagged, adipose fin clipped, and bypassed for the NBS to assess adult contribution relative to flow conditions experienced by outmigrating juveniles. The same quality control measures which were used in 1993 (Wagner, 1993) to ensure that the fish were properly handled and marked were used again in 1994. The 1994 marking objective for this program was 49,500 fish per each of three replicates (148,500 total).

Overall, 132,569 subyearling chinook were marked at McNary Dam in 1994 to index the early, middle, and late segments of the outmigration. Of these, 130,019 were bypassed and 2,550 were held for quality control assessment and were reported[1] as transported (Appendix Tables 5-7). Sixteen hundred fish were checked for freeze brand quality. The brand ratings were 95.8% good, 3.6% light, and 0.6% burned (Appendix Table 6). A total of 561 branded subyearlings were also rated by NMFS SMP personnel upon recovery at John Day Dam. The brand ratings at John Day Dam were 79.3% good, 11.6% light but still readable, 2.1% burned, 7.0% partial but still readable. Twenty four hundred and fifty fish were checked for adipose fin clip quality and coded wire tag loss at McNary Dam. The adipose clips were rated as 96.8% good and coded wire tag loss equalled 0.3% (Appendix Table 8). Twenty five hundred and fifty fish were held for delayed mortality assessment. The delayed mortality rate for these fish equalled 1.2% (Appendix Table 9). Most of the mortality occurred during the final replicate. Marked fish were held in raceway 9E and then bypassed after sunset. The raceway 9E mortality rate equalled 0.3% (Appendix Table 9).

[1]100 fish from the July 15 and 16 mark groups were held for quality control assessment but were actually bypassed on July 17 during the emergency release of all fish from the McNary facility.

In general, the marking program proceeded smoothly until July 16 when high collection mortality resulted in the unwatering of the facility and a change in operation mode to emergency bypass through July 28. The emergency actions were in response to high subyearling chinook mortality due to thermal stress and the malfunctioning of the primary dewatering screen cleaning system. Because of this, freeze branding and coded wire tagging of the third and final zero age fall chinook release group was postponed from the pre-scheduled starting date of July 25. Marking of the third replicate began on August 2 shortly after inflow was restored to the McNary facility. The delay resulted in marking operations proceeding during a period of low fish abundance. The original third replicate marking objective of 49,500 was therefore not reached. Due to the low numbers of fish, the objective was modified to 33,000 which required 42 days of marking between August 2 and September 14. Daily sampling rates ranging to 50% were necessary to complete the work. Marking operations were also canceled on August 11 and 12 due once again to mechanical problems with the primary dewatering screen cleaning system and the resulting unwatering of the collection facility. In addition, under the pre-established format, a unique mark was to be used each day fish were branded and all branded fish designated for bypass were to be released on the same day that they were marked. However, during the third replicate fish were given the same brand on successive days and allowed to accumulate in raceway 9E prior to release on three occasions (August 14-15, August 22-24, August 30-31). This was done during periods of extreme low fish abundance so that enough fish of each brand group would be released at once to provide a meaningful number of recoveries downstream for travel time assessment.

Generally, the switch to emergency bypass impacted the marking program in two basic ways:

1)During the July 17 - 28 time period sampling did not occur and collection/passage index estimates were not obtained. Therefore, determination of subyearling passage timing (early, middle, late) was not possible in 1994.

2) The delayed starting date for the third replicate resulted in marking proceeding during a period of low fish abundance, warm water, and poor fish quality. This translated to the marking objective of 49,500 fish not being met, an elevation in mortality rates, marking occurring for 42 days instead of the pre-scheduled 9, elevated sampling rates, and a general deviation from the established workplan.

4.2 WDFW ZERO AGE CHINOOK PIT TAGGING

Objectives

PIT tagging of wild zero age upriver bright fall chinook on the Hanford Reach by McNary Smolt Monitoring Program personnel began in 1991 and has continued each year through 1994. In 1994, the work was expanded to include the PIT tagging of zero age upriver bright fall chinook from Priest Rapids Hatchery. The objectives of the 1994 work were: 1) index the arrival timing of wild and hatchery zero age upriver bright fall chinook to McNary Dam and 2) collect information regarding relative survival rates.

Methods

Priest Rapids Hatchery

The marking objective for hatchery subyearling chinook was 1,500 fish 60mm in forklength or larger. A temporary marking station was established within a concrete spawning shed located adjacent to the holding ponds. Fish were dipnetted from three of the five ponds and transferred to the marking station in garbage cans of water. The fish were then held in a live trough located outside the marking station prior to being tagged. PIT tagged fish were held at the shed for a brief period of time in a perforated garbage can with a freshwater inflow and then transferred back to the original holding pond and mixed with the general population. Direct mortalities were counted during the marking operation and 30 marked fish were held overnight to assess 24 hour delayed mortality. All PIT tagged fish were released from the hatchery into the river with the general population. Recapture occurred at McNary Dam by passive interrogation.

Hanford Reach

The marking objective for wild subyearling chinook was 3,000 fish 60mm in forklength or larger. The methods used to capture, hold, mark, and release wild subyearling chinook in 1994 were essentially the same as those used in 1993 (Wagner, 1993). The marking station was moved in 1994 from the usual location outside and immediately adjacent to the WDFW marking trailer to an abandoned storage garage located approximately 50 yards away. This was necessary to protect the computer equipment from inclement weather (i.e., rain). The new location was generally satisfactory but did require the hand bucketing of fish for a greater distance.

Umatilla and Yakama tribal personnel captured fish with beach and stick seines. The fish were then transferred by jet boat to a holding area located at the ferry landing, anesthetized, and hand sorted by size within the WDFW coded wire tagging trailer. A portion of the fish with forklengths equal to or greater than 60mm were PIT tagged. PIT tags were applied with individual syringe injectors. The injector needles were disinfected with ethyl alcohol after each use to minimize the spread of disease between fish. Marked fish were transferred by jet boat several miles below the ferry landing and released. Thirty PIT tagged fish were held overnight to assess 24 hour delayed mortality.

Results

Marking

Priest Rapids Hatchery

A total of 1,487 subyearling chinook were PIT tagged at Priest Rapids Hatchery on June 2 (Table 6). Overall, only one fish was less than the 60mm minimum forklength criterion and therefore virtually all (99.9%) of the fish handled were large enough to mark. Direct mortality due to tagging equalled 0.2% (3 fish) and observed delayed mortality equalled zero (Table 6). The tagged fish were returned to three of the five holding ponds on June 2 and released with the general population in roughly equal allotments. The marked fish ranged in size from 61mm to 107mm and averaged 85.3mm for all three groups combined.

PIT tagging at Priest Rapids hatchery generally proceeded smoothly with one exception. A flexible garden hose which was used as a freshwater intake to the holding trough located outside the spawning shed partially collapsed and restricted the inflow. This resulted in approximately 200 mortalities prior to marking. However, the marked population was not effected by this incident. The flexible hose was replaced and the marking program was continued and completed shortly thereafter.

Table 6. 1994 Priest Rapids Hatchery PIT tag marking summary.

Marking and Handling Record					Mortality				
					Direct		Delayed		
Date	Number Tagged	Number <60mm	Total Handled	Markable Percent	#	%	#Held	# Mort	%
June 2	1,487	1	1,488	99.9%	3	0.2	30	0	0.0
Total	1,487	1	1,488	99.9%	3	0.2	30	0	0.0

Hanford Reach

A total of 3,141 wild zero age chinook were PIT tagged on June 6 and June 7 and 2,984 of these survived to be released (Table 7). The capturing crews were unable to catch an adequate number of fish in shallow slackwater zones with stick seines and therefore utilized beach seines to access deeper water. The larger boat drawn seines did effectively catch more fish but also resulted in a higher injury and descaling rate. Because of this, 128 fish which were large enough to mark were rejected due to poor condition. These are included in the "Markable Percent" calculated in Table 7. Both direct and delayed mortality rates for the tagging program were elevated in 1994 (4.9% and 3.3%) most likely due to the deterioration in fish condition associated with the rougher capturing method. The tags were removed from direct mortalities and re-used and the original tag record for each mortality was deleted from the tagging file.

The marked fish ranged in size from 55mm to 102mm and averaged 67.1mm. Only 0.4% of the fish marked were less than the 60mm minimum criterion and this resulted from a small level of error in the hand sorting process. A relatively high percentage of the fish handled (44.2%) were large enough to mark in 1994 compared to the previous year (11.5% - 1993). The 1994 markable percentage was roughly half that of 1992 (86.5%) and most similar to that of 1991 (39.9%).

Table 7. 1994 Hanford Reach PIT tag summary.

Marking and Handling Record						Mortality				
						Direct		Delayed		
Date	Number Tagged	Number <60mm	Number Rejects	Total Handled	Markable Percent*	#	%	#Held	# Mort	%
June 6	1,570	2,852	56	4,478	36.3%	97	6.2	30	1	3.3
June 7	1,571	1,279	72	2,922	56.2%	57	3.6	0	NA	NA
Total	3,141	4,131	128	7,400	44.2%	154	4.9	30	1	3.3

* The markable percent is equal to: (# Tagged + # Rejected)/(Total Handled).

Recapture

Qualifying Statement - As indicated previously in this text, the McNary juvenile collection facility was unwatered and placed in an emergency bypass mode beginning on July 17 and continuing through July 28. This was due to a massive subyearling chinook kill which resulted from thermal stress. During this time, the PIT tag

interrogation system was unwatered and all recovery data was lost. This critical time period appeared to correspond with the peak arrival of zero age chinook. Because of this, the 1994 PIT tag recovery data is incomplete. Given this constraint, only general patterns within the 1994 recovery data will be discussed in this section. A precise analysis of the relative recovery rates, migration timing, or an annual wild fish population survival comparison will not be possible. The 1994 data will be discussed in its raw form but no attempt will be made to extrapolate recovery results.

Priest Rapids Hatchery

The first group of PIT tagged zero age chinook were released from Priest Rapids Hatchery on June 13. These were the first to arrive at McNary Dam followed by the second (June 19) and third (June 21) release groups. The first group had the highest recovery rate and the second and third release groups had progressively lower rates (Table 8). Hatchery fish were recovered from June 19 through July 31. In general and independent of release date, the fish that were largest at release had the earliest arrival times, the shortest travel or "in river" times, and the highest recovery rates (Table 9). This general pattern of earlier arrival and higher recovery rates for larger hatchery fish is identical to that observed for PIT tagged wild fish from the Hanford Reach in past years.

Table 8. Priest Rapids Hatchery PIT tag release and recovery data, 1994.

Date Released	# Released	Peak Recovery Date	# Recovered	% Recovered
June 13	499	June 24	190	38.1
June 19	505	July 6	160	31.7
June 21	483	July 6-7	132	27.3
Total	1,487	July 6	482	32.4

Table 9. Size, arrival, and recovery rates for zero age chinook PIT tagged at Priest Rapids Hatchery in 1994.

Forklength Range (mm)	Mean Arrival Date	Mean Travel Time (days)	Recovery Rate (%)
60-69	July 11	24.6	24.1
70-79	July 8	20.5	29.5
80-89	July 3	17.1	31.7
90-99	June 29	13.7	35.8
100-109	June 27	12.6	33.3

Hanford Reach

The first PIT tagged wild fish arrived at McNary Dam on June 10 and the last recovery was on September 24. Peak arrival date for wild PIT tagged fish was July 16; immediately prior to the McNary juvenile fish facility unwatering and the placing of the collection system in an emergency bypass mode. Obviously, the recovery data for this group of fish is incomplete, but 324 fish, or 10.3% of those released, were detected via passive

interrogation. Although the data is incomplete, the general pattern of earlier arrival times, shorter travel ("in river") times, and higher recovery rates for fish that were larger at release was again observed in 1994 (Table 10). This same general pattern has consistently been observed for wild fish in past years and for hatchery fish in 1994.

Table 10. Size, arrival, and recovery rates for zero age chinook PIT tagged on the Hanford Reach in 1994.

Forklength Range(mm)*	Mean Arrival Date	Mean Travel Time (days)	Recovery Rate (%)
60-69	July 13	36.8	7.4
70-79	July 8	32.1	16.6
80-89	July 4	28.3	30.0
90-99	June 26	19.7	42.9
100-109	NA	NA	NA

* Only 14 fish in the 50-59mm size range and 1 fish in the 100-109mm size range were marked and released. None of these fish were recovered. Because of the small sample size, data for these fish are not included in Table 10.

Discussion

The shutdown of the McNary juvenile facility between July 17 and July 28 left a substantial "hole" in the PIT tag recovery database (Figure 1). The two week shutdown period appeared to correspond with the peak arrival of wild fish and a secondary movement period of fish originating from Priest Rapids Hatchery. In addition, it is also likely that a large proportion of the collection at that time consisted of subyearling chinook originating from Ringold Hatchery. These fish were unmarked and released for the first time in 1994 and therefore their arrival timing is difficult to assess. However, it is likely that all three groups of fish (Hanford wild, Priest Rapids Hatchery, Ringold Hatchery) were passing McNary Dam during the shutdown period.

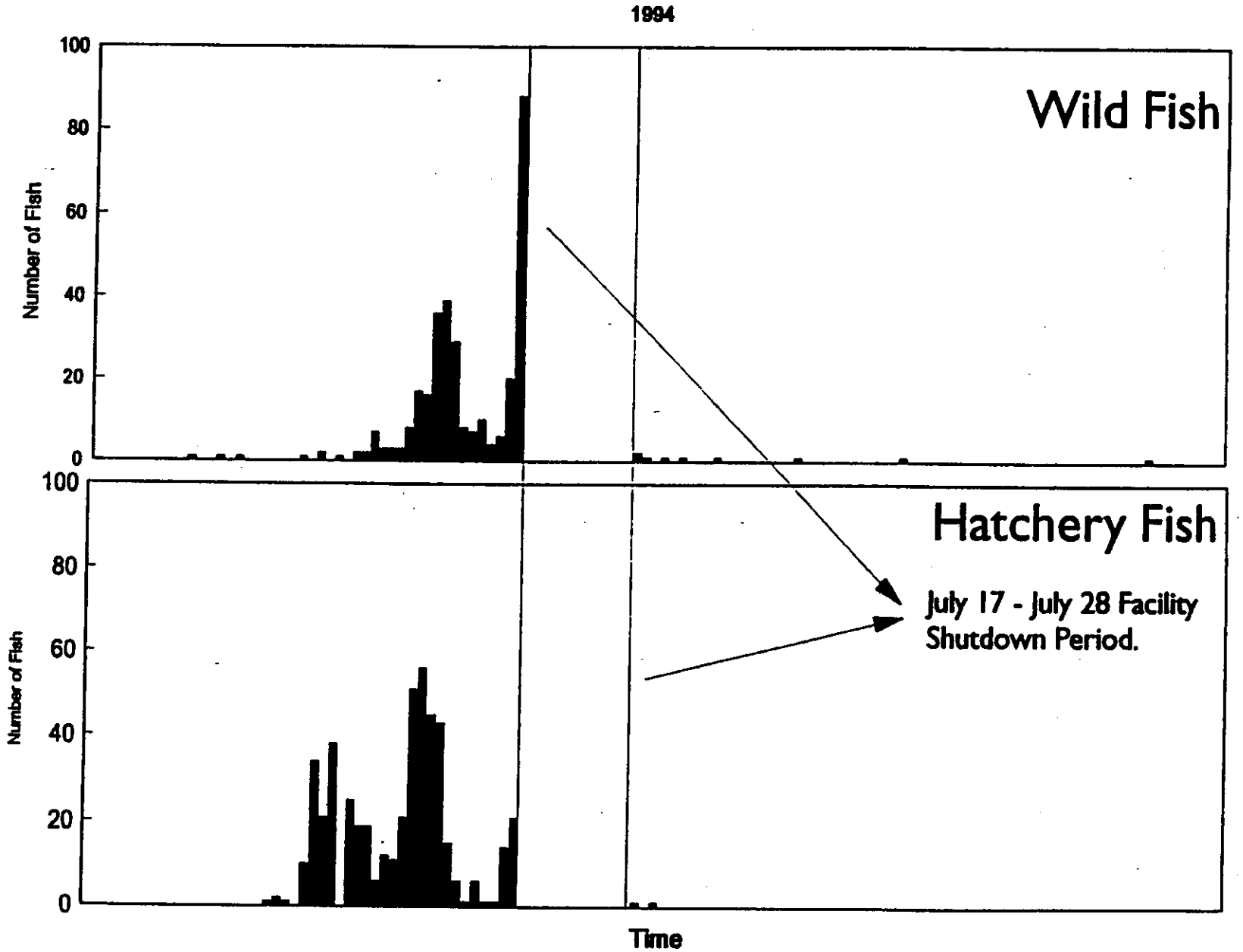
Although complete passage information is lacking in the 1994 analysis, two interesting observations can be made from the existing raw data.

1) For both hatchery and wild fish, those that were largest at release had the highest recovery rates, shortest travel (inriver passage) times, and earliest arrival times.

2) Hatchery and wild fish that were in the same size range (i.e., 60-69mm, 70-79mm, etc.) when they were tagged had virtually identical mean arrival dates at McNary Dam (Tables 9 and 10).

Observation 1 is consistent with what has been observed for PIT tagged wild fish in past years. Observation 2 is new and was made possible by the application of PIT tags to hatchery fish beginning in 1994. The similarity in arrival dates for similar sized hatchery and wild fish regardless of release time would suggest that zero age fall chinook rear until they reach a size threshold and then outmigrate. This was also suggested by coded wire tag data from mortalities collected from the McNary raceway tailscreens in 1991. In 1991, hatchery fish arrived at McNary Dam considerably earlier than did their wild counterparts but the average size of the coded wire tagged mortalities collected from the tailscreens were identical (97.6mm) for both groups of fish (Wagner and Hillson, 1991).

Figure 1. Arrival Timing of PIT Tagged Hatchery and Wild Zero Age Chinook to McNary Dam.



4.3 NBS SMOLT ASSESSMENT

The National Biological Survey sampled 1,172 subyearling chinook, 73 hatchery steelhead, and 70 wild steelhead to measure physiological indices of smoltification. All of these were sampled via non-lethal methods except for 453 subyearling chinook which were sacrificed. The fish were provided to the NBS by the McNary SMP.

4.4 NMFS MARKING PROGRAMS AT LOWER MONUMENTAL DAM

In 1994, the NMFS conducted two spring marking programs at Lower Monumental Dam. The first was to assess juvenile survival through Snake River dams and reservoirs. For this work 27,907 hatchery yearling chinook and 8,159 hatchery steelhead were removed from the sampling system and PIT tagged. The second program was to assess injury/descaling as a result of passage through the Lower Monumental collection system. For this second program, 4,840 yearling chinook and 2,683 steelhead were taken from the sampling system and caudal clipped. These fish were high-graded and only those in excellent condition were marked so that new injuries could be easily identified. Because of this, a relatively large number of fish had to be handled in order to provide an adequate number of markable fish for the second program. The two programs coincided and the relatively large number of sample fish that were handled to provide a relatively small number of markable fish for program 2 was somewhat offset by the marking of many of the excess fish in program 1. The combination of these two marking programs resulted in a four to five fold increase in the number of fish sampled in 1994 over that of 1993. All of these fish were provided through the Lower Monumental SMP. The use of NMFS personnel to assist in the sorting process and multiple sample rate changes within a 24 hour period were necessary to complete this work.

5.0 FULL SAMPLE DESCALING

Beginning in 1991, all live sample fish were examined for scale loss at McNary Dam and beginning in 1993 at Lower Monumental Dam. At McNary Dam, the 1994 descaling rates ranged from 2.3% for subyearling chinook to 13.8% for hatchery steelhead and averaged 4.3% overall. All groups of fish had higher descaling rates in 1994 than in 1993 except for coho (Table 11). It is unknown why descaling rates increased at McNary Dam in 1994. Operation of an entirely new collection facility could be considered as a potential cause. However, the new McNary system was evaluated by WDFW and the NMFS prior to fullscale operations and the results of this evaluation indicated that descaling rates were not increased as a result of passage through the new system. In addition, the first group of fish which arrived at McNary Dam in 1994 were yearling chinook originating from Ringold hatchery. These fish are distinct in morphology and arrival timing and do not pass any hydroelectric projects prior to arriving at McNary Dam. Therefore, Ringold yearling chinook are easily identified and typically have low descaling rates. This was again the case in 199 The 1994 descaling rate for all groups of fish (4.3%) although higher than that of 1993 (3.7%) was actually lower than that of 1992 (4.9%). This further suggests that passage through the new McNary collection systen did not result in elevated descaling rates.

At Lower Monumental Dam, all fish arrived in better condition in 1994 than in 1993. The 1994 descaling rates ranged from 1.8% for wild subyearling chinook to 19.2% for sockeye (Table 12). Hatchery releases o subyearling chinook did not occur upstream from Lower Monumental Dam in 1994 and therefore there is n 1994 descaling data reported in Table 12 for this group of fish. The general improvement in fish condition observed in 1994 at Lower Monumental Dam may be attributed to: 1) improvements within the bypass

system, 2) reduced levels of spill, and/or 3) an earlier season start which allowed a greater portion of the overall collection to consist of fish originating downstream of Little Goose and Lower Granite Dams (i.e., fish from Lyons Ferry Hatchery). Passage at projects located upstream has consistently been shown to increase the descaling rates of fish arriving at either McNary or Lower Monumental Dams (Wagner, 1991-1993).

Table 11. 1993 and 1994 descaling rates for juvenile fish sampled at McNary Dam.

Year	CH-I	CH-0	SH-H	SH-W	COHO	SOCK-H	SOCK-W	TOTAL
1993	5.6%	1.7%	8.3%	3.7%	4.8%	2.9%	8.5%	3.7%
1994	8.4%	2.3%	13.8%	5.0%	3.5%	7.9%	12.4%	4.3%
Difference	+2.8%	+0.6%	+5.5%	+1.3%	-1.3%	+5.0%	+3.9%	+0.6%

Table 12. 1993 and 1994 descaling rates for juvenile fish sampled at Lower Monumental Dam.

Year	CH-1H	CH-1W	CH-0H	CH-0W	SH-H	SH-W	SOCK	TOTAL
1993	9.2%	5.8%	2.4%	4.2%	10.5%	3.1%	26.6%	6.7%
1994	6.2%	6.1%	NA	1.8%	4.4%	3.0%	19.2%	5.4%
Difference	-3.0%	+0.3%	NA	-2.4%	-6.1%	-0.1%	-7.4%	-1.3%

6.0 RECOMMENDATIONS

1. Adherence to the USFWS (NBS) recommended guidelines pertaining to anesthetic practices should be continued in 1995 at both the McNary and Lower Monumental sites. The longer pre-anesthetic induction time required at the new McNary site should be further investigated.

2. The closure of the McNary facility from July 17 through July 28 was an unfortunate incident which eliminated much of the 1994 subyearling chinook PIT tag recovery data and basically ruined the 1994 analysis. However, the PIT tagging of 3,000 wild and 1,500 hatchery zero age chinook should be continued in 1995 on the Hanford Reach and at Priest Rapids Hatchery respectively. In past years this program has provided valuable information pertaining to the arrival timing and relative survival of the wild fish population (Wagner, 1993). In addition, direct comparisons of arrival timing and recovery rates for similarly marked hatchery and wild fish should be possible in the future provided that the McNary bypass system is made viable for passage of summer migrants during warm water periods. The use of PIT tags to mark a portion of the Ringold subyearling release should be considered as well.

3. Examination of sample fish for symptoms of gas bubble trauma should be continued in 1995 at both the McNary and Lower Monumental sites. The internal examination procedure used in 1994 appeared to have been flawed or was incorrectly performed. This procedure should be modified or the examinations should be conducted by trained fish pathologists. The use of controls should also be considered. Training in the recognition of external GBT symptoms should be provided to SMP personnel by FPC personnel prior to the commencement of 1995 operations.

7.0 LITERATURE CITED

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8.0 APPENDICES

Appendix Table 1. Re-circulating anesthetic (MS222) concentrations - McNary 1994.

Date	ppm		Date	ppm		Date	ppm		Date	ppm		Date	ppm		Date	ppm	
	Starting	Addition		Starting	Addition		Starting	Addition		Starting	Addition		Starting	Addition		Starting	Addition
09-Apr	27.6		27-May	33.1		14-Jul	27.6		31-Aug	27.6		18-Oct	0		06-Dec	0	
10-Apr	27.6		28-May	33.1		15-Jul	27.6		01-Sep	27.6		19-Oct	0		08-Dec	0	
11-Apr	27.6		29-May	33.1		16-Jul	27.6	5.5	02-Sep	27.6		20-Oct	0				
12-Apr	27.6		30-May	33.1		17-Jul	0.0		03-Sep	27.6		21-Oct	0				
13-Apr	27.6		31-May	33.1		18-Jul	0.0		04-Sep	27.6		22-Oct	0				
14-Apr	27.6		01-Jun	33.1		19-Jul	0.0		05-Sep	27.6		23-Oct	0				
15-Apr	27.6		02-Jun	33.1		20-Jul	0.0		06-Sep	27.6		24-Oct	0				
16-Apr	27.6		03-Jun	33.1		21-Jul	0.0		07-Sep	27.6		25-Oct	0				
17-Apr	27.6		04-Jun	33.1		22-Jul	0.0		08-Sep	27.6		26-Oct	0				
18-Apr	27.6		05-Jun	33.1		23-Jul	0.0		09-Sep	27.6		27-Oct	0				
19-Apr	27.6		06-Jun	33.1		24-Jul	0.0		10-Sep	27.6		28-Oct	0				
20-Apr	27.6		07-Jun	33.1		25-Jul	0.0		11-Sep	27.6		29-Oct	0				
21-Apr	27.6		08-Jun	33.1		26-Jul	0.0		12-Sep	27.6		30-Oct	0				
22-Apr	27.6		09-Jun	33.1		27-Jul	0.0		13-Sep	27.6		31-Oct	0				
23-Apr	27.6		10-Jun	33.1		28-Jul	0.0		14-Sep	27.6		01-Nov	0				
24-Apr	27.6		11-Jun	33.1		29-Jul	27.6		15-Sep	27.6		02-Nov	0				
25-Apr	27.6		12-Jun	33.1		30-Jul	27.6		16-Sep	27.6		03-Nov	0				
26-Apr	27.6		13-Jun	33.1		31-Jul	27.6		17-Sep	27.6		04-Nov	0				
27-Apr	27.6		14-Jun	33.1		01-Aug	27.6		18-Sep	27.6		05-Nov	0				
28-Apr	27.6		15-Jun	33.1		02-Aug	27.6		19-Sep	27.6		06-Nov	0				
29-Apr	27.6		16-Jun	33.1		03-Aug	27.6		20-Sep	27.6		07-Nov	0				
30-Apr	27.6		17-Jun	33.1		04-Aug	27.6		21-Sep	0.0		08-Nov	0				
01-May	27.6		18-Jun	33.1		05-Aug	27.6		22-Sep	0.0		09-Nov	0				
02-May	27.6		19-Jun	33.1		06-Aug	27.6		23-Sep	0.0		10-Nov	0				
03-May	33.1		20-Jun	33.1		07-Aug	27.6		24-Sep	0.0		11-Nov	0				
04-May	33.1		21-Jun	33.1		08-Aug	27.6		25-Sep	0.0		12-Nov	0				
05-May	33.1		22-Jun	27.6		09-Aug	27.6		26-Sep	0.0		13-Nov	0				
06-May	33.1		23-Jun	27.6		10-Aug	27.6		27-Sep	0.0		14-Nov	0				
07-May	33.1		24-Jun	27.6		11-Aug	27.6		28-Sep	0.0		15-Nov	0				
08-May	33.1		25-Jun	27.6		12-Aug	27.6		29-Sep	0.0		16-Nov	0				
09-May	33.1		26-Jun	27.6	6.5	13-Aug	27.6		30-Sep	0.0		17-Nov	0				
10-May	33.1		27-Jun	27.6		14-Aug	27.6		01-Oct	0.0		18-Nov	0				
11-May	33.1		28-Jun	27.6		15-Aug	27.6		02-Oct	0.0		19-Nov	0				
12-May	33.1		29-Jun	55.2		16-Aug	27.6		03-Oct	0.0		20-Nov	0				
13-May	33.1		30-Jun	27.6	5.5	17-Aug	27.6		04-Oct	0.0		21-Nov	0				
14-May	33.1		01-Jul	27.6		18-Aug	27.6		05-Oct	0.0		22-Nov	0				
15-May	33.1		02-Jul	33.1		19-Aug	27.6		06-Oct	0.0		23-Nov	0				
16-May	33.1		03-Jul	33.1		20-Aug	27.6		07-Oct	0.0		24-Nov	0				
17-May	33.1		04-Jul	27.6		21-Aug	27.6		08-Oct	0.0		25-Nov	0				
18-May	33.1		05-Jul	27.6		22-Aug	27.6		09-Oct	0.0		26-Nov	0				
19-May	33.1		06-Jul	27.6		23-Aug	27.6		10-Oct	0.0		27-Nov	0				
20-May	33.1		07-Jul	27.6	18.8	24-Aug	27.6		11-Oct	0.0		28-Nov	0				
21-May	33.1		08-Jul	27.6	14.4	25-Aug	27.6		12-Oct	0.0		29-Nov	0				
22-May	33.1		09-Jul	27.6		26-Aug	27.6		13-Oct	0.0		30-Nov	0				
23-May	33.1		10-Jul	27.6	5.5	27-Aug	27.6		14-Oct	0.0		01-Dec	0				
24-May	33.1		11-Jul	27.6		28-Aug	27.6		15-Oct	0.0		02-Dec	0				
25-May	33.1		12-Jul	27.6		29-Aug	27.6		16-Oct	0.0		03-Dec	0				
26-May	33.1		13-Jul	27.6		30-Aug	27.6		17-Oct	0.0		04-Dec	0				
Average	32.9	0.0		31.4	9.9		20.7	5.5		27.6	0.0		0.0	0.0		0.0	0.0

Year Summary	Starting	Addition
Average	18.7	11.0
Minimum	0.0	0.0
Maximum	33.1	18.8

Appendix Table 2. Re-circulating anesthetic (MS222) concentrations - Lower Monumental 1994.

Date	ppm		Date	ppm		Date	ppm	Date	ppm	Date	ppm	
	Starting	Addition		Starting	Addition		Starting Addition		Starting Addition		Starting	Addit
07-Apr	31.2		25-May	31.2	11.3	12-Jul	34.1	29-Aug	34.1	16-Oct	34.1	
08-Apr	31.2		26-May	31.2	11.3	13-Jul	34.1	30-Aug		17-Oct		
09-Apr	34.0		27-May	31.2		14-Jul	34.1	31-Aug	34.1	18-Oct	34.1	1
10-Apr	34.0		28-May	31.2		15-Jul	34.1	01-Sep		19-Oct		
11-Apr	34.0		29-May	31.2	11.3	16-Jul	34.1	02-Sep	34.1	20-Oct	34.1	
12-Apr	34.0		30-May	31.2	11.3	17-Jul	34.1	03-Sep		21-Oct		
13-Apr	31.2		31-May	31.2		18-Jul	34.1	04-Sep	34.1	22-Oct	34.1	
14-Apr	31.2		01-Jun	31.2		19-Jul	34.1	05-Sep		23-Oct		
15-Apr	31.2		02-Jun	31.2		20-Jul	34.1	06-Sep	34.1	24-Oct	34.1	
16-Apr	31.2		03-Jun	31.2		21-Jul	34.1	07-Sep		25-Oct		
17-Apr	31.2		04-Jun	31.2		22-Jul	34.1	08-Sep	34.1	26-Oct	34.1	
18-Apr	31.2		05-Jun	31.2		23-Jul	34.1	09-Sep		27-Oct		
19-Apr	31.2		06-Jun	34.1		24-Jul	34.1	10-Sep	34.1	28-Oct	34.1	
20-Apr	31.2		07-Jun	34.1		25-Jul	34.1	11-Sep		29-Oct		
21-Apr	31.2		08-Jun	34.1		26-Jul	34.1	12-Sep	34.1	30-Oct	34.1	
22-Apr	31.2		09-Jun	34.1		27-Jul	34.1	13-Sep		31-Oct		
23-Apr	31.2		10-Jun	34.1		28-Jul	34.1	14-Sep	34.1	01-Nov	34.1	
24-Apr	31.2	15.6	11-Jun	34.1		29-Jul	34.1	15-Sep				
25-Apr	34.0		12-Jun	34.1		30-Jul	34.1	16-Sep	34.1			
26-Apr	34.0	23.4	13-Jun	34.1		31-Jul	34.1	17-Sep				
27-Apr	34.0		14-Jun	34.1		01-Aug	34.1	18-Sep	34.1			
28-Apr	34.0		15-Jun	34.1		02-Aug	34.1	19-Sep				
29-Apr	34.0		16-Jun	34.1		03-Aug	34.1	20-Sep	34.1			
30-Apr	34.0	15.6	17-Jun	34.1		04-Aug	34.1	21-Sep				
01-May	31.2		18-Jun	34.1		05-Aug	34.1	22-Sep	34.1			
02-May	34.0	34.0	19-Jun	34.1		06-Aug		23-Sep				
03-May	34.0	56.7	20-Jun	34.1		07-Aug	34.1	24-Sep	34.1			
04-May	31.2	56.7	21-Jun	34.1		08-Aug		25-Sep				
05-May	34.0		22-Jun	34.1		09-Aug	34.1	26-Sep	34.1			
06-May	31.2	11.3	23-Jun	34.1		10-Aug		27-Sep				
07-May	34.0	22.6	24-Jun	34.1		11-Aug	34.1	28-Sep	34.1			
08-May	31.2		25-Jun	34.1		12-Aug		29-Sep				
09-May	34.0	11.3	26-Jun	34.1		13-Aug	34.0	30-Sep	34.1			
10-May	31.2	11.3	27-Jun	34.1		14-Aug		01-Oct				
11-May	31.2		28-Jun	34.1		15-Aug	34.1	02-Oct	34.1			
12-May	34.0	34.0	29-Jun	34.1		16-Aug		03-Oct				
13-May	34.0		30-Jun	34.1		17-Aug	34.1	04-Oct	34.1			
14-May	34.0	11.3	01-Jul	34.1		18-Aug		05-Oct				
15-May	34.0	11.3	02-Jul	34.1		19-Aug	34.1	06-Oct	34.1			
16-May	34.0	34.0	03-Jul	34.1		20-Aug		07-Oct				
17-May	31.2	11.3	04-Jul	34.1		21-Aug	34.1	08-Oct	34.1			
18-May	34.0	11.3	05-Jul	34.1	11.3	22-Aug		09-Oct				
19-May	31.2	11.3	06-Jul	34.1		23-Aug	34.1	10-Oct	34.1			
20-May	34.0	5.7	07-Jul	34.1		24-Aug		11-Oct				
21-May	31.2	11.3	08-Jul	34.1		25-Aug	34.1	12-Oct	34.1			
22-May	34.0		09-Jul	34.1		26-Aug		13-Oct				
23-May	31.2		10-Jul	34.1		27-Aug	34.1	14-Oct	34.1			
24-May	31.2	11.3	11-Jul	34.1		28-Aug		15-Oct				
Average	32.5	20.6		33.4	11.3		34.1		34.1		34.1	

Year Summary	Starting	Addition
Average	33.6	14.4
Minimum	31.2	5.7
Maximum	34.1	56.7

Appendix Table 3. Pre-anesthetic induction times (minutes) at Mallory Dam in 1994.

	A tank			B tank		A & B tanks	
Date	Time	Time	Time	Time	Time	Time	Time
10-Apr	4.00	4.00	3.50	3.75	3.75	4.50	3.97
11-Apr				5.00	3.50	4.00	4.17
12-Apr	4.50			4.00	5.25	4.50	4.58
13-Apr	5.00			5.00	5.00	5.00	5.00
14-Apr	5.00			5.00	4.75		4.75
15-Apr	3.75			4.50	5.00	5.00	4.58
16-Apr							
17-Apr							
18-Apr	4.75			4.75			4.75
19-Apr	4.25	5.00	5.00	4.25	4.50	3.75	4.46
20-Apr	4.75	4.00	4.50	4.75	4.75	4.25	4.42
21-Apr	4.00	4.50	5.00	4.25	5.00	3.50	4.38
22-Apr	4.50	4.50		4.00	4.50	4.25	4.29
23-Apr							
24-Apr							
25-Apr	4.25			4.50	5.00	4.75	4.63
26-Apr	4.50	5.00		5.00	4.25	4.25	4.20
27-Apr	5.00			3.75	4.75	4.75	4.58
28-Apr	3.75			5.00	4.75	4.75	4.58
29-Apr		4.00		4.75	4.50	5.00	4.44
30-May	3.25	3.25	3.00	4.00	4.00	5.00	3.75
01-May	4.50	5.00	4.75	3.50	4.75	5.00	4.58
02-May	5.00	4.75	4.50	4.25	4.75	4.50	4.63
03-May	4.50	4.25	4.75	4.50	5.00	4.50	4.58
04-May	4.75	5.50	4.75	4.25	5.75	5.75	5.13
05-May	4.50	4.75	4.25	4.75	5.00	5.00	4.71
06-May	3.75	4.00	3.25	4.00	4.25	3.75	3.83
07-May	3.50	3.75	3.50	4.00	4.75	4.50	4.00
08-May	5.00	5.00	3.50	3.50	5.00	4.50	4.42
09-May	4.00	4.50	3.50	3.75	4.25	4.00	4.00
10-May	4.00	4.50	5.00	4.50	4.50	4.00	4.42
11-May	5.00	5.00	5.00	4.00	4.25	4.50	4.63
12-May	4.50	4.75	4.25	5.50	5.50	4.25	4.79
13-May	3.75	5.50	4.00	3.75	3.75	4.25	4.17
14-May	3.75	3.50	3.00	3.75	5.75	3.75	3.99
15-May	4.00	4.25	4.00	3.75	4.50	4.75	4.21
16-May	3.75	4.50	5.00	4.50	4.50	4.75	4.50
17-May	4.75	3.50	4.75	3.50	5.00	4.25	4.38
18-May	4.00	5.00	5.00	4.00	4.75	4.50	4.64
19-May	5.00	5.25	5.00	4.50	5.50	4.50	4.96
20-May	4.75	5.50	4.25	3.00	3.50	3.75	3.99
21-May	4.00	4.00	3.25	4.00	4.25	4.00	3.92
22-May	4.25	5.25	4.25	4.25	4.75	4.75	4.58
23-May	5.00	4.50		4.00	4.50	5.00	4.60
24-May	4.75	4.00	4.75	4.75	4.75	4.75	4.75
25-May	4.00	4.25	4.50	4.00	4.50	5.50	4.44
26-May	3.25	3.75		3.50	3.75	4.75	3.80
27-May	3.75	4.00		3.00	3.50	4.25	3.70
28-May	4.75	4.75		3.75	4.50	4.75	4.50
29-May	4.75	3.75		4.50	4.50	4.25	4.25
30-May							
31-May	3.50			3.75	4.00	4.25	3.88
01-Jun	4.75	3.75		3.75	4.50	4.75	4.26
02-Jun	3.25	2.00		3.50	3.50	3.75	3.40
03-Jun	3.25	3.50	3.75	3.25	3.50	3.50	3.48
04-Jun	3.75	3.25		3.75	4.25	4.00	3.80
05-Jun	4.00	3.75	4.00	4.00	4.00	4.75	4.08
06-Jun	4.00	3.50	3.50	4.50	4.50	4.25	4.04
07-Jun	3.75	4.25	3.50	4.00	4.00	4.00	3.92
08-Jun	3.75	4.00	3.25	4.00	4.00	3.75	3.78
09-Jun	4.25	3.00	3.50	3.25	4.00	3.75	3.63
10-Jun	5.00	4.00	4.50	3.50	4.25	3.75	4.17
11-Jun	3.50	4.00	3.75	4.00	4.50	4.00	3.96
12-Jun	4.00	3.00	3.00	3.75	4.00	4.00	3.54
13-Jun	4.00	3.50	2.75	3.75	5.00	5.00	4.00
14-Jun	2.75	4.00	3.00	4.25	4.25	3.75	3.67
15-Jun	3.00	3.00	3.50	3.50	3.50	2.75	3.21
16-Jun	4.50	3.50	3.50	3.50	4.50	3.75	3.88
17-Jun	4.75	4.00	3.50	4.25	3.75	3.75	4.00
18-Jul	3.50	3.75	3.75	3.75	3.25	3.50	3.17
19-Jul	3.00	3.00	3.00	3.50	3.25	3.00	3.13
20-Jul	3.50	3.25	3.25	3.75	3.75	3.75	3.48
21-Jul	3.50	3.50	4.00	3.00	3.75	3.75	3.58
22-Jul	3.00	3.00	3.25	3.00	3.00	3.50	3.13
23-Jul	2.75	3.50	3.25	3.25	3.50	3.50	3.29
24-Jul	3.50	4.00	4.00	3.50	4.00	3.50	3.75
25-Jul	3.00	3.25	3.00	3.25	3.75	3.00	3.21
26-Jul	2.00	2.75	2.75	3.75	3.25	3.25	2.96
27-Jul	3.25	3.50	3.50	3.25	3.50	3.50	3.42
28-Jul	3.50	3.25	3.00	3.00	3.75	3.25	3.21
29-Jul	3.00	3.00	3.00	2.25	3.25	3.00	2.87
30-Jul							
31-Jul							
01-Aug							
02-Aug							
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27-Nov							
28-Nov							
29-Nov							
30-Nov							
01-Dec							
02-Dec							
03-Dec							
04-Dec							
05-Dec							
Minimum							
Maximum							
Average							

	A tank			B tank		A & B tanks	
Date	Time	Time	Time	Time	Time	Time	Time
04-Aug	3.00	3.50	3.25	3.00	3.50	3.00	3.21
05-Aug	3.00	3.00	3.00	4.00	2.25	3.50	3.13
06-Aug	3.50	3.75	3.50	3.50	4.00	3.75	3.67
07-Aug	3.50	3.25	3.50	3.25	3.00	3.00	3.25
08-Aug	3.50	3.50	3.00	3.00	3.25	2.75	3.17
09-Aug	3.75	3.50	3.00	4.00	3.50	3.00	3.46
10-Aug	3.00	3.75	3.25	3.50	3.50	3.00	3.33
11-Aug	3.00	3.00	3.00	3.00	3.25	3.00	3.04
12-Aug	3.00	3.25		3.25	3.25	3.25	3.20
13-Aug	3.50	3.25	4.00	3.75	3.00	3.25	3.46
14-Aug	3.00	3.50	3.25	3.25	3.00	3.75	3.29
15-Aug	3.25	3.75	4.00	3.75	3.50	3.50	3.63
16-Aug	2.75	3.50	3.50	3.75	3.50	2.75	3.29
17-Aug	3.50	3.25	3.00	3.25	3.25	3.50	3.29
18-Aug	3.50	3.50	3.00	3.50	3.50	3.25	3.38
19-Aug	3.25	3.75	2.75	3.50	3.50	3.50	3.38
20-Aug	3.75	3.75	3.50	3.75	3.50	3.50	3.63
21-Aug	3.75	3.75	3.75	3.75	3.75		3.75
22-Aug	3.75	3.00		3.75	3.50	3.75	3.55
23-Aug	3.75			3.50	3.75	3.00	3.50
01-Sep	3.75	3.75	3.75	4.50	4.00	4.25	4.00
02-Sep	4.25	4.00	3.50	4.25	3.75	4.00	3.99
03-Sep	3.00	3.50		3.25	4.25	3.50	3.50
04-Sep	3.75	4.00		3.75	4.00	3.25	3.75
05-Sep	4.00	4.25	3.75	4.25	4.00	3.75	4.00
06-Sep	4.25	4.00		4.00	3.75	3.50	3.90
07-Sep	4.00	4.25	3.50	4.00	3.75	4.00	3.92
08-Sep	4.00	4.00	4.25	4.00	3.75	3.50	3.92
09-Sep	4.50	4.00		4.00	4.00	4.50	4.20
10-Sep	4.50	4.50		4.00	3.75	3.75	4.10
11-Sep	4.50	4.25		4.00	4.00	3.75	4.10
12-Sep	4.25			4.75	4.25	4.00	4.31
13-Sep	4.00			4.25	4.00	3.75	4.00
14-Sep	4.25			3.50	3.75	3.50	4.00
15-Sep	4.25			4.50	3.75	3.50	4.00
16-Sep	4.00			4.75	4.00	4.25	4.25
17-Sep	4.25			4.50	4.25	3.75	4.19
18-Sep	3.75			4.00	4.50	4.75	4.25
19-Sep	4.75			4.50	4.50		4.58
20-Sep	4.25			4.50	4.25		4.33
21-Sep	4.25			4.50			4.38
22-Sep	4.00			4.50	4.75		4.42
23-Sep	5.00			5.00	4.75	5.00	4.94
24-Sep	4.50			4.75	4.00		4.42
25-Sep	4.50			3.00	4.50		4.00
26-Sep	5.00			4.75			5.38
27-Sep	5.00			5.00			5.50
28-Sep	5.25			4.50	5.50		5.08
29-Sep	5.00			3.75			4.38
30-Sep	5.00			5.50			5.25
01-Oct	4.50			3.00			3.75
02-Oct	4.75			4.25			4.50
03-Oct	5.00			5.25			5.13
04-Oct	5.00			4.75			4.88
05-Oct	4.00			4.00			4.00
06-Oct	5.50			5.00	5.00		5.00
07-Oct	5.50			4.50	4.50	5.00	4.88
08-Oct	4.50			4.00	3.75		4.08
09-Oct	4.50			4.75	4.50	4.50	4.58
10-Oct	5.00			5.00	5.25		5.08
11-Oct	5.25			4.50	5.00		4.92
12-Oct	5.00			5.00	4.75		4.92
13-Oct	5.00			3.75	5.00		4.58
14-Oct	5.50			4.25	4.75		4.83
15-Oct	4.00			4.00	4.25		4.08
16-Oct	4.00			4.00	4.25		4.08
17-Oct	4.50			4.50	5.50	5.00	4.88
18-Oct	4.75			4.25	5.50	4.75	4.81
19-Oct	4.00			4.75			4.38
20-Oct	4.75			4.75			4.75
21-Oct	4.00	4.25	4.00	4.00	3.75	4.00	4.00
22-Oct	5.00		4.00	5.00		5.00	4.75
23-Oct	4.75		4.00	4.50			4.25
24-Oct	3.25	4.00	4.00	4.00	3.50	4.00	3.79
25-Oct	3.75			3.50			3.63
26-Oct							
27-Oct							
28-Oct	4.50	4.50	5.00	4.00	4.00	4.00	4.33
29-Oct	4.00		4.00	4.00		4.00	4.00
30-Oct	4.00		4.00	4.50		4.00	4.13
31-Oct	4.00	4.00	4.00	4.50		4.00	4.10
01-Nov							
02-Nov							
03-Nov	4.00	4.00	4.00	4.00		4.00	4.00
04-Nov	4.00	4.00	4.00	4.00		4.00	4.00
05-Nov							
06-Nov	3.50		4.00	4.00		3.50	3.75
07-Nov	4.00	4.00	4.00	4.00	4.00	4.00	4.00
08-Nov	4.00		4.00	3.50	4.50	4.00	4.00
09-Nov	4.00		4.00	4.00		4.00	4.00
10-Nov	4.00		4.00	4.00	4.00	4.00	4.00
11-Nov	4.00		4.00	4.00		4.00	4.00
12-Nov	4.00		4.00	4.00		4.00	4.00
13-Nov	4.00		4.00	4.00		4.00	4.00
14-Nov							
15-Nov							
16-Nov							
17-Nov							
18-Nov							
19-Nov							
20-Nov							
21-Nov							
22-Nov							
23-Nov							
24-Nov							
25-Nov							
26-Nov							
27-Nov							
28-Nov							
29-Nov							
30-Nov							
01-Dec							
02-Dec							
03-Dec							
04-Dec							
05-Dec							
Minimum	3.00	3.75	3.75	3.25	3.25	3.75	3.92
Maximum	5.00	5.50	5.00	5.00	5.75	5.75	5.50
Average	4.08	3.92	3.91	4.00	4.11	3.97	4.08

Appendix Table 4. Pre-anesthetic induction times immunized at Lower Monumental Dam in 1994.

	A tank			B tank			A & B tanks		A tank			B tank			A & B tanks
Date	Time	Time	Time	Time	Time	Time	Time	Date	Time	Time	Time	Time	Time	Time	Time
07-Apr	5.00			4.50			4.75	23-Jul	4.00			4.50	4.00	4.00	4.13
08-Apr	3.00			4.00	5.50	5.50	4.50	24-Jul	3.50			4.50	3.50	4.50	4.00
09-Apr	3.00	2.50	3.50	4.00	3.50	3.00	3.25	25-Jul	4.00			4.00	4.00	4.50	4.13
10-Apr	3.00	3.50	3.00	3.00	2.50	3.00	3.00	26-Jul	4.00			4.00	4.50	5.00	4.38
11-Apr	3.00	4.00	3.00	3.00	3.00	3.50	3.25	27-Jul	4.50			5.00	5.00		4.83
12-Apr	3.00	3.00		4.00	3.00	2.50	3.10	28-Jul	4.00	4.00		4.50	4.75		4.31
13-Apr	2.50	2.50		4.00	3.50	3.50	3.20	29-Jul	4.50			4.00	3.50		4.00
14-Apr	3.00	2.50	2.50	2.50	3.00	3.00	2.75	30-Jul	3.00			4.25	4.00	4.50	3.94
15-Apr	2.50			2.50	4.00	4.50	3.38	31-Jul	3.50			4.50	3.50	4.00	3.88
16-Apr	2.50			2.50			2.50	01-Aug	4.00			4.50	3.75	5.00	4.31
17-Apr	4.50		4.50	4.00	4.00		4.25	02-Aug	3.75			4.00	4.00		3.92
18-Apr	3.50			3.50	4.50		3.83	03-Aug	3.75			4.00			3.88
19-Apr	4.00		4.50	3.50			4.00	04-Aug	3.50			4.50	4.50	4.50	4.25
20-Apr	4.00	4.50	4.50	4.00	5.00	4.50	4.42	05-Aug	4.50			4.00	4.00		4.17
21-Apr	3.00	4.00	3.50	4.50	4.50	4.50	4.00	06-Aug	3.50			3.00	3.50		3.33
22-Apr	4.50	4.00	4.50	4.50	4.00	4.50	4.33	07-Aug	3.75			4.00	4.00		3.92
23-Apr	4.50	5.00	4.50	4.50	4.00	4.00	4.42	08-Aug	4.00			4.00	3.00		3.67
24-Apr	4.00	4.50	4.50	4.50	4.50	4.50	4.42	09-Aug	3.75			3.75			3.75
25-Apr	4.50	4.50	4.50	3.50	4.50	4.00	4.25	10-Aug	4.00			4.00	4.00		4.00
26-Apr	4.00	4.00	4.00	4.00	4.00	4.00	4.00	11-Aug	3.75			3.75			3.75
27-Apr	3.50	3.50	4.00	4.00	3.50	4.00	3.75	12-Aug	4.00			3.00			3.50
28-Apr	4.00	3.50	4.00	3.50	4.00	4.00	3.83	13-Aug	3.00			3.50			3.25
29-Apr	4.00	4.00	3.50	3.50	3.50	3.50	3.67	14-Aug	5.00			3.50	5.00		4.50
30-Apr	2.75	3.25	3.25	3.50	2.00	3.00	2.96	15-Aug	4.00			4.00	3.50		3.83
01-May	2.25	3.25	3.00	4.00	3.50	2.50	3.08	16-Aug	3.50			4.00			3.75
02-May	4.00	3.00	3.50	4.00	3.00	3.00	3.42	17-Aug	3.75			4.00			3.88
03-May	3.00	3.25	3.25	3.50	4.00	3.50	3.42	18-Aug	4.00			3.50			3.75
04-May	3.50	3.50	3.50	3.25	3.50	3.00	3.38	19-Aug	3.75			4.00	5.00		4.25
05-May	3.50	4.25	2.50	4.00	4.00	3.50	3.75	20-Aug	3.00			4.50	3.50		3.67
06-May	4.00	4.00	4.00	3.50	4.00	3.50	3.83	21-Aug	4.50			4.50	3.50		4.17
07-May	4.00	3.50	4.00	3.50	3.50	3.00	3.58	22-Aug	4.00			4.00	4.50		4.17
08-May	4.00	3.25	4.00	4.75	4.50	4.50	4.17	23-Aug	3.75			4.00	4.00		3.92
09-May	3.50	3.75	3.00	4.00	3.50	3.50	3.54	24-Aug	3.50			4.00	4.00		3.83
10-May	2.50	3.25	3.50	4.50	4.00	4.25	3.67	25-Aug	4.00			4.00	4.50		4.17
11-May	3.50	3.75	2.00	3.00	4.00	3.25	3.25	26-Aug	3.75			3.00	4.00		3.58
12-May	2.25	2.50	2.50	4.50	4.00	3.75	3.25	27-Aug	3.00			4.50	3.75		3.75
13-May	3.00	2.50	2.50	4.00	3.75	4.00	3.29	28-Aug	3.50			3.50	4.00		3.67
14-May	2.50	3.25	3.00	4.00	4.25	4.50	3.58	29-Aug	4.00			4.00	3.50		3.83
15-May	3.00	2.50	5.00	4.00	3.50	3.75	3.63	30-Aug	3.00			4.00	3.50		3.50
16-May	3.00	2.50	3.00	3.50	3.00	4.00	3.17	31-Aug	4.50			4.00	3.75	4.00	4.06
17-May	4.00	3.75	4.00	6.00	5.00	6.50	4.71	01-Sep	3.00			4.00	3.75		3.58
18-May	5.00	5.75	5.00	3.00	2.50	2.50	3.96	02-Sep	3.50			4.00	4.00		3.83
19-May	4.25	4.25	4.50	4.00	5.00	4.50	4.42	03-Sep	3.50			3.75	3.50		3.58
20-May	3.50	4.00	4.25	4.50	4.25	4.25	4.13	04-Sep	3.50			4.50	3.75		3.92
21-May	4.50	5.00	6.00	5.00	4.50	4.50	4.92	05-Sep	3.50			4.50	3.00		3.67
22-May	5.00	4.50		3.50	3.50	4.75	4.25	06-Sep	3.50			4.25	4.00		3.92
23-May	5.50	6.00		4.50	5.50		5.13	07-Sep	5.00			3.50	4.50		4.33
24-May	5.00	5.50	5.00	5.25	4.00		4.96	08-Sep	3.50			4.00	3.75		3.75
25-May	4.50	4.50	4.00	4.50	5.00	4.50	4.50	09-Sep	4.75			1.25	1.50		2.50
26-May	4.00	4.25	5.00	4.75	4.25		4.46	10-Sep	4.50			4.25	3.50	4.00	4.06
27-May	5.75	4.50	4.50	4.50	4.50	3.25	4.50	11-Sep	4.00			4.50	3.50		4.00
28-May	5.00	5.50	6.50	5.00	4.75	4.50	5.21	12-Sep	4.00			4.25	3.75		4.00
29-May	4.50	5.75	6.00	4.50	5.00	5.00	4.96	13-Sep	3.75			4.00	3.00	3.75	3.63
30-May	4.50	4.50		5.00	5.50	5.00	4.90	14-Sep	3.50			3.75	4.00		3.75
31-May	3.50	4.00		5.00	4.00	4.00	4.10	15-Sep	3.00			4.75	4.50		4.08
01-Jun	5.00	4.50		5.00	4.50		4.75	16-Sep	4.50			4.50	4.00		4.33
02-Jun	4.75	4.50		4.75	4.50		4.63	17-Sep	4.00			4.00	4.00		4.00
03-Jun	5.50	5.00		4.25	4.75		4.88	18-Sep	3.50			4.50	4.00	4.00	4.00
04-Jun	4.50	4.75		4.75	5.00		4.75	19-Sep	4.00			4.50	3.75	3.00	3.81
05-Jun	5.00	5.75		4.00	4.50	5.00	4.85	20-Sep	4.00			3.00	4.00	3.75	3.69
06-Jun	4.50	4.00		4.50	5.00	4.75	4.55	21-Sep	4.00			3.50	4.00		3.83
07-Jun	6.00	7.00		4.50	5.00	4.75	5.25	22-Sep	4.00			3.00	3.00		3.33
08-Jun	4.50			4.25	4.75		4.50	23-Sep	3.75			4.00	4.00	3.75	3.88
09-Jun	5.00	3.50		4.50	3.75	4.50	4.25	24-Sep	3.50			4.00	3.50	4.00	3.75
10-Jun	5.00	3.50		4.75	4.50		4.44	25-Sep	3.00			4.00	4.00		3.67
11-Jun	4.25	4.00		4.50	4.50		4.31	26-Sep	3.00			3.75	3.50		3.42
12-Jun	5.00			3.75	4.00		4.25	27-Sep	3.75			4.50	4.25		4.17
13-Jun	5.00	4.75		4.00	4.50		4.58	28-Sep	3.00			4.00	5.00		4.00
14-Jun	4.75			4.00			4.38	29-Sep							
15-Jun	4.00			4.50	4.50		4.33	30-Sep							
16-Jun	4.50			4.50	5.00	5.00	4.75	01-Oct	2.50			4.00	3.75		3.42
17-Jun	4.50	4.50		4.50	5.00	4.75	4.65	02-Oct	3.75			4.00			3.88
18-Jun	4.50	5.00	5.00	5.00	5.25	4.50	4.88	03-Oct	3.00			3.75	4.00		3.58
19-Jun	4.00	5.00	4.50	5.00	4.50	4.50	4.63	04-Oct	4.00			4.00			4.00
20-Jun	4.50	4.25	4.50	4.75	4.00	4.50	4.42	05-Oct	3.00			3.00			3.00
21-Jun	4.00	4.00	4.00	4.00	4.00	3.75	3.98	06-Oct	2.50			3.50			3.00
22-Jun	4.00	4.00		5.00	4.00	4.75	4.35	07-Oct	5.00			4.00	4.50		4.50
23-Jun	4.50	4.75		4.50	4.00	4.00	4.38	08-Oct	3.00			4.50			3.75
24-Jun	5.00	4.75		5.00	5.00		4.94	09-Oct	3.00			4.00			3.50
25-Jun	5.00			4.00	5.00		4.67	10-Oct	3.00			4.25			3.63
26-Jun	4.50			3.50	4.00		4.00	11-Oct	3.00			4.25			3.63
27-Jun	4.75			5.00	5.00		4.92	12-Oct	4.00			3.75			3.88
28-Jun	4.25	4.25		4.00	5.00	4.50	4.40	13-Oct	3.00			4.50			3.75
29-Jun	5.00	4.75		4.00	4.50	4.00	4.45	14-Oct	4.00			5.00	4.50		4.50
30-Jun	4.00			3.50	4.00		3.83	15-Oct	3.75			4.00	3.75	4.00	3.88
01-Jul	4.25			4.50	4.50		4.42	16-Oct	2.50			3.25	4.50	4.50	3.69
02-Jul	4.25			4.50	4.00		4.25	17-Oct	3.00			3.50	4.00	4.00	3.83
03-Jul	4.00			4.50	4.00		4.17	18-Oct	3.00			3.75	4.00	4.00	3.88
04-Jul	4.00			4.00	3.50		3.83	19-Oct	4.00			3.50	4.00	3.75	3.81
05-Jul	4.50			3.50	3.50		3.83	20-Oct	3.50			3.00	3.75	4.00	3.58
06-Jul	4.75			4.25	3.50		4.17	21-Oct	2.50			4.50	3.50		3.50
07-Jul	4.00			4.00	3.50	3.50	3.75	22-Oct	4.00			4.50	3.00		3.83
08-Jul	4.00	3.75	3.50	3.00	3.00	3.25	3.42	23-Oct	3.00			3.50	4.00		3.50
09-Jul	3.00	3.50		4.00	5.00	4.50	4.00	24-Oct	3.50			3.25	3.00		3.25
10-Jul	4.00	4.00		4.25	4.25	3.50	4.00	25-Oct	2.00			3.25			2.83
11-Jul	4.00	3.75		4.50	4.50	4.25	4.20	26-Oct	4.00			4.00			4.00
12-Jul	4.00			4.50	4.00	4.50	4.25	27-Oct	3.00			3.75			3.38
13-Jul	4.00			3.75	4.75		4.17	28-Oct	3.00			4.00	3.25	4.00	3.56
14-Jul	3.00			4.50	4.50		4.00	29-Oct	2.00			4.00	4.00	3.75	3.44
15-Jul	4.00	3.75		5.00	4.00	4.00	4.15	30-Oct	4.00			4.00	4.00	3.75	3.94
16-Jul	3.50	4.00		3.50	3.75	4.00	3.75	31-Oct	3.00			3.00	4.00		3.33
17-Jul	3.50	4.00		3.25	3.50	4.50	3.75	01-Nov	3.00			3.75	4.00	4.00	3.89
18-Jul	3.75			4.50	4.25	4.50	4.25								
19-Jul	4.00			4.00	4.00	4.50	4.13	Minimum	2.00	2.50	2.00	41.0	1.25	1.25	2.50
20-Jul	3.50			3.75	3.50	3.75	3.63	Maximum	5.75	7.00	6.50	47.0	6.00	6.00	5.50
21-Jul	4.50			3.50	4.00	4.00	4.00	Average	3.82	4.08	3.96	44.0	4.04	4.04	4.04
22-Jul	3.75			4.50	4.00	3.75	4.00								

Appendix Table 5. 1994 subyearling chinook marking record.

Date	Brand	CWT Code	Number Bypassed	Number Transported	Total Marked	Previously Branded	Descaled	Other	Undersized	Previously Ad-clipped	Total Unmarkable	Total Handled	Markable Percent
June 21	RDR71	05-35-48	3,832	50	3,882	9	326	319	24	77	755	4,637	83.7%
June 22	RDR72	05-35-48	6,769	50	6,819	31	386	282	19	106	834	7,653	89.1%
June 23	RDR73	05-35-48	1,280	0	1,280	8	68	34	1	25	136	1,416	90.4%
June 23	CWT only	05-35-59	4,450	50	4,500	19	107	89	20	62	296	4,796	93.8%
June 24	RDR74	05-35-49	5,436	50	5,486	57	280	176	13	106	610	6,096	90.0%
June 25	LDR71	05-35-49	4,563	50	4,613	50	158	96	4	179	489	5,102	90.4%
June 26	LDR72	05-35-49	1,988	0	1,988	30	48	20	1	115	215	2,203	90.2%
June 26	CWT only	05-35-60	4,450	50	4,500	52	120	35	2	279	488	4,988	90.2%
June 27	LDR73	05-35-50	6,096	50	6,146	71	85	87	11	468	722	6,867	89.5%
June 28	LDR74	05-35-50	4,460	50	4,510	66	67	68	2	413	636	5,146	87.6%
June 29	RDTU1	05-35-50	1,423	0	1,423	17	16	29	1	114	177	1,600	88.9%
June 29	CWT only	05-35-61	3,757	50	3,807	54	96	76	2	332	560	4,367	87.2%
June 30	CWT only	05-35-61	693	50	743	10	48	13	0	31	102	845	87.9%
July 7	RDTI1	05-35-51	4,961	50	5,011	81	83	102	0	416	682	5,673	88.3%
July 8	RDTI3	05-35-51	5,154	50	5,204	54	66	80	0	436	636	5,840	89.1%
July 9	LDTI1	05-35-51	1,962	0	1,962	26	18	25	7	189	265	2,227	88.1%
July 9	CWT only	05-35-62	4,476	75	4,550	52	43	73	1	270	439	4,989	91.2%
July 10	LDTI3	05-35-52	5,399	50	5,449	37	65	110	1	488	701	6,150	88.6%
July 11	RDTX1	05-35-52	4,244	50	4,294	30	94	104	1	447	676	4,970	86.4%
July 12	RDTX3	05-35-52	2,209	50	2,259	19	56	14	0	196	285	2,544	88.8%
July 12	CWT only	05-35-63	4,506	50	4,556	27	89	59	0	336	513	5,069	89.9%
July 14	LDTX1	05-35-53	5,950	50	6,000	20	140	122	0	594	876	6,876	87.3%
July 15	LDTX3	05-35-53	4,551	50	4,601	38	75	84	1	357	555	5,156	89.2%
July 16	RD2C1	05-35-53	1,505	0	1,505	8	23	36	0	135	201	1,706	88.2%
July 16	CWT only	05-36-05	4,450	50	4,500	25	80	112	0	415	632	5,132	87.7%
Aug. 02	RDTO1	05-35-54	977	50	1,027	0	41	65	0	123	229	1,256	81.8%
Aug. 03	RDTO3	05-35-54	1518	50	1,568	0	64	85	0	174	323	1,891	82.9%
Aug. 04	LDTO1	05-35-54	1787	50	1,837	0	60	93	1	163	317	2,154	85.3%
Aug. 05	LDTO3	05-35-54	2759	50	2,809	2	71	88	0	199	360	3,169	88.6%
Aug. 07	RD9C1	05-35-54	3235	50	3,285	1	83	119	1	243	447	3,732	88.0%
Aug. 08	RD9C3	05-35-54	1095	50	1,145	0	28	54	0	87	169	1,314	87.1%
Aug. 08	LD9C1	05-35-54	329	0	329	0	6	13	0	13	32	361	91.1%
Aug. 09	CWT only	05-36-06	805	50	855	0	29	48	0	51	128	983	87.0%
Aug. 10	CWT only	05-36-06	958	50	1,008	1	26	44	0	61	132	1,140	88.4%
Aug. 11	no marking		1087	50	1,137	0	10	13	0	59	82	1,219	93.3%
Aug. 12	no marking				0							0	
Aug. 13	CWT only	05-36-06			0							0	
Aug. 14-15	LD9C3	05-35-55	1375	50	1,425	0	20	67	0	102	189	1,614	88.3%
Aug. 16	RDK3	05-35-55	947	50	997	0	27	104	0	70	201	1,198	83.2%
Aug. 17	RDK2	05-35-55	1,066	50	1,116	0	29	78	0	83	190	1,306	85.5%
Aug. 18	RDK1	05-35-55	1,702	50	1,752	0	14	57	0	95	166	1,918	91.3%
Aug. 19	RDK4	05-35-55	1036	50	1,086	1	17	66	2	67	153	1,238	87.6%
Aug. 20	LDK1	05-35-55	640	50	690	0	6	30	0	35	71	761	90.7%
Aug. 21	LDK2	05-35-55	544	50	594	0	12	44	0	30	86	680	87.4%
Aug. 22-24	LDK3	05-35-55	433	50	483	0	7	29	0	28	64	547	88.3%
Aug. 25	LDK4	05-35-55	720	50	770	0	17	87	0	33	117	887	86.8%
Aug. 26	RAK1	05-35-55	499	50	549	0	9	24	0	24	58	605	90.7%
Aug. 27	RAK2	05-35-55	1112	50	1,162	0	9	56	0	47	112	1,274	91.2%
Aug. 28	RAK3	05-35-55	984	50	1,034	0	11	64	0	44	119	1,153	89.7%
Aug. 29	RAK4	05-35-55	748	50	798	1	9	41	0	30	81	879	90.8%
Aug. 30-31	LAK1	05-35-55	452	50	502	0	8	37	0	23	68	570	88.1%
Aug. 31	CWT only	05-36-07	473	50	523	0	9	51	1	34	95	618	84.6%
Sep. 01	CWT only	05-36-07	278	0	278	0	4	26	0	14	44	322	86.3%
Sep. 02	CWT only	05-36-07	253	25	278	0	4	14	0	21	39	317	87.7%
Sep. 03	CWT only	05-36-07	358	25	383	0	5	24	0	12	41	424	90.3%
Sep. 04	CWT only	05-36-07	514	25	539	0	3	28	1	24	56	595	90.6%
Sep. 05	CWT only	05-36-07	389	25	414	0	6	29	0	16	50	464	89.2%
Sep. 06	CWT only	05-36-07	199	25	224	0	1	19	0	14	34	258	86.8%
Sep. 07	CWT only	05-36-07	183	25	208	0	2	22	0	8	32	240	86.7%
Sep. 08	CWT only	05-36-07	332	25	357	0	7	21	0	7	35	392	91.1%
Sep. 09	CWT only	05-36-07	407	25	432	0	9	19	1	15	44	476	90.8%
Sep. 10	CWT only	05-36-07	296	25	321	1	3	13	2	14	33	354	90.7%
Sep. 11	CWT only	05-36-07	319	25	344	0	10	11	1	19	41	385	89.4%
Sep. 12	CWT only	05-36-07	304	25	329	0	3	7	0	6	16	345	95.4%
Sep. 13	CWT only	05-36-07	162	25	187	0	2	7	0	14	23	210	89.0%
Sep. 14	CWT only	05-36-07	121	25	146	0	4	10	0	4	18	164	89.0%
			60	0	60	0	1	8	0	3	12	72	83.3%
Total			130,019	2,550	132,569	878	3,302	3,969	121	8,696	16,966	149,535	88.7%
Percent						0.6%	2.2%	2.7%	0.1%	5.8%	11.3%	100.0%	

Appendix Table 6. 1994 coded wire tag group summary - subyearling chinook.

Dates	Tag Code	Number Bypassed	Number Transported	Total Marked	% Tag Loss	% Delayed Mortality
June 21-23	05-35-48	11,881	100	11,981	0.0%	2.0%
June 23	05-35-59	4,450	50	4,500	0.0%	0.0%
June 24-26	05-35-49	11,989	100	12,089	0.0%	0.0%
June 26	05-35-60	4,450	50	4,500	0.0%	0.0%
June 27-29	05-35-50	11,978	100	12,078	0.0%	1.0%
June 29-30	05-35-61	4,450	100	4,550	1.0%	0.0%
July 7-9	05-35-51	12,077	100	12,177	0.0%	0.0%
July 9	05-35-62	4,475	75	4,550	1.3%	1.3%
July 10-12	05-35-52	11,852	150	12,002	0.0%	0.0%
July 12	05-35-63	4,506	50	4,556	2.0%	0.0%
July 14-16	05-35-53	12,006	100	12,106	0.0%	1.0%
July 16	05-36-05	4,450	50	4,500	0.0%	6.0%
Aug. 02-08	05-35-54	11,700	300	12,000	0.3%	1.7%
Aug. 08-13	05-36-06	4,225	200	4,425	0.0%	2.5%
Aug. 14-31	05-35-55	11,355	700	12,055	0.1%	1.1%
Aug.31-Sep.14	05-36-07	4,175	325	4,500	0.6%	1.2%
Total		130,019	2,550	132,569	0.3%	1.2%

Appendix Table 7. 1994 replicate summary - subyearling chinook.

Dates	Replicate	Number Bypassed	Number Transported	Total Marked	% Tag Loss	% Delayed Mortality
June 21-30	Early	49,198	500	49,698	0.2%	0.6%
July 7-16	Middle	49,366	525	49,891	0.4%	0.2%
Aug.02-Sep.14	Late	31,455	1,525	32,980	0.3%	1.7%
Total		130,019	2,550	132,569	0.3%	1.2%

Appendix Table 8. 48 hour quality control - 1994 subyearling chinook.

		Freeze Brands			Adipose Clips				CWT Retention	
Date	Brand	Good	Light	Burned	Good	Partial	Sailboat	Scalped	# Lost Tags	Percent
June 21	RDR71	46	4	0	49	0	1	0	0	0.0%
June 22	RDR72	50	0	0	40	1	9	0	0	0.0%
June 23	RDR73	----	----	----	0	0	0	0	----	----
June 23	CWT only	----	----	----	50	0	0	0	0	0.0%
June 24	RDR74	47	3	0	50	0	0	0	0	0.0%
June 25	LDR71	50	0	0	49	0	1	0	0	0.0%
June 26	LDR72	----	----	----	----	----	----	----	----	----
June 26	CWT only	----	----	----	50	0	0	0	0	0.0%
June 27	LDR73	50	0	0	50	0	0	0	0	0.0%
June 28	LDR74	38	12	0	50	0	0	0	0	0.0%
June 29	RDTU1	----	----	----	----	----	----	----	----	----
June 29	CWT only	----	----	----	50	0	0	0	0	0.0%
June 30	CWT only	----	----	----	50	0	0	0	1	2.0%
July 7	RDTI1	48	2	0	50	0	0	0	0	0.0%
July 8	RDTI3	50	0	0	48	2	0	0	0	0.0%
July 9	LDTI1	----	----	----	----	----	----	----	----	----
July 9	CWT only	----	----	----	71	2	0	2	1	1.3%
July 10	LDTI3	45	4	1	49	1	0	0	0	0.0%
July 11	RDTX1	48	2	0	50	0	0	0	0	0.0%
July 12	RDTX3	48	2	0	50	0	0	0	0	0.0%
July 12	CWT only	----	----	----	49	0	1	0	1	2.0%
July 14	LDTX1	46	4	0	49	1	0	0	0	0.0%
July 15	LDTX3	----	----	----	----	----	----	----	----	----
July 16	RD2C1	----	----	----	----	----	----	----	----	----
July 16	CWT only	----	----	----	----	----	----	----	----	----
Aug. 02	RDTO1	49	0	1	49	0	1	0	0	0.0%
Aug. 03	RDTO3	47	3	0	50	0	0	0	0	0.0%
Aug. 04	LDTO1	47	2	1	50	0	0	0	1	2.0%
Aug. 05	LDTO3	49	0	1	44	5	1	0	0	0.0%
Aug. 06	RD9C1	50	0	0	46	2	2	0	0	0.0%
Aug. 07	RD9C3	49	1	0	50	0	0	0	0	0.0%
Aug. 08	LD9C1	----	----	----	----	----	----	----	----	----
Aug. 08	CWT only	----	----	----	50	0	0	0	0	0.0%
Aug. 09	CWT only	----	----	----	50	0	0	0	0	0.0%
Aug. 10	CWT only	----	----	----	46	0	0	4	0	0.0%
Aug. 11	no marking	----	----	----	----	----	----	----	----	----
Aug. 12	no marking	----	----	----	----	----	----	----	----	----
Aug. 13	CWT only	----	----	----	49	1	0	0	0	0.0%
Aug. 14-1	LD9C3	49	1	0	48	0	0	2	0	0.0%
Aug. 16	RDK3	46	4	0	46	4	0	0	0	0.0%
Aug. 17	RDK2	46	4	0	45	0	5	0	0	0.0%
Aug. 18	RDK1	48	2	0	50	0	0	0	0	0.0%
Aug. 19	RDK4	47	1	2	50	0	0	0	0	0.0%
Aug. 20	LDK1	48	0	2	49	1	0	0	0	0.0%
Aug. 21	LDK2	50	0	0	49	1	0	0	0	0.0%
Aug. 22-2	LDK3	50	0	0	49	1	0	0	0	0.0%
Aug. 25	LDK4	48	2	0	33	4	13	0	0	0.0%
Aug. 26	RAK1	49	1	0	50	0	0	0	0	0.0%
Aug. 27	RAK2	49	1	0	50	0	0	0	0	0.0%
Aug. 28	RAK3	50	0	0	47	3	0	0	1	2.0%
Aug. 29	RAK4	48	0	2	50	0	0	0	0	0.0%
Aug. 30-3	LAK1	47	3	0	50	0	0	0	0	0.0%
Aug. 31	CWT only	----	----	----	----	----	----	----	----	----
Sep. 01	CWT only	----	----	----	25	0	0	0	1	4.0%
Sep. 02	CWT only	----	----	----	21	4	0	0	0	0.0%
Sep. 03	CWT only	----	----	----	22	3	0	0	0	0.0%
Sep. 04	CWT only	----	----	----	25	0	0	0	1	4.0%
Sep. 05	CWT only	----	----	----	25	0	0	0	0	0.0%
Sep. 06	CWT only	----	----	----	25	0	0	0	0	0.0%
Sep. 07	CWT only	----	----	----	25	0	0	0	0	0.0%
Sep. 08	CWT only	----	----	----	25	0	0	0	0	0.0%
Sep. 09	CWT only	----	----	----	25	0	0	0	0	0.0%
Sep. 10	CWT only	----	----	----	25	0	0	0	0	0.0%
Sep. 11	CWT only	----	----	----	25	0	0	0	0	0.0%
Sep. 12	CWT only	----	----	----	25	0	0	0	0	0.0%
Sep. 13	CWT only	----	----	----	25	0	0	0	0	0.0%
Sep. 14	CWT only	----	----	----	----	----	----	----	----	----
Total		1,532	58	10	2,372	36	34	8	7	0.3%
Percent		95.8%	3.6%	0.6%	96.8%	1.5%	1.4%	0.3%		

Appendix Table 9. 1994 mortality summary - subyearling chinook.

		48 Hour Delayed Mortality			Raceway 9E		
Date	Brand	Number Held	Number Morts	Percent Mortality	Number Morts	Number Held	Percent Mortality
June 21	RDR71	50	1	2.0%	67	3,832	1.7%
June 22	RDR72	50	1	2.0%	18	6,769	0.3%
June 23	RDR73	0	0	0.0%	20	5,730	0.3%
June 23	CWT only	50	0	0.0%			
June 24	RDR74	50	0	0.0%	5	5,438	0.1%
June 25	LDR71	50	0	0.0%	10	4,583	0.2%
June 26	LDR72	50	0	0.0%	3	6,438	0.0%
June 27	LDR73	50	0	0.0%	3	6,095	0.0%
June 28	LDR74	50	1	2.0%	14	4,460	0.3%
June 29	RDTU1	50	0	0.0%	11	5,180	0.2%
June 30	CWT only	50	0	0.0%	1	693	0.1%
July 7	RDTI1	50	0	0.0%	10	4,981	0.2%
July 8	RDTI3	50	0	0.0%	4	5,154	0.1%
July 9	LDTI1	0	0	0.0%	0	1,962	0.0%
July 9	CWT only	75	0	0.0%	0	4,475	0.0%
July 10	LDTI3	50	0	0.0%	8	5,399	0.1%
July 11	RDTX1	50	1	2.0%	25	4,244	0.6%
July 12	RDTX3	50	0	0.0%	0	2,209	0.0%
July 12	CWT only	50	0	0.0%	9	4,506	0.2%
July 14	LDTX1	50	0	0.0%	30	5,950	0.5%
July 15	LDTX3	50	0	0.0%	25	4,551	0.5%
July 16	RD2C1	0	0	0.0%	0	1,505	0.0%
July 16	CWT only	50	0	0.0%	22	4,450	0.5%
Aug. 02	RDTO1	50	1	2.0%	9	977	0.9%
Aug. 03	RDTO3	50	3	6.0%	15	1,518	1.0%
Aug. 04	LDTO1	50	1	2.0%	14	1,787	0.8%
Aug. 05	LDTO3	50	1	2.0%	9	2,759	0.3%
Aug. 06	RD9C1	50	2	4.0%	17	3,235	0.5%
Aug. 07	RD9C3	50	1	2.0%	4	1,095	0.4%
Aug. 08	LD9C1	0	0	0.0%			
Aug. 08	CWT only	50	0	0.0%	14	1,134	1.2%
Aug. 09	CWT only	50	0	0.0%	3	958	0.3%
Aug. 10	CWT only	50	0	0.0%	5	1,087	0.5%
Aug. 11	no marking	----	----	----	----	----	----
Aug. 12	no marking	----	----	----	----	----	----
Aug. 13	CWT only	50	2	4.0%	1	1,375	0.1%
Aug. 14-15	LD9C3	50	0	0.0%	11	947	1.2%
Aug. 16	RDK3	50	3	6.0%	2	1,066	0.2%
Aug. 17	RDK2	50	1	2.0%	4	1,702	0.2%
Aug. 18	RDK1	50	0	0.0%	5	1035	0.5%
Aug. 19	RDK4	50	0	0.0%	4	640	0.6%
Aug. 20	LDK1	50	1	2.0%	1	544	0.2%
Aug. 21	LDK2	50	2	4.0%	6	433	1.4%
Aug. 22-24	LDK3	50	3	6.0%	22	720	3.1%
Aug. 25	LDK4	50	0	0.0%	1	499	0.2%
Aug. 26	RAK1	50	0	0.0%	1	1112	0.1%
Aug. 27	RAK2	50	1	2.0%	1	984	0.1%
Aug. 28	RAK3	50	0	0.0%	1	748	0.1%
Aug. 29	RAK4	50	0	0.0%	1	452	0.2%
Aug. 30-31	LAK1	50	0	0.0%	7	473	1.5%
Aug. 31	05-36-07	0	0	0.0%	0	278	0.0%
Sep. 01	05-36-07	25	0	0.0%	1	253	0.4%
Sep. 02	05-36-07	25	0	0.0%	1	358	0.3%
Sep. 03	05-36-07	25	1	4.0%	0	514	0.0%
Sep. 04	05-36-07	25	0	0.0%	0	389	0.0%
Sep. 05	05-36-07	25	0	0.0%	2	199	1.0%
Sep. 06	05-36-07	25	1	4.0%	0	183	0.0%
Sep. 07	05-36-07	25	0	0.0%	0	332	0.0%
Sep. 08	05-36-07	25	0	0.0%	0	407	0.0%
Sep. 09	05-36-07	25	1	4.0%	0	296	0.0%
Sep. 10	05-36-07	25	1	4.0%	4	319	1.3%
Sep. 11	05-36-07	25	0	0.0%	0	304	0.0%
Sep. 12	05-36-07	25	0	0.0%	1	162	0.6%
Sep. 13	05-36-07	25	0	0.0%	0	121	0.0%
Sep. 14	05-36-07	0	0	0.0%	0	60	0.0%
Total		2,550	30	1.2%	452	130,019	0.3%

X Fish held for 24 hours only due to emergency release.

1995 MCNARY DAM AND LOWER MONUMENTAL DAM SMOLT MONITORING PROGRAM ANNUAL REPORT

ANNUAL REPORT

Prepared by:

Paul Wagner

Washington Department of Fish and Wildlife

July 1995

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1.0 INTRODUCTION

The Washington Department of Fisheries (WDF) assumed responsibility for the Smolt Monitoring Program at McNary Dam on the Columbia River in 1990 and at the new juvenile collection facility at Lower Monumental Dam on the Snake River in 1993. This report summarizes the 1995 Smolt Monitoring work at both sites.

In general, the 1995 passage season at both the McNary and Lower Monumental sites can be characterized by increased juvenile collection and passage, elevated river flows and spill, cooler water temperatures, and record low facility mortality rates. In addition, a change in policy in accordance with the National Marine Fisheries Service recommendations (NMFS, 1995) resulted in all spring migrants being bypassed at McNary Dam in 1995. Collection and sampling began on March 27 at McNary Dam and on April 1 at Lower Monumental Dam. Monitoring operations were conducted through December 12 at McNary Dam and through November 1 at Lower Monumental Dam. A large transportation evaluation summer migrant marking program was conducted at McNary Dam in 1995 by the NMFS which necessitated the sampling of 321,948 additional fish beyond the recommended sampling guidelines. All total, 466,869 and 93,305 juvenile salmonids were anesthetized, individually counted, and examined for scale loss and brands by WDFW Smolt Monitoring personnel in 1995 at McNary Dam and Lower Monumental Dam, respectively.

2.0 SUMMARY OF ANESTHETIC PRACTICES

2.1 ANESTHETIZATION OF SAMPLE FISH

The anesthetic practices used at McNary Dam and Lower Monumental Dam in 1995 were similar to those used in 1994. These included:

1) Documentation of the concentration of MS222 used in the re-circulating anesthetic system.

2) Documentation of the concentration of benzocaine used in the pre-anesthetic system.

3) Documentation of the time that fish were held in the pre-anesthetic (induction time).

4) Documentation of total daily sample tank mortality. This information is normally included as part of the daily data summary.

5) Documentation of post handling mortality.

6) Direct observation by the anesthetist of the number of raceway mortalities loaded onto the transportation vehicles.

2.2 CONCENTRATIONS

Pre-anesthetic System - McNary Dam

The pre-anesthetic stock solution used in 1995 at the McNary site was 450 grams of benzocaine per gallon of ethyl alcohol. This was identical to what was used in 1994 at McNary and in 1994 and

1995 at the Lower Monumental site (see next section). The pre-anesthetic concentration averaged 44.3ppm in 1995 at the McNary site which is very similar to the 45.6ppm 1994 concentration average. Pre-anesthetic concentrations ranged from 37.1ppm to 57.1ppm in 1995 (Appendix Table 1). This was similar to but slightly in excess of the 20ppm to 50ppm pre-anesthetic concentration range recommended by the USFWS (NBS). On some occasions, pre-anesthetic concentrations ranging in excess of the 50ppm recommended guideline were simply necessary to render the sample fish unconscious.

Pre-anesthetic System - Lower Monumental Dam

A stock solution of 450 grams of benzocaine per gallon of alcohol was used throughout the 1995 season at Lower Monumental Dam. The 1995 pre-anesthetic concentrations averaged 42.9ppm in 1995 compared to 44.0ppm in 1994. The 1995 concentrations ranged from 42.8ppm to 54.3ppm (Appendix Table 2). As at McNary, on a very limited number of occasions, use of concentrations in excess of the 50ppm recommended guideline were necessary to properly anesthetize the sample fish.

Re-circulation System - McNary Dam

At McNary Dam, the MS222 concentrations in the re-circulating anesthetic system were recorded daily (Appendix Table 3). Starting concentrations ranged from 9.0ppm to 28.8ppm and averaged 21.4ppm which is comparable to the 1994 average of 18.7ppm. As in the past and as shown in Appendix Table 3, addition of anesthetic to the re-circulation system was periodically necessary to compensate for: A) flush water dilution or B) the removal of anesthetic from the re-circulating water by thousands of sample fish. However, the re-circulation system anesthetic concentrations used at McNary Dam in 1995 were at all times within the USFWS (NBS) recommended re-circulating anesthetic concentration range of 10ppm to 30ppm.

Re-circulation System - Lower Monumental Dam

Anesthetic was not added to the Lower Monumental re-circulation system from October 21 through November 1 due to the low (<15) numbers of fish present in the daily samples. Outside of this time period MS222 was added to the system each day sample processing was conducted during the 1995 sampling season and the concentrations ranged from 24.4ppm to 35.0ppm with an average of 24.8ppm (Appendix Table 4). As at McNary Dam, anesthetic was occasionally added to the Lower Monumental re-circulation system to compensate for flush water dilution or the removal of anesthetic by sample fish during sample processing.

The NMFS PIT tagged hatchery yearling chinook and steelhead at the Lower Monumental site during the spring of 1995. Because of the additional handling time required to mark the fish, the starting anesthetic concentrations were increased on nine occasions to 29.6ppm and once to 35.0ppm to accommodate this program. Therefore, the anesthetic concentrations used in 1995 at Lower Monumental Dam were on all but one occasion within the 10ppm to 30ppm recommended guidelines (Appendix Table 4).

2.3 INDUCTION AND EXPOSURE TIMES

Sample fish are exposed to anesthetic in two phases at McNary and Lower Monumental Dams.

Phase 1: An allotment of fish is crowded into the pre-anesthetic tank and anesthetized with benzocaine. All fish in each allotment experience the same period of exposure to benzocaine because all fish are removed at the same time from the tank and are then passed to the sorting trough.

Phase 2: Fish are removed from the sorting trough individually and therefore individual fish are exposed to MS222 for varying periods of time.

Time In The Pre-anesthetic System - McNary Dam

The total time (induction time) that fish were held in pre-anesthetic during the 1995 season ranged from 2.0 minutes to 6.0 minutes and averaged 3.9 minutes overall (Appendix Table 1). This is consistent with the USFWS (NBS) recommendation of an induction time of not less than one minute and similar to the 1994 average induction time of 4.1 minutes. The USFWS (NBS) also recommended an induction time of not less than two minutes when water temperatures exceed 60 degrees fahrenheit. Facility water temperatures exceeded 60 degrees from June 23 through October 12, and during this period the induction times ranged from 2.0 to 6.0 minutes with an average time of 3.6 minutes.

Time In The Pre-anesthetic System - Lower Monumental Dam

Induction time ranged from 1.5 minutes to 5.0 minutes with an average of 3.5 minutes (Appendix Table 2) in 1995. This compares to an average induction time of 4.0 minutes in 1994. Facility water temperatures exceeded 60 degrees from June 3 through October 16, and during this period the induction times ranged from 1.5 to 4.3 minutes with an average time of 3.2 minutes.

2.4 POST HANDLING MORTALITY

McNary Dam

In 1995 the NMFS initiated a massive summer migrant Transportation Evaluation coded wire tagging program which required the handling of an additional 321,948 zero age chinook by the McNary SMP crew. In addition, the marked fish were sent to raceways 5, 9 east, and 9 west and held with other fish from the daily samples. The 1995 post handling mortality rate equalled 0.9% which is based upon complete mortality counts from raceways 5, 9 east, and 9 west. This is an increase from the 1994 post handling mortality rate (0.4%). However, this increase was undoubtedly influenced by the presence of thousands of research fish which had undergone the additional stress associated with the marking program.

The sample tank mortality rate is based primarily on pre-handling mortality but is related to the sampling program. Of the 4,052 mortalities counted from the sample, only 181 were the direct result of handling. The remaining 3,871 were removed from the sample tank prior to pre-anesthetization and handling. The 1995 sample tank mortality rate (0.9%) was also the lowest on record at McNary Dam and much lower than that of 1994 (3.0%). This reduction in the mortality rate most likely resulted from generally favorable inriver passage conditions. Favorable environmental conditions such as cooler water temperatures have been shown to have a profound effect on the overall rate of mortality. Facility water temperatures averaged 58.5 degrees fahrenheit in 1995 compared to the 1994 average of 59.6 degrees. This contributed to a lower rate of mortality for all species in 1995 which

was particularly evident from the lack of zero age chinook mortality resulting from thermal stress during the summer outmigration. In contrast, thermal stress induced mortality resulted in the complete shutdown of the juvenile collection facility during the peak zero age chinook outmigration period of 1994.

Lower Monumental Dam

The only measure of the post-handling mortality rate is the recovery of mortalities from raceway 1. All mortalities are recovered from raceway 1 at Lower Monumental Dam and a complete mortality count and mortality rate is therefore available. However, this rate is somewhat inflated by the incidental loading of transportation fish into raceway 1 during barge and truck loading of raceway 2. Due to the configuration of the raceway loading system, fish must be diverted to the adjacent raceway 1 while raceway 2 is being drained during transportation vehicle loading operations. Fish that are passed into raceway 1 during this time are not counted in the raceway 1 loading total but probably result in some additional mortalities which are included in the post-handling statistics. Therefore, the raceway 1 mortality rate should be considered the best index of post-handling mortality resulting from the sampling system and the reported rate should be considered a maximum. The raceway 1 mortality rate was 0.4% in 1995 compared to 0.6% in 1994. Sample tank mortality was also lower in 1995 (0.5%) than in 1994 (0.8%). Similar to McNary, this was the lowest sample tank mortality rate on record at Lower Monumental Dam and favorable environmental conditions such as cooler water temperatures were most likely the primary contributing factors. Facility water temperatures averaged 60.7 degrees fahrenheit in 1995 compared to 62.1 degrees in 1994. Another factor which contributed to the lower rate of sample tank mortality was the reduction in the total number of fish sampled in 1995. In 1994 a total of 181,021 fish were sampled primarily to accommodate research marking programs. In 1995 the research marking effort was continued but at a reduced level and only half as many (93,305) fish were sampled. The overall reduction in the number of fish sampled in 1995 resulted in fewer congestion related problems in the sample tank which undoubtedly contributed to the lower 1995 sample tank mortality rate. In addition, fish that had an increased likelihood of mortality were not used in the marking programs (i.e., dying or descaled fish were not marked) but were sent to raceway 1. Therefore, while the marking was being conducted, the only fish that were sent to raceway 1 were: A) previously marked fish, B) non-target species, and C) descaled or D) severely injured dying target species. The raceway 1 population was composed of a smaller proportion of C and D type fish in 1995 than in 1994. Therefore, the reduced marking effort in 1995 resulted in a lower rate of mortality in both the sample tank and raceway 1.

2.5 SUMMARY

The anesthetic procedures used by McNary and Lower Monumental SMP personnel in 1995 were very similar for the two sites and similar to what was used in 1994. These procedures were also consistent with the USFWS recommended anesthetic guidelines. In general, favorable environmental conditions resulted in a lower rate of mortality at each site although this was influenced by the level of research marking conducted. The return of experienced anesthetists to both sites was another factor which may have also contributed to the low mortality rates.

The first year of operation of the new McNary juvenile collection facility was in 1994 and a doubling of the induction time in the new pre-anesthetic system was observed (Wagner, 1995). One proposed explanation for this was loss of anesthetic through the new standpipe drain system. In 1995 this was

evaluated and it could not be determined that anesthetic was being disproportionally lost through the standpipe system prior to mixing in the new 54 gallon pre-anesthetic chambers. It was therefore concluded that the longer induction time was simply the result of greater mixing time required due to the larger capacity (54 gallon versus 20 gallon) pre-anesthetic chambers.

An important change in WDFW policy pertaining to the use of anesthetics occurred in 1995. A memorandum was issued on June 27 from the WDFW pathologist office prohibiting the use of benzocaine by WDFW personnel (see attachment). Benzocaine, unlike tricaine, is not currently registered by the U.S. Food and Drug Administration (FDA) for use on food fish. Unfortunately, inherent to the design of the sampling systems at all transportation sites are pre-anesthetic systems utilizing disposable anesthetic. Because the anesthetic currently cannot be recovered from these systems, a change from benzocaine ($65/kg) to tricaine ($360/kg) represents a significant increase in anesthetic costs. At McNary Dam benzocaine was used throughout the 1995 season until the existing supply was exhausted. Beginning November 10 and continuing through the 1995 sampling season end, tricaine was used as the pre-anesthetic at the McNary site. The concentration of tricaine necessary to properly pre-anesthetize the fish was basically the same as that of benzocaine. Therefore, a changeover from benzocaine to tricaine as a pre-anesthetic will result in a five to six fold increase in SMP anesthetic costs at the McNary site. Currently, at the Lower Monumental site, the anesthetic used in the sampling program is purchased by the Corps of Engineers and is not part of the annual SMP budget.

3.0 SPECIAL DATA COLLECTION

3.1 ELASTOMER VISIBLE IMPLANT MARKED YEARLING CHINOOK

For the third time in as many years, yearling chinook from the Lyons Ferry Hatchery program were marked with a visible implant (VI) elastomer in the adipose eyelid tissue. Two implant colors (red and green) were used in 1995. The fish were marked to distinguish Snake River chinook from other stocks of fish and to continue evaluation of the mark including the new color green which replaced the difficult to distinguish yellow elastomere used in 1994. All of the fish released from the 1995 Lyons Ferry program were VI marked on either the left or the right side with one of the two colors. None of the marked fish were transported by barge below Ice Harbor Dam as was the case for a portion of the release in past years.

Most (349,086) of the 1995 left red VI marked outmigrants were yearling fall chinook from Lyons Ferry Hatchery although some (14,632) were spring chinook from the Tucannon River satellite facility. The remaining VI marked fish (right red, left green, right green) were all spring chinook which were released into the Tucannon River in March and April of 1995.

Visible implant marked fish were recovered at both the Lower Monumental and McNary sites (Tables 1 and 2). Overall, VI marked fish recovered at the McNary site were 4mm smaller on average than those recovered at the Lower Monumental site. Travel time between the two sites was roughly one week. Left red VI marked fish were composed primarily of yearling fall chinook and: 1) were the largest of the arrivals, 2) had the highest recovery rates, and 3) arrived in the best condition at both sites.

Fish condition deteriorated as the fish moved from Lower Monumental to McNary as evidenced by the

Table 1. Summary of elastomer visible implant yearling chinook recovered at Lower Monumental Dam in 1995.

Category	Right Red	Left Red	Right Green	Left Green	Total
Recovery Data					
Released	15,678	363,718	45,385	45,038	469,819
Sampled (Rate)	82 (0.5%)	3,924 (1.1%)	264 (0.6%)	250 (0.6%)	4,520 (1.0%)
Collected (Rate)	1,816 (11.6%)	102,973 (28.3%)	6,104 (13.4%)	5,750 (12.8%)	116,643 (24.8%)
P. Index (Rate)	2,231 (14.2%)	129,471 (35.6%)	7,505 (16.5%)	7,032 (15.6%)	146,239 (31.1%)
Arrival Timing					
10th Percentile	April 19	April 22	April 19	April 17	April 18
50th Percentile	May 4	May 4	May 3	May 4	May 4
90th Percentile	May 11	May 9	May 9	May 8	May 10
Size and Condition					
Forklength(mm)	155	181	156	161	177
Descaled (%)	7.3	0.4	0.8	1.6	0.6

Table 2. Summary of elastomer visible implant yearling chinook released in the Snake River system and recovered at McNary Dam in 1995.

Category	Right Red	Left Red	Right Green	Left Green	Total
Recovery Data					
Released	15,678	363,718	45,385	45,038	469,819
Sampled (Rate)	14 (0.1%)	471 (0.1%)	24 (0.1%)	29 (0.1%)	538 (0.1%)
Collected (Rate)	1,300 (8.3%)	38,015 (10.5%)	2,125 (4.7%)	2,450 (5.4%)	43,890 (9.3%)
P.Index (Rate)	2,269 (14.5%)	65,448 (18.0%)	3,677 (8.1%)	4,314 (9.6%)	75,708 (16.1%)
Arrival Timing					
10th Percentile	May 5	May 3	May 4	May 4	May 3
50th Percentile	May 10	May 9	May 12	May 12	May 10
90th Percentile	May 13	May 17	May 20	May 19	May 17
Size and Condition					
Forklength(mm)	143	177	152	155	173
Descaled (%)	21.4	13.4	20.8	20.7	14.3

increase in scale loss. This same general pattern of increase between the two sites was also documented in 1994. The 1995 descaling rate (0.6%) for VI fish recovered at Lower Monumental Dam was similar to that of 1994 (0.8%). However, the 1995 descaling rate for VI fish recovered at McNary Dam (14.3%) was better than double that of 1994 (6.2%). The deterioration in fish condition as fish moved from Lower Monumental to McNary Dam in both 1994 and 1995 is most likely due to the cumulative effect of passage through the turbines or spillways at Lower Monumental and Ice Harbor Dams or possibly due to passage at the as yet unevaluated Ice Harbor juvenile bypass system. The increase in descaling rates for VI fish recovered at McNary Dam in 1995 over that of 1994 is consistent with the generally higher descaling rates observed at McNary Dam in 1995 and may have been related to the higher volumes of spill which occurred on the Snake River during April and May of this past spring.

In contrast to the relatively high descaling rates observed at McNary Dam for red and green VI marked yearling spring and fall chinook which originated from the Snake River system, VI yearling summer chinook which were released from the Methow (right blue VI) and Similkameen (left blue VI) rivers on the Mid-Columbia exhibited low rates of scale loss when recovered at McNary (Table 3). These fish passed five hydroelectric projects prior to arriving at McNary Dam but fish originating from the Mid-Columbia have been shown to have consistently lower rates of descaling than those originating from the Snake River even when passing a similar number of hydroelectric projects. The low blue VI descaling rates suggest that the higher rates observed for Snake River origin VI fish and other unmarked yearling chinook in 1995 probably cannot be attributed to passage through the McNary bypass system but rather resulted from sources located upstream of McNary Dam.

Table 3. Summary of elastomer visible implant yearling chinook released in the Methow and Similkameen Rivers and recovered at McNary Dam in 1995.

Category	Right Blue	Left Blue	Total
Recovery Data			
Released	230,989	202,139	433,128
Sampled (Rate)	280 (0.1%)	119 (0.1%)	399 (0.1%)
Collected (Rate)	9,517 (4.1%)	7,614 (3.8%)	17,131 (4.0%)
Passage Index (Rate)	16,808 (7.3%)	12,833 (6.3%)	29,641 (6.8%)
Arrival Timing			
10th Percentile	May 24	April 30	May 3
50th Percentile	June 1	May 6	May 27
90th Percentile	June 12	May 25	June 7
Size and Condition			
Forklength (mm)	154	152	153
Descaled (%)	1.8	2.5	2.0

In general, all three VI mark colors recovered in 1995 (red, green, blue) were distinct and easy to identify. This is in contrast to the yellow VI used in 1994 which closely matched the coloration of the adipose eyelid tissue and was therefore difficult to identify. Fragmentation of the elastomere appeared to be less of a problem in 1995 than in 1994 and therefore color distinction was also less of a problem in 1995.

3.2 GAS BUBBLE TRAUMA

Smolt Monitoring Program personnel attended a single day training seminar pertaining to the examination of juvenile salmonids for symptoms of gas bubble trauma (GBT) at the NBS/USFWS field station located in Cook, Washington on March 29 prior to the start of 1995 field operations. Examination of 100 fish of each of the dominant two species in the sample were conducted three times per week beginning April 6 at both sites. The examinations were conducted at both sites with the use of 10X magnifying lamps and this work was coordinated with NBS personnel who conducted GBT examinations of fish collected upstream of the separator. The examination schedule was increased to seven days per week beginning May 29 and concluding June 12 in response to elevated gas saturation levels. After June 12 the examination schedule was reduced to three times per week and continued through July 20 at Lower Monumental and through August 31 at McNary. A total of 8,483 juvenile fish were examined for GBT at the Lower Monumental site by SMP personnel and 12 (0.1%) of these fish were found to have GBT symptoms. Similarly, SMP personnel at the McNary site examined a total of 9,293 juvenile fish and 10 (0.1%) of these exhibited GBT symptoms.

3.3 ATPASE SAMPLING AT LOWER MONUMENTAL DAM

Gill samples were collected via non-lethal methods every two weeks from juvenile steelhead by WDFW personnel at the Lower Monumental site beginning on June 20 and concluding October 24 to measure ATPase levels. Sampling was normally conducted on a single day during each two week interval with a target sampling goal of twenty fish. However, the general lack of late arriving fish in September and October resulted in sample sizes ranging as low as only four fish. The samples were collected to assess the degree of smoltification of late steelhead outmigrants. The gill samples were frozen in liquid nitrogen and then transferred to the National Biological Service (NBS) research laboratory (Cook, Washington) were NBS performed the ATPase bioassays.

In terms of degree of smoltification, ATPase values translated to the following:

Value Range	Degree of Smoltification
0-10	Low
10-20	Medium
20-30	High

A summary of the number of fish sampled, number of fish in the low, medium, and high ATPase value ranges, as well as the average, maximum, and minimum ATPase values is included in Table 4. A summary of fish lengths by sampling period is also included. In general no fish were found to be highly smolted and roughly 10% were found to have ATPase values in the medium smoltification range. No fish were found to have ATPase values above the low value range after July. Very few wild steelhead were sampled (5) and they had lower average ATPase levels than did their hatchery

counterparts. There was no relationship between fish size and degree of smoltification. The average ATPase values showed a steady pattern of decline through mid-August and then steadily increased (although still remained in the low value range) through the end of the sampling period (October). From this data, it can be very broadly concluded that 15-20% of the juvenile steelhead which passed Lower Monumental Dam during the months of June and July were still outmigrating smolts and the remainder were essentially rearing residuals. From August through October all juvenile steelhead were apparently residuals which appeared to be undergoing the onset of a cyclic physiological change in preparation for outmigration the following spring.

Table 4. Summary of ATPase sampling of juvenile steelhead at Lower Monumental Dam in 1995.

ATPASE VALUES												
	6/20	7/13	7/26	8/10	8/30	9/13	9/26	10/10	10/24	Total	Sh-W	Sh-H
#Fish	20	16	20	13	10	5	5	4	9	102	5	97
#LOW	16	12	18	13	10	5	5	4	9	92	5	87
#MED	4	4	2	0	0	0	0	0	0	10	0	10
#HIGH	0	0	0	0	0	0	0	0	0	0	0	0
AVG	7.1	5.5	5.1	1.9	2.4	3.0	3.6	3.9	5.3	4.7	3.3	4.7
MAX	15.6	18.3	12.0	4.2	3.6	7.4	5.5	5.6	8.0	18.3	4.4	18.3
MIN	1.3	0.9	1.7	0.2	1.2	1.5	2.8	2.4	3.3	0.2	2.3	0.2
FORK LENGTH (mm)												
AVG	248	267	257	264	243	284	245	286	250	258	227	259
MAX	309	360	318	332	318	292	296	334	343	360	281	360
MIN	182	202	193	160	128	278	144	238	151	128	142	128

4.0 RESEARCH

4.1 WDFW ZERO AGE CHINOOK PIT TAGGING

Objectives

PIT tagging of wild zero age upriver bright fall chinook on the Hanford Reach by McNary Smolt Monitoring Program personnel began in 1991 and has continued each year through 1995. In 1994, the work was expanded to include the PIT tagging of zero age upriver bright fall chinook from Priest Rapids Hatchery. In 1995, marking at Priest Rapids Hatchery was conducted by the USFWS under an SMP contract. Zero age chinook were also PIT tagged at Ringold Hatchery as part of a WDFW hatcheries evaluation program. Although only the Hanford Reach PIT tagging program was conducted by WDFW SMP personnel, all three primary sources (Hanford Reach, Priest Rapids Hatchery, Ringold Hatchery) of zero age summer migrants arriving at McNary Dam were PIT tagged

in 1995 and a comparison of the arrival timing and recovery rates of all three groups will be included in this section.

The specific objectives of the 1995 Hanford Reach work were: 1) index the arrival timing of wild and hatchery zero age upriver bright fall chinook to McNary Dam and 2) collect information regarding relative survival rates.

Methods

Ringold Hatchery

A total of 1,464 zero age chinook were PIT tagged at Ringold Hatchery by WDFW personnel on June 15 as part of a State of Washington Hatcheries Evaluation Program and mixed with the general hatchery population. These fish were scheduled to be released on June 28. However, due to a leak in the hatchery holding pond, an unknown portion of both marked and unmarked fish escaped to the Columbia River prior to the scheduled release date. The calculated in river/travel times to McNary Dam are based upon the June 28 release date and are therefore biased low to some unknown extent because of fish that escaped early. Unfortunately, records were not kept of the number of fish that were handled but were too small to mark. Therefore, it is unknown what proportion of the hatchery population is represented by tagged fish. The marked fish ranged in size from 59mm to 106mm (forklength) with an average size of 82.8mm. The large average size suggests that most of the fish handled were larger than the 60mm minimum criterion and were large enough to mark.

Priest Rapids Hatchery

A total of 1,490 zero age chinook were marked by USFWS personnel at Priest Rapids Hatchery on May 22 and 23. These fish were divided into approximately three equal sized groups, held with the general hatchery population, and then released with the first (June 13), third (June 19), and fifth and final (June 23) hatchery release groups. Unfortunately, records were not kept of the number of fish that were handled but were to small to mark (less than the 60mm minimum marking size criterion). The marked fish ranged in size from 60mm to 92mm and averaged 75.5mm in forklength in 1995 compared to an 85.3mm average in 1994. In 1994 99.9% of the fish handled at Priest Rapids Hatchery were large enough to mark and it is likely that a high percentage were markable in 1995 but the exact proportion represented by the marked population is unknown.

Hanford Reach

The 1995 marking objective for wild subyearling chinook was 3,000 fish 60mm in forklength or larger. The methods used to capture, hold, mark, and release wild subyearling chinook in 1995 were essentially the same as those used in 1994 (Wagner, 1995). The abandoned storage garage first used in 1994 as a marking station was again used in 1995. This facility is owned by Pacific Northwest Laboratories and unfortunately is scheduled for demolition by 1996.

As in 1994, in 1995 Umatilla and Yakama tribal personnel captured fish with beach and stick seines. The fish were then transferred by jet boat to a holding area located at the ferry landing, anesthetized, and hand sorted by size within the WDFW coded wire tagging trailer. A portion of the fish with forklengths equal to or greater than 60mm were PIT tagged. PIT tags were applied with individual syringe injectors. The injector needles were disinfected with ethyl alcohol after each use to minimize

the spread of disease between fish. Marked fish were transferred by jet boat several miles below the ferry landing and released. Ninety seven PIT tagged fish were held overnight to assess 24 hour delayed mortality and tag loss.

A total of 15,289 wild zero age chinook were handled on June 6, 7, and 8 of which 3,034 were large enough (forklength $\geq$ 60mm) to be PIT tagged (Table 5). The marked fish averaged 65.4 mm in forklength. The percentage of the fish handled that were large enough to mark in 1995 (20.1%) was most similar to that of 1993 (11.5%) and much lower that of other previous years (44.2% - 1994, 86.5% - 1992, 39.9% - 1991).

The direct mortality rate due to handling and tagging increased during the marking program to a maximum of 5.7% on June 8. Generally, the condition of fish deteriorated during the three day period as capturing crews were forced to switch from stick seines to boat drawn beach seines to access deeper water as fish abundance declined in the shallows. Overall, direct mortality averaged 2.3% and delayed mortality equalled zero (Table 5). Tag loss for the 97 fish held overnight equalled 1.0%. Tags from direct mortalities were re-used (except tags recovered during the final release) and the total number of fish which survived to be released was 2,995.

Table 5. 1995 Hanford Reach PIT tag summary.

Marking and Handling Record						Mortality				
						Direct		Delayed		
Date	Number Tagged	Number <60mm	Number Rejects	Total Handled	Mark Percent*	#	%	#Held	#Morts	%
June 6	580	2,175	0	2,755	21.1	5	0.9	0	NA	NA
June 7	1,788	7,374	16	9,178	19.7	26	1.5	97	0	0.0
June 8	666	2,664	26	3,356	20.6	38	5.7	0	NA	NA
Total	3,034	12,213	42	15,289	20.1	69	2.3	97	0	0.0

* The markable percent is equal to: (# Tagged + # Rejected)/(Total Handled).

Results

Analysis of the 1995 data and comparison of the 1995 data to that of past years is conducted under two basic assumptions. 1) The collection efficiency of the McNary bypass system remains constant and comparable from year to year, and 2) the distribution of fish per unit of river flow is equivalent for the powerhouse and the spillway (1 to 1 spillway efficiency ratio) and remains constant from year to year.

Ringold Hatchery

A total of 507 of the 1,464 PIT tagged fish (34.6%) were interrogated at McNary Dam (Table 6). The mean arrival date for all fish was July 5 with a 7.41 day in river/travel time. In general, larger fish did arrive earlier than smaller fish and had shorter in river/travel times. However, the recovery rates calculated by fish size increment were fairly similar for each size group and were not progressively higher for larger sized fish as has been consistently observed in the past for other groups

of PIT tagged zero age chinook . The number of interrogations were expanded to account for tagged fish which passed over the spillway and are presented in Table 6 under the passage index heading. Overall, 43.4% of the tagged fish are estimated to have passed McNary Dam.

Table 6. Recovery rates and passage timing of PIT tagged zero age chinook released from Ringold hatchery in 1995.

Forklength (mm)	Number Released	Number Recovered	Recovery Rate (%)	Mean Arrival Date	Mean Travel Time (Days)	Passage Index (%)
50-59	1	0	0.0	NA	NA	NA
60-69	52	20	38.5	July 8	11.00	46.4
70-79	485	159	32.8	July 7	9.41	40.7
80-89	625	223	35.7	July 4	6.58	44.9
90-99	286	99	34.6	July 3	5.45	44.0
100-109	15	6	40.0	July 3	5.41	52.0
Total	1,464	507	34.6	July 5	7.41	43.4

Priest Rapids Hatchery

The first group of PIT tagged zero age chinook were released from Priest Rapids Hatchery on June 13. These were the first to arrive at McNary Dam followed by the second (June 19) and third (June 23) release groups. Overall, 363 of the 1,490 PIT tagged fish were interrogated as they passed through the collection system at McNary Dam for an overall recovery rate of 24.4% (Table 7). The mean arrival date and mean inriver/travel time was July 1 and 11.92 days respectively. Tagged fish were grouped by 10mm size increment and similar to what was observed for PIT tagged fish from Ringold Hatchery, larger fish had progressively earlier arrival times and shorter inriver/travel times. This pattern was evident for each release group (June 13, 19, 23) and for all groups combined. Also similar to fish from Ringold Hatchery, incrementally larger PIT tagged fish from Priest Rapids hatchery did not show progressively higher recovery rates as had been observed in the past. The number of interrogations were also expanded to account for tagged fish that were spilled and the expanded passage index count equalled 34.0% of the fish tagged.

When each release group is examined separately, a progressive pattern of lower interrogation (recovery) rates is evident from first to final release (Table 7). However, this pattern disappears when the number of interrogations are expanded to calculate the passage index rates.

Table 7. Recovery rates and passage timing of three groups of PIT tagged zero age chinook released from Priest Rapids hatchery in 1995.

Forklength (mm)	Number Released	Number Recovered	Recovery Rate (%)	Mean Arrival Date	Mean Travel Time (Days)	Passage Index (%)
June 13						
60-69	51	12	23.5	June 29	16.11	23.5
70-79	331	71	21.5	June 26	13.24	21.5
80-89	117	21	17.9	June 24	10.79	17.9
90-99	0	0	NA	NA	NA	NA
Total	499	104	20.8	June 26	13.07	34.6
June 19						
60-69	85	29	34.1	July 4	14.60	46.6
70-79	403	80	19.9	July 3	13.79	26.9
80-89	10	3	30.0	June 29	10.09	47.8
90-99	0	0	NA	NA	NA	NA
Total	498	112	22.5	July 3	13.90	30.7
June 23						
60-69	13	4	30.8	July 7	13.42	33.9
70-79	280	96	34.3	July 3	10.06	38.7
80-89	197	47	23.9	July 1	8.31	34.5
90-99	3	0	0.0	NA	NA	0.0
Total	493	147	29.8	July 3	9.59	36.7
Combined Total						
60-69	149	45	30.2	July 3	14.90	42.5
70-79	1,014	247	24.4	July 1	12.18	33.0
80-89	324	71	21.9	June 29	9.12	33.5
90-99	3	0	0.0	NA	NA	0.0
Total	1,490	363	24.4	July 1	11.92	34.0

Hanford Reach

A total of 463 of the 2,995 wild PIT tagged zero age chinook were interrogated at McNary Dam for an overall recovery rate of 15.5% (Table 8). The mean arrival date was July 5 and average in river/travel time was 28.09 days. The marked fish ranged in forklength from 57mm to 91mm and averaged 95.4mm. As has been observed in the past, and in 1995 for both groups of PIT tagged hatchery fish, larger fish had shorter in river/travel times and earlier mean arrival dates (Table 8). As was also observed for PIT tagged hatchery fish in 1995 and contrary to what had been observed for PIT tagged wild fish in the past, recovery rates did not increase with fish size. The number of interrogations was further expanded to account for the number fish which passed over the spillway. The resulting passage index equalled 20.1% of the tagged wild fish (Table 8).

Table 8. Recovery rates and passage timing of zero age chinook PIT tagged on the Hanford Reach in 1995.

Forklength (mm)	Number Released	Number Recovered	Recovery Rate (%)	Mean Arrival Date	Mean Travel Time (Days)	Passage Index (%)
50-59	153	19	12.4	July 8	31.40	14.3
60-69	2,344	368	15.7	July 6	29.14	19.9
70-79	471	73	15.5	June 29	22.34	23.6
80-89	26	3	11.5	June 25	17.52	18.6
90-99	1	0	0.0	NA	NA	0.0
Total	2,995	463	15.5	July 5	28.09	20.1

Discussion

The analysis of the PIT tag recovery data for zero age chinook originating from Ringold Hatchery, Priest Rapids Hatchery, and the Hanford Reach showed trends similar to what has been consistently observed in the past but also some surprising changes. Fish, both hatchery and wild origin, that have been largest at time of tagging have in the past consistently shown:

1) earlier arrival times
2) shorter in river/travel times
3) higher recovery rates

Both 1) and 2) were again observed in 1995 for all three sources of fish as well as for each of the three separate release groups originating from Priest Rapids Hatchery. However, 3) was not observed to be true for any group of PIT tagged fish in 1995. In fact, larger fish from the Hanford reach had progressively lower recovery rates than smaller fish based upon unadjusted numbers of passive interrogations (Table 8). It follows logically that larger smolts can: A) swim faster, B) arrive earlier, therefore C) be exposed to predation for shorter periods, and D) be expected to have higher survival/recovery rates than smaller fish. This has been consistently observed for all groups of PIT

tagged zero age chinook in past years. Why then, was this not observed for any group of PIT tagged fish in 1995? One potential explanation is that larger fish arrived earlier during higher periods of spill and a higher proportion simply passed over the spillway. However, the number of interrogations was adjusted to account for spillway passage (see Passage Index portion of Tables 6-8) and again a pattern of higher recovery rates for larger fish was not observed. Another potential explanation is that larger fish were spilled at a higher rate than were smaller fish. In 1995, a substantial amount of water was spilled at McNary Dam during the peak subyearling passage period compared to previous years. During periods of high volumes of spill, the 1 to 1 spillway efficiency ratio may not be valid for all groups of fish and larger fish may follow the stronger surface flow and therefore be more susceptible to spillway passage. This is in violation of one of the basic assumptions used in this analysis, is speculative, and is impossible to verify, but is a potential explanation for the change in recovery rate pattern observed in 1995.

In 1994, hatchery and wild fish that were in the same size range (i.e., 60-69mm, 70-79mm, etc.) when they were tagged had virtually identical mean arrival dates at McNary Dam. This was not evident in the 1995 recovery data but was most likely confounded by the variance in tagging and release times. For example, wild fish from the Hanford reach were measured and tagged on June 6, 7 and 8 and released on those same dates. Fish from Priest Rapids Hatchery were tagged and measured on May 22 and 23 but not released until June 13-23. Growth between time of tagging and time of release cannot be accounted for in the data but does tend to invalidate a straight comparison of arrival timing versus fish size for each of the three sources of tagged fish. In addition, an unknown portion of the Ringold release is known to have escaped early (e.g., six of the recovered fish had negative travel times) which confounds this type of analysis even further.

A broader review of the recovery rate and passage timing data for all three sources of PIT tagged fish does show similarity to what has been observed in past years. Fish from Ringold Hatchery were on average larger than those from Priest Rapids Hatchery (82.8mm versus 75.5mm) at time of tagging and larger than those from the Hanford Reach (65.4mm). Ringold Hatchery fish were the first to arrive at McNary Dam, had the shortest average in river/travel time and the highest adjusted/unadjusted recovery rates followed by fish from Priest Rapids Hatchery and then by wild fish from the Hanford Reach. Therefore it can be very generally concluded from the recovery data for all three sources of PIT tagged subyearling chinook that larger fish had the shortest travel times to McNary Dam, the earliest arrival dates, and the highest recovery rates. However, this same conclusion cannot be drawn from the incremental size and recovery data for any of the individual release groups in 1995.

4.2 NBS SMOLT ASSESSMENT

The National Biological Service sampled 1,370 subyearling chinook to conduct salt water challenge tests in 1995. The fish were provided to the NBS through the McNary SMP and were then transferred to the Columbia River Research Lab (Cook, WA) were the challenges were performed. Of the 1,370 fish, 609 were sacrificed and the remaining 761 were released back to the river when the tests were concluded.

4.3 NMFS MARKING PROGRAMS AT MCNARY DAM

In 1995, the NMFS conducted a coded wire tag marking program to evaluate transportation of summer migrants at McNary Dam. A total of 298,053 zero age chinook were removed from the sampling system, adipose fin clipped, and coded wire tagged as part of this program. The sampling rates were frequently increased to accommodate this work and a total of 321,948 additional fish were sampled by the McNary

Smolt Monitoring Program crew as a result.

4.4 NMFS MARKING PROGRAMS AT LOWER MONUMENTAL DAM

In 1995, the NMFS conducted a PIT tag marking program at Lower Monumental Dam to assess juvenile survival through Snake River dams and reservoirs. For this work 8,256 hatchery yearling chinook and 8,127 hatchery steelhead were removed from the sampling system and PIT tagged. The sampling rates were raised in order to provide fish for this program and a total of 44,826 additional fish were sampled by the Lower Monumental Smolt Monitoring Program crew in 1995 as a result.

5.0 FULL SAMPLE DESCALING

Beginning in 1991, all live sample fish were examined for scale loss at McNary Dam and beginning in 1993 at Lower Monumental Dam. At McNary Dam, a total of 462,812 fish were individually examined for scale loss. The 1995 descaling rates ranged from 4.2% for wild steelhead to 18.3% for wild sockeye and averaged 5.5% for all species of fish. Overall, the 1995 descaling rate (5.5%) was similar to but slightly higher than that of 1994 (4.3%, Table 9). A total of 89,151 fish were examined for scale loss at the Lower Monumental site in 1995. Descaling rates ranged from 1.9% for wild steelhead to 12.1% for sockeye and averaged 4.3% for all groups of fish combined. Overall, the 1995 descaling rate (4.3%) was similar to and slightly lower than that of 1994 (5.4%, Table 10). The apparent changes in the 1994 and 1995 descaling rates at the two projects may have been related to differences in passage conditions resulting from operational modifications at projects located upstream or due to simple random variability in the data.

Table 9. 1994 and 1995 descaling rates for juvenile fish sampled at McNary Dam.

Year	CH-I	CH-0	SH-H	SH-W	COHO	SOCK-H	SOCK-W	TOTAL
1994	8.4%	2.3%	13.8%	5.0%	3.5%	7.9%	12.4%	4.3%
1995	11.1%	4.7%	8.7%	4.2%	8.8%	5.7%	18.3%	5.5%
Difference	+2.7%	+2.4%	-5.1%	-0.8%	+5.3%	-2.2%	+5.9%	+1.2%

Table 10. 1994 and 1995 descaling rates for juvenile fish sampled at Lower Monumental Dam.

Year	CH-1H	CH-1W	CH-0H*	CH-0W	SH-H	SH-W	SOCK**	TOTAL
1994	6.2%	6.1%	NA	1.8%	4.4%	3.0%	19.2%	5.4%
1995	4.2%	3.2%	2.4%	3.5%	5.1%	1.9%	12.1%	4.3%
Difference	-2.0%	-2.9%	NA	+1.7%	+0.7%	-1.1%	-7.1%	-1.1%

* Hatchery subyearling chinook were not released above Lower Monumental Dam in 1994.

** Hatchery and wild sockeye were categorized separately in 1995 but not in 1994. The 1995 sockeye descaling data is combined in Table 12 to allow comparison between years.

6.0 RECOMMENDATIONS

1. Use of tricaine in the pre-anesthetic systems should be continued consistent with WDFW policy and FDA regulations. Use of less expensive alternative methods of anesthetizing fish, such as carbon dioxide gas, should be investigated.

2. The PIT tagging of 3,000 wild and 1,500 hatchery zero age chinook should be continued in 1996 on the Hanford Reach and at Priest Rapids Hatchery respectively. PIT tagging of 1,500 zero age chinook was conducted at Ringold Hatchery in 1995 through the WDFW Hatcheries Program but is not scheduled to be continued in 1996. Continuation of the Ringold PIT tagging program under the SMP should be considered.

3. Examination of fish for symptoms of gas bubble trauma should be continued in 1996 at both the McNary and Lower Monumental sites. Examination of fish for GBT symptoms at the new Ice Harbor Dam juvenile collection facility which is scheduled to become operational in 1996 should be considered as well.

7.0 LITERATURE CITED

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8.0 APPENDICES

Appendix Table 1. Pre-anesthetic induction time (minutes) and concentrations (ppm) at McNary Dam, 1995.

Water Temp.		A tank			B tank			Concentrations		Water Temp.		A tank			B tank			Concentrations		Water Temp.		A tank			B tank			Concentrations	
								A tank	B tank									A tank	B tank									A tank	B tank
43.5	28-Mar				4.00			42.0	42.0	53.0	15-May	4.00	4.25	4.25	4.25	4.25	4.25	42.0	42.0	66.4	02-Jul	3.25	3.50	4.00	4.25	3.75	4.00	42.0	42.0
43.6	29-Mar	4.00	4.00		4.00	4.00		42.0	42.0	53.4	16-May	4.00	4.25	4.00	4.25	4.00	4.25	42.0	42.0	66.2	03-Jul	3.50	3.75	4.25	4.25	3.75	4.00	42.0	45.7
45.4	30-Mar	4.00			4.00	4.00	4.50	42.0	42.0	54.2	17-May	4.25	4.25	4.25	4.00	4.00	4.00	42.0	42.0	65.4	04-Jul	3.75	3.75	4.00	4.00	4.00	4.00	45.7	45.7
44.4	31-Mar				4.00	4.00	4.00		42.0	54.4	18-May	4.00	4.00	4.25	4.00	4.00	4.00	42.0	42.0	65.5	05-Jul	3.75	3.50	3.75	3.25	3.75	4.00	42.0	42.0
45.1	01-Apr	4.25			4.00	4.00	4.00	42.0	42.0	55.0	19-May	4.00	4.00	4.00	4.00	3.75	4.00	42.0	42.0	65.4	06-Jul	3.25	3.25	3.25	3.50	3.50	3.75	42.0	42.0
45.0	02-Apr	4.50			4.50	4.50	4.50	42.0	42.0	55.0	20-May	3.50	3.50	3.75	3.25	3.25	3.50	42.0	42.0	64.7	07-Jul	3.00	3.75	3.50	3.75	3.25	3.25	42.0	42.0
46.2	03-Apr	4.00			4.25	4.00	4.25	42.0	42.0	55.6	21-May	3.50	3.25	3.50	3.75	3.25	3.50	42.0	42.0	65.5	08-Jul	3.50	3.50	3.25	4.00	3.25	3.25	57.1	57.1
46.2	04-Apr	4.25			4.00	4.50	4.50	42.0	42.0	55.6	22-May	3.75	4.00	4.00	3.75	3.75	3.75	42.0	42.0	65.0	09-Jul	3.50	3.50	4.00	4.25	3.50	3.75	51.4	57.1
46.7	05-Apr	4.50	4.50		4.50	4.00	4.50	42.0	42.0	56.1	23-May	3.50	4.25	4.25	4.00	4.00	4.00	42.0	42.0	65.0	10-Jul	3.75	3.50	3.50	3.50	3.50	3.50	42.0	42.0
47.1	06-Apr	4.50	4.75		4.50	4.50	4.50	42.0	42.0	56.0	24-May	3.75	4.00	3.75	4.00	3.75	3.50	42.0	42.0	65.4	11-Jul	3.50	3.50	3.50	3.00	3.50	3.50	42.0	42.0
47.0	07-Apr	4.50	4.50		4.50	4.50	4.50	42.0	42.0	56.2	25-May	3.75	4.00	3.75	3.75	3.75	4.00	42.0	42.0	67.0	12-Jul	3.50	3.75	3.25	3.50	3.25	3.75	42.0	42.0
46.2	08-Apr	4.50	4.50	4.50	4.00	4.25	4.25	42.0	48.5	55.0	26-May	3.75	3.75	4.00	4.00	3.75	3.75	42.0	42.0	66.5	13-Jul	3.25	3.50	3.25	3.75	3.50	3.50	42.0	42.0
46.5	09-Apr	4.50	4.25		4.50	4.50	4.25	45.7	51.4	57.0	27-May	3.75	4.00	3.75	4.00	4.00	3.25	42.0	42.0	66.5	14-Jul	3.75	3.50	3.50	3.50	3.50	3.00	42.0	42.0
46.6	10-Apr	4.75			4.50	4.50	4.50	42.0	42.0	57.7	28-May	3.00	3.00	3.75	4.00	5.00	3.50	42.0	42.0	66.7	15-Jul	3.00	3.50	3.50	3.50	3.00	3.00	48.5	48.5
47.5	11-Apr	4.50	4.50		4.50	4.50	4.50	42.0	42.0	57.2	29-May	3.50	3.75	3.75	3.75	3.75	3.75	42.0	42.0	66.5	16-Jul	3.50	3.25	3.50	3.50	3.25	3.25	48.5	48.5
48.2	12-Apr	4.75	4.50	4.50	4.50	4.50	4.50	42.0	42.0	59.3	30-May	3.75	3.50	3.75	3.75	3.25	3.50	42.0	42.0	68.0	17-Jul	3.50	3.25	3.50	3.50	3.50	3.25	42.0	42.0
48.0	13-Apr	4.50	4.50		4.50	4.50	4.50	42.0	42.0	59.3	31-May	3.50	3.75	3.50	3.75	3.25	3.75	42.0	42.0	68.0	18-Jul	3.50	3.50	3.75	3.00	3.50	3.00	42.0	42.0
47.6	14-Apr	4.50			4.50	4.25	4.50	42.0	42.0	58.6	01-Jun	3.75	3.50	3.75	3.25	3.25	3.75	42.0	42.0	68.5	19-Jul	3.00	3.50	3.50	3.00	3.00	3.25	42.0	42.0
47.2	15-Apr	4.50	4.50		3.75	4.50	4.25	42.0	42.0	58.6	02-Jun	3.75	3.75	3.25	3.25	3.25	3.25	42.0	42.0	68.9	20-Jul	2.50	3.25	3.75	3.00	3.00	3.50	42.0	42.0
47.2	16-Apr	4.25	4.50	4.50	4.50	4.25	4.50	42.0	42.0	58.5	03-Jun	3.75	3.75	3.75	3.75	3.25	3.75	42.0	42.0	67.9	21-Jul	2.50	3.25	3.50	3.25	3.25	3.00	42.0	42.0
47.7	17-Apr	4.75	4.50	4.50	4.50	4.25	4.50	42.0	42.0	59.5	04-Jun	4.00	4.00	4.25	3.25	2.75	3.50	42.0	42.0	67.5	22-Jul	3.25	3.25	3.75	3.00	3.00	3.00	42.0	42.0
47.5	18-Apr	4.75	4.75	4.50	4.50	4.50	4.50	42.0	42.0	58.8	05-Jun	4.00	3.75	3.50	3.50	4.00	3.50	42.0	42.0	68.8	23-Jul	3.25	3.00	3.50	3.00	3.50	3.25	42.0	42.0
47.9	19-Apr	4.50	4.50		4.50	4.50	4.25	42.0	42.0	58.6	06-Jun	4.00	4.00	3.75	4.00	3.75	3.75	42.0	42.0	69.5	24-Jul	3.00	3.25	2.50	3.00	3.25	3.00	42.0	42.0
48.3	20-Apr	4.75	4.75	4.50	4.50	4.50	4.00	42.0	42.0	58.5	07-Jun	3.75	3.75	3.50	3.75	3.75	3.75	42.0	42.0	69.5	25-Jul	3.25	3.25	4.50	3.25	3.50	3.25	42.0	42.0
47.9	21-Apr	4.50	4.50		4.50	4.25	4.50	42.0	42.0	58.0	08-Jun	4.00	3.75	3.75	4.00	3.75	3.75	42.0	42.0	69.0	26-Jul	3.50	3.50	3.50	3.25	3.25	3.25	42.0	42.0
48.5	22-Apr	4.50	4.25	4.50	4.00	4.50	4.50	42.0	42.0	57.9	09-Jun	3.75	3.50	3.75	4.00	3.75	3.50	42.0	42.0	69.0	27-Jul	3.25	3.50	3.50	3.50	3.00	3.50	42.0	42.0
49.2	23-Apr	4.00	4.50	4.50	4.25	4.50	4.50	42.0	45.7	59.0	10-Jun	3.75	3.75	4.25	4.50	3.75	4.00	42.0	42.0	70.2	28-Jul	3.25	3.00	3.25	3.25	3.25	3.50	42.0	42.0
49.7	24-Apr	4.50	4.25	4.25	4.25	4.75	4.50	42.0	42.0	58.6	11-Jun	4.00	4.50	4.50	4.75	3.25	4.00	48.5	42.0	69.3	29-Jul	3.75	4.25	4.00	3.00	3.75	4.00	42.0	42.0
49.7	25-Apr	4.25	4.25	4.50	4.00	4.00	4.00	42.0	42.0	58.5	12-Jun	4.00	3.50	3.75	3.75	3.50	3.50	42.0	42.0	69.8	30-Jul	3.25	3.50	4.00	3.25	3.25	3.75	42.0	42.0
50.3	26-Apr	4.00	4.00	4.00	4.50	4.50	4.25	42.0	48.0	58.4	13-Jun	3.75	3.75	3.75	3.75	4.00	3.50	42.0	42.0	69.8	31-Jul	3.75	3.50	3.50	3.25	3.50	3.75	42.0	42.0
50.1	27-Apr	4.50	4.75	4.50	4.50	4.00	4.00	42.0	48.0	57.8	14-Jun	3.75	3.75	3.75	3.75	3.75	3.75	42.0	42.0	69.4	01-Aug	3.50	3.50	3.25	3.25	3.50	3.50	42.0	42.0
50.1	28-Apr	4.00	4.25	4.25	4.50	4.00	3.75	42.0	48.0	56.8	15-Jun	3.75	3.75	3.50	3.75	3.75	3.75	42.0	42.0	69.8	02-Aug	3.50	3.50	3.75	3.25	3.50	3.00	42.0	42.0
50.1	29-Apr	4.50	4.00	4.50	4.50	4.50	4.50	42.0	42.0	56.4	16-Jun	3.75	3.50	3.50	4.00	3.75	3.75	42.0	42.0	70.7	03-Aug	3.50	3.50	3.25	3.50	3.25	3.50	42.0	42.0
49.8	30-Apr	4.50	4.25	4.50	4.50	3.50	3.50	42.0	42.0	56.7	17-Jun	3.50	4.00	4.25	3.50	3.50	3.50	42.0	42.0	70.5	04-Aug	3.50	3.50	3.50	3.25	3.50	3.50	42.0	42.0
50.3	01-May	4.25	4.00	4.00	4.00	4.00	4.25	42.0	42.0	59.9	18-Jun	3.75	4.25	3.75	4.50	4.00	3.75	42.0	42.0	71.0	05-Aug	3.50	3.00	3.50	3.50	3.75	3.75	42.0	42.0
50.9	02-May	4.00	4.00	4.00	4.25	4.50	4.50	42.0	42.0	60.8	19-Jun	3.75	3.75	4.00	3.75	3.75	3.75	42.0	42.0	70.5	06-Aug	3.50	3.00	3.50	4.00	3.25	3.50	42.0	42.0
50.1	03-May	4.50	4.50	4.50	4.50	4.50	4.50	42.0	42.0	59.9	20-Jun	4.00	3.50	3.75	3.50	3.75	3.75	42.0	42.0	69.8	07-Aug	3.50	3.50	3.50	3.50	3.50	3.50	41.9	42.0
50.0	04-May	4.50	4.50	4.25	4.50	4.25		42.0	42.0	58.7	21-Jun	3.50	3.50	3.50	3.50	3.75	3.75	42.0	40.0	68.5	08-Aug	3.75	3.50	3.75	3.50	3.75	3.50	42.0	42.0
50.0	05-May	4.50	4.50	4.50	4.25	4.50	4.50	42.0	42.0	59.5	22-Jun	3.50	3.50	3.50	3.50	3.50	3.50	42.0	40.0	68.0	09-Aug	3.50	3.50	3.25	3.50	3.75	3.50	42.0	42.0
50.4	06-May	3.75	4.50	4.50	4.75	4.00	4.50	42.0	42.0	60.0	23-Jun	3.25	3.50	3.50	4.00	3.50	3.50	42.0	40.0	69.3	10-Aug	3.75	3.50	3.75	3.50	3.75	3.50	42.0	42.0
50.6	07-May	3.75	4.00	4.50	4.00	4.00	4.50	42.0	42.0	62.0	24-Jun	3.00	3.00	3.50	3.75	3.50	3.50	42.0	42.0	67.6	11-Aug	3.50	3.75	4.00	4.00	3.75	4.00	42.0	42.0
50.7	08-May	4.25	4.25	4.25	4.00	4.25	4.25	42.0	42.0	62.1	25-Jun	3.00	3.00	3.25	3.25	3.50	3.50	42.0	42.0	67.9	12-Aug	4.00	4.25	4.75	3.25	3.50	3.25	42.0	42.0
52.1	09-May	4.25	4.25	4.25	4.00	4.25	4.25	42.0	42.0	65.4	26-Jun	3.25	3.50	3.00	3.50	3.00	3.25	42.0	40.0	67.5	13-Aug	4.00	3.75	4.00	3.25	3.50	3.50	42.0	42.0
52.3	10-May	4.50	4.50	4.25	4.00	4.25	4.50	42.0	42.0	63.0	27-Jun	3.50	3.50	3.75	3.50	3.50	3.75	42.0	37.1	67.4	14-Aug	3.75	4.50	3.50	3.50	4.00	3.50	42.0	42.0
52.7	11-May	4.00	4.25	4.00	4.25	4.25	4.25	42.0	42.0	62.4	28-Jun	3.25	3.75	3.75	3.25	3.75	4.00	42.0	42.0	67.5	15-Aug	4.00	4.00	4.50	3.75	4.00	3.25	42.0	42.0
52.3	12-May	4.00	4.25	4.25	4.00	4.25	4.00	42.0	42.0	61.5	29-Jun	3.25	3.50	3.50	4.00	3.75	3.25	42.0	42.0	67.0	16-Aug	4.00	3.75	4.00	4.00	3.75	4.00	42.0	42.0
53.0	13-May	3.75	4.25	3.75	3.00	3.25	3.50	42.0	42.0	61.6	30-Jun	4.50	3.50	3.50	3.50	4.00	4.50	42.0	42.0	66.5	17-Aug	4.00	4.00	4.25	4.00	3.50	3.50	42.0	42.0
52.0	14-May	3.50	3.75	3.25	3.25	3.00	3.25	42.0	42.0	64.9	01-Jul	2.75	4.00	3.50	3.75	3.50	4.25	42.0	42.0	66.2	18-Aug	4.00	4.25		4.25	4.00	4.00	42.0	42.0
48.5	Average	4.35	4.39	4.35	4.29	4.29	4.33	42.9	43.9	58.1	Average	3.88	3.66	3.77	3.80	3.53	3.89	43.0	42.3	67.8	Average	3.46	3.44	3.69	3.47	3.40	3.42	41.6	43.0
	Minimum	3.50	3.75	3.25	3.00	3.00	3.25	41.0	48.0		Minimum	2.75	3.00	3.00	3.25	2.75	3.25	42.0	37.1		Minimum	2.50	3.00	2.50	3.00	3.00	3.00	42.0	42.0
	Maximum	4.75	4.75	4.5	4.75	4.75	4.5	45.7	51.4		Maximum	4.50	4.50	4.50	4.75	4.25	4.50	48.5	42.0		Maximum	4.00	4.50	6.00	4.25	4.00	4.00	57.1	57.1

Appendix Table 1. continued

Water Temp.		A tank			B tank			Concentrations		Water Temp.		A tank			B tank			Concentrations		Water Temp.		A tank			B tank			Concentrations	
								A tank	B tank									A tank	B tank									A tank	B tank
66.7	19-Aug	3.50	4.50	4.00	4.00	4.00	4.00	42.0	42.0	62.4	06-Oct	4.00	4.00	4.00	4.00	4.00	4.00	42.0	42.0	49.3	25-Nov	4.50		4.50	4.50		4.50	53.1	53.1
67.0	20-Aug	4.00	4.00	4.00	4.25	4.00	4.00	42.0	42.0	61.8	07-Oct	4.00	4.00	4.00	4.00	4.00	4.00	42.0	42.0	49.4	26-Nov	4.50		4.50	4.50		4.50	53.1	53.1
67.4	21-Aug	4.00	4.00	3.00	4.25	4.25	4.00	42.0	42.0	61.7	08-Oct	4.00	4.00	3.75	4.00	3.75	3.75	42.0	42.0	49.4	25-Nov	4.50		4.50	4.50		4.50	53.1	53.1
67.3	22-Aug	3.50	3.50	3.50	2.50	3.50	4.50	42.0	42.0	61.4	09-Oct	4.00		3.75	3.75		3.75	42.0	42.0	49.3	26-Nov	4.50		4.50	4.50		4.50	53.1	53.1
68.4	23-Aug	4.00	4.00	4.00	4.00	3.75	4.00	42.0	42.0	61.3	10-Oct	3.50	3.00	3.00	3.00	3.00	3.00	42.0	42.0	49.1	27-Nov	4.50		4.50	4.50		4.50	53.1	53.1
67.5	24-Aug	4.00	4.00	4.00	4.00	4.00	4.00	42.0	42.0	61.1	11-Oct	4.00	4.00	4.00	4.00	3.50	4.00	42.0	42.0	49.0	28-Nov	4.50			4.50		4.50	53.1	53.1
66.9	25-Aug							42.0	42.0	60.3	12-Oct	3.50	4.00	4.00	3.50		4.00	42.0	42.0	48.8	29-Nov	4.50		4.50	4.50		4.50	53.1	53.1
68.0	26-Aug	4.00	4.00	4.00	3.50	4.00	3.50	42.0	42.0	59.2	13-Oct	3.50	3.50	3.50	3.50	3.50	3.50	42.0	42.0	48.9	30-Nov	4.50			4.50		4.00	53.1	53.1
67.9	27-Aug	4.00	4.00	4.00	4.00	4.00	3.50	42.0	42.0	58.5	14-Oct	3.50	3.50	3.50	3.50	3.50	3.25	42.0	42.0	48.8	01-Dec	4.50			4.50		4.50	53.1	53.1
68.0	28-Aug	4.00		4.00	4.00	4.00	3.50	42.0	42.0	58.3	15-Oct	3.50	3.75	3.75	3.75	3.50	3.50	42.0	42.0	48.3	02-Dec	4.50			4.50	4.50	4.50	53.1	53.1
67.4	29-Aug	2.50	3.50	3.50	4.50	3.50	3.50	42.0	42.0	58.1	16-Oct	3.50		3.75	3.50	3.75	3.75	42.0	42.0	47.4	03-Dec	4.50			4.50	4.50	4.50	53.1	53.1
67.2	30-Aug	4.00	4.00	4.00	3.00	4.00	4.00	42.0	42.0	58.0	17-Oct	3.00		3.00	3.00	3.00	3.50	42.0	42.0	46.6	04-Dec	4.50			4.50	4.50	4.50	53.1	53.1
68.0	31-Aug	4.00	4.00	4.00	4.00	4.00	4.00	42.0	42.0	59.6	18-Oct	3.50	4.00	4.00	3.50	3.50	4.00	42.0	42.0	46.1	05-Dec	4.50		4.50	4.50	4.50	4.50	53.1	53.1
68.0	01-Sep	3.50		3.50	4.00	4.00	3.50	42.0	42.0	59.5	19-Oct	3.75	3.50	4.00	3.75	4.00	4.00	42.0	42.0	45.5	06-Dec	4.50		4.50	4.50	4.50	4.50	53.1	53.1
68.7	02-Sep	3.50	4.00	3.50	4.00	4.00	3.50	42.0	42.0	59.0	20-Oct	3.50	3.00	4.00	3.50	3.00	3.50	42.0	42.0	44.7	07-Dec	4.50		4.50	4.50	4.50	4.50	53.1	53.1
68.7	03-Sep	3.50		3.50	4.00	4.00	3.50	42.0	42.0	58.5	21-Oct	3.75	4.25	4.25	4.00	4.25	4.25	42.0	42.0	43.9	08-Dec	4.50			4.50	4.50	4.50	53.1	53.1
68.1	04-Sep	3.50		3.50	3.50	3.50	3.50	42.0	42.0	57.7	22-Oct	4.00		4.00	4.00		4.00	42.0	42.0	43.0	09-Dec	4.50			4.50		4.50	53.1	53.1
68.5	05-Sep	3.00	3.00	3.00	2.50	3.50	3.50	42.0	42.0	57.4	23-Oct	3.50		3.50	3.50	3.50	3.50	42.0	42.0	42.1	10-Dec	4.50			4.50		4.50	53.1	53.1
68.6	06-Sep	3.50	3.50	3.50	3.50	3.50	4.00	42.0	42.0	56.8	24-Oct	3.50		3.50	3.50	3.50	3.50	42.0	42.0	41.6	11-Dec	4.50			4.50		4.50	53.1	53.1
68.9	07-Sep	3.25	4.00	4.00	3.00	4.00	4.00	42.0	42.0	56.4	25-Oct	4.00	4.50	4.00	4.00	4.00	4.00	42.0	42.0	41.8	12-Dec	4.50			4.50		4.50	53.1	53.1
68.3	08-Sep	4.00	3.50	3.50	3.50	3.00	3.50	42.0	42.0	56.1	26-Oct							42.0	42.0										
68.0	09-Sep	4.00	4.00	3.50	3.50	3.50	3.50	42.0	42.0	56.2	27-Oct	4.25	4.25	4.00	4.00		4.00	42.0	42.0										
68.7	10-Sep	3.50	4.00	3.50	3.50	3.50	3.50	42.0	42.0	56.1	28-Oct	4.25	4.25	4.00	4.00	4.25	4.25	42.0	42.0										
68.9	11-Sep	4.00	3.50	3.25	3.50	3.50	3.50	42.0	42.0	55.8	29-Oct	4.25	4.25	4.25	4.25	4.25	4.25	42.0	42.0										
68.9	12-Sep	3.50	3.50	3.50	3.50	3.50	3.50	42.0	42.0	55.3	30-Oct	4.25	4.25	4.25	4.25	4.25	3.50	42.0	42.0										
68.9	13-Sep	2.50		3.00	3.00	3.50	3.00	42.0	42.0	55.1	31-Oct	3.75	4.00	4.00	4.00	4.00	4.00	42.0	42.0										
69.0	14-Sep	3.50		3.50	3.75	3.50	3.50	42.0	42.0	54.2	01-Nov	4.25	4.50	4.50	4.50	4.50	4.50	42.0	42.0										
69.3	15-Sep							42.0	42.0	53.5	02-Nov	4.50	4.50	4.00	4.50	4.25	4.00	42.0	42.0										
69.6	16-Sep	3.50		3.50	3.00		3.50	42.0	42.0	53.0	03-Nov	3.50	3.50	3.50	3.50	3.50	3.50	42.0	42.0										
69.8	17-Sep	3.50		3.50	3.50	3.50	3.50	42.0	42.0	52.4	04-Nov	4.50	4.50	4.50	4.50	4.50	4.50	42.0	42.0										
69.5	18-Sep	3.50		3.50	4.00	3.50	3.25	42.0	42.0	52.5	05-Nov	4.50	4.50	4.50	4.50	4.50	4.50	42.0	42.0										
69.6	19-Sep	3.00		3.00	2.00	2.50	3.00	42.0	42.0	51.2	06-Nov	4.50	4.50	4.25	4.50	4.50	4.50	42.0	42.0										
69.1	20-Sep				3.00		3.50	42.0	42.0	51.5	07-Nov	4.00	4.00	4.00	4.50		4.50	42.0	42.0										
68.4	21-Sep							42.0	42.0	51.5	08-Nov	4.50	4.50	4.50	4.50	4.50	4.50	42.0	42.0										
68.1	22-Sep							42.0	42.0	51.0	09-Nov	4.50	4.50	4.50	4.50	4.50	4.50	42.0	42.0										
67.7	23-Sep	3.50		3.50	3.50		3.50	42.0	42.0	51.0	10-Nov	6.00		5.50	6.75	4.50	4.50	39.0	48.0										
67.3	24-Sep	3.50		3.50	3.50		3.50	42.0	42.0	51.3	11-Nov	5.50		5.50	4.50	4.50	4.50	48.0	53.1										
66.7	25-Sep	3.50		3.75	3.50		3.75	42.0	42.0	51.5	12-Nov	4.50		4.50	4.50	4.50	4.50	53.1	53.1										
66.0	26-Sep							42.0	42.0	51.2	13-Nov	4.50	4.50	4.50	4.50	4.50	4.50	53.1	53.1										
66.3	27-Sep							42.0	42.0	51.0	14-Nov	2.00		4.00	3.00	5.00	5.00	48.0	48.0										
66.3	28-Sep									50.8	15-Nov	4.00		4.00	4.00	4.00	4.00	53.1	53.1										
65.5	29-Sep	3.50		3.50	3.50	3.50	3.50			51.0	16-Nov	4.00		4.50	4.00	4.00	4.50	53.1	53.1										
65.2	30-Sep	3.50		3.75	3.50	3.50	3.50			51.3	17-Nov	4.00		5.00	5.00	5.00	5.00	53.1	53.1										
64.7	01-Oct	3.50	3.50	3.50	3.00		3.50			51.3	18-Nov	4.50		4.50	4.50	4.25	4.50	53.1	53.1										
64.2	02-Oct	3.50		3.50	3.50		4.00			50.7	19-Nov	4.50		4.50	4.50		4.50	53.1	53.1										
63.9	03-Oct	3.50		3.50	3.50		3.50			50.5	20-Nov	4.50		4.50	4.50	4.50	4.50	53.1	53.1										
63.2	04-Oct	3.75		4.00	4.00		4.00			50.8	21-Nov	4.50		4.50	4.00		4.00	53.1	53.1										
62.9	05-Oct	4.00	3.75	4.00	4.00	4.00	4.00			49.7	22-Nov	4.50			4.50		4.50	53.1	53.1										
67.7	Average	3.57	3.64	3.59	3.53	3.56	3.63	42.0	42.0	53.6	Average	4.02	3.92	4.11	4.00	3.94	4.00	44.8	45.1	46.7	Average	4.50	0.00	4.50	4.50	3.94	4.48	53.1	53.1
	Minimum	2.50	3.00	3.00	2.00	2.50	3.00	42.0	42.0		Minimum	2.00	3.00	3.00	3.00	3.00	3.00	30.0	42.0		Minimum	4.50	0.00	4.50	4.50	4.50	4.00	53.1	53.1
	Maximum	4.00	4.50	4.00	4.50	4.25	4.50	42.0	42.0		Maximum	6.00	4.50	5.50	5.00	5.00	5.00	53.1	53.1		Maximum	4.50	0.00	4.50	4.50	4.50	4.50	53.1	53.1

Season Averages

	ppm	minutes
Average	44.3	3.99
Minimum	37.1	2.00
Maximum	57.1	6.00

Appendix Table 2. Pre-anesthetic induction time (minutes) and concentrations at Lower Monumental Dam, 1996.

	A tank			B tank				A & B tanks		A tank				B tank				A & B tanks
Date	ppm	Time	Time	ppm	Time	Time	Time	Time	Date	ppm	Time	Time	Time	ppm	Time	Time	Time	Time
02-Apr	42.8	5:00		42.8	4:30	4:30	4:30	4:40	18-Jul	42.8	3:30			42.8	3:00	3:30	3:00	3:15
03-Apr	42.8	4:30		42.8	3:45	4:00	4:00	3:54	19-Jul	42.8	3:30			42.8	3:00	3:30	3:30	3:22
04-Apr	42.8	4:30		42.8	3:30	3:30	3:45	3:36	20-Jul	42.8	3:30			42.8	3:15	3:30	3:30	3:26
05-Apr	42.8	3:45		42.8	3:45	3:45	3:50	3:46	21-Jul	42.8	3:30			42.8	3:30	3:30	3:15	3:25
06-Apr	42.8	4:00		42.8	3:00	3:50	4:00	3:76	22-Jul	42.8	3:30			42.8	3:00	3:00	3:00	3:08
07-Apr	42.8	5:00		43.6	4:45	5:05	4:50	4:74	23-Jul	42.8	3:30			42.8	3:00	3:00	3:00	3:00
08-Apr	42.8	3:45		42.8	5:00	4:50	5:00	4:45	24-Jul	42.8	3:15			42.8	3:00	3:30	3:00	3:11
09-Apr	42.8	4:00		42.8	4:15	4:00	4:00	4:15	25-Jul	42.8	3:00			42.8	3:45	3:00	3:30	3:38
10-Apr	42.8	4:30		42.8	5:00	4:30	4:30	4:40	26-Jul	42.8	3:30			42.8	3:30	3:30	3:30	3:30
11-Apr	42.8	5:00		43.8	5:00	5:00	4:30	4:63	27-Jul	42.8	3:30	3:30		42.8	3:30	3:30	3:30	3:30
12-Apr	42.8	4:00		42.8	4:15	4:30	4:00	4:30	28-Jul	42.8	3:30	3:30		42.8	3:30	1:45	3:00	3:07
13-Apr	42.8	3:30	4:00	42.8	4:30	4:00	4:30	4:07	29-Jul	42.8	3:30	3:30		42.8	3:30	3:30	3:30	3:30
14-Apr	42.8	4:30	4:30	42.8	4:30	4:30	4:30	4:30	30-Jul	42.8	3:30	3:30		42.8	3:30	3:30	3:30	3:30
15-Apr	42.8	4:30	4:00	42.8	4:30	4:30	4:30	4:34	31-Jul	42.8	3:30			42.8	3:45	3:30	3:30	3:33
16-Apr	42.8	4:30	4:30	42.8	4:30	4:30	4:30	4:30	01-Aug	42.8	3:30			42.8	3:30	3:30	2:15	2:78
17-Apr	42.8	4:30		42.8	4:30	4:30	4:30	4:30	02-Aug	42.8	3:00			42.8	3:15	2:30	2:30	2:44
18-Apr	42.8	4:30	4:30	43.8	4:30	4:30	4:30	4:30	03-Aug	42.8	2:00	3:30		42.8	3:30	2:30	2:15	2:17
19-Apr	42.8	4:30	4:30	42.8	4:30	4:30	4:30	4:30	04-Aug	42.8	3:15			42.8	3:30	3:00	2:30	2:44
20-Apr	46.7	4:30	4:30	46.7	4:30	4:30	4:30	4:30	05-Aug	42.8	3:30			42.8	3:30	2:30	2:30	2:30
21-Apr	42.8	4:30	4:30	42.8	4:30	4:30	4:30	4:30	06-Aug	42.8	3:30			42.8	3:30	2:30	2:30	2:30
22-Apr	46.7	4:00	4:30	46.7	4:30	4:30	4:30	4:34	07-Aug	42.8	3:00			42.8	3:30	2:30	2:30	2:48
23-Apr	42.8	4:30	4:30	42.8	4:00	4:30	4:30	4:24	08-Aug	42.8	3:30			42.8	3:30	3:30	3:30	3:30
24-Apr	54.3	4:00	4:30	54.3	4:30	4:30	4:30	4:34	09-Aug	42.8	3:30			42.8	3:30	3:00	3:00	2:65
25-Apr	42.8	4:00	4:30	42.8	4:30	4:30	4:30	4:75	10-Aug	42.8	3:30			42.8	3:00	2:30	3:00	2:85
26-Apr	42.8	4:30	4:30	42.8	4:30	4:30	4:15	4:30	11-Aug	42.8	2:75			42.8	3:00	3:00	3:00	2:81
27-Apr	42.8	4:00	4:00	42.8	4:00	4:00	3:45	3:90	12-Aug	42.8	3:00			42.8	2:45	3:00	3:00	2:98
28-Apr	42.8	3:50	4:00	42.8	3:45	3:50	4:00	3:74	13-Aug	42.8	3:30			42.8	2:50	3:00	3:00	2:75
29-Apr	42.8	3:50	4:00	42.8	3:50	3:00	4:00	3:50	14-Aug	42.8	3:00			42.8	2:30	3:00	3:00	2:84
30-Apr	42.8	4:00	4:00	42.8	3:30	4:50	4:00	3:82	15-Aug	42.8	3:00			42.8	3:00	3:00	3:00	3:00
01-May	42.8	4:00	4:00	42.8	4:00	4:15	4:50	4:11	16-Aug		3:00				3:00	3:00		3:00
02-May	42.8	3:30	4:30	42.8	4:00	4:00	4:00	3:96	17-Aug	42.8	3:00			42.8	3:00			3:00
03-May	42.8	4:00	3:45	42.8	4:00	4:00	4:00	3:93	18-Aug		3:00				3:00	3:00	3:00	3:00
04-May	42.8	4:00	4:00	42.8	4:00	3:45	4:00	3:91	19-Aug	42.8	3:00			42.8	3:00	3:00		3:00
05-May	42.8	3:30	4:00	42.8	3:30	3:45	3:30	3:47	20-Aug		3:00				3:00	3:00		3:00
06-May	42.8	3:30	3:00	42.8	4:00	4:00	3:45	3:83	21-Aug	42.8	3:00			42.8	3:00	3:00		3:00
07-May	42.8	4:00	3:30	42.8	3:30	4:00	4:30	3:98	22-Aug		3:00				3:00	3:00		3:00
08-May	42.8	3:30	3:30	42.8	3:15	3:30	3:30	3:39	23-Aug	42.8	3:00			42.8	3:00	3:00	3:00	3:00
09-May	42.8	3:00	3:30	42.8	4:00	4:00	4:00	3:88	24-Aug		3:00				3:00	3:00	3:00	3:00
10-May	46.7	3:00	3:00	46.7	4:00	4:00	4:00	3:80	25-Aug	42.8	3:00			42.8	3:30	3:00		3:10
11-May	42.8	3:00	3:30	42.8	4:00	4:00	4:00	3:73	26-Aug		3:00				3:30	3:00		3:10
12-May	42.8	3:00	3:00	42.8	3:00	3:00	3:45	3:41	27-Aug	42.8	3:00			42.8	3:00	3:00		3:00
13-May	42.8	4:00	4:00	42.8	3:00	3:00	4:00	3:83	28-Aug		3:00				3:00	3:00		3:00
14-May	42.8	4:00	4:00	42.8	4:00	4:00	4:00	4:00	29-Aug	42.8	3:00			42.8	3:00	3:00		3:00
15-May	46.7	4:00	4:00	46.7	4:15	4:00	4:00	4:10	30-Aug		3:00				3:00			3:00
16-May	42.8	4:00	3:00	42.8	3:00	3:00	3:50	3:50	31-Aug	42.8	3:00			42.8	3:00			3:00
17-May	42.8	4:00	3:30	42.8	4:00	4:00	3:50	3:90	01-Sep		3:00				3:00			3:00
18-May	42.8	4:30	4:00	42.8	3:50	4:00	3:30	3:86	02-Sep	42.8	3:00			42.8	3:00			3:00
19-May	42.8	4:15	4:30	42.8	3:50	4:00	4:00	3:98	03-Sep		3:00				3:00			3:00
20-May	42.8	3:00	3:00	3:15	42.8	3:50	4:00	3:50	3:30	04-Sep	42.8	3:00			42.8	3:00			3:00
21-May	42.8	3:50	3:00	3:30	42.8	4:00	3:45	3:50	3:48	05-Sep		3:00				3:00			3:00
22-May	42.8	3:30	4:00	3:00	42.8	3:50	3:00	3:50	3:66	06-Sep	42.8	3:00			42.8	3:00			3:00
23-May	42.8	3:00	4:00	3:45	42.8	4:00	4:00	3:50	3:68	07-Sep		3:00				3:00			3:00
24-May	42.8	4:00	4:00	3:00	42.8	3:30	3:00	3:50	3:63	08-Sep	42.8	3:00			42.8	3:00			3:00
25-May	42.8	3:45			42.8	3:00	3:45	3:35	3:75	09-Sep		3:00				3:00			3:00
26-May	42.8	3:00			42.8	4:00	4:00	4:00	3:75	10-Sep	42.8	3:00			42.8	3:00			3:00
27-May	42.8	3:00	3:50		42.8	4:30	4:00	4:00	3:76	11-Sep		3:00				3:00			3:00
28-May	42.8	3:50	4:00		42.8	4:00	4:00	3:50	3:80	12-Sep	42.8	3:00			42.8	3:00			3:00
29-May	42.8	4:00	4:70		42.8	4:00	4:00	3:70	3:88	13-Sep		3:00				3:00			3:00
30-May	42.8	3:30	3:00		42.8	4:00	3:45	4:00	3:54	14-Sep	42.8	3:00			42.8	2:15			2:88
31-May	42.8	3:30	4:00		42.8	4:00	4:00	3:45	3:74	15-Sep		3:30				3:30			2:80
01-Jun	42.8	3:30	3:30		42.8	3:45	4:00	4:00	3:81	16-Sep	42.8	3:00			42.8	3:00			3:00
02-Jun	42.8	4:00	3:30	4:00	42.8	3:00	4:00	4:00	3:72	17-Sep		3:00				3:00			3:00
03-Jun	42.8	3:30	4:00		42.8	3:00	4:00	3:75	3:81	18-Sep	42.8	3:00			42.8	3:00			3:00
04-Jun	42.8	3:30	3:30		42.8	3:75	3:00	3:00	3:11	19-Sep		3:00				3:00			3:00
05-Jun	42.8	3:30	3:30	4:30	42.8	3:70	4:00	4:00	3:86	20-Sep	42.8	3:00			42.8	3:30			2:88
06-Jun	42.8	3:30	3:00		42.8	3:70	4:30	4:30	3:92	21-Sep		3:00				3:00			3:00
07-Jun	42.8	3:30	3:30		42.8	3:30	4:00	3:00	3:30	22-Sep	42.8	3:00			42.8	3:00			3:00
08-Jun	42.8	4:00	3:30		42.8	4:00	4:00	4:00	3:98	23-Sep		3:00				3:00			3:00
09-Jun	42.8	4:00	3:30		42.8	4:70	4:30	4:30	4:07	24-Sep	42.8	3:00			42.8	3:00			3:00
10-Jun	42.8	4:00	4:00		42.8	4:15	4:30	4:00	4:09	25-Sep		3:00				3:00			3:00
11-Jun	42.8	3:30	4:00		42.8	4:00	4:00	4:00	3:98	26-Sep	42.8	3:00			42.8	3:00			3:00
12-Jun	42.8	4:00	3:00		42.8	4:00	3:30	4:00	3:97	27-Sep		3:00				3:00			3:00
13-Jun	42.8	3:30			42.8	4:00	4:00	4:00	3:93	28-Sep	42.8	3:00			42.8	3:00	3:00		3:00
14-Jun	42.8	4:00	3:30		42.8	4:00	4:00	4:00	3:98	29-Sep		3:00				3:00			3:00
15-Jun	42.8	4:00			42.8	4:00	4:00	3:30	3:92	30-Sep	42.8	3:00			42.8	3:30			3:15
16-Jun	42.8	4:00			42.8	4:00	4:30	4:30	4:15	01-Oct		3:00				3:30			3:15
17-Jun	42.8	4:00			42.8	4:00	4:00	4:00	4:00	02-Oct	42.8	3:00			42.8	3:00			3:00
18-Jun	42.8	4:00			42.8	4:00	4:00	4:00	4:00	03-Oct		3:00				3:00			3:00
19-Jun	42.8	4:00			42.8	4:00	4:00	4:00	4:00	04-Oct	42.8	3:00			42.8	3:00			3:00
20-Jun	42.8	4:00			42.8	4:00	4:00	4:00	4:00	05-Oct		3:00				3:00			3:00
21-Jun	42.8	4:30			42.8	4:10	4:30	4:30	4:23	06-Oct	42.8	3:00			42.8	3:15			3:05
22-Jun	42.8	4:15			42.8	4:30	4:30		4:22	07-Oct		3:00				3:00			3:00
23-Jun	42.8	4:15			42.8	4:00	4:00		4:06	08-Oct	42.8	3:00			42.8	3:15			3:08
24-Jun	42.8	4:00			42.8	4:00	4:00		4:00	09-Oct		3:00				3:15			3:05
25-Jun	42.8	4:00			42.8	4:15	4:70		4:17	10-Oct	42.8	3:00			42.8	3:00			3:00
26-Jun	42.8	4:02			42.8	4:00			4:00	11-Oct		3:00				3:15			3:05
27-Jun	42.8	4:30			42.8	4:15	4:00		4:15	12-Oct	42.8	3:15			42.8	3:15			3:13
28-Jun	42.8	4:15			42.8	4:15	4:00		4:10	13-Oct		3:00				3:15			3:08
29-Jun	42.8	4:70			42.8	4:30	4:00	4:10	4:15	14-Oct	42.8	3:00			42.8	3:15			3:05
30-Jun	42.8	4:00			42.8	4:00	4:10	4:00	4:02	15-Oct		3:00				3:08			3:08
01-Jul	42.8	4:10	4:00		42.8	4:15	4:70	4:15	4:13	16-Oct	42.8	3:00			42.8	3:15			3:05
02-Jul	42.8	4:00			42.8	4:00	4:00		4:00	17-Oct		3:00				3:30			3:16
03-Jul	42.8	4:00			42.8	4:00	4:00		4:00	18-Oct	42.8	3:00			42.8	3:15			3:08
04-Jul	42.8	4:10			42.8	4:00	4:00		4:03	19-Oct		3:15				3:30			3:23
05-Jul	42.8	4:00			42.8	4:00			4:00	20-Oct	42.8	3:30			42.8	3:15			3:10
06-Jul	42.8	4:00			42.8	4:00			4:00	21-Oct		3:00				3:15			3:08
07-Jul	42.8	4:00			42.8	4:00		4:00	4:00	22-Oct	42.8	3:00			42.8	3:30			3:10
08-Jul	42.8	4:00			42.8	4:00			4:00	23-Oct		3:15				3:30			3:10
09-Jul	42.8	4:00			42.8	4:00	4:00		4:00	24-Oct	42.8	3:00			42.8	3:15			3:08
10-Jul	42.8	4:00			42.8	4:00	4:00		4:00	25-Oct		3:00				3:10			3:05
11-Jul	42.8	4:00			42.8	4:00			4:00	26-Oct	42.8	3:15			42.8	3:15			3:15
12-Jul	42.8	4:00			42.8	4:00			4:00	27-Oct		3:10				3:30			3:15
13-Jul	42.8	3:30			42.8	4:00			3:96	28-Oct	42.8	3:00			42.8	3:15			3:09
14-Jul	42.8	3:00			42.8	4:00			3:90	29-Oct		3:00				3:15			3:09
15-Jul	42.8	3:30			42.8	3:30	3:30	3:10	3:75	30-Oct	42.8	3:00			42.8	3:15			3:09
16-Jul	42.8	3:00			42.8	4:00	3:00	3:02	3:75	31-Oct		3:00				3:30			3:10
17-Jul	42.8	3:30			42.8	3:30	3:00	3:30	3:30	01-Nov	42.8	3:00			42.8	3:30			3:10
minimum	42.8	3:00	3:00	3:00	42.8	2:50	2:40	2:35	2:79	minimum	42.8	2:00	2:30	0:00	42.8	2:15	1:45	2:00	2:07
maximum	54.3	5:00	4:30	5:00	54.3	5:00	5:00	5:00	4:63	maximum	42.8	3:30	2:30	0:00	42.8	3:30	3:30	3:30	3:26
average	43.0	3:58	3:77	3:58	43.0	3:50	3:58	3:52	3:51	average	42.8	2:52	2:30	0:00	42.8	2:51	2:78	2:58	2:52

Season Summary

	A & B tanks Time	A & B tanks ppm
minimum	1:45	42.8
maximum	5:00	54.3
average	3:50	42.9
Total days	214	

At or Above 68° F June 3 - Oct 16, 1996

	A & B tanks Time	A & B tanks ppm
minimum	1:45	42.8
maximum	4:30	42.8
average	3:23	42.9
Total days	136	

Appendix Table 3. Re-circulating anesthetic (MS222) concentrations - McNary 1995

Date	ppm Starting	Addition	Date	ppm Starting	Addition	Date	ppm Starting	Addition	Date	ppm Starting	Addition	Date	ppm Starting	Addition	Date	ppm Starting	Addition
28-Mar	22.5		15-May	22.5		02-Jul	17.0		19-Aug	21.1		06-Oct	22.5		23-Nov	9.0	
29-Mar	22.5		16-May	21.5		03-Jul	17.0		20-Aug	22.5		07-Oct	22.5		24-Nov	18.0	
30-Mar	22.5		17-May	22.5		04-Jul	16.1		21-Aug	22.5		08-Oct	22.5		25-Nov	18.0	
31-Mar	22.5		18-May	21.5		05-Jul	17.0		22-Aug	21.1		09-Oct	22.5		26-Nov	18.0	
01-Apr	22.5		19-May	22.5		06-Jul	16.1		23-Aug	22.5		10-Oct	22.5		27-Nov	18.0	
02-Apr	22.5		20-May	21.5		07-Jul	17.0		24-Aug	25.3		11-Oct	23.4		28-Nov	18.0	
03-Apr	22.5		21-May	22.5		08-Jul	16.1		25-Aug	22.5		12-Oct	22.5		29-Nov	22.5	
04-Apr	22.5		22-May	22.5		09-Jul	17.0		26-Aug	25.3		13-Oct	22.5		30-Nov	22.5	
05-Apr	22.5		23-May	21.5		10-Jul	17.0		27-Aug	22.5		14-Oct	22.5		01-Dec	22.5	
06-Apr	21.5		24-May	22.5		11-Jul	16.1		28-Aug	22.5		15-Oct	22.5		02-Dec	22.5	
07-Apr	22.5		25-May	21.5		12-Jul	17.0		29-Aug	21.1		16-Oct	23.4		03-Dec	22.5	
08-Apr	21.5		26-May	22.5		13-Jul	16.1		30-Aug	22.5		17-Oct	23.4		04-Dec	22.5	
09-Apr	22.5		27-May	21.5		14-Jul	17.0		31-Aug	21.1		18-Oct	22.5		05-Dec	22.5	
10-Apr	22.5		28-May	22.5		15-Jul	16.1		01-Sep	22.5		19-Oct	22.5		06-Dec	22.5	
11-Apr	21.5		29-May	21.5		16-Jul	17.0		02-Sep	22.5		20-Oct	22.5		07-Dec	22.5	
12-Apr	22.5		30-May	21.5		17-Jul	17.0		03-Sep	22.5		21-Oct	22.5		08-Dec	22.5	
13-Apr	21.5		31-May	21.5		18-Jul	17.0		04-Sep	27.0		22-Oct	23.4		09-Dec	22.5	
14-Apr	22.5		01-Jun	21.5		19-Jul	17.0		05-Sep	22.5		23-Oct	22.5		10-Dec	22.5	
15-Apr	21.5		02-Jun	21.5		20-Jul	16.1		06-Sep	22.5		24-Oct	23.4		11-Dec	22.5	
16-Apr	22.5		03-Jun	21.5		21-Jul	17.0		07-Sep	22.5		25-Oct	22.5		12-Dec	22.5	
17-Apr	22.5		04-Jun	21.5		22-Jul	16.1		08-Sep	27.0		26-Oct	22.5				
18-Apr	21.5		05-Jun	21.5		23-Jul	17.0		09-Sep	22.5		27-Oct	22.5				
19-Apr	22.5		06-Jun	21.5		24-Jul	17.0		10-Sep	22.5		28-Oct	22.5				
20-Apr	21.5		07-Jun	21.5		25-Jul	16.1		11-Sep	27.9		29-Oct	22.5				
21-Apr	22.5		08-Jun	21.5		26-Jul	17.0		12-Sep	27.0		30-Oct	23.4				
22-Apr	21.5		09-Jun	21.5		27-Jul	16.1		13-Sep	28.8		31-Oct	23.4				
23-Apr	22.5		10-Jun	21.5		28-Jul	18.8		14-Sep	22.5		01-Nov	23.5				
24-Apr	22.5		11-Jun	21.5		29-Jul	21.1		15-Sep	22.5		02-Nov	22.5				
25-Apr	21.5		12-Jun	21.5		30-Jul	22.5		16-Sep	22.5		03-Nov	22.5				
26-Apr	22.5		13-Jun	21.5		31-Jul	19.4		17-Sep	19.8		04-Nov	22.5				
27-Apr	21.5		14-Jun	22.5		01-Aug	17.8		18-Sep	26.1		05-Nov	22.5				
28-Apr	22.5		15-Jun	21.5		02-Aug	19.4		19-Sep	22.5		06-Nov	22.5				
29-Apr	21.5		16-Jun	22.5		03-Aug	17.8		20-Sep	24.3		07-Nov	22.5				
30-Apr	22.5		17-Jun	21.5		04-Aug	19.4		21-Sep	22.5		08-Nov	22.5				
01-May	22.5		18-Jun	22.5		05-Aug	21.1		22-Sep	22.5		09-Nov	22.5				
02-May	21.5		19-Jun	22.5		06-Aug	22.5		23-Sep	22.5		10-Nov	22.5				
03-May	22.5		20-Jun	21.5		07-Aug	18.8		24-Sep	22.5		11-Nov	22.5				
04-May	21.5		21-Jun	17.0	4.1	08-Aug	18.3		25-Sep	22.5		12-Nov	22.5				
05-May	22.5		22-Jun	16.2		09-Aug	18.8		26-Sep	22.5		13-Nov	22.5				
06-May	21.5		23-Jun	17.0	2.0	10-Aug	18.3		27-Sep	22.5		14-Nov	22.5				
07-May	22.5		24-Jun	16.2		11-Aug	18.8		28-Sep	22.5		15-Nov	22.5				
08-May	22.5		25-Jun	17.0		12-Aug	21.1		29-Sep	22.5		16-Nov	22.5				
09-May	21.5		26-Jun	17.0		13-Aug	22.5		30-Sep	27.0		17-Nov	22.5				
10-May	22.5		27-Jun	16.2		14-Aug	19.4		01-Oct	27.0		18-Nov	22.5				
11-May	21.5		28-Jun	17.0		15-Aug	17.8		02-Oct	22.5		19-Nov	22.5				
12-May	22.5		29-Jun	16.2		16-Aug	19.4		03-Oct	22.5		20-Nov	22.5				
13-May	25.8		30-Jun	17.0		17-Aug	17.8		04-Oct	22.5		21-Nov	22.5				
14-May	22.5		01-Jul	16.2		18-Aug	22.5		05-Oct	22.5		22-Nov	22.5				
avg	22.2	0.0	avg	20.6	3.1	avg	18.0	0.0	avg	23.3	0.0	avg	22.7	0.0	avg	20.7	0.0
min	21.5	0.0	min	16.2	2.0	min	16.1	0.0	min	19.8	0.0	min	22.5	0.0	min	9.0	0.0
max	25.8	0.0	max	22.5	4.1	max	22.5	0.0	max	28.8	0.0	max	23.4	0.0	max	22.5	0.0

Year Summary	Starting	Addition
Average:	21.4	3.1
Minimum:	9.0	2.0
Maximum:	28.8	4.1

Appendix Table 4. Re-circulating anesthetic (MS222) concentrations - Lower Monumental 1995.

Date	ppm		Date	ppm		Date	ppm		Date	ppm		Date	ppm	
	Starting	Addition		Starting	Addition		Starting	Addition		Starting	Addition		Starting	Addition
02-Apr	27.5		20-May	24.4		07-Jul	24.4		24-Aug			11-Oct		
03-Apr	24.4		21-May	29.6		08-Jul	24.4		25-Aug	24.4		12-Oct	24.4	
04-Apr	24.4		22-May	24.4		09-Jul	24.4		26-Aug			13-Oct		
05-Apr	24.4		23-May	24.4		10-Jul	24.4		27-Aug	24.4		14-Oct	24.4	
06-Apr	24.4		24-May	24.4		11-Jul	24.4		28-Aug			15-Oct		
07-Apr	24.4		25-May	24.4		12-Jul	24.4		29-Aug	24.4		16-Oct	24.4	
08-Apr	24.4		26-May	29.6		13-Jul	24.4		30-Aug			17-Oct		
09-Apr	24.4		27-May	24.4		14-Jul	24.4		31-Aug	24.4		18-Oct	24.4	
10-Apr	24.4		28-May	24.4		15-Jul	24.4		01-Sep			19-Oct		
11-Apr	24.4		29-May	24.4		16-Jul	24.4		02-Sep	24.4		20-Oct	24.4	
12-Apr	24.4		30-May	24.4		17-Jul	24.4		03-Sep			21-Oct		
13-Apr	24.4		31-May	29.6		18-Jul	24.4		04-Sep	24.4		22-Oct		
14-Apr	24.4		01-Jun	24.4		19-Jul	24.4		05-Sep			23-Oct		
15-Apr	24.4		02-Jun	24.4		20-Jul	24.4	13.9	06-Sep	24.4		24-Oct		
16-Apr	24.4		03-Jun	24.4		21-Jul	24.4		07-Sep			25-Oct		
17-Apr	24.4		04-Jun	24.4		22-Jul	24.4		08-Sep	24.4		26-Oct		
18-Apr	24.4		05-Jun	24.4	13.9	23-Jul	24.4		09-Sep			27-Oct		
19-Apr	24.4		06-Jun	24.4		24-Jul	24.4		10-Sep	24.4		28-Oct		
20-Apr	24.4		07-Jun	24.4		25-Jul	24.4		11-Sep			29-Oct		
21-Apr	24.4		08-Jun	24.4	13.9	26-Jul	24.4		12-Sep	24.4		30-Oct		
22-Apr	24.4		09-Jun	24.4		27-Jul	24.4		13-Sep			31-Oct		
23-Apr	24.4		10-Jun	24.4		28-Jul	24.4		14-Sep	24.4		01-Nov		
24-Apr	24.4		11-Jun	24.4		29-Jul	24.4		15-Sep					
25-Apr	24.4		12-Jun	24.4		30-Jul	24.4		16-Sep	24.4				
26-Apr	24.4		13-Jun	24.4		31-Jul	24.4		17-Sep					
27-Apr	24.4		14-Jun	24.4		01-Aug	24.4		18-Sep	24.4				
28-Apr	24.4		15-Jun	24.4		02-Aug	24.4		19-Sep					
29-Apr	24.4		16-Jun	24.4		03-Aug	24.4		20-Sep	24.4				
30-Apr	24.4		17-Jun	24.4		04-Aug	24.4		21-Sep					
01-May	24.4		18-Jun	24.4		05-Aug	24.4		22-Sep	24.4				
02-May	24.4		19-Jun	24.4		06-Aug	24.4		23-Sep					
03-May	35.0	13.9	20-Jun	24.4		07-Aug	24.4		24-Sep	24.4				
04-May	24.4		21-Jun	24.4		08-Aug	24.4		25-Sep					
05-May	24.4		22-Jun	24.4		09-Aug	24.4		26-Sep	24.4				
06-May	29.6	13.9	23-Jun	24.4		10-Aug	24.4		27-Sep					
07-May	24.4		24-Jun	24.4		11-Aug	24.4		28-Sep	24.4				
08-May	24.4		25-Jun	24.4		12-Aug	24.4		29-Sep					
09-May	24.4		26-Jun	24.4		13-Aug	24.4		30-Sep	24.4				
10-May	29.6	13.9	27-Jun	24.4		14-Aug	24.4		01-Oct					
11-May	24.4	13.9	28-Jun	24.4		15-Aug	24.4		02-Oct	24.4				
12-May	29.6		29-Jun	24.4		16-Aug			03-Oct					
13-May	24.4		30-Jun	24.4		17-Aug	24.4		04-Oct	24.4				
14-May	29.6		01-Jul	24.4		18-Aug			05-Oct					
15-May	24.4		02-Jul	24.4		19-Aug	24.4		06-Oct	24.4				
16-May	29.6		03-Jul	24.4		20-Aug			07-Oct					
17-May	24.4		04-Jul	24.4		21-Aug	24.4		08-Oct	24.4				
18-May	29.6		05-Jul	24.4		22-Aug			09-Oct					
19-May	24.4		06-Jul	24.4		23-Aug	24.4		10-Oct	24.4				
avg.	25.4	13.9	avg.	24.8	13.9	avg.	24.4	13.9	avg.	24.4	0.0	avg.	24.4	0.0

note: Starting August 16 sample examinations took place every other day.

note: Starting October 21 no anesthetics were added to the re-circutation tank due to low numbers of fish.

Year Summary	ppm	
	Starting	Addition
Average	24.8	13.9
Minimum	24.4	13.9
Maximum	35.0	13.9