Abundance and Microhabitat Selection of Juvenile *Oncorhynchus mykiss* and Juvenile Chinook Salmon (*O. tshawytscha*) Within Shitike Creek, Oregon at Varying Fish Densities and Presence or Absence of Bull Trout (*Salvelinus confluentus*).

Progress Report Fiscal Year 2005 and 2006 Work Plan

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This assessment addresses objectives and obligations of the cooperative agreement between the U.S. Fish and Wildlife Service and Confederated Tribes of the Warm Springs Reservation of Oregon – FWS Agreement Number 133102J185.

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Introduction

In 2002, the Service and the Confederated Tribes of the Warm Springs Reservation of Oregon (CTWSRO) received funding to evaluate the outplanting program in Shitike Creek and provide information on ecological interactions between spring Chinook and other fish species (FONS Project Number 1999-010). One aspect of the evaluation is to determine habitat use and ecological interactions between juvenile spring Chinook salmon (*Oncorhynchus tshawytscha*), juvenile summer steelhead or rainbow trout (*O. mykiss*), and bull trout (*Salvelinus confluentus*) in Shitike Creek. In 2003, the Service and the CTWSRO implemented a summer snorkel survey to specifically evaluate microhabitat selection of juvenile salmonids and investigate ecological interactions from the Chinook salmon outplanting program. The results of the evaluation will be used by Service personnel and managers of natural resources to mitigate and reduce ecological interactions between hatchery and wild fish. The following project objectives were proposed for fiscal year 2003-2005.

Objectives:

1) Identify microhabitat selection (depth, water velocity, species association, cover use, temperature) by juvenile Chinook salmon, juvenile *O. mykiss* and bull trout within Shitike Creek at varying densities.

2) Determine if there is a relationship between microhabitat selection and fish density in slow and fast-water habitat units.

<u>Potential Management Action:</u> Adjust or manipulate the number or location of adult Chinook outplantings to maximize number of Chinook produced and minimize density effects on microhabitat selection of juvenile *O. mykiss* or bull trout.

Input from project cooperators, the CTWSRO Fish and Wildlife Committee and biometric specialists slightly altered methodologies and actions proposed within previous Annual Reports and work plans. Results presented in this report have addressed project objectives and management actions.

Methods

Objective 1: Identify microhabitat selection by juvenile Chinook salmon, juvenile O. mykiss and Bull trout within Shitike Creek at varying densities.

Snorkel surveys were conducted during 2003-2005. In 2003 and 2004, the surveys had two purposes; identify microhabitat selection of juvenile Chinook salmon, juvenile *O. mykiss*, and bull trout within Shitike Creek and to estimate abundance of these species. The 2005 snorkel survey had only one purpose, to estimate abundance of juvenile Chinook salmon, juvenile *O. mykiss*, and bull trout within Shitike Creek. The snorkel surveys conducted in 2003-2005 were purposely designed to be similar to a previous abundance survey conducted by Oregon Department of Fish and Wildlife during 2001(ODFW, Dambacher 2002).

Snorkel surveys completed in 2003 and 2004 consisted of a two, three or four person snorkel crew performing visual observation and enumeration of juvenile Chinook salmon, juvenile *O. mykiss* and bull trout. Slow-water habitat units, such as a pool or large backwater area, were randomly selected for snorkel observation in three of the five identified reaches from the 2001 snorkel survey (Dambacher 2002, Figure 1). Based on results of the 2001 abundance survey, a greater percentage of the juvenile Chinook salmon and juvenile *O. mykiss* populations occur in slow-water habitat rather than fast-water habitat (Figures 2 and 3). For FY 2003 and 2004 only slow-water habitat units were sampled during the microhabitat and abundance survey conducted by the Service

In each slow-water unit, a bounded count was performed by snorkelers to estimate fish abundance. The methodology of the bounded counts for juvenile abundance was performed by snorkelers during the 2001 ODFW survey as well. In this previous juvenile salmonid abundance survey, a number of fast and slow water habitats were identified, snorkeled and abundance estimates generated for each sampled habitat unit throughout the distribution of juvenile Chinook salmon in Shitike Creek (Figure 1). A change to the past survey abundance methodology used in Shitike Creek by ODFW (Dambacher 2002) involved a modification to the bounded counts estimator used to estimate juvenile fish abundance when performing snorkel counts (Robson and Whitlock 1954; Routledge 1982). The bounded counts estimator is

$$\hat{Y} = X_m + (X_m - X_{m-1})$$

where,

$\hat{Y}$ = abundance estimate for unit

X_m = highest count

X_{m-1} = next highest count

Dambacher (2002) found that in most units sampled for juvenile abundance, only counts made by snorkelers during the first 3 of 4 passes were used in the bounded counts estimator therefore, only 3 passes were required for snorkelers during the bounded counts performed in slow-water habitat units in abundance surveys. In each slow-water unit, snorkelers would enter in the downstream edge of the unit enumerating fish on dive slates into species (*O. mykiss*, Chinook salmon, bull trout or other) and age categories (0+, 1+ and greater) as they slowly moved upstream. Only fish greater than 50 mm were enumerated by snorkelers. In slow-water units where more than one snorkeler was needed to effectively enumerate juvenile fish, counts between snorkelers were summed together for each pass. Snorkelers would switch positions within slow-water units after each pass to reduce bias in fish enumeration.

Validation of a bounded count estimate on a slow-water or fast-water habitat unit is traditionally conducted using multiple pass electrofishing (Hankin and Reeves 1988). In an effort to calibrate snorkel counts, reduce stress on juvenile fish and conserve man-hours, mark-recapture calibration was attempted (Table 1). Mark-recapture estimates calculated for each slow-water unit were considered the "true" number of Chinook salmon within the slow-water habitat unit for the calibration of snorkel counts. None of the slow-water habitat units snorkeled in FY 2003 were calibrated using the mark-recapture protocol, but calibrations did occur in 2004 and 2005.

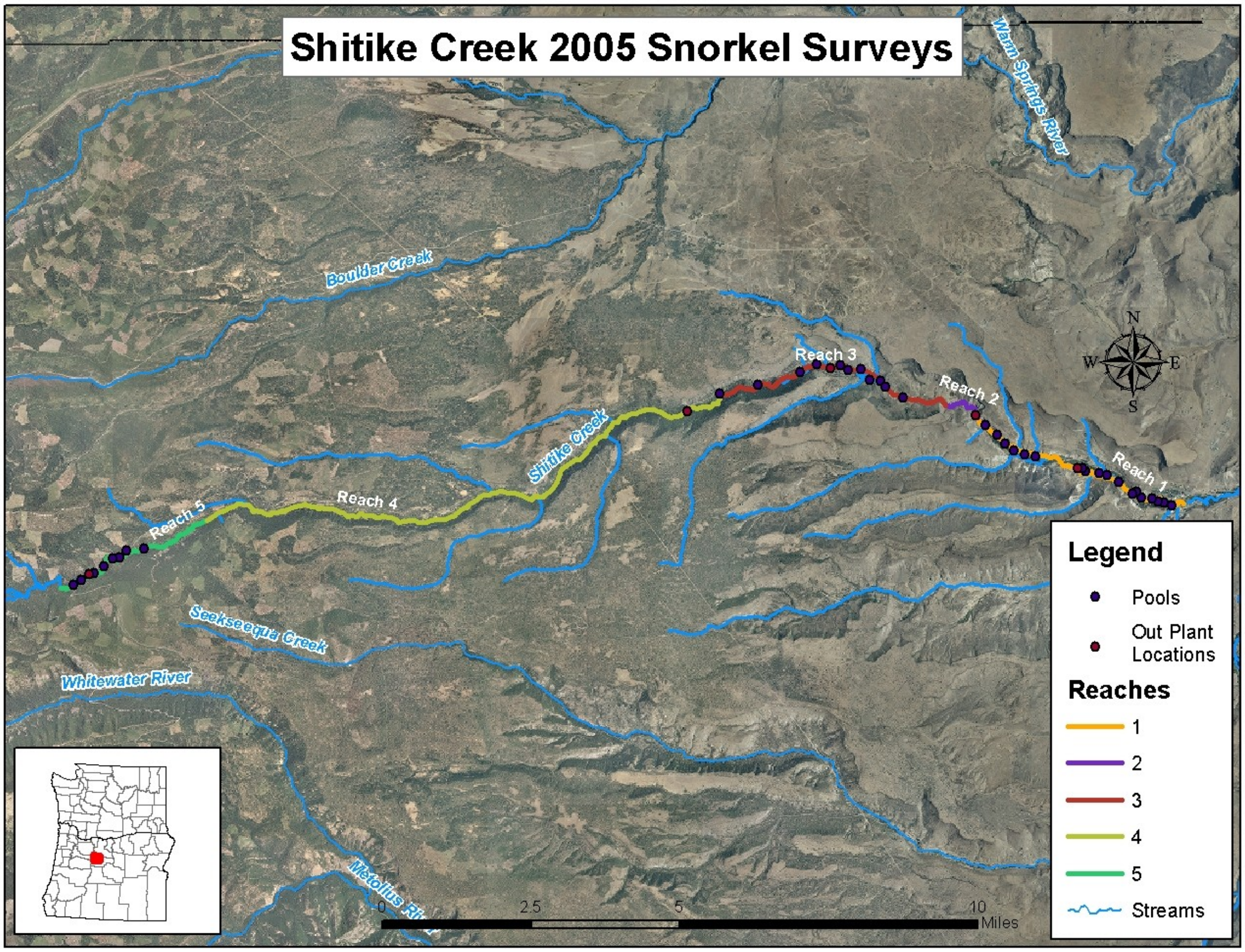


Figure 1. Shitike Creek basin, tributary to the Deschutes River, in the Confederated Tribes of the Warm Springs Reservation, Oregon. Reach 1 includes the area from the Community Center to Thompson's Bridge. Reach 2 includes Thompson's Bridge to Headworks. Reach 3 includes the area from Headworks to Bennetts. Reach 4 includes the area known as Upper Crossing. Reach 5 is the area known as Peters Pasture. Pools sampled during 2005 and historical outplant locations of adult Chinook salmon are identified. Map by David Hines, USFWS.

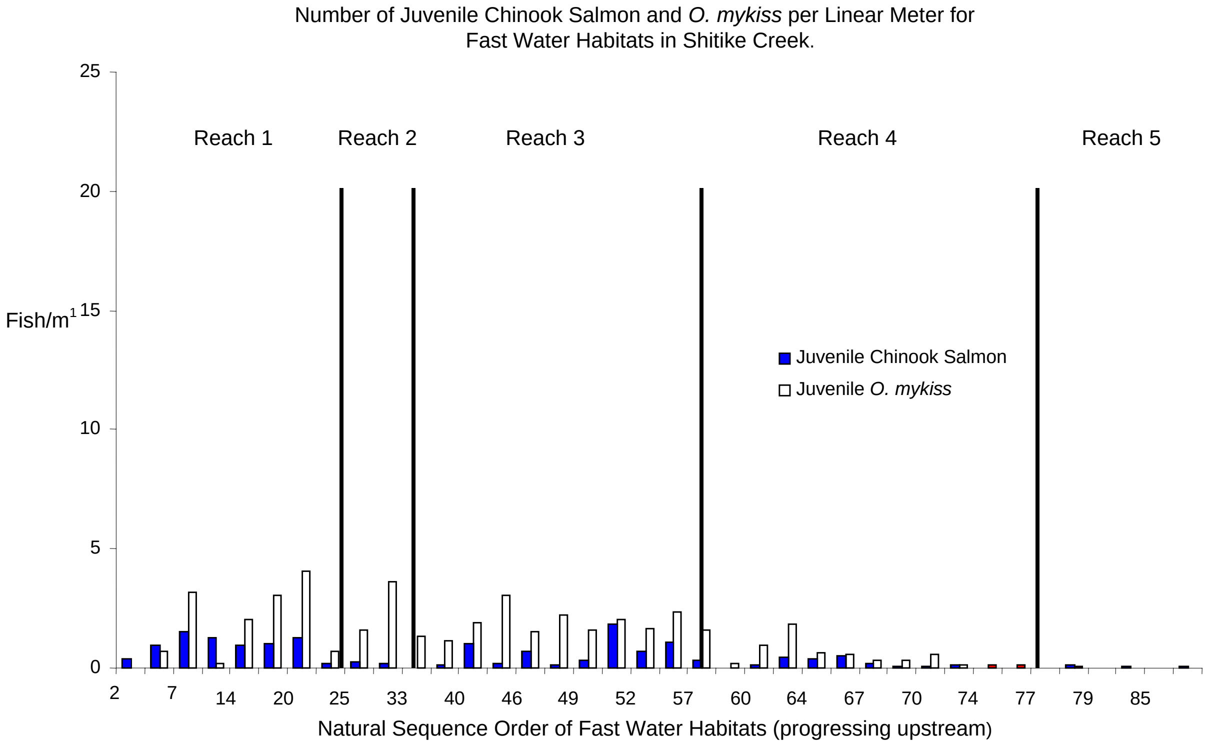


Figure 2. Number of juvenile Chinook salmon and *O. mykiss* per linear meter of fast water habitat units in Shitike Creek, OR 2001. Reach 1 includes the area from the Community Center to Thompson's Bridge. Reach 2 includes Thompson's Bridge to Headworks. Reach 3 includes the area from Headworks to Bennett's. Reach 4 includes the area known as Upper Crossing. Reach 5 is the area from Peters Pasture upstream. Data presented is from Dambacher (2002).

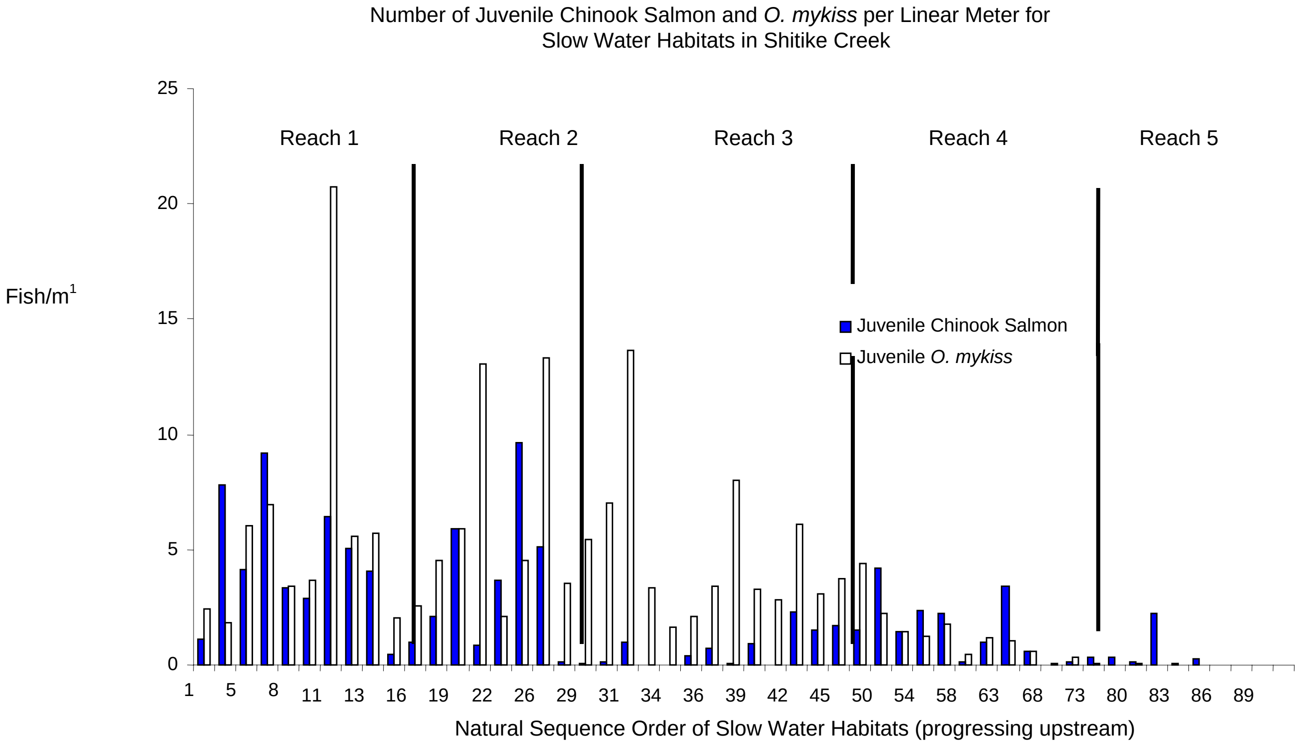


Figure 3. Number of juvenile Chinook salmon and *O. mykiss* per linear meter of slow water habitat units in Shitike Creek, OR during 2001. Reach 1 includes the area from the Community Center to Thompson's Bridge. Reach 2 includes Thompson's Bridge to Headworks. Reach 3 includes the area from Headworks to Bennett's. Reach 4 includes the area known as Upper Crossing. Reach 5 is the area from Peters Pasture upstream. Data presented is from Dambacher (2002).

Table 1. Mark recapture methodology conducted on three randomly selected slow-water habitat units within Shitike Creek, OR. This methodology did not occur in 2003 due to high water temperatures at the time of snorkel surveys in 2003, but did occur in 2004-2005.

Step Number	Procedure	Description
1	Block net unit on up and downstream sections.	Ensures no immigration or emigration from selected slow-water unit during marking procedure or after marked fish are released back into unit
2	Multiple seine pulls through unit while using roe balls as attractant.	A lead snorkeler would attract fish using balls of roe in fine mesh netting and slowly move down stream as crew members with a fine mesh seine moved upstream. At least two seine captures were attempted in each selected unit to maximize catch for marking.
3	Collect fish	Collected fish held in perforated buckets within Shitike Creek to maintain adequate flow. Water temperature will also be monitored. Fish will not be marked or captured in water temperatures that are in excess of 18C, or on days that water temperature could exceed 18C for more than a 2 hour period.
4	Fish marked with a solution of Bismarck Brown Y and released.	Fish placed in a tub of stream water and Bismarck Brown Y solution. Stream water and Bismarck Brown Y mixed to form a 0.007% solution. Fish placed in the solution for 10 minutes then released back into the slow-water unit. The concentration of Bismarck Brown Y solution and immersion time will illicit a mark retention of approximately 2 days, dependent on water quality. Marked fish were placed back to points of capture by survey crews.
5	A 2 hour block of time allows marked fish to acclimate.	Meets assumptions of a mark-recapture procedure, marked fish must exhibit normal behavior and mix with unmarked fish within the unit. Visual observation of marked and unmarked fish did occur and both marked and unmarked fish were observed using similar behaviors (feeding or holding in current).
6	Recapture marked fish using multiple seine pulls through unit using roe balls as attractant and seining.	An enumeration of marked and unmarked individuals within the slow-water unit is tallied to calculate the "true" number of juvenile *O. mykiss* and Chinook salmon within the unit.
7	Block nets removed and correction factor on abundance estimates calculated.	Block nets were removed from the upstream and downstream sections of the slow-water unit to allow immigration and emigration of juvenile salmonids. A correction factor to snorkeling observations was then calculated using an observation probability between bounded count estimates and mark-recapture estimates.

Pools selected for calibration were chosen based on moderate daytime water temperatures (15-18 °C) to reduce handling stress, and for the absence of bull trout, a listed species under the Endangered Species Act. Calibrations were made by applying snorkeler observation probabilities to mark-recapture abundance estimates and followed expansions identical to Dolloff et al. (1993). The effective capture of juvenile *O. mykiss* for mark-recapture estimates was problematic due to their location within slow-water habitat units, their size, and their swimming speed. Often, less than 5% of the bounded count estimate of juvenile *O. mykiss* were captured during the mark recapture abundance estimates, making estimates unreliable and highly variable. During seining, age 1+ and greater juvenile *O.mykiss* actively avoided capture by increasing swimming speed, swimming into deeper sections of the habitat unit, or flipping out of the seine when being pulled out of the water.

In lieu of poor capture of juvenile *O. mykiss* during mark-recapture efforts, the observation probability between bounded counts and mark-recapture estimates of juvenile Chinook salmon was applied to the counts of juvenile *O. mykiss*. This application may artificially inflate the variances around abundance estimates of juvenile *O. mykiss* for several reasons. Juvenile Chinook salmon in Shitike Creek are most often in shallow areas or within cover that can be difficult to accurately observe fish in during the early summer months whereas juvenile *O. mykiss* were often larger than juvenile Chinook salmon at that time and in open, higher velocity water. This open, faster velocity water is often in deeper, more visible sections of a slow-water habitat and easier for a snorkeler to see. For these reason, bounded counts of juvenile *O.mykiss* may actually be more accurate than for juvenile Chinook salmon in Shitike Creek but without accurate and successful calibrations of both species for variance around counts, this is only speculation.

Abundance estimates for juvenile Chinook salmon and juvenile *O. mykiss* in each slow-water unit were calculated using the bounded counts estimator. An average slow-water habitat unit abundance estimate was calculated for each species, in each reach and applied to units not snorkeled. The variance of these estimates has only one stage, the variability between units. In 2003, abundance estimates only have this first stage of variance and are not calibrated by mark-recapture. In 2004 and 2005, validation of snorkel counts using mark-recapture allowed estimates for juvenile Chinook salmon with two stages of variance. A first stage consisted of the bounded count estimate corrected by an observation probability between bounded counts and mark-recapture in a number of slow-water habitat units. The second stage consisted of the variability of snorkel estimates between slow-water units.

Microhabitat variables measured on fish observed in Shitike Creek were variables Underwood et al. (1995) used to determine microhabitat preference (Table 2). Microhabitat information was collected after the completion of the bounded counts in each unit and after a 15 minute period of inactivity within the unit. A snorkeler, or pair of snorkelers depending on the size of the unit, would enter the downstream end of the unit and move upstream randomly selecting a fraction of fish for microhabitat measurements. Only fish undisturbed by the snorkeler were selected for microhabitat observation. Often, observations were made downstream of fish, or groups of fish, with snorkelers recording microhabitat information on diver slates. Snorkelers would displace observed fish after recording most microhabitat information and mark fish locations with a numbered marker. Most microhabitat measurements were made visually by snorkeler after fish observation and location marking was complete. Water velocity, distance to closest cover, and total depth were measured from marker locations using a Flow Mate® Model 2000 Marsh McBirney Flow Meter and tape measure.

Table 2. Microhabitat variables (Underwood et al. 1995) to be collected on randomly selected juvenile *O. mykiss*, Chinook salmon and bull trout within Shitike Creek, OR. Variables measured relate to the selected area the fish inhabits at the time of observation.

Variable	Unit or Category(s)	Description
Species	SST SCS BLT	Steelhead or Rainbow Trout (*Oncorhynchus mykiss*) Spring Chinook Salmon Bull Trout
Age	0+ Post age 0+	SCS – Age 0+ ≤ 115 mm SST – Age 0+ ≤ 90 mm Post age 0+ >90 mm BLT – Age 0+ ≤ 90 mm Post age 0+ >90 mm
Distance from Streambed	Meters (0.1)	Vertical distance from streambed at the time of snorkel observation.
Most Prevalent Substrate Type	Silt or Fines (<2.0 mm) Small Gravel (2.0 – 15 mm) Large Gravel (>15mm – 60mm) Small Cobble (60-130 mm) Large Cobble (120-250 mm) Boulder (>250 mm)NA	Estimated from snorkel observation. The snorkel observation crew will be calibrated at start of microhabitat survey on their identification and classification of these substrate categories
Total Depth	Meters (0.1)	Measured at point of fish location from streambed to surface of water.
Nearest Cover Type	Boulders Undercut Banks Turbulence (Bubble Curtain) Overhead Vegetation Small Woody Debris Large Wood Debris	Cover type will be determined by snorkel observation of fish for a time of at least one minute.
Distance to Nearest Cover Type	Meters (0.1)	Visually estimated from snorkel observation if cover was observed only underwater. If cover could be visually seen above water, distance was measured using a tape measure.
Nearest fish Species	SST SCS BLT Other	Steelhead or Rainbow trout Spring Chinook Salmon Bull Trout Other species present within Shitike Creek such as mountain whitefish or brook trout.
Distance of nearest fish Species	Meters (0.1)	Visually estimated from snorkel observation.
Grouped or Ungrouped	G or U	In a group of other fish (within 30cm) or not grouped with other fish (> 30cm away from another fish. If grouped with other fish an estimate of the number of fish will be made by the snorkeler and the species composition of that group.
Water Velocity	Meters per second (MPS)	Measured using a Marsh-McBirney Model 2000 flow meter. In an effort not to disturb observed fish, a marker was placed below the observed fish and velocity was measured at the after microhabitat observations were completed in the selected unit.

Only fish >50 mm were selected for microhabitat observation since fish smaller than that size are newly emerged and can be difficult to accurately enumerate.

When microhabitat observations and bounded counts were completed in a slow-water habitat unit, the total length of the unit down the thalweg and three width measurements, systematically spaced through the unit, were recorded. Maximum depth at each width measurement was also noted. Unit dimensions, length and average width, were used to calculate the total area of the slow-water habitat unit (m^2).

Objective 2: Determine if there is a relationship between microhabitat selection and fish density in slow and fast-water habitat units.

Logistic regression analyses were performed to determine relationships between fish density and the grouping of juvenile Chinook salmon and juvenile *O. mykiss*, as defined in Table 1. The logistic regression had six independent variables: 1) juvenile Chinook salmon density within unit (fish/m^2), 2) juvenile steelhead density within unit (fish/m^2), 3) presence or absence of bull trout, 4) age of the fish being observed (either age 0+ or ≥ 1+), 5) species of the fish being observed (*O. tshawytscha*, *O. mykiss* or *Salvelinus confluentus*) and 6) year of the study (2003 or 2004). The dependent variable was identified as grouping of the observed fish. All variables were discrete except juvenile Chinook salmon and steelhead densities which were continuous. The densities used in the regression were not corrected with the observation probability between bounded counts and mark recapture. Instead the densities were the point estimates of each species from the bounded counts estimator divided by the area of the unit sampled. All fish densities used in the logistic analysis are assumed to be directly related to the actual number of juvenile fish in each unit. Logistic regressions were performed using SAS statistical package (significance $\alpha = 0.05$). Comparisons of individual microhabitat preferences between juvenile steelhead trout and juvenile Chinook salmon were analyzed using an unbalanced analysis of variance (ANOVA) and t-tests (significance $\alpha = 0.05$).

Results

Objective 1: Identify microhabitat selection of juvenile Chinook salmon, juvenile O. mykiss and Bull trout within Shitike Creek at varying densities.

During microhabitat surveys in 2003 and 2004, a total of 698 individual fish observations of microhabitat were recorded (Table 3). The most common observation was juvenile Chinook salmon grouped with other juvenile Chinook salmon. Juvenile Chinook salmon and juvenile *O. mykiss* had very similar observations of "unlike" and "solitary" groupings.

Table 3. Number of juvenile Chinook salmon, juvenile *O. mykiss*, bull trout and brook trout/hybrids observed by grouping category (same species, unlike species, not grouped) by snorkelers in Shitike Creek during 2003 and 2004. Only fish > 50 mm were selected for observation. Same species grouping is defined as within 30 cm from fish of the same species, Unlike species grouping is within 30 cm from an unlike species of fish and not grouped is > 30 cm from another fish. Observations of Brook trout and brook trout/bull trout hybrids are combined.

	Species Grouping Category			
Species/Category	Solitary	Same	Unlike	**Total**
Brook trout/hybrids	9		5	**14**
Bull Trout	22		11	**33**
Juvenile Chinook salmon	61	279	65	**405**
Juvenile *O. mykiss*	58	136	52	**246**
Total Observations	**150**	**415**	**133**	**698**

Three cover types were the most prevalent with the 698 observations; Boulder, Large Wood (>15 cm diameter, 2 m length), and Small Wood (<15 cm diameter and 2 m in length, Figure 4). Over 73 and 71% of all juvenile Chinook salmon and *O. mykiss*, respectively, were observed in one of these three cover categories. Observations of juvenile Chinook salmon were also prevalent in vegetation with 15% of observations occurring near vegetation cover.

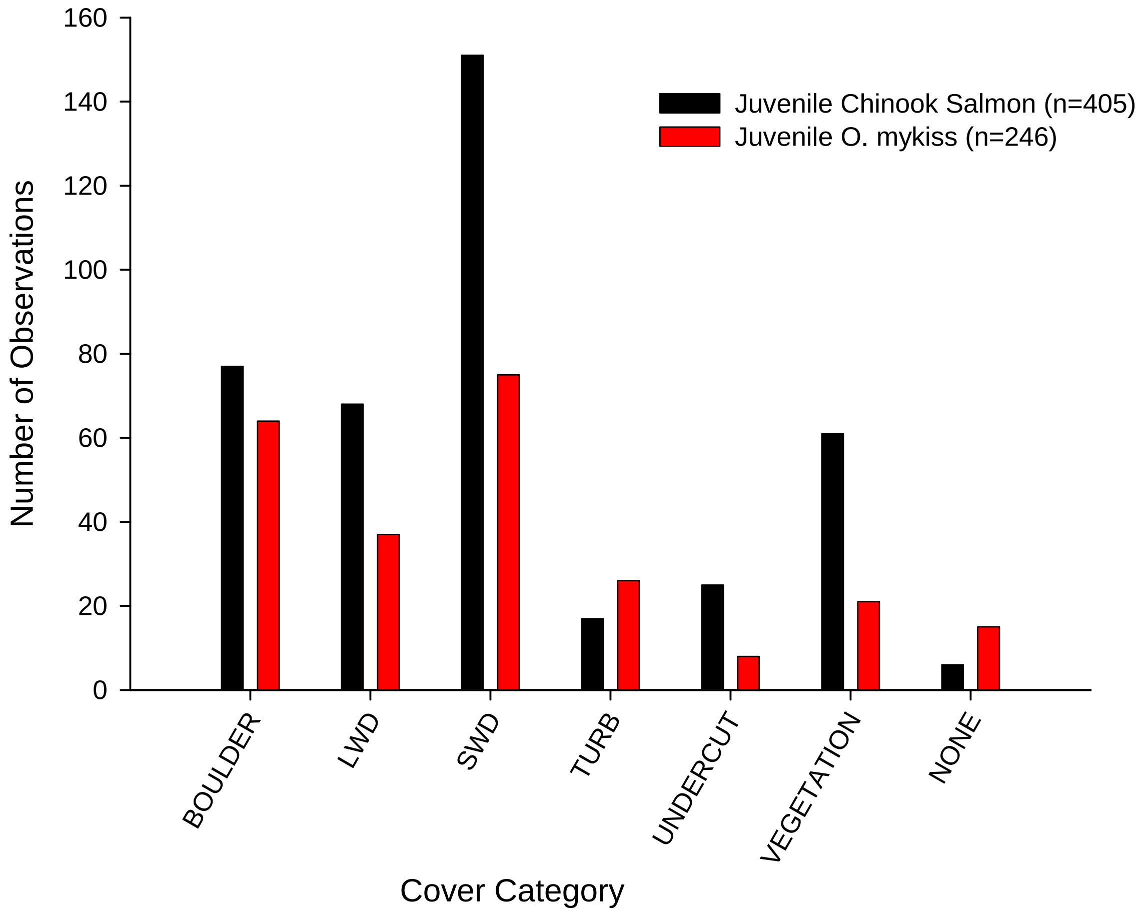


Figure 4. Number of juvenile Chinook salmon or *O. mykiss* observations with boulder, large wood (LWD), small wood (SWD), turbulence (TURB), undercut bank or overhang (UNDERCUT), vegetation and no specific cover (NONE). Over 81% of all juvenile Chinook salmon or juvenile *O. mykiss* fish observations had boulder, large wood, or small wood as being used as cover.

A total of 26 pools were sampled over the three reaches on Shitike Creek during the USFWS 2003 abundance survey, 32 pools in four reaches for 2004, and 37 pools in three reaches during 2005 (Table 4). Sampling fractions for pools remained similar to the ODFW abundance survey in 2001. Abundance of juvenile Chinook salmon and juvenile *O. mykiss* varied between years for Reach 1 but remained similar between years and species for reach 3 (Table 5). Densities of juvenile Chinook salmon and juvenile *O. mykiss* are highly correlated (r^2=0.88, Figure 5) for slow-water habitat units in Shitike Creek during 2003 but not in 2001 (r^2=0.26). A slight correlation was apparent in 2004 (r^2=0.41).

Table 4. Total slow water habitat units (N), number sampled (n) and the sampling fraction of each reach in Shitike Creek, OR for 2001, 2003, and 2004. The USFWS surveys were conducted in 2003 and 2004. Oregon Department of Fish and Wildlife in 2001 are also presented for comparison.

	2001			2003			2004			2005		
Reach	*N*	n	Fraction	*N*	n	Fraction	*N*	n	Fraction	N	n	Fraction
1	81	16	20%	50	10	20%	48	11	23%	54	18	33%
2	9	9	100%	Not Sampled			7	2	29%	Not Sampled		
3	54	11	20%	33	9	27%	37	10	27%	44	11	25%
5	37	8	22%	21	7	33%	27	9	33%	27	8	30%
Total	181	44	24%	104	26	25%	119	32	27%	125	37	30%

Table 5. Slow water population estimates for juvenile *O. mykiss* and juvenile Chinook salmon in sampled reaches of Shitike Creek during 2004. Confidence intervals (95%) are given in parentheses. Estimates in 2004 and 2005 are corrected using observation probability of juvenile Chinook salmon during snorkeling.

	2001		2003		2004		2005	
Reach	*O. mykiss**	Chinook Salmon	*O. mykiss*	Chinook Salmon	*O. mykiss*	Chinook Salmon	*O. mykiss*	Chinook Salmon
1	2,703* (±946)	10,991 (±3,322)	2,240 (±711)	2,435 (±908)	2,237 (±2,611)	4,732 (±2,611)	3,663 (±1,655)	5,554 (±1,655)
2	121* (±0)	168 (±0)	Not Sampled		593 (±553)	179 (±553)	Not Sampled	
3	835* (±366)	2,968 (±1,474)	1,474 (±475)	2,075 (±649)	2,120 (±1,973)	3,958 (±1,973)	1,403 (±1,276)	3,485 (±1,276)
5	0*	1,158 (±1,362)	180 (±87)	66 (±53)	161 (±1,368)	2,462 (±1,368)	111 (±734)	3,363 (±734)
Total	3,659 (±1,014)	15,285 (±3,897)	3,894 (±859)	4,576 (1,118±)	5,112 (±1,778)	11,332 (±1,778)	5,178 (±2,215)	12,402 (±2,215)

* denotes age 1+ *O. mykiss* estimates only

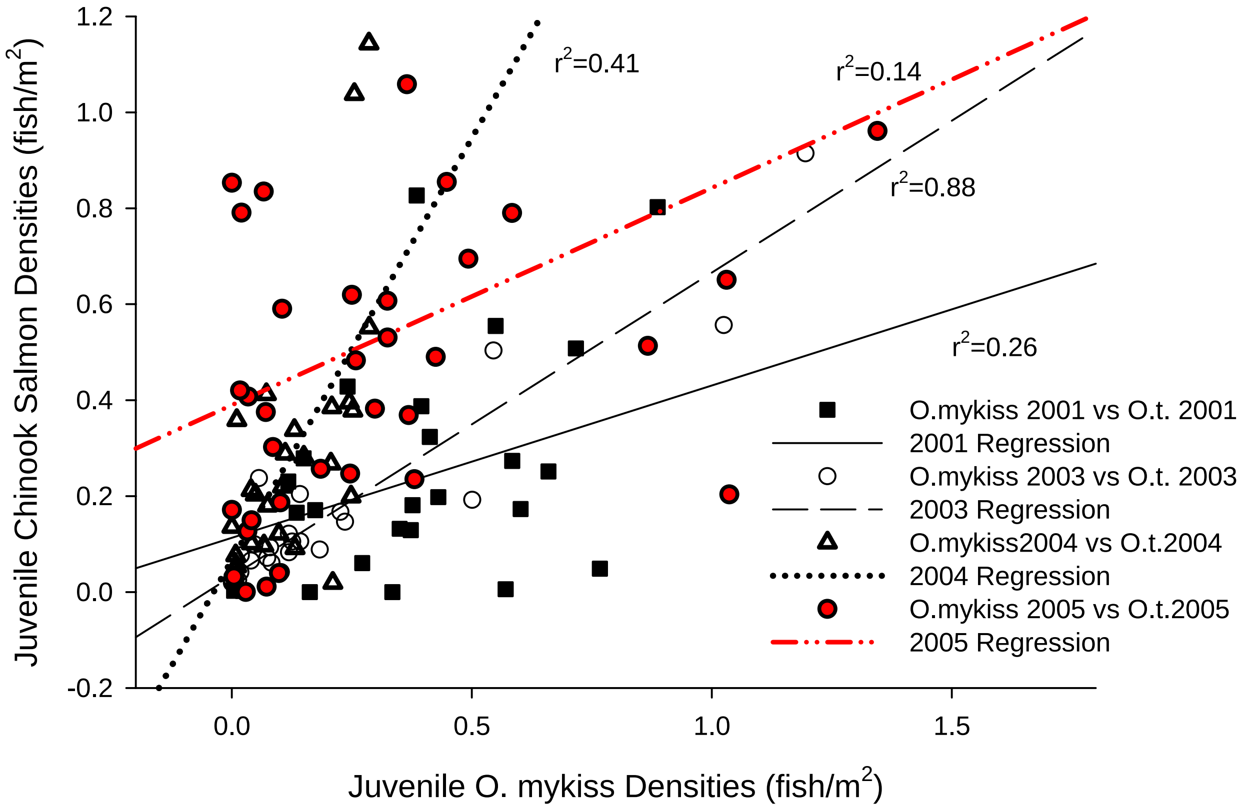


Figure 5. Juvenile *O. mykiss* densities vs. juvenile Chinook salmon densities in 2001, 2003 and 2004. The densities plotted for 2001 were collected during a survey conducted by ODFW (Dambacher 2002).

The mark-recapture protocol for verifying abundance in snorkeled units was conducted in three slow-water habitat units within Shitike Creek during 2004 and two during 2005. All three slow-water habitat units were within Reach 3 and two of the three pools were selected for snorkeling during the abundance survey on Shitike Creek during 2004. In 2005, one of the mark-recapture pools was a pool selected during the juvenile abundance surveys. Mark-recapture estimates could only be calculated for juvenile Chinook salmon and not juvenile *O. mykiss* due to a difference in capture efficiency by seining. The observation probability of bounded counts and mark recapture estimates of juvenile Chinook salmon were applied to juvenile *O. mykiss*. Estimates between mark-recapture and bounded counts varied between pools and were not consistently within the 95% CI for the mark-recapture pool estimate in 2004 and 2005 (Figures 6-10).

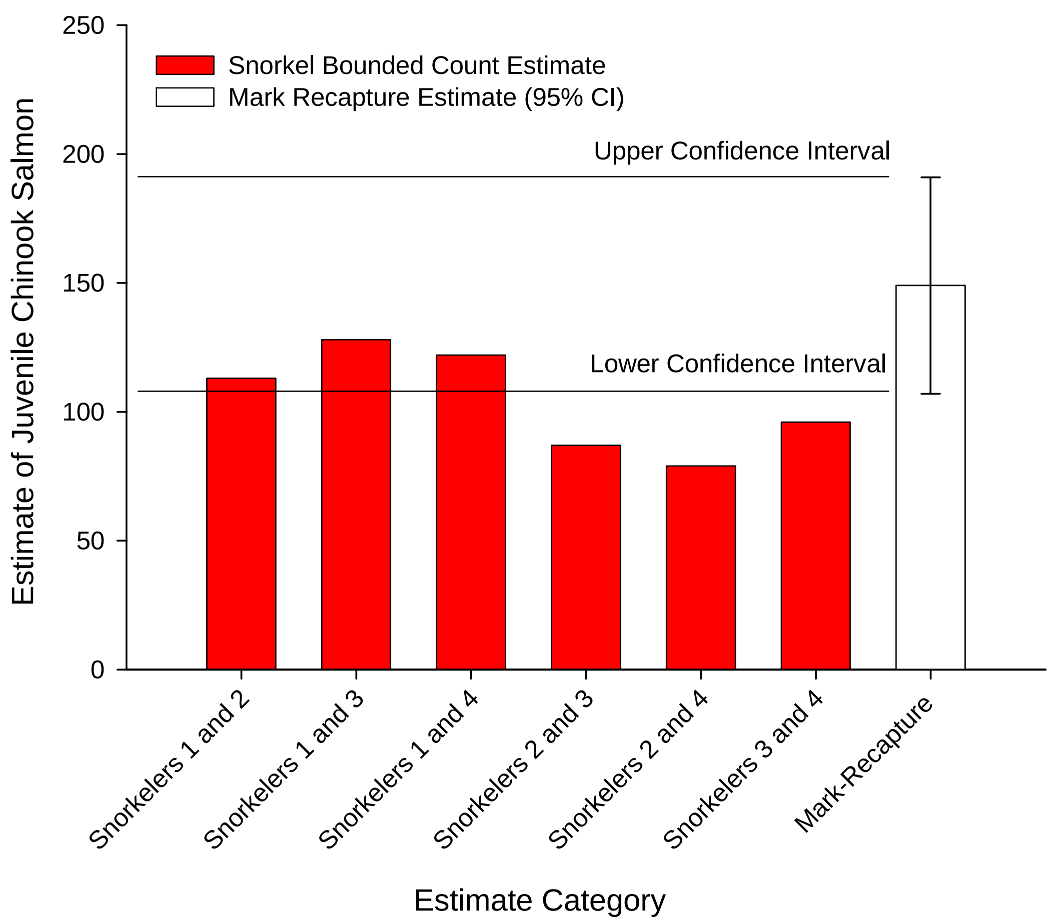


Figure 6. Bounded count estimates of juvenile Chinook abundance by multiple snorkeler combinations compared to a mark-recapture estimate in pool number 1 in Shitike Creek, OR during 2004. Upper and lower confidence intervals are presented for the mark-recapture estimate.

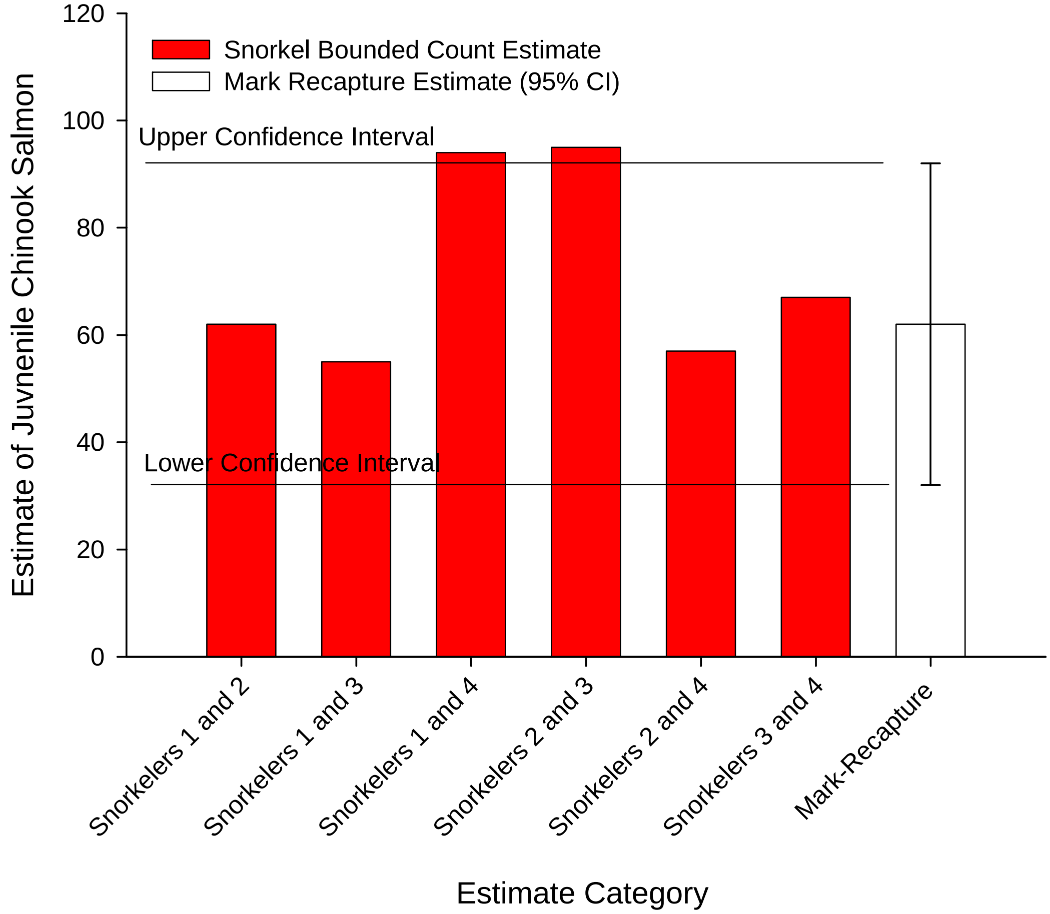


Figure 7. Bounded count estimates of juvenile Chinook salmon abundance by multiple snorkeler combinations compared to a mark-recapture estimate in pool number 2 in Shitike Creek, OR during 2004. Upper and lower confidence intervals are presented for the mark-recapture estimate.

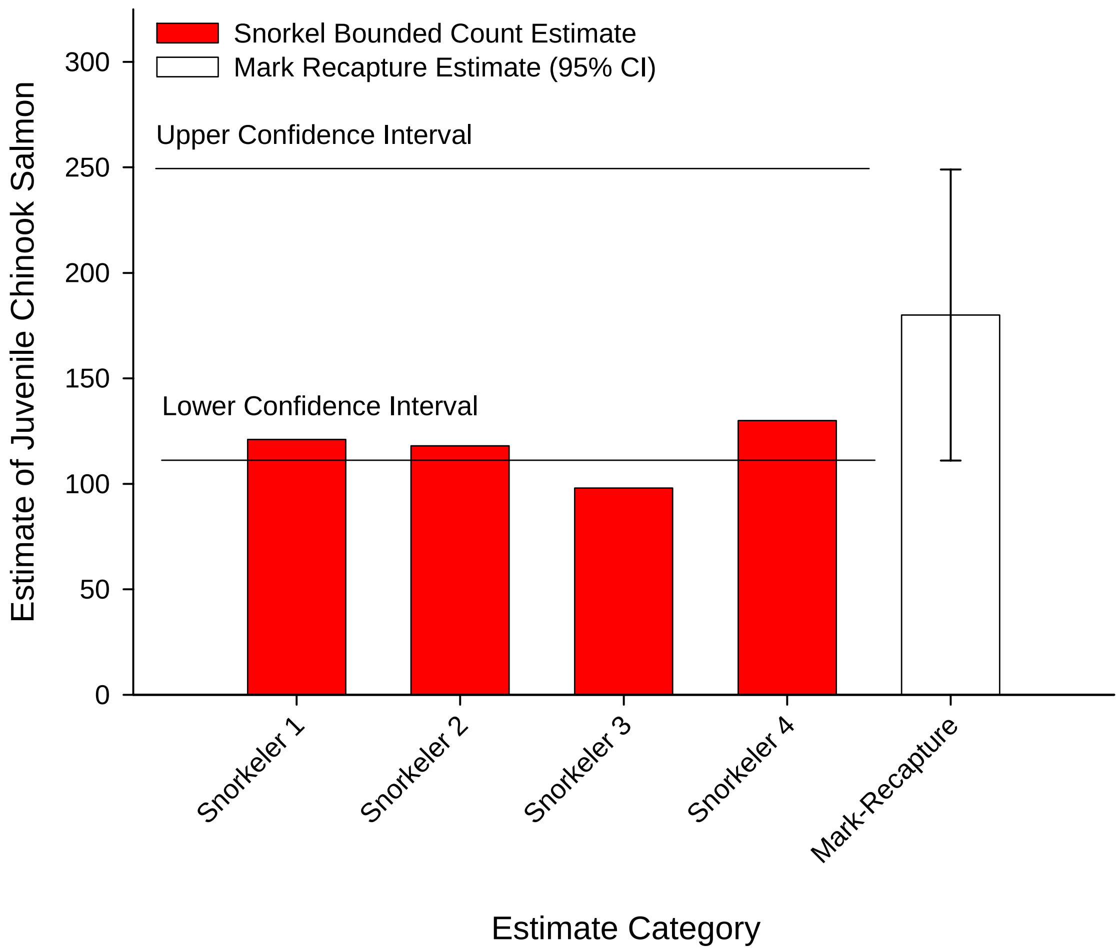


Figure 8. Bounded count estimates of juvenile Chinook salmon abundance by single snorkelers compared to a mark-recapture estimate in pool number 3 in Shitike Creek, OR during 2004. Upper and lower confidence intervals are presented for the mark-recapture estimate.

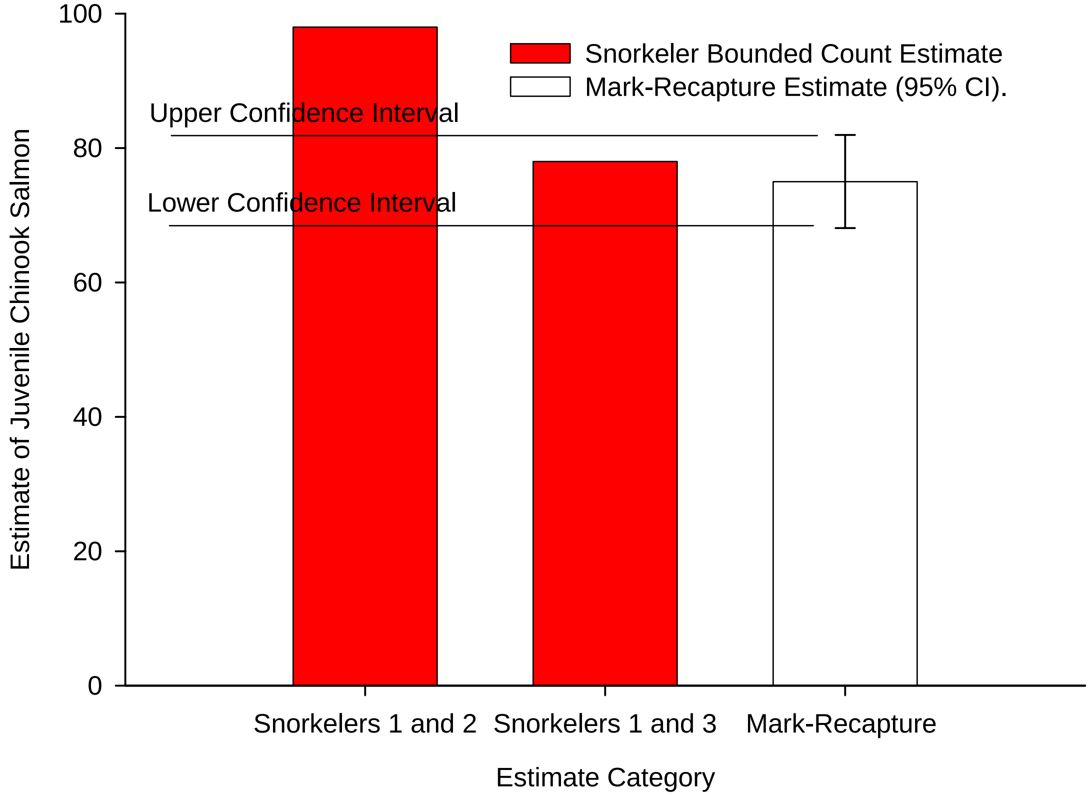


Figure 9. Bounded count estimates of juvenile Chinook salmon abundance by snorkelers compared to a mark-recapture estimate in pool number 1 in Shitike Creek, OR during 2005. Upper and lower confidence intervals are presented for the mark-recapture estimate.

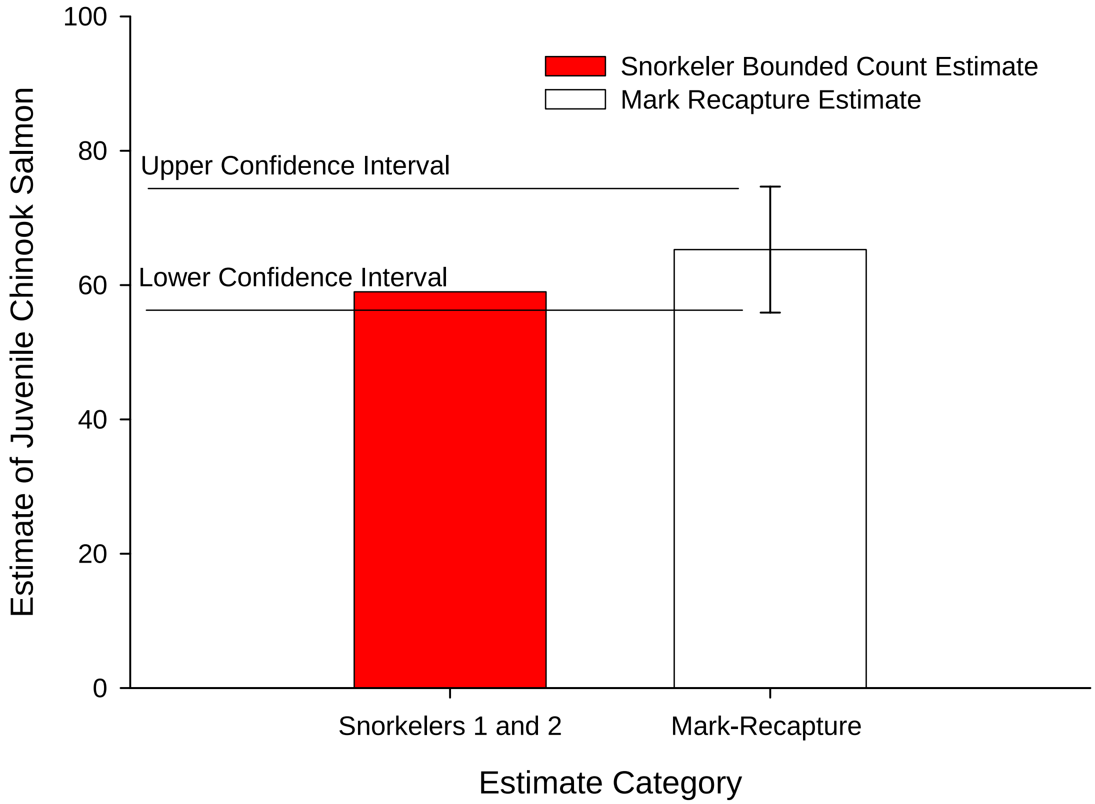


Figure 10. Bounded count estimates of juvenile Chinook salmon abundance by snorkelers compared to a mark-recapture estimate in pool number 2 in Shitike Creek, OR during 2005. Upper and lower confidence intervals are presented for the mark-recapture estimate.

Objective 2: Determine if there is a relationship between microhabitat selection and fish density in slow and fast-water habitat units.

Based on the results of the logistic regression analysis, there is no relationship between the effects of juvenile Chinook salmon density, juvenile *O.mykiss* density, year of the survey, and the presence or absence of bull trout in the grouping of juvenile *O.mykiss* or juvenile Chinook salmon (Table 6). The variables of Age ($\chi^2 = 10.27$, $p < 0.01$) and Species ($\chi^2 = 15.99$, $p < 0.01$) most explained whether fish observed during the snorkel survey were grouped or not grouped.

The microhabitat variables of distance to cover, bed depth, total depth, and focal point velocity were examined for juvenile Chinook salmon and *O.mykiss* in the three grouping categories (Table 7, Figures 11-18). Focal point velocity for juvenile Chinook salmon (Figure 11) and distance to cover of age 1+ *O. mykiss* (Figure 18) were significantly different between the three grouping categories. All other microhabitat variables were very similar between solitary, same species, and the opposite species groupings.

Table 6. Effects or variables used to determine the grouping or non-grouping of observed juvenile Chinook salmon and juvenile *O. mykiss*. Effects for the model are listed and identified as either discrete (with categories) or continuous. Chi-square values and significance is also given.

Effect or Variable	Discrete or Continuous	Chi-Square Value χ^2	P-value
Juvenile Chinook Density	Continuous	0.93	0.34
Juvenile *O. mykiss* Density	Continuous	0.60	0.44
Year of Survey	Discrete 2003 or 2004	2.50	0.11
Bull Trout	Discrete Presence or Absence	1.75	0.19
Age	Discrete 0+ or post age 0+	10.27	<0.01
Species	Discrete Chinook salmon or *O. mykiss*	15.99	<0.01

Table 7. ANOVA comparisons for solitary, same species and opposite species grouping categories of juvenile Chinook salmon and juvenile *O. mykiss* age 0+ and 1+. Sample size (n), F-Ratio and P-value is given for each microhabitat variable.

Variable	Species Observed	Sample Size (n)	F-Ratio	P-value
Distance to Cover	Chinook	399	2.14	0.119
	O. mykiss 0+	61	0.55	0.578
	O. mykiss 1+	173	3.91	0.022*
Bed Depth	Chinook	404	1.87	0.154
	O.mykiss 0+	68	1.18	0.313
	O. mykiss 1+	178	0.65	0.519
Total Depth	Chinook	404	0.35	0.705
	O.mykiss 0+	68	0.08	0.921
	O. mykiss 1+	178	0.21	0.807
Velocity	Chinook	404	6.70	0.001*
	O.mykiss 0+	68	1.35	0.265
	O. mykiss 1+	178	0.22	0.795

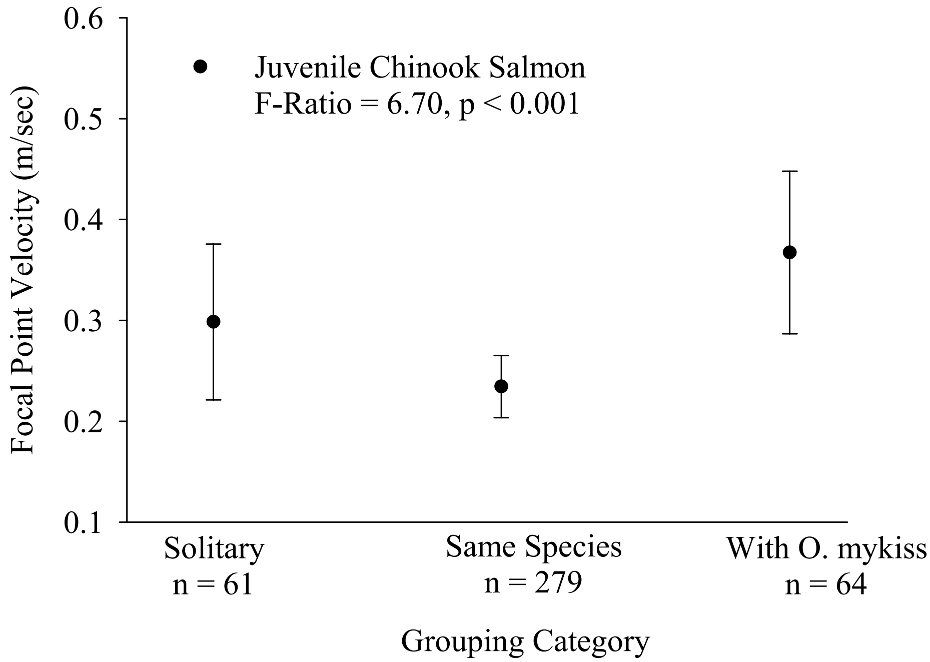
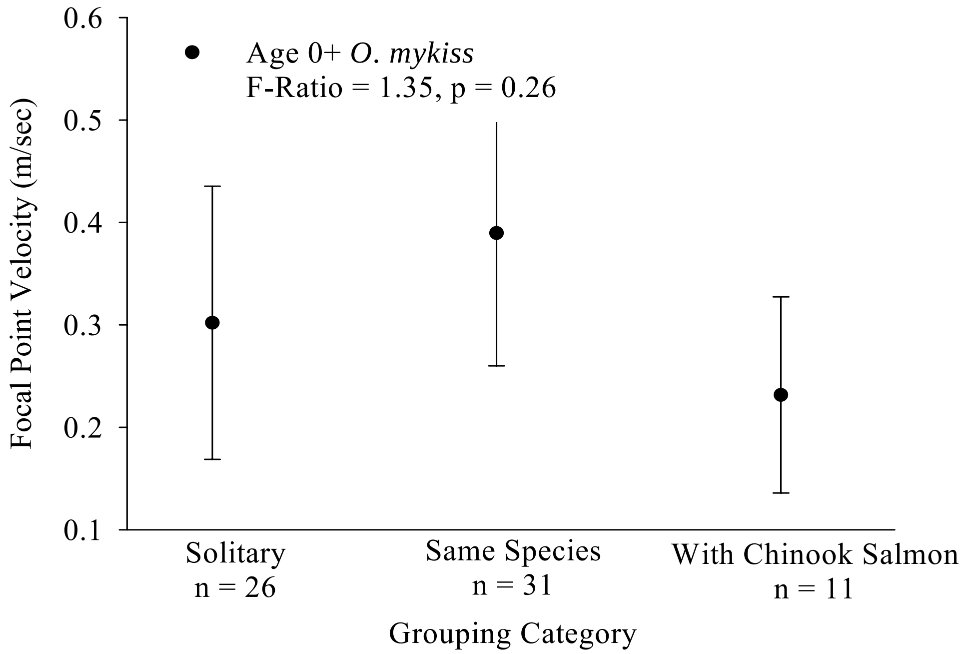


Figure 11. Focal point velocities (meters/second) for observed juvenile Chinook salmon within grouping categories. Error bars represent 95% confidence intervals. Same Species and With *O. mykiss* groupings are significantly different from one another.



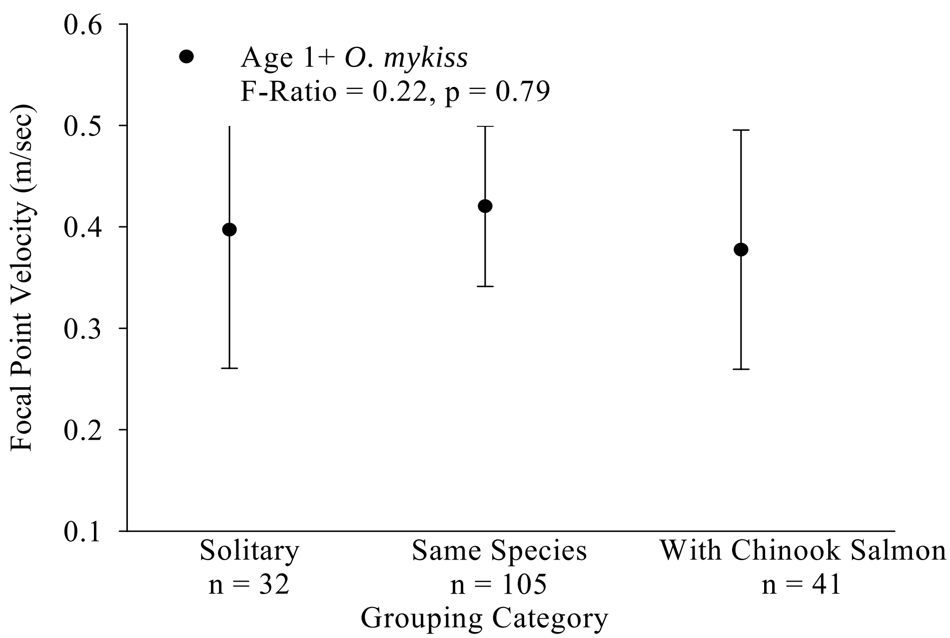


Figure 12. Focal point velocities (meters/second) for observed age classes of juvenile *O. mykiss* within grouping categories. Error bars represent 95% confidence intervals.

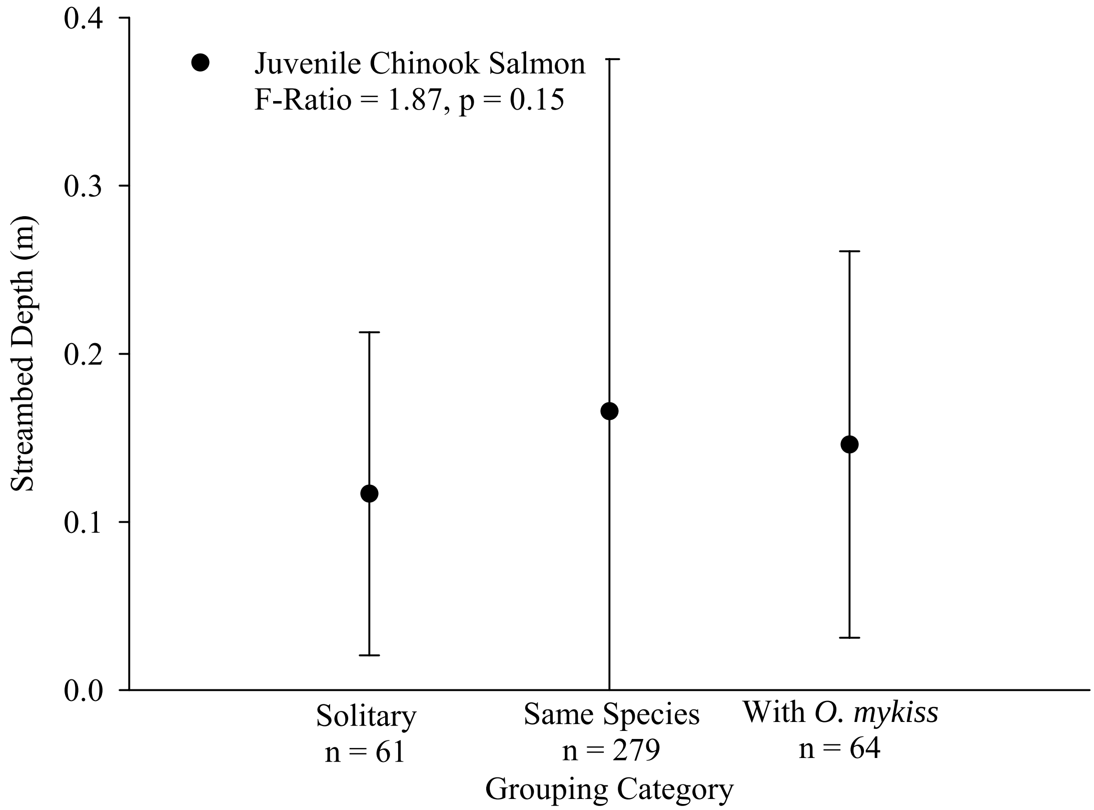


Figure 13. Streambed depth, in meters, for observed juvenile Chinook salmon within grouping categories. Error bars represent 95% confidence intervals.

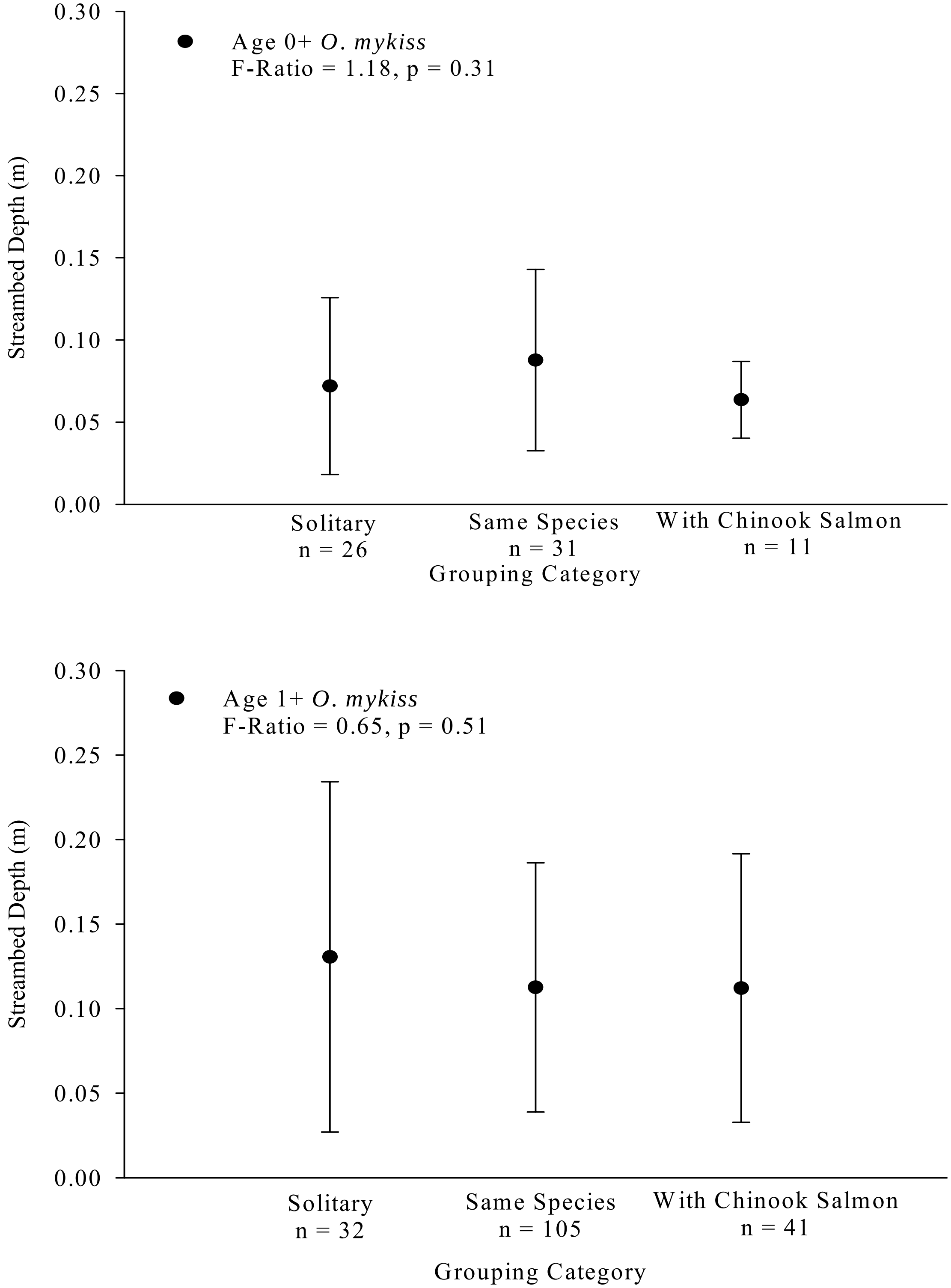


Figure 14. Streambed depth, in meters, for observed age classes of juvenile *O. mykiss* within grouping categories. Error bars represent 95% confidence intervals.

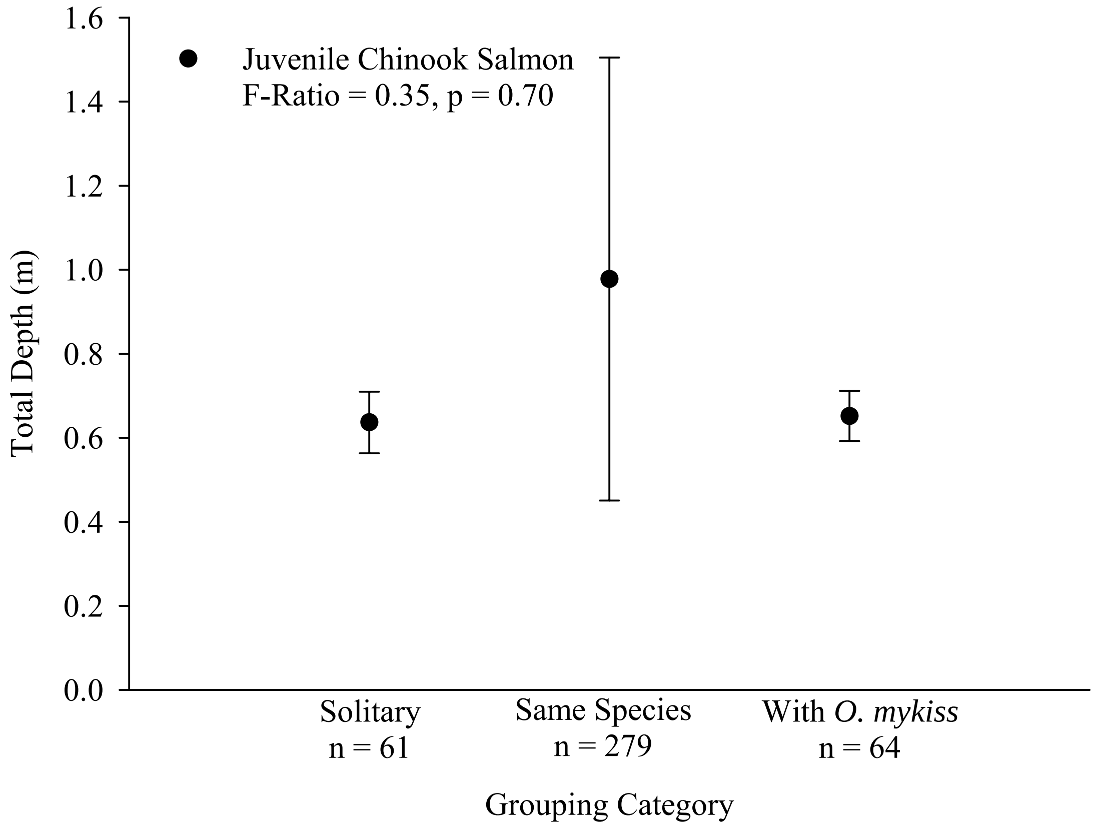
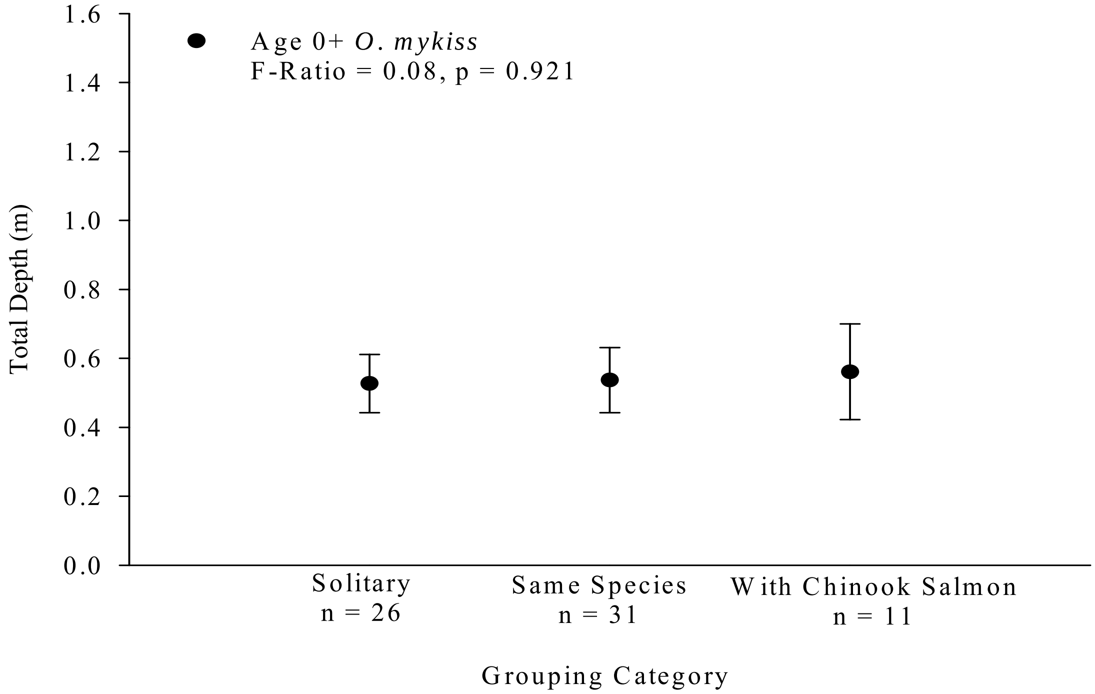


Figure 15. Total depth, in meters, for observed juvenile Chinook salmon within grouping categories. Error bars represent 95% confidence intervals.



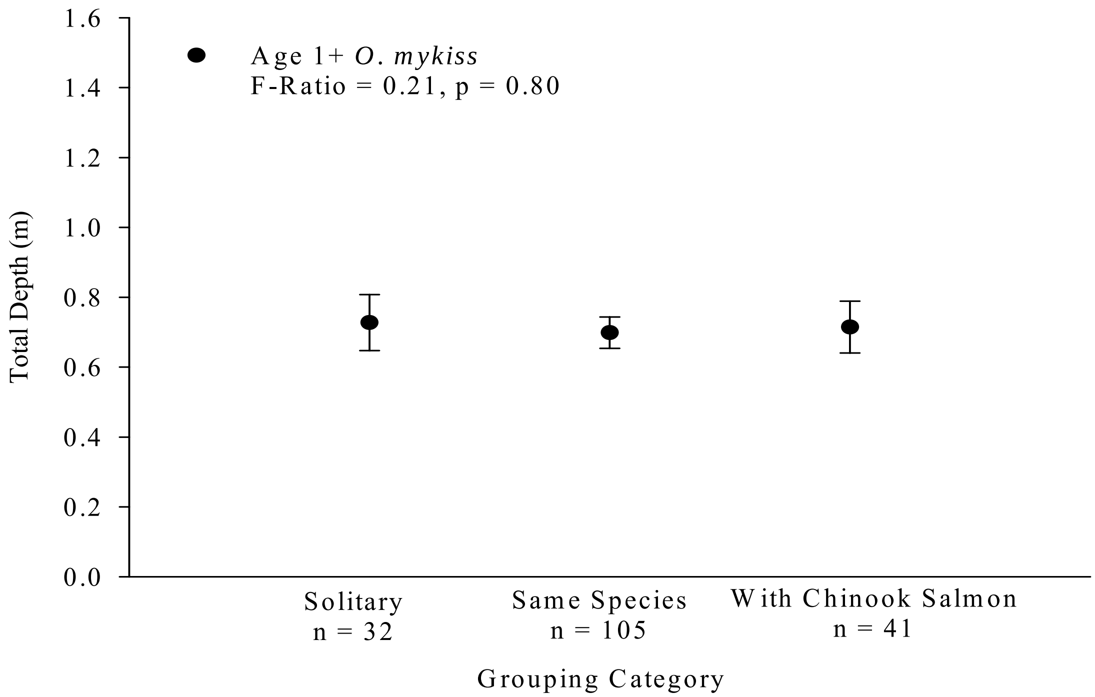


Figure 16. Total depth, in meters, for observed age classes of juvenile *O. mykiss* within grouping categories. Error bars represent 95% confidence intervals.

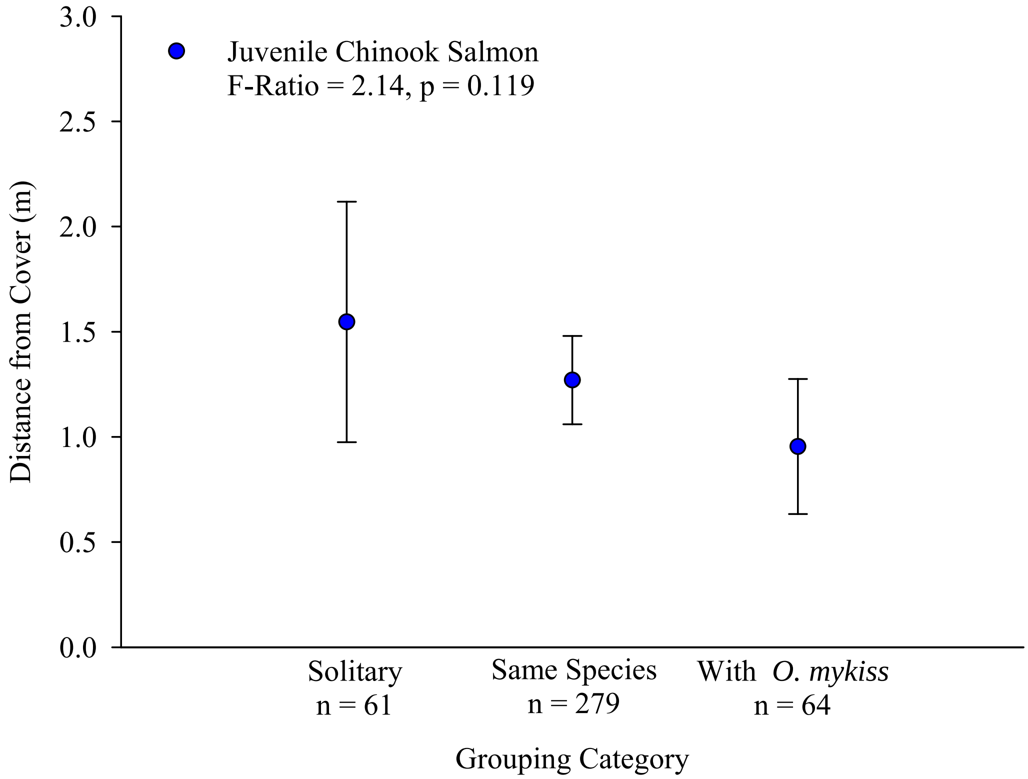
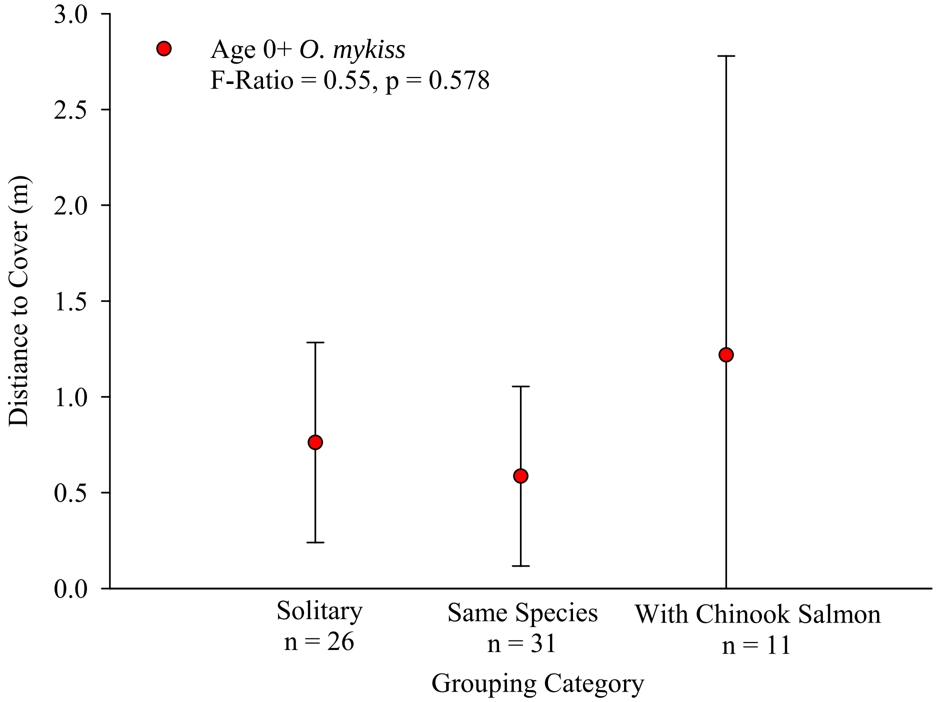


Figure 17. Distance to cover, in meters, for observed juvenile Chinook salmon within grouping categories. Error bars represent 95% confidence intervals.



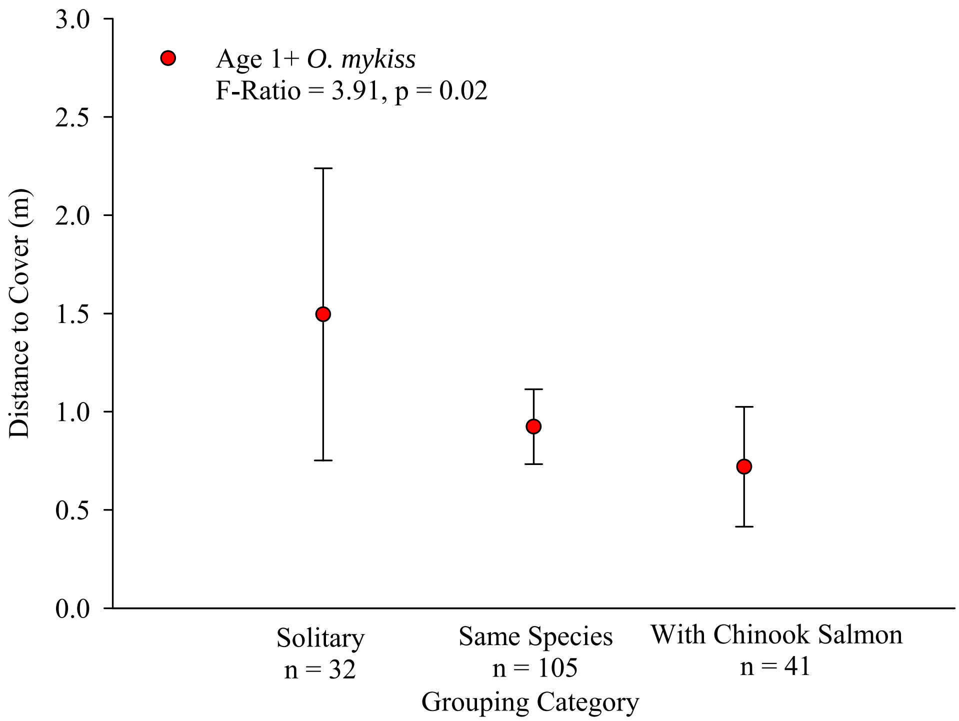


Figure 18. Distance to cover, in meters, for observed age classes of *O. mykiss* within grouping categories. Error bars represent 95% confidence intervals.

FY2006 Work Plan

The evaluation of the outplanting program in Shitike Creek and identification of ecological interactions between spring Chinook and other fish species (FONS Project Number 1999-010) will continue in FY 2006 but will be modified from previous years. During 2003-2005, objectives identified for *O.mykiss* populations within Shitike Creek were met. However, the effect of increasing densities of juvenile Chinook salmon on juvenile, sub-adult and adult bull trout was not adequately addressed. This was primarily due to limited data collected in areas where bull trout and Chinook salmon were abundant due constraints with ESA considerations and permitting. Additionally, surveys were performed during daylight hours and have been documented times of reduced activity for bull trout. Summary information on the past evaluations of the outplanting program in Shitike Creek is needed to formulate future direction of the project. With these needs, the following objectives were identified for fiscal year 2006.

FY2006 Objectives:

- Summarize 2003-2005 juvenile abundance and microhabitat surveys and present formal results and recommendations to fisheries managers.

- Provide technical support and expertise with ongoing juvenile abundance and summer sampling within Shitike Creek and associated Warm Springs NFH ecological interactions studies.

- Formulate methodologies and experimental designs to properly assess potential interactions between juvenile Chinook salmon and bull trout within Shitike Creek for 2007.

- Publish technical notes and findings where appropriate.

Potential Management Actions:
Adjust or manipulate the number or location of adult Chinook outplantings to maximize number of Chinook produced but minimize negative effects other aquatic species, particularly ESA listed bull trout and summer steelhead populations.

Input from project cooperators, the CTWSRO Fish and Wildlife Committee or staff biologists and may slightly alter or change the methodologies and actions proposed for FY2006.

Proposed Schedule and Completion Timeline FY 2006.

Objective	Activity	Fiscal Year 2006				Fiscal Year 2007
		April - May	June - July	August	September	October -December
Summarize 2003-2005 juvenile abundance and microhabitat surveys and present formal results and recommendations to fisheries managers.	Co-author summary report of Shitike Creek outplanting project.	In addition to assigned duties	In addition to assigned duties	In addition to assigned duties	In addition to assigned duties	In addition to assigned duties Tentative Completion December 2006
Provide technical support and expertise with ongoing juvenile abundance and summer sampling within Shitike Creek and associated Warm Springs NFH ecological interactions studies.	Participate in hatchery assessment activities and collection of information on adult returns	Collect snouts from coded wire tagged adults returning to Warm Springs NFH	Collect snouts from coded wire tagged adults returning to Warm Springs NFH	Provide assistance to design and implementati on of juvenile abundance survey on Shitike Creek	Provide assistance to design and implementati on of juvenile abundance survey on Shitike Creek	
Formulate methodologies and experimental designs to properly assess potential interactions between juvenile Chinook salmon and bull trout within Shitike Creek for 2007.	Present project and sampling designs to fisheries managers in a detailed work plan.	In addition to assigned duties	In addition to assigned duties	In addition to assigned duties	In addition to assigned duties	In addition to assigned duties Tentative completion December 2006
Publish technical notes and findings.	Prepare technical notes for publication.					In addition to assigned duties Tentative completion February 2007

Acknowledgements

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