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OREGON

IMPLEMENTATION OF THE ENVIRONMENTAL MONITORING AND ASSESSMENT PROGRAM (EMAP) PROTOCOL IN THE JOHN DAY SUBBASIN OF THE COLUMBIA PLATEAU PROVINCE

ANNUAL PROGRESS REPORT

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EXECUTIVE SUMMARY

Objectives

1. Monitor status and trends in the abundance of juvenile salmonids and stream and riparian habitats in the John Day River basin.

2. Monitor status and trends in steelhead redd abundance and spawners in the John Day River basin.

Accomplishments and Findings

We sampled 47 random, spatially-balanced sites throughout the John Day River basin during the spring (27 February–14 June) of 2006 to determine summer steelhead *Oncorhynchus mykiss* redd abundance. Survey sites encompassed 90.5 km (56.2 miles) of an estimated 4,326 km (2,688 miles) of steelhead spawning and rearing habitat within the basin. During these surveys, 67 redds and 32 live steelhead were observed. Redd and adult steelhead escapement estimates for the basin were 3,202 and 6,725, respectively. The adult steelhead escapement estimate in 2006 was greater, although not significantly, than that reported for similar surveys in 2005 (1,681 redds; 3,529 adult spawners) but was similar to 2004 estimates (3,071 redds, 6,449 adult spawners). Annual sites surveyed during 2006 yielded 37 redds and 19 live fish, which was similar to 2004 (40 redds and 37 live fish) but greater than 2005 (four redds and zero live fish). Annual variability observed at the Service Creek site (rkm 245) was a strong influence on these trends. In both 2004 and 2006, greater than 40% of redds and 70% of live fish observed at annual survey sites were detected in Service Creek while no fish or redds were observed there during 2005. Although the John Day River basin is managed exclusively for wild steelhead, hatchery steelhead comprised an estimated 41% (seven of 17) of live fish and 50% of recovered carcasses (one of two) where the presence or absence of an adipose fin clip could be determined. This finding is similar to observations from 2004 but greater than results from 2005. We estimate that 2,757 hatchery and 3,968 wild steelhead escaped to the John Day River basin during the 2006 spawning season. These estimates are strongly influenced by observations from Service Creek where 67% of fish identified to origin at this site had adipose fin clips and 86% of all live hatchery steelhead identified in the basin were detected there.

During the summer (5 July–4 October) we surveyed 46 sites to determine juvenile salmonid distribution and abundance. Salmonid abundance was quantified by one-pass upstream snorkeling or electrofishing through pools at each site. Steelhead were the most abundant salmonid observed occurring at 38 of 46 sites. Spring Chinook salmon *O. tshawytscha*, westslope cutthroat trout *O. clarki*, and bull trout *Salvelinus confluentus* were observed at a small percentage of sites (15%, 11%, and 2%, respectively). No Eastern brook trout *S. fontinalis* were observed at survey sites during 2006. The mean percentage of pools with steelhead at sites where at least one conspecific individual was present was 68% (Subbasin Range; 63%–78%). Spring Chinook were the most abundant salmonid in pools when at least one conspecific was present at a site (78%, Subbasin Range; 17%–88%). However, spring Chinook were not observed in two subbasins in the drainage: the Lower Mainstem and South Fork John Day River. Two annual sites (Service Creek [Site ID 11] and West Fork Lick Creek [Site ID 15]) continued to show declines in steelhead density from 2005 and 2004. However, two annual sites in Rock Creek (Site IDs 6 and 9) which had lower steelhead densities in 2005, increased to levels comparable to those observed in 2004. Westslope cutthroat trout and bull trout occurred infrequently during surveying and were less abundant in pools at sites where their respective species were present (34% and 42%, respectively). In addition to salmonids, at least seven non-target species were observed during salmonid surveys; suckers *Catostomus* spp., sculpin *Cottus* spp., mountain whitefish *Prosopium williamsoni*, northern pikeminnow *Ptychocheilus oregonensis*, redside shiner *Richardsonius balteatus*, smallmouth bass *Micropterus dolomeiu*, and dace *Rhynichthys* spp.

Habitat sites surveyed during 2006 (n=46) were dominated by grass or shrub vegetation in the riparian zone and had constrained channel forms. Grazing was identified as the dominant land use at nearly one-third of all sites visited, with the Lower mainstem (8 of 11 sites) and the South Fork (2 out of 2 sites) subbasins having the greatest proportion of grazed sites. Data analysis of 2006 selected habitat parameters across the five John Day River subbasins yielded only a few statistical differences. The Lower Mainstem had higher bank erosion than the North Fork which is consistent with previous years. In addition, the Middle Fork had a higher percentage of gravel, both in riffle and pool habitat, compared to the North Fork. Future surveys should allow for a more comprehensive evaluation of habitat in the basin by providing more data and a larger time frame over which to compare habitat conditions.

Management Recommendations

1. Continue to monitor steelhead redd abundance in the John Day River basin using the EMAP site selection process in order to refine the current knowledge of steelhead spawning distribution in the basin and to determine the status and trend of the population. Comparison of EMAP results with that of index surveys will allow for a more comprehensive and accurate assessment of the current health and condition of steelhead in the basin.

2. Continue to manage the John Day River basin exclusively for wild steelhead and determine the extent and distribution of hatchery steelhead in the basin through observations of hatchery fish during the spawning season and compiling hatchery steelhead information from other sources and projects. Consider using genetic analysis to understand the influence of hatchery stocks on John Day River wild summer steelhead stock genetics.

3. Use channel and riparian habitat data to assess the current condition of stream habitat available to juvenile and adult salmonids in the John Day River basin. Begin acquiring information on the utilization of statistical models (i.e. HabRate [see Burke et al. 2001] and Habitat Limiting Factors Model [HLFM; see Nickelson 1998]) to assess habitat factors and limitations of key salmonid species.

4. Continue to monitor juvenile steelhead and other salmonids in the John Day River basin in order to refine the current knowledge of salmonid distribution in the basin and to determine the status and trend of these populations.

ACKNOWLEDGEMENTS

We would like to acknowledge the assistance and cooperation of the many private landowners throughout the John Day River basin who allowed us access to survey on their property. The cooperation of private landowners and The Confederated Tribes of the Warm Springs Reservation were essential in meeting our project objectives. Additionally, we would also like to thank Tim Unterwegner and Jeff Neal for providing much needed guidance and advice regarding steelhead spawning ground surveys. Their information was extremely helpful for survey planning and landowner contacts. This project was funded by the U. S. Department of Energy, Bonneville Power Administration, Environment, Fish, and Wildlife. Project Number: 199801600. Contract Number: 15113.

INTRODUCTION

The John Day River, located in northeastern Oregon, is unique in that it supports one of the last remaining wild populations of summer steelhead *Oncorhynchus mykiss* in the Columbia River Basin with no hatchery supplementation. However, this population remains depressed relative to historic levels. In 1999, the National Marine Fisheries Service (NMFS) listed the Middle Columbia River summer steelhead ESU, which includes John Day River summer steelhead, as threatened under the Endangered Species Act (ESA). Although numerous habitat protection and rehabilitation projects have been implemented within the John Day River basin to improve steelhead and other salmonid freshwater production and survival, it has been difficult to estimate the effectiveness of these projects without a systematic program in place to collect information on the status, trends, and distribution of salmonids and habitat conditions within the basin. Prior to the inception of this project, population and environmental monitoring of steelhead in the basin consisted of a combination of index surveys and periodic monitoring of some status and trend indicators. While index spawning data is useful in drawing inference about trends in adult steelhead abundance, it is limited in determining the status of steelhead escapement or distribution at the basin-wide scale because survey sites are not randomly selected, and are likely biased towards streams with higher redd densities. A broader approach to the monitoring and evaluation of status and trends in anadromous and resident salmonid populations and their habitats was needed to provide data to effectively support restoration efforts and guide alternative future management actions in the basin.

The Independent Scientific Review Panel (ISRP), in their guidance on monitoring, strongly recommended that the region move away from index surveys and embrace probabilistic sampling for most population and habitat monitoring. To meet the ISRP's recommendation, the structure and methods employed by the Oregon Plan for Salmon and Watersheds Monitoring Program were extended to the John Day basin. This approach incorporates the sampling strategy of the U.S. Environmental Protection Agency's (EPA's) Environmental Monitoring and Assessment Program (EMAP). The EMAP is a long-term research effort with a statistically based and spatially explicit sampling design. This program applies a rigorous, Tier-2 sampling design to answer key monitoring questions, integrate on-going sampling efforts, and improve agency coordination. EMAP objectives specific to the John Day basin are to determine annual estimates of steelhead spawner escapement, hatchery to wild steelhead stray ratios, juvenile steelhead and other salmonid rearing distributions, physical habitat conditions, and track changes in the status and trends of these estimates over time. In addition, data from on-going projects in the basin, such as smolt monitoring, will be incorporated in future years to develop a more complete picture of status and trends in resources (e.g. life-stage specific survival) not targeted under the EMAP program.

This project provides information as directed under two measures of the Columbia Basin Fish and Wildlife Program. Measure 4.3C specifies that key indicator naturally spawning populations should be monitored to provide detailed stock status information. In addition, measure 7.1C identifies the need for collection of population status, life history, and other data on wild and naturally spawning populations. This project was developed in direct response to the recommendations and needs of regional modeling efforts, the ISRP, the Fish and Wildlife Program, the Oregon Plan for Salmon and Watersheds, and the Columbia Basin Fish and Wildlife Authority Multi-Year Implementation Plan.

METHODS

Study Area

The John Day River basin is located in north central and northeastern Oregon (Figure 1), and is the fourth largest drainage in the state. The basin is bounded by the Columbia River to the north, the Blue Mountains to the east, the Strawberry and Aldrich Mountains to the south, and the Ochoco Mountains to the west. The John Day River originates in the Strawberry Mountains at an elevation near 1,800 m (5,900 ft) and flows approximately 457 km (284 miles) to its mouth, at an elevation of 90 m (295 ft), at river km 349 (rmi 217) of the Columbia River. It is the second longest free-flowing river in the continental United States, and is one of only two tributaries to the Columbia River managed for wild salmon and steelhead. There are no hydroelectric dams or hatcheries located on the John Day River, although numerous irrigation diversions dot the drainage. Major tributaries flowing into the mainstem John Day River include the North Fork, Middle Fork, and South Fork John Day rivers. The North Fork is the largest tributary, contributing approximately 60% of the flow to the mainstem. The John Day River basin contains 15,455 km (9,603 miles) of stream habitat available for fish, but only 4,326 km (2,688 miles; 26%) are known or assumed to be used for various anadromous salmonid life history stages (spawning, rearing, and migration; Figure 2).

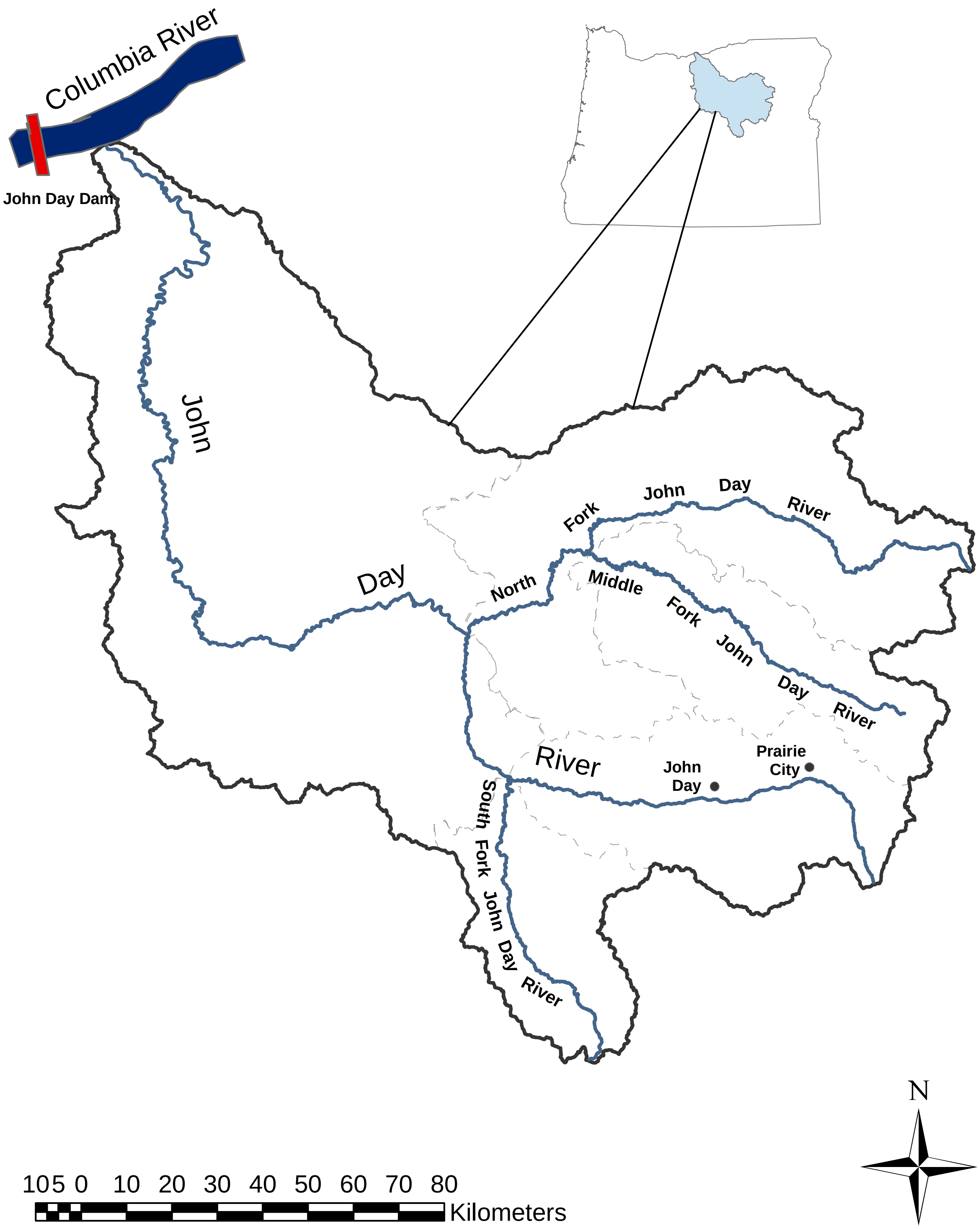


Figure 1. Map of the John Day River basin including the Mainstem John Day River and all three major forks (North Fork, Middle Fork, and South Fork). Dashed grey lines represent subbasin delineations (Lower Mainstem, Upper Mainstem, North Fork, Middle Fork, and South Fork subbasins).

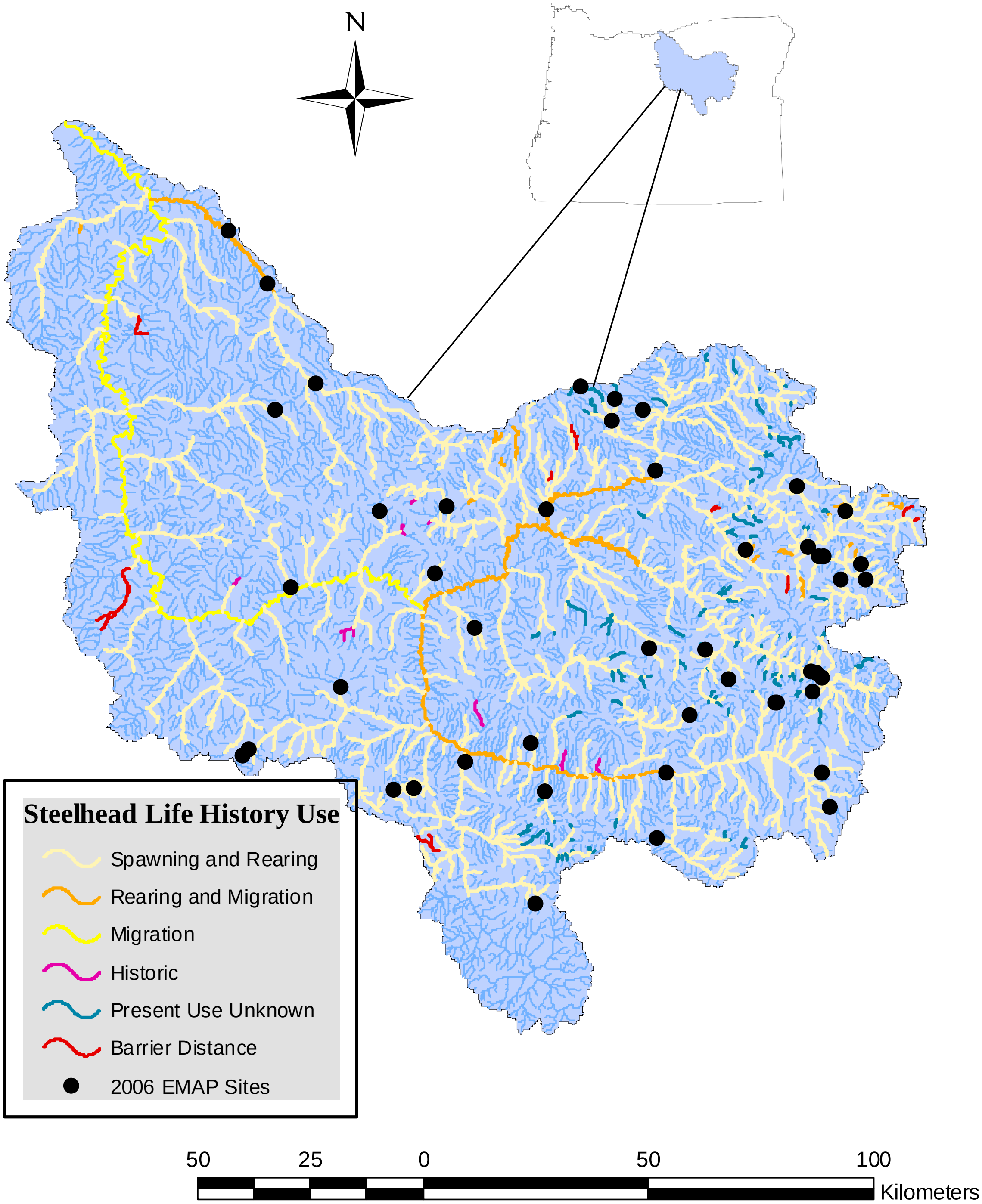


Figure 2. Map of summer steelhead life history use in the John Day River basin and 2006 EMAP sample sites.

Sampling Domain and Site Selection

The sampling universe for EMAP surveys is based on professional knowledge of steelhead life history use in the John Day River basin. This knowledge is derived from ODFW biologists as well as biologists from other natural resource entities, and is currently the best information available concerning the distribution and habitat use of steelhead in the John Day River basin (Figure 2). Sample sites were derived from a 1:100,000 EPA River Reach file and all streams upstream of known barriers to anadromous fish passage were eliminated from the sampling universe. Fifty sample sites are targeted each year. In order to balance the needs of status (more random sites) and trend (more repeat sites) monitoring, the following rotating panel design was implemented in the John Day River basin:

- 17 sites repeated every year (annual)
- 16 sites repeated once every four years on a staggered basis (four)
- 17 sites new every year (new)

A Geographic Information System (GIS) incorporating a 1:100,000 digital stream network was used to insure an unbiased and spatially balanced selection of sample sites. The GIS site selection process provides geographic coordinates (i.e. latitude and longitude) of each candidate site. From these site coordinates, topographic maps were produced showing the location of each sample point. Landowner contacts were then developed based on county plat maps. With the assistance of ODFW District Biologists, permission was sought from landowners for survey sites. In the field, crews used a handheld Global Positioning System (GPS) to locate the established survey reaches which encompassed the selected EMAP points. Some candidate sites were not sampled due to a lack of permission from private landowners or because sites were located upstream of previously unknown fish passage barriers. In such events, replacement sites were drawn from a pre-selected list of over-sample sites. Every year the EMAP sampling universe is refined based on field observations of previously unknown barriers (EMAP blocked reaches; Figure 2), the removal of barriers (e.g. road culverts), and other restrictions (e.g. dry streams) that limit fish life history stages. These stream miles are removed or added back into our sampling universe accordingly.

Steelhead Redd Surveys

Steelhead redd surveys based on standard ODFW methods (Susac and Jacobs 1999; Jacobs et al. 2000; Jacobs et al. 2001) were conducted from February to June 2006 (Table 1). Sites were surveyed up to six times to quantify the number of redds constructed at each site, with approximately two week intervals between successive surveys to account for the temporal variation in spawning activity. Survey reaches were approximately 2 km in length and encompassed the sample point derived from the EMAP sampling design. Surveyors walked upstream from the downstream end of each reach and counted all redds, live fish, and carcasses observed. New redds were flagged and the location marked with a GPS unit (UTM - NAD 27).

During each visit, surveyors recorded the number of flagged redds, new redds, and redds missed during the previous survey. Missed redds were distinguished from new redds by the amount of periphytic growth in the redd pocket. New redds were expected to be devoid of periphyton whereas older redds would be obscured by periphytic growth or sediment deposits.

Ideally, each site was to be visited by different surveyors on successive visits, however this was not always logistically possible with the number of personnel available.

Overall redd density (R_D) was estimated by:

$$R_D = \sum_{i=1}^{n} r_i/d_i \qquad (1)$$

where r_i is the number of redds observed at site i, d_i is the distance surveyed (km) at site i, and i is the individual sites surveyed. The total number of redds (R_T) occurring throughout the basin was estimated by:

$$R_T = R_D \cdot d_u \qquad (2)$$

where d_u is the total kilometers available to steelhead for spawning and rearing (4,325 km). Steelhead escapement (E_S) was then estimated by:

$$E_S = 2.1 \cdot R_T \qquad (3)$$

where 2.1 is a fish per redd constant developed from repeated spawner surveys in the Grande Ronde River basin (Flesher et al. 2005; Gerold Grant and Jim Ruzycki, ODFW, unpublished data). A locally weighted neighborhood variance estimator (Stevens 2002), which incorporates the pair-wise dependency of all points and the spatially constrained nature of the design, was used to estimate a 95% confidence interval of the escapement estimate.

Steelhead carcasses were examined to obtain population and life history information (age, sex, length, and spawner origin). For all carcasses, surveyors collected scale samples from the key scale area (Nicholas and Van Dyke 1982) for age determination, recorded sex, measured MEPS length (middle of eye to posterior scale), and determined spawner origin (hatchery or wild) by inspecting carcasses for the presence (wild) or absence (hatchery) of an adipose fin. The hatchery : wild fish ratio was calculated by dividing the total number of fin marked fish by all fish that could be observed for marks (live fish only). The number of hatchery fish straying to the basin was estimated by multiplying this proportion of hatchery and wild steelhead by our estimate of steelhead escapement.

South Fork John Day River Spawning Subsample

Because of the limited area available for steelhead spawning in the South Fork subbasin, few sites, usually two or less, fall into our sampling frame in any given year. In 2006, 12 sites in addition to two sites already in the 2006 sampling frame were selected from the South Fork John Day River subbasin to gather additional spawning data (Figure 3) and to provide an escapement estimate for this subbasin. Subsample sites were determined by selecting the first 12 sites that occurred in the South Fork subbasin from the list of EMAP sample sites. Spawning surveys were conducted as previously outlined in this report and adult steelhead escapement to the South Fork subbasin was estimated using the same equations as noted above except that the distance in the sampling universe (d_u) only encompassed that area within the South Fork subbasin available for steelhead spawning and rearing (260 km).

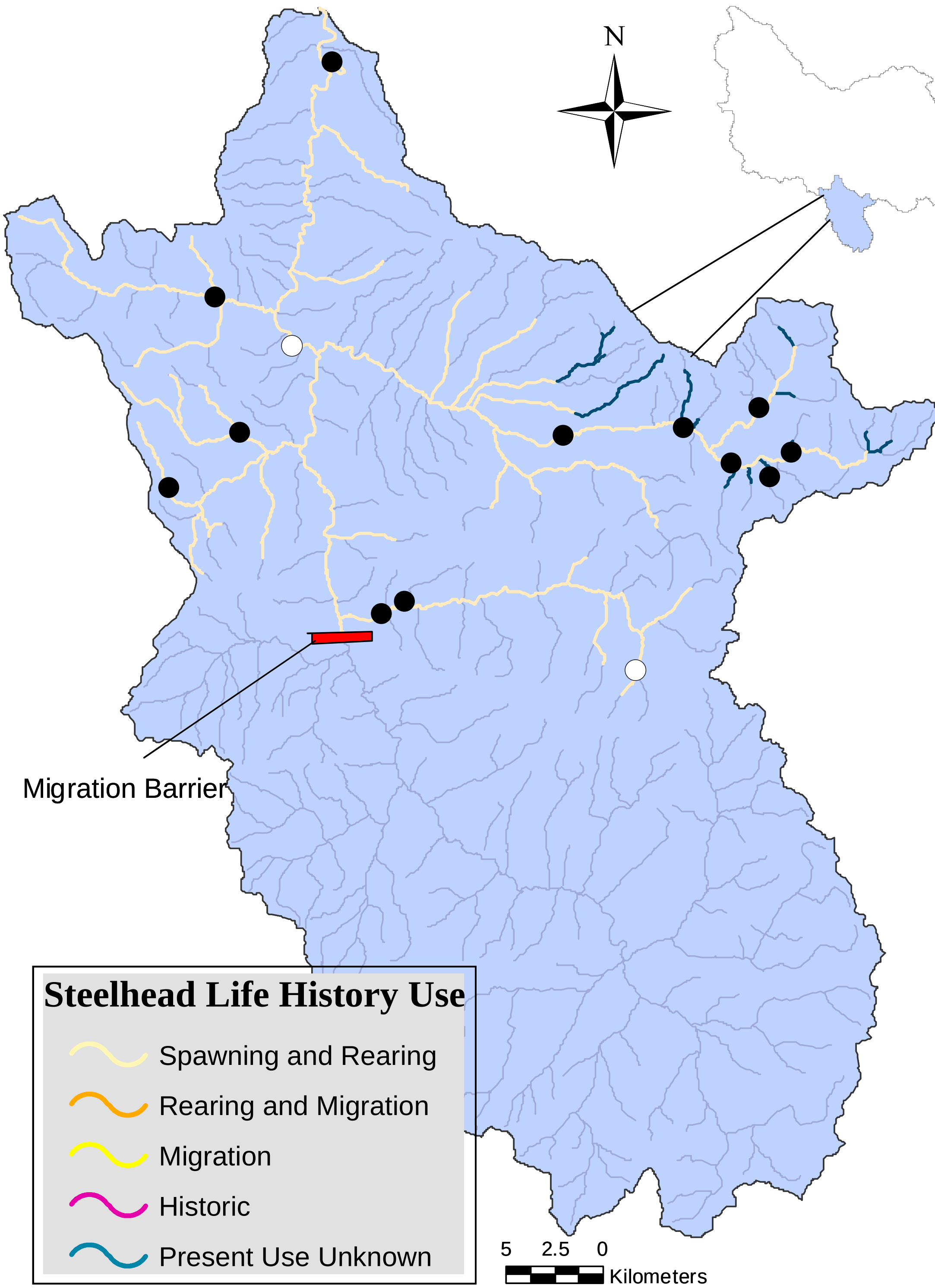


Figure 3. Map of sites selected for sub-sample spawning surveys in the South Fork John Day River subbasin in 2006. White circles denote sites incorporated from the basin-wide sampling frame and black circles denote sites selected for sub-basin sampling.

Juvenile Salmonid Surveys

Juvenile salmonid surveys were conducted concurrently with habitat surveys from July to October to determine the distribution and abundance of salmonids and other fishes occurring in the basin (Table 2). Juvenile sampling was conducted in habitat units classified as a "pool". Pool habitats were electrofished if depths were shallow enough (average maximum pool depth < 60 cm) to safely and effectively sample them with a backpack electrofisher and water temperatures were below 18˚C. Pool habitats were snorkeled when electrofishing was not feasible, when the average maximum pool depth exceeded 40 cm, and when the site had adequate water clarity.

Electrofishing involved a single pass upstream through pools within the reach using one Smith-Root model 12-B backpack electrofisher (DC; variable voltage) following NMFS electrofishing guidelines for juvenile salmonid presence : absence. Stunned fish were captured with dip nets (0.32 cm mesh) and held in a bucket for identification after the pool was sampled. No block nets were used for this sampling. Snorkeling involved a single pass upstream through pools within the reach using a sufficient number of snorkelers to effectively cover each pool (generally 1–2 snorkelers). The number of juvenile (<152 mm; fork length, FL) and adult (>152 mm, FL) salmonids for each species were recorded for each pool. The length used for discriminating between juvenile versus adult salmonids (152 mm) is based on size classes developed from local data and standards used by ODFW and co-managers. Although this size distinction is used as a general guide, numerous juvenile steelhead larger than 152 mm FL have been recorded in the basin. Incidental species encountered during salmonid surveys were identified to genus and species, when possible, and recorded as present.

Salmonid distribution and abundance in the John Day River basin were assessed by determining the number and percentage of sites occupied by each species and by their respective juvenile (<152 mm) and adult (>152 mm) forms. Salmonid abundance was further assessed by calculating the percentage of pools occupied at sites where conspecifics occurred. Density estimates (number of fish/m^2) at annual sites were used to assess trends in steelhead and spring Chinook salmon *O. tshawytscha* (Chinook) observed during juvenile salmonid surveys. When juvenile steelhead are referenced in this document, we acknowledge the presence of alternate life-history forms and that some juveniles of all sizes may be resident fish (redband trout; steelhead). These alternate life-history forms are typically morphologically indistinguishable. We therefore refer to all juvenile *O. mykiss* as juvenile steelhead. In contrast, adult steelhead are generally easy to distinguish from resident redband adults based on body size. The distribution and frequency of occurrence of incidental species was also determined for each site, subbasin, and for the entire John Day River basin.

Habitat and Riparian Surveys

Habitat and riparian surveys were conducted from July to October 2006 (Table 2) and were designed to describe important attributes of fish habitat structure within and adjacent to the stream channel. The objectives of these surveys were to describe current habitat conditions (status) and to track their trends over time. Surveys were conducted as described by Moore et al. (2002) with two modifications. First, our surveys were 500 m in length for sites with an active channel width less than five meters, and 1,000 m in length for sites with an active channel width greater than five meters. Second, all wood (≥0.15 m DBH and ≥3.0 m length) within or intercepting the active channel and all habitat unit lengths and widths were measured (as opposed to estimating).

Once a sample reach was located, surveys were conducted by walking upstream from the downstream end of each survey reach identifying channel unit types (e.g. pools, riffles, rapids, cascades, etc.), measuring unit dimensions (length, width, and depth), and determining unit slope. Channel characteristics such as substrate composition, % eroded banks, and % undercut banks were estimated for each unit. The amount of large woody debris was quantified by measuring all wood pieces (≥ 0.15 m DBH and ≥ 3 m in length) within or intercepting the active channel. Three riparian transects were conducted within the reach which included estimating the percentage of canopy, grass, and shrub cover, quantifying the number and sizes of hardwood and conifer trees, and determining the slope of the riparian zone. These variables are indicators of habitat structure, sediment supply and quality, riparian-forest connectivity and health, and in-stream habitat complexity. They describe some of the key components for evaluating salmonid habitat, and are good indicators of habitat structure, and streamside and upland processes.

Statistical analysis was conducted on 18 selected habitat features from the data set. Each response was modeled using a One-Way ANOVA with subbasin (Lower Mainstem, Upper Mainstem, North Fork, Middle Fork, or South Fork) as the main effect. Prior to modeling, data were assessed for normality and equal variance in order to comply with model assumptions. Non-normal response variables were transformed either with a Log_{10}, $Log_{10}(x+1)$, or Square Root transformation. Significant model effects ($P<0.05$) were then tested using Tukey's Pairwise multiple comparisons in order to protect Type I error rates.

Table 1. Stream, site identification number, start and end coordinates (UTM-NAD27), panel type, number of visits, survey distance, and dates for steelhead spawning surveys conducted in the John Day River basin from 27 February to 13 June, 2006. LMJDR: Lower Mainstem subbasin; UMJDR: Upper Mainstem subbasin; NFJDR: North Fork subbasin; MFJDR: Middle Fork subbasin; SFJDR: South Fork subbasin.

			Start Coordinates		End Coordinates					Survey Date					
Stream	Site ID	UTM Zone	Easting	Northing	Easting	Northing	Panel Type	# of Visits	Distance Surveyed (km)	1	2	3	4	5	6
LMJDR															
Cottonwood Creek	65	11	287216	4921144	287189	4919487	Four3	1	2.0	5/22					
E Bologna Canyon	128	11	292728	4965818	294246	4966874	New3	4	2.0	3/24	4/7	4/13	5/3		
Lost Valley Creek	56	10	731396	5004436	732765	5003344	Four3	3	2.0	3/28	4/12	4/26			
Milk Creek	127	10	727444	4927348	726563	4927263	New3	1	1.0	5/24					
Milk Creek	497	10	728121	4928713	727445	4927348	Annual	1	1.7	5/24					
Rock Creek	539	11	268309	5010640	269458	5010014	Four3	3	2.0	3/13	3/21	4/26			
Rock Creek	9	10	718867	5044432	719995	5043658	Annual	4	2.0	2/27	3/13	4/19	5/1		
Rock Creek	6	10	728344	5033646	729031	5032360	Annual	5	2.0	2/27	3/13	4/4	4/19	5/1	
Service Creek	11	10	737165	4964565	735738	4965368	Annual	5	1.8	3/16	3/30	4/12	4/20	5/3	
Unnamed Creek	126	11	283771	4918553	282046	4919370	New3	1	2.0	6/13					
Unnamed Creek	63	11	282022	4980864	282569	4981466	Four3	3	0.9	4/7	4/20	5/4			
Willow Creek	528	11	271351	4940787	271787	4942470	New3	2	2.0	4/17	5/8				
UMJDR															
Cummings Creek	116	11	313892	4926510	313714	4928295	New3	4	2.0	3/27	4/14	5/4	5/23		
Fields Creek	493	11	316090	4917418	316053	4915794	Annual	5	2.0	4/3	4/11	4/26	5/8	5/23	
John Day River	547	11	342405	4920305	344324	4920427	Four3	1	2.0	4/17					
Rail Creek	13	11	377482	4910520	379322	4911070	Annual	2	2.0	5/24	6/5				
Reynolds Creek	549	11	377361	4919129	378993	4919504	New3	5	2.0	4/6	4/19	5/3	5/18	6/8	
Standard Creek	51	11	367960	4934701	369241	4935722	Four3	2	1.7	5/16	6/2				
Standard Creek	58	11	366507	4933724	367960	4934701	Four3	2	2.0	5/16	6/2				
Tinker Creek	5	11	349136	4933091	349678	4934711	Annual	3	2.0	4/24	5/1	5/15			
Vance Creek	15	11	342566	4905274	340714	4906205	Annual	3	2.1	4/6	4/19	5/3			
NFJDR															
Battle Creek	535	11	361217	4968533	362942	4969070	Annual	2	2.0	5/17	5/31				
Bull Run Creek	50	11	387637	4962350	389156	4961126	Four3	4	2.0	4/27	5/17	5/23	6/7		
Camas Creek	4	11	343517	4987110	343984	4989146	Annual	3	2.3	3/24	5/18	6/12			
Clear Creek	16	11	383722	4961548	383865	4959655	Annual	3	2.1	6/1	6/8	6/14			
Deerlick Creek	543	11	343345	5000920	341570	5000926	Four3	3	2.0	4/3	4/17	5/2			
Fivemile Creek	62	11	334520	4997323	334356	4998832	Four3	2	2.0	5/4	5/10				

Table 1. (Cont.)

			Start Coordinates		End Coordinates					Survey Dates					
Stream	Site ID	UTM Zone	Easting	Northing	Easting	Northing	Panel Type	# of Visits	Distance Surveyed (km)	1	2	3	4	5	6
NFJDR															
Fivemile Creek	124	11	329506	5006312	327924	5006810	New3	1	2.0	5/4					
Gilmore Creek	7	11	302011	4954449	302611	4953198	Annual	5	1.7	3/29	4/13	4/21	5/4	5/18	
Granite Creek	52	11	377626	4967592	379224	4966912	Four3	2	2.0	6/1	6/6				
Granite Creek	533	11	387917	4963439	388259	4965122	New3	5	2.0	4/27	5/2	5/17	5/31	6/6	
Granite Creek	490	11	376641	4968983	377626	4967590	Annual	2	2.1	6/1	6/6				
Lick Creek	548	11	380016	4966589	381343	4967772	Four3	2	2.0	5/2	5/17				
Meadow Creek	531	11	374022	4981181	375155	4982621	New3	1	2.0	5/23					
NF John Day River	61	11	319206	4978099	319186	4979839	Four3	3	2.0	3/24	6/12	7/20			
Sugarbowl Creek	540	11	335717	5001813	335560	5003725	Four3	2	2.0	4/25	5/10				
Trout Creek	529	11	386082	4975613	385234	4976978	Annual	1	2.0	6/7					
Wilson Creek	132	11	297656	4980188	296881	4981532	New3	3	2.0	4/10	4/20	5/4			
MFJDR															
Davis Creek	122	11	378191	4938241	376628	4936985	New3	4	2.0	4/25	5/9	5/18	5/30		
MF John Day River	534	11	374803	4941921	376194	4941394	Annual	5	2.0	4/18	4/25	5/9	5/29	6/5	
SF Long Creek	538	11	340271	4949773	340507	4948146	Four3	3	2.0	4/3	4/17	5/2			
Vincent Creek	2	11	377837	4940909	377982	4942453	Annual	6	1.7	4/5	4/18	4/25	5/9	5/17	5/23
Vinegar Creek	536	11	378252	4939602	379849	4940636	Four3	5	2.0	4/18	4/25	5/9	5/30	6/8	
WF Lick Creek	17	11	358255	4942481	358053	4940539	Annual	3	2.0	4/24	5/2	5/11			
Whisky Creek	10	11	354555	4946886	353113	4947271	Annual	2	1.7	4/5	4/25				
SFJDR															
SF Deer Creek	532	11	313523	4894513	313118	4892743	Annual	2	2.0	5/8	6/1				
SF John Day River	129	11	298338	4925540	299223	4924471	New3	2	1.7	3/23	6/6				

Table 2. Stream, site identification number, start and end coordinates (UTM-NAD27), panel type, and survey dates for juvenile salmonid and habitat surveys conducted in the John Day river basin from 5 July to 4 October, 2006. LMJDR: Lower Mainstem subbasin; UMJDR: Upper Mainstem subbasin; NFJDR: North Fork subbasin; MFJDR: Middle Fork subbasin; SFJDR: South Fork subbasin.

			Start Coordinates		End Coordinates				
Stream	Site ID	UTM Zone	Easting	Northing	Easting	Northing	Panel Type	Juvenile Salmonid Survey Date	Habitat Survey Date
LMJDR									
Cottonwood Creek	65	11	287216	4921141	287142	4919559	Four3	9/26	9/26
East Bologna Canyon	128	11	293867	4966560	294246	4966874	New3	7/17	7/17
Lost Valley Creek	56	10	731572	5004240	732280	5003566	Four3	9/21	9/21
Milk Creek	497	10	728120	4928716	728108	4928347	Annual	9/13	9/13
Rock Creek	9	10	718869	5044429	719291	5043791	Annual	7/5	7/5
Rock Creek	6	10	728345	5033643	728420	5032850	Annual	7/7	7/7
Rock Creek	539	11	268777	5010347	269460	5010011	Four3	7/6	7/6
Service Creek	11	10	737166	4964562	736318	4964732	Annual	7/13	7/13
Unnamed Creek	63	11	282023	4980860	282246	4981267	Four3	7/18	7/18
Unnamed Creek	126	11	283109	4919011	282621	4919075	New3	9/25	9/25
Willow Creek	528	11	271734	4942024	271787	4942470	New3	10/4	10/4
UMJDR									
Cummings Creek	116	11	313454	4927899	313714	4928295	New3	7/12	7/12
Fields Creek	493	11	316091	4917414	315682	4916602	Annual	8/28	8/28
John Day River	547	11	342405	4920305	343404	4920334	Four3	7/12	7/12
Rail Creek	13	11	378096	4910758	378854	4911037	Annual	9/6	9/6
Reynolds Creek	549	11	377361	4919129	378185	4918855	New3	9/5	9/5
Standard Creek	58	11	367475	4934736	367960	4934697	Four3	7/31	7/31
Standard Creek	51	11	367960	4934697	368380	4934790	Four3	7/31	7/31
Tinker Creek	5	11	348999	4932966	349335	4933296	Annual	7/26	7/26
Vance Creek	15	11	342566	4905270	342269	4905565	Annual	9/20	9/20
NFJDR									
Battle Creek	535	11	361988	4969010	362942	4969070	Annual	8/16	8/16
Bull Run Creek	50	11	388386	4961731	389155	4961123	Four3	8/8	8/8
Camas Creek	4	11	343754	4987349	344117	4988206	Annual	8/7	8/7
Clear Creek	16	11	383722	4961546	383469	4960708	Annual	8/21	8/21
Deerlick Creek	543	11	342387	5000661	341570	5000926	Four3	8/3	8/1
Fivemile Creek	62	11	334492	4998072	343580	4998830	Four3	8/3	8/2
Fivemile Creek	124	11	328373	5006879	328071	5006806	New3	8/2	8/2
Gilmore Creek	7	11	302012	4954446	302567	4953954	Annual	7/25	7/25
Granite Creek	490	11	376641	4968983	376944	4968127	Annual	8/22	8/22

Table 2. (Cont.)

Stream	Site ID	UTM Zone	Start Coordinates Easting	Start Coordinates Northing	End Coordinates Easting	End Coordinates Northing	Panel Type	Juvenile Salmonid Survey Date	Habitat Survey Date
Granite Creek	52	11	378432	4967166	379224	4966910	Four3	8/23	8/23
Granite Creek	533	11	388282	4964690	388235	4965105	New3	8/17	8/15
Lick Creek	548	11	380016	4966589	380298	4966803	Four3	8/15	8/15
Meadow Creek	531	11	374682	4981833	375085	4982574	New3	8/30	8/30
North Fork John Day River	61	11	319176	4979054	319187	4979835	Four3	7/20	7/20
Sugarbowl Creek	540	11	335608	5003229	335560	5003725	Four3	8/3	8/3
Trout Creek	529	11	385694	4976407	385234	4976978	Annual	8/29	8/29
Wilson Creek	132	11	297553	4980870	296881	4981532	New3	7/18	7/18
MFJDR									
Davis Creek	122	11	377016	4937300	376628	4936985	New3	7/10	7/10
Middle Fork John Day River	534	11	375376	4941755	376194	4941394	Annual	7/27	7/27
South Fork Long Creek	538	11	340244	4948865	340507	4948146	Four3	8/31	8/31
Vincent Creek	2	11	377837	4940906	377997	4941757	Annual	7/27	7/27
Vinegar Creek	536	11	378669	4939989	379548	4940410	Four3	7/26	7/26
West Fork Lick Creek	17	11	358255	4942477	358194	4941644	Annual	8/14	8/14
Whisky Creek	10	11	354555	4946882	353714	4947189	Annual	8/24	8/24
SFJDR									
South Fork Deer Creek	532	11	313322	4893182	313128	4892877	Annual	9/12	9/12
South Fork John Day River	129	11	298380	4924876	299223	4924467	New3	7/11	7/11

RESULTS

Steelhead Redds and Escapement

We observed 67 steelhead redds while surveying 90.5 rkm (56.2 mi) of an estimated 4,326 rkm (2,688 mi) of steelhead spawning and rearing habitat within the John Day River basin (Table 3) during 2006. Of all subbasins, the Lower Mainstem had the highest number of redds (Table 3; Figure 4) followed by the Middle Fork (Figure 5), the Upper Mainstem (Figure 6), and the North Fork (Figure 7) subbasins, respectively. No redds were observed in the South Fork in 2006 (Table 3; Figure 8). An estimated 3,202 redds were constructed within the John Day River basin in 2006 (0.74 redds/km; Table 4) by an estimated 6,725 spawners. This adult steelhead escapement is similar to that estimated in 2004, but apparently greater than the 2005 estimate, however, large confidence intervals for all years preclude any statistical differences (Figure 9).

The number of redds observed in 2006 varied by subbasin and the total distance surveyed within each subbasin. The greatest number of redds were observed in the Lower Mainstem while the highest density of redds occurred in the Middle Fork subbasin (Table 3). A large proportion of the redds in the Lower Mainstem John Day River were observed at one site (Service Creek; Site ID 11; Figure 3; Table 3) while all but one site in the Middle Fork John Day River had one or more redds observed during steelhead spawning surveys in 2006 (Table 3, Figure 5). Although redd densities for the other three subbasins appear low, they are consistent with previous years results (Table 5; Figure 10).

The number of redds observed in the John Day River basin in 2006 was nearly double that reported in 2005 (Table 5). Redd observations in the Middle Fork and Lower Mainstem John Day River subbasins increased from zero and eight redds in 2005, respectively, to 19 and 23 redds, respectively, in 2006 (Table 5). The increase in the Lower Mainstem John Day river was most pronounced at the annual Service Creek site where 14 redds were observed during the current year compared to zero redds in 2005 (Table 6). The number of redds observed in the Upper Mainstem fell from 20 redds in 2005 to 13 redds in 2006 (Table 5). In comparison to 2004, redd observations in the Upper Mainstem John Day river in 2006 increased from zero to 13 redds (Table 5).

Adult summer steelhead observations in the John Day River Basin increased in 2006 compared to 2005 (Table 5). This change was most discernable at the Service Creek site where 47% (15 out of 32) of all live adult steelhead were observed in 2006 (Table 3). Both the Middle Fork and North Fork subbasins also increased in adult steelhead observations in 2006 (eight and four fish, respectively) from 2005 where no adult steelhead were observed in either subbasin (Table 5). In the South Fork John Day river subbasin, no adult steelhead were observed in 2006, which is consistent with results from 2005 (Table 5). Nearly every subbasin in the John Day River Basin had similar adult steelhead observations in 2006 compared to 2004 (Table 5). Only the Lower Mainstem John Day river subbasin showed any noticeable difference. This difference is again attributable to varying results from Service Creek where 12 more fish were observed in 2004 (n=27) than in 2006 (Table 6).

South Fork John Day River Spawning Subsample **—** A total of 18 redds were observed at all surveyed sites in the South Fork John Day River subbasin (Table 7). Redd densities at sites in the subbasin varied from zero to 2.5 redds/km (Table 7; Figure 11). Overall, the average redd density in the subbasin was 0.69 redds/km with an estimated total redd count of 182 redds (Table 8). We estimate that 383 adult steelhead spawners escaped to the South Fork subbasin (Table 8).

Hatchery:Wild Observations

Hatchery steelhead composed 41% of live steelhead observed in the John Day River basin where the presence (unmarked, presumed wild) or absence (marked, presumed hatchery) of an adipose fin could be determined, however, origin was only determined for 53% of live fish (Table 9). Using the ratio of live clipped : unclipped steelhead (41% and 59%, respectively) observed in the John Day river basin, we estimate that 2,757 hatchery origin steelhead and 3,968 wild origin steelhead were present during spawning surveys in 2006. All live fish verified as hatchery origin (N=7) were observed at two sites: Service Creek on the Lower Mainstem John Day river (n=6; Site ID 11) and Wilson Creek on the North Fork John Day river (n=1; Site ID 132; Table 3, Figure 12) and only one adult hatchery steelhead was observed near a constructed redd (Table 9). Of the two carcasses recovered during 2006, one collected from Rock Creek on the Lower Mainstem John Day River (Site ID 6; Table 3) was of hatchery origin. The hatchery : wild ratio of live adult steelhead present in the John Day river basin has apparently increased from 29% in 2004 to 41% in 2006 but these differences are not statistically significant (z-test; $P \geq 0.93$). In both 2004 and 2005, all hatchery steelhead observed during EMAP spawning surveys were observed in the Lower Mainstem. Similarly, most (six of seven, 86%) hatchery origin spawners were observed in the Lower Mainstem during 2006.

Table 3. Total number of steelhead redds, redd density (redd/km), and unmarked, marked, and unknown live and dead steelhead observed during spawning surveys conducted in the John Day River basin from February to June, 2006. LMJDR: Lower Mainstem subbasin; UMJDR: Upper Mainstem subbasin; NFJDR: North Fork subbasin; MFJDR: Middle Fork subbasin; SFJDR: South Fork subbasin.

				# Live Fish			# Dead Fish		
Stream	**Site ID**	**# of Redds**	**Redds/km**	**Unmarked**	**Marked**	**Unknown**	**Unmarked**	**Marked**	**Unknown**
LMJDR									
Cottonwood Creek	65	0	0.00	0	0	0	0	0	0
E Bologna Canyon	128	2	1.00	1	0	1	0	0	0
Lost Valley Creek	56	7	3.50	0	0	0	0	0	0
Milk Creek	127	0	0.00	0	0	0	0	0	0
Milk Creek	497	0	0.00	0	0	0	0	0	0
Rock Creek	539	0	0.00	0	0	0	0	0	0
Rock Creek	6	6	3.00	0	0	1	0	1	0
Rock Creek	9	0	0.00	0	0	0	0	0	0
Service Creek	11	14	7.78	3	6	6	0	0	0
Unnamed Creek	126	0	0.00	0	0	0	0	0	0
Unnamed Creek	63	0	0.00	0	0	0	0	0	0
Willow Creek	528	0	0.00	0	0	0	0	0	0
LMJDR TOTAL		**29**	**1.36**	**4**	**6**	**8**	**0**	**1**	**0**
UMJDR									
Cummings Creek	116	0	0.00	0	0	0	0	0	0
Fields Creek	493	4	2.00	0	0	2	0	0	0
John Day River	547	0	0.00	0	0	0	0	0	0
Rail Creek	13	0	0.00	0	0	0	0	0	0
Reynolds Creek	549	9	4.50	0	0	0	0	0	0
Standard Creek	51	0	0.00	0	0	0	0	0	0
Standard Creek	58	0	0.00	0	0	0	0	0	0
Tinker Creek	5	0	0.00	0	0	0	0	0	0
Vance Creek	15	0	0.00	0	0	0	0	0	0
UMJDR TOTAL		**13**	**0.73**	**0**	**0**	**2**	**0**	**0**	**0**
NFJDR									
Battle Creek	535	0	0.00	0	0	0	0	0	0
Bull Run Creek	50	0	0.00	0	0	0	0	0	0
Camas Creek	4	0	0.00	0	0	0	1	0	0
Clear Creek	16	2	0.95	0	0	0	0	0	0
Deerlick Creek	543	0	0.00	0	0	0	0	0	0
Fivemile Creek	62	2	1.00	0	0	0	0	0	0
Fivemile Creek	124	0	0.00	0	0	0	0	0	0
Gilmore Creek	7	0	0.00	0	0	0	0	0	0
Granite Creek	533	1	0.50	2	0	1	0	0	0
Granite Creek	52	0	0.00	0	0	0	0	0	0

Table 3. (Cont.)

Stream	Site ID	# of Redds	Redds/km	# Live Fish Unmarked	# Live Fish Marked	# Live Fish Unknown	# Dead Fish Unmarked	# Dead Fish Marked	# Dead Fish Unknown
Granite Creek	490	0	0.00	0	0	0	0	0	0
Lick Creek	548	0	0.00	0	0	0	0	0	0
Meadow Creek	531	0	0.00	0	0	0	0	0	0
NF John Day River	61	1	0.50	0	0	0	0	0	0
Sugarbowl Creek	540	0	0.00	0	0	0	0	0	0
Trout Creek	529	0	0.00	0	0	0	0	0	0
Wilson Creek	132	0	0.00	0	1	0	0	0	0
NFJDR TOTAL		**6**	**0.18**	**2**	**1**	**1**	**1**	**0**	**0**
MFJDR									
Davis Creek	122	1	0.50	0	0	0	0	0	0
MF John Day River	534	1	0.50	0	0	0	0	0	0
SF Long Creek	538	5	2.50	1	0	1	0	0	0
Vincent Creek	2	8	4.71	0	0	0	0	0	0
Vinegar Creek	536	2	1.00	2	0	3	0	0	0
WF Lick Creek	17	2	1.00	1	0	0	0	0	0
Whisky Creek	10	0	0.00	0	0	0	0	0	0
MFJDR TOTAL		**19**	**1.42**	**4**	**0**	**4**	**0**	**0**	**0**
SFJDR									
SF Deer Creek	532	0	0.00	0	0	0	0	0	0
SF John Day River	129	0	0.00	0	0	0	0	0	0
SFJDR TOTAL		**0**	**0.00**	**0**	**0**	**0**	**0**	**0**	**0**
BASIN TOTAL		**67**	**0.74**	**10**	**7**	**15**	**1**	**1**	**0**

Table 4. Distance surveyed, number of unique redds observed, redd densities (redds/km and redds/mi), estimated total number of redds and spawner escapement with 95% C.I. for the John Day River basin from 2004 to 2006.

	Distance Surveyed		Summer Steelhead					95% C.I.	
Year	km	miles	Redds	Redds/km	Redds/mi	Total Redds	Escapement	Lower	Upper
2004	94.7	58.8	66	0.70	1.12	3071	6449	2383	10514
2005	101.2	62.9	39	0.39	0.62	1681	3529	1203	5856
2006	90.5	56.2	67	0.74	1.19	3202	6725	2770	10680

Table 5. Total redds, redd density (redds/km), and live fish observed throughout the John Day River basin (JDR Basin) and by subbasin (LMJDR: Lower Mainstem subbasin; UMJDR: Upper Mainstem subbasin; NFJDR: North Fork subbasin; MFJDR: Middle Fork subbasin; SFJDR: South Fork subbasin) from 2004 to 2006.

	JDR Basin			LMJDR			UMJDR			NFJDR			MFJDR			SFJDR		
Year	Redds	Redds per km	Fish	Redds	Redds per km	Fish	Redds	Redds per km	Fish	Redds	Redds per km	Fish	Redds	Redds per km	Fish	Redds	Redds per km	Fish
2004	66	0.70	50	38	1.83	35	0	0.00	0	8	0.21	7	17	1.27	0	3	0.35	1
2005	39	0.39	12	8	0.34	6	20	0.75	6	11	0.38	0	0	0.00	0	0	0.00	0
2006	67	0.74	32	29	1.36	18	13	0.73	2	6	0.18	4	19	1.42	8	0	0.00	0

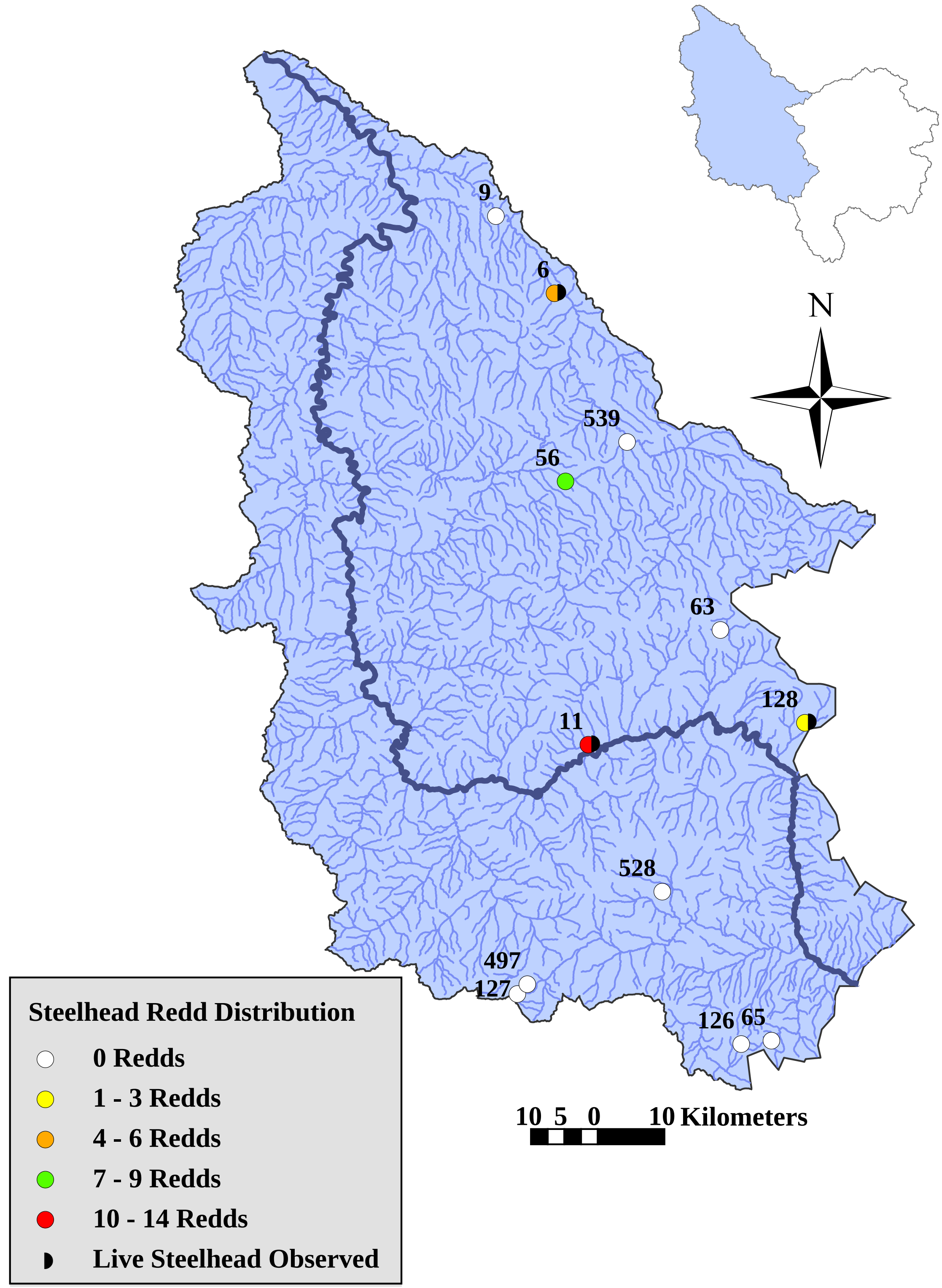


Figure 4. Map of the location and number of redds and live steelhead spawners observed in the Lower Mainstem John Day River during spawning surveys conducted between 27 February and 14 June, 2006. Site identification numbers are shown next to each point for reference.

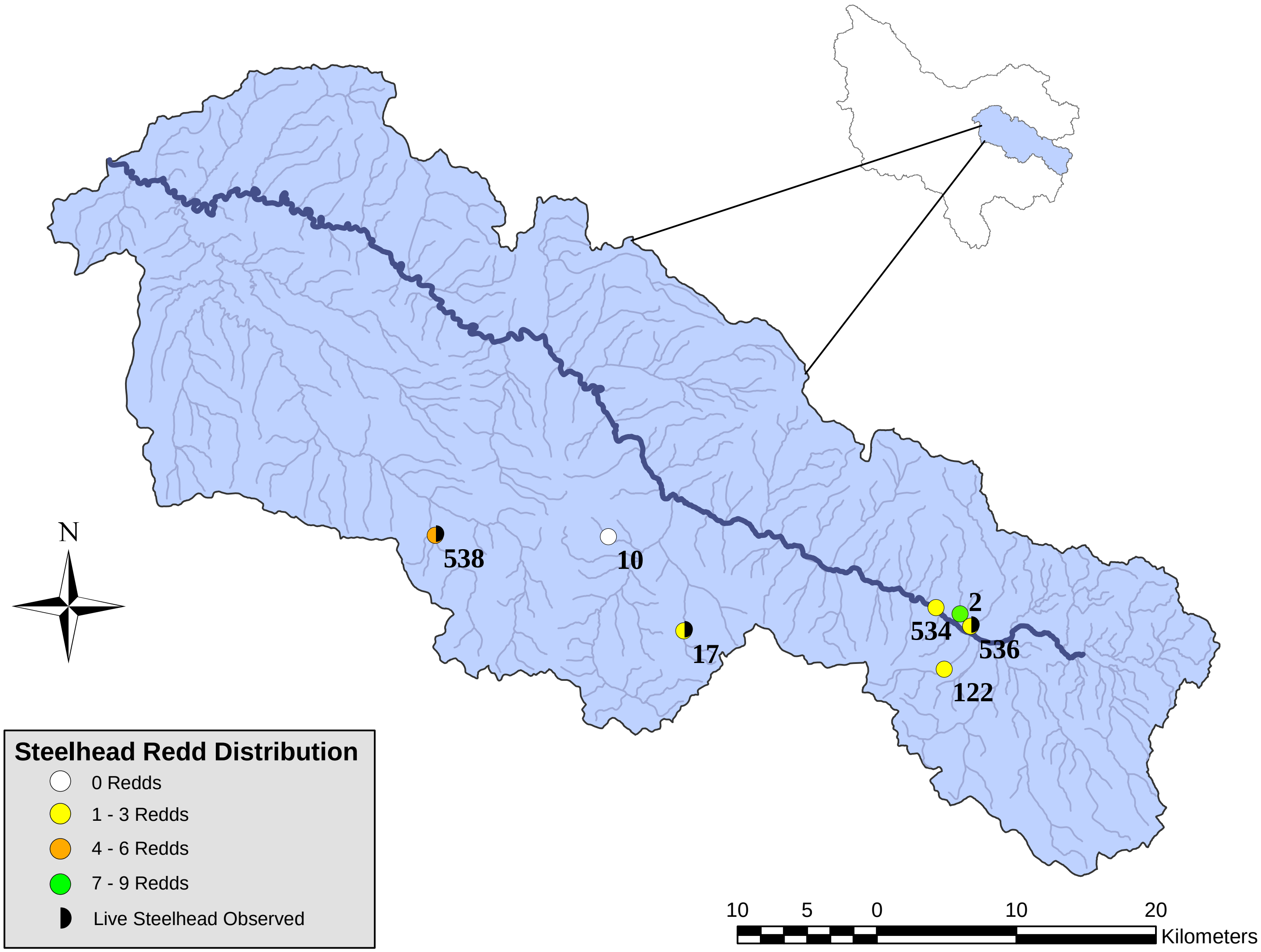


Figure 5. Map of the location and number of redds and live steelhead spawners observed in the Middle Fork John Day River during spawning surveys conducted between 27 February and 14 June, 2006. Site identification numbers are shown next to each point for reference.

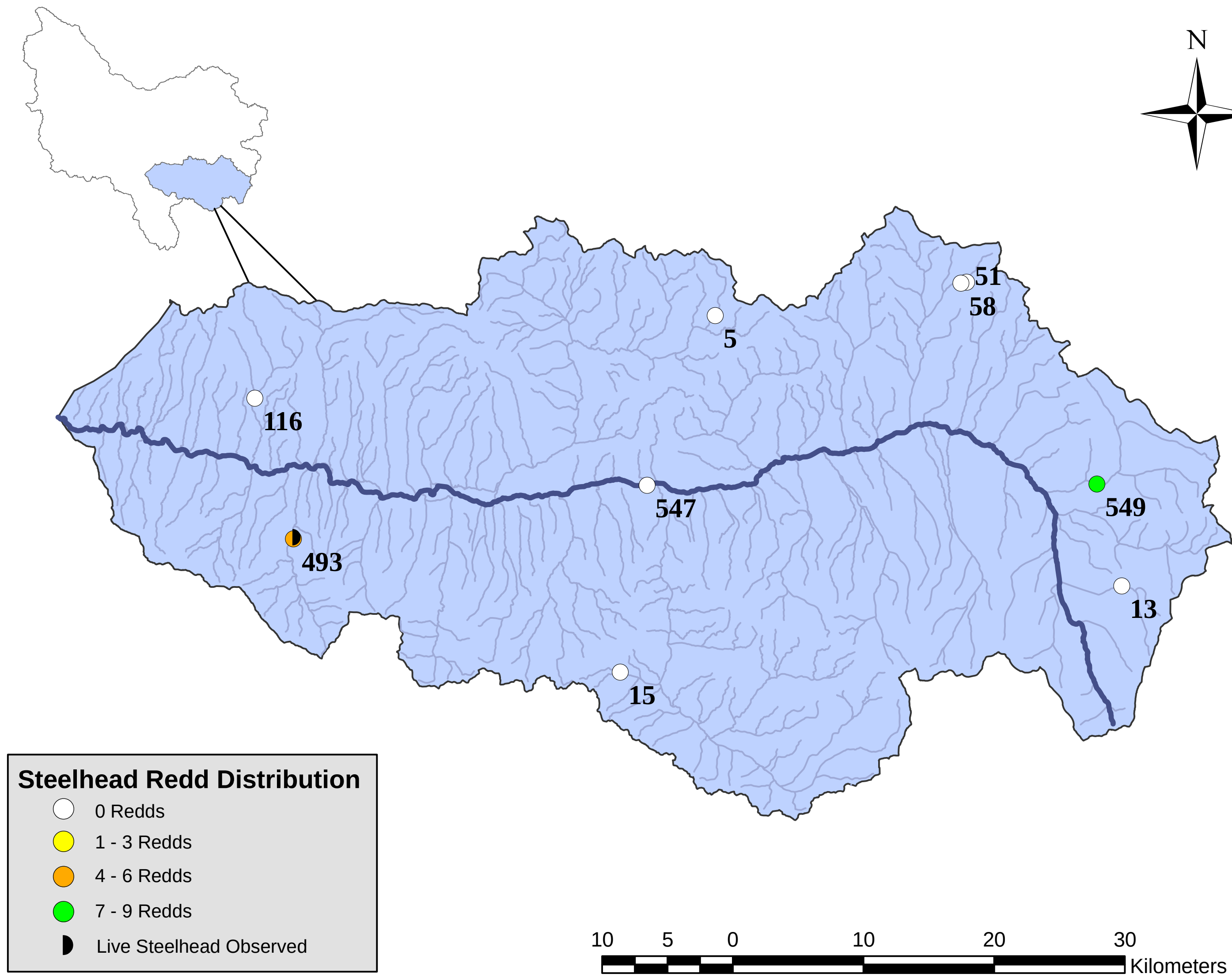


Figure 6. Map of the location and number of redds and live steelhead spawners observed in the Upper Mainstem John Day River during spawning surveys conducted between 27 February and 14 June, 2006. Site identification numbers are shown next to each point for reference.

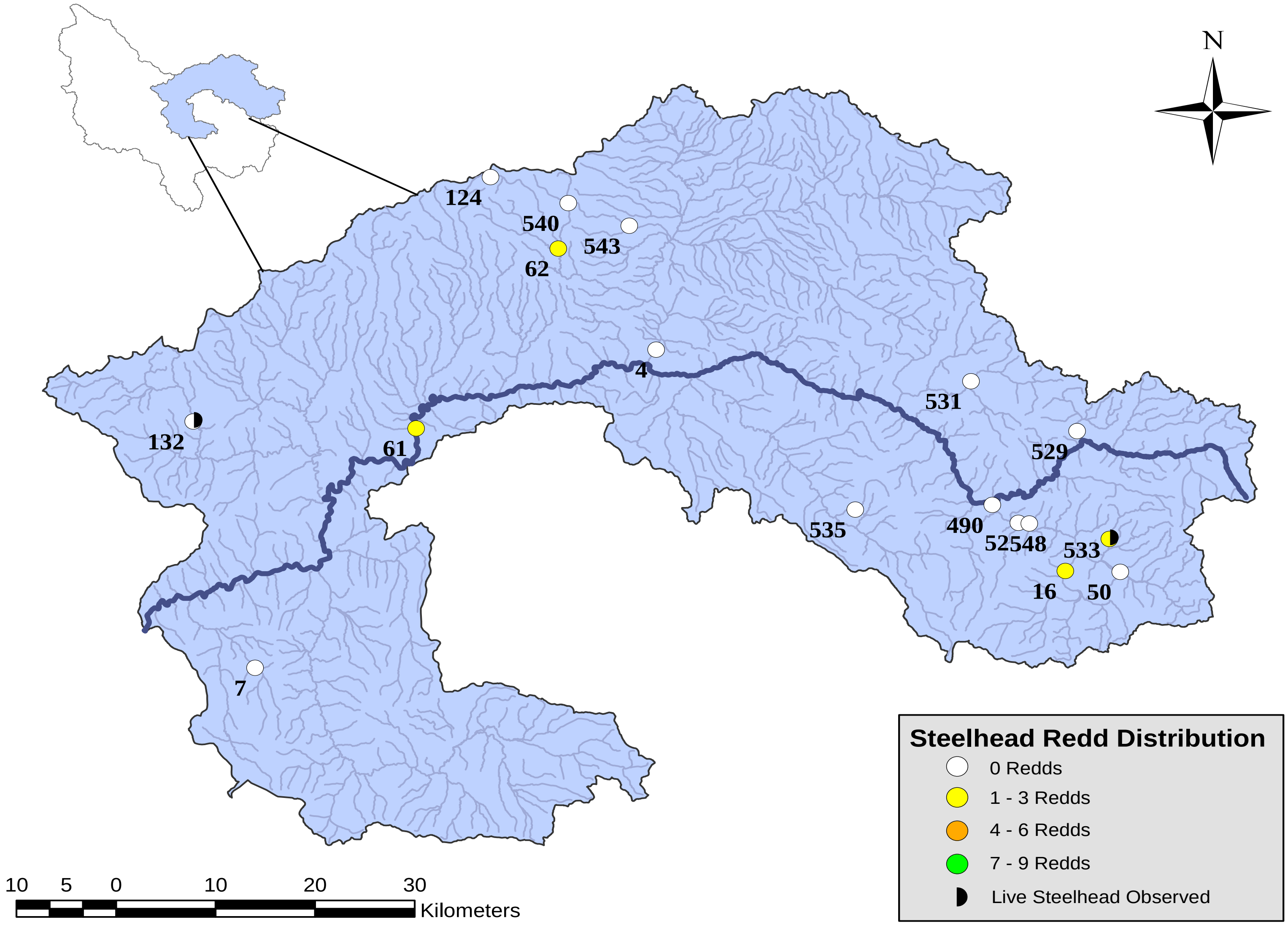


Figure 7. Map of the location and number of redds and live steelhead spawners observed in the North Fork John Day River during spawning surveys conducted between 27 February and 14 June, 2006. Site identification numbers are shown next to each point for reference.

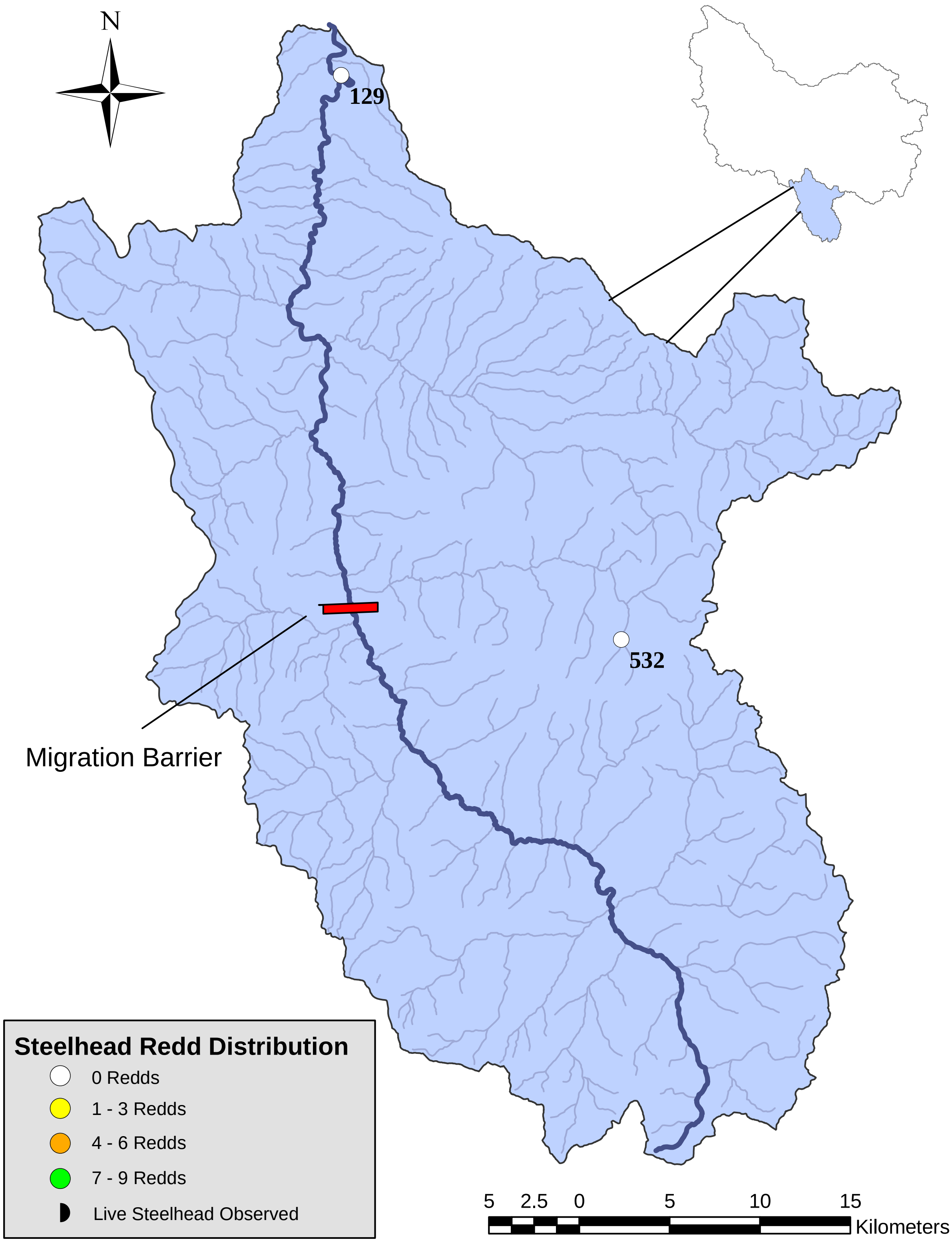


Figure 8. Map of the location and number of redds and live steelhead spawners observed in the South Fork John Day River during spawning surveys conducted between 27 February and 14 June, 2006. Site identification numbers are shown next to each point for reference.

Table 6. Redd and steelhead spawner observations at annual spawning survey sites in the John Day River basin conducted from February to June, 2004–2006. N/A represents sites which were not surveyed during that year but were added later to replace previous annual sites where access was revoked.

			# of Redds			# Live Steelhead			# Dead Steelhead		
Stream	**Site ID**	**Subbasin**	**2004**	**2005**	**2006**	**2004**	**2005**	**2006**	**2004**	**2005**	**2006**
Battle Creek	535	NFJDR	N/A	N/A	0	N/A	N/A	0	N/A	N/A	0
Camas Creek	4	NFJDR	0	0	0	0	0	0	0	0	1
Clear Creek	16	NFJDR	3	1	2	4	0	0	0	0	0
Fields Creek	493	UMJDR	0	0	2	0	0	2	0	0	0
Gilmore Creek	7	NFJDR	0	0	0	0	0	0	0	0	0
Granite Creek	490	NFJDR	0	0	0	0	0	0	0	0	0
M.F. John Day	534	MFJDR	N/A	N/A	1	N/A	N/A	0	N/A	N/A	0
Milk Creek	497	LMJDR	0	0	0	0	0	0	0	0	0
Rail Creek	13	UMJDR	0	0	0	0	0	0	0	0	0
Rock Creek	6	LMJDR	3	1	6	1	0	1	1	0	1
Rock Creek	9	LMJDR	8	2	0	5	0	0	0	0	0
Service Creek	11	LMJDR	17	0	14	27	0	15	4	0	0
Tinker Creek	5	UMJDR	0	0	0	0	0	0	0	0	0
Vance Creek	15	UMJDR	0	0	0	0	0	0	0	0	0
Vincent Creek	2	MFJDR	5	0	8	0	0	0	0	0	0
WF Lick Creek	17	MFJDR	4	0	2	0	0	1	0	0	0
Whisky Creek	10	MFJDR	0	0	0	0	0	0	0	0	0
Trout Creek	529	NFJDR	N/A	N/A	0	N/A	N/A	0	N/A	N/A	0
S.F. Deer Creek	532	SFJDR	N/A	N/A	0	N/A	N/A	0	N/A	N/A	0
TOTAL			**40**	**4**	**37**	**37**	**0**	**19**	**5**	**0**	**2**

Table 7. Total number of steelhead redds, redd density (redds/km), and unmarked, marked, and unknown live and dead steelhead observed during subbasin spawning surveys conducted in the South Fork John Day River subbasin in 2006.

				#Live Fish				# Dead Fish			
Stream	**Site ID**	**# of Redds**	**Redds/k m**	**Unmarked**	**Marked**	**Unknown**	**Total**	**Unmarked**	**Marked**	**Unknown**	**Total**
Black Canyon Creek	140	1	0.5	2	0	0	2	0	0	0	0
Charlie Mack Creek	141	0	0.0	0	0	0	0	0	0	0	0
Deer Creek	200	5	2.5	0	0	0	0	0	0	0	0
Deer Creek	33	1	0.5	0	0	0	0	0	0	0	0
Lemon Creek	187	0	0.0	0	0	0	0	0	0	0	0
Murderers Creek	223	4	2.0	0	0	0	0	0	0	0	0
Murderers Creek	204	2	1.0	1	0	1	2	0	0	0	0
Murderers Creek	161	2	1.0	0	0	3	3	0	0	0	0
NF Wind Creek	97	0	0.0	0	0	0	0	0	0	0	0
SF Deer Creek	532	0	0.0	0	0	0	0	0	0	0	0
SF John Day River	175	0	0.0	0	0	0	0	0	0	0	0
SF John Day River	129	0	0.0	0	0	0	0	0	0	0	0
Tex Creek	66	3	1.5	0	0	0	0	0	0	0	0
Wind Creek	152	0	0.0	0	0	0	0	0	0	0	0
SFJD BASIN TOTAL		**18**	**0.69**	**3**	**0**	**4**	**7**	**0**	**0**	**0**	**0**

Table 8. Distance surveyed (km and miles), observed redds, redd densities (redds/km and redds/mi), estimated total number of redds and spawner escapement with 95% C.I. for the South Fork John Day River subbasin subsample in 2006.

	Distance			Summer Steelhead				95% Confidence Interval	
SFJDR Subbasin	**Km**	**Miles**	**Redds**	**Redds/km**	**Redds/Mi**	**Total Redds**	**Escapement**	**Lower**	**Upper**
2006	25.9	16.1	18	0.69	1.12	182	383	181	585

Table 9. Number of live steelhead observed and determined for origin, number and percentage marked and unmarked, and number and percentage marked and unmarked steelhead near redds during surveys conducted during 2006. LMJDR: Lower Mainstem subbasin; UMJDR: Upper Mainstem subbasin; NFJDR: North Fork subbasin; MFJDR: Middle Fork subbasin; SFJDR: South Fork subbasin.

Subbasin	**# Observed**	**# Determined**	**# Marked**	**% Marked**	**# Marked Near Redd**	**% Marked Near Redd**	**# Unmarked**	**% Unmarked**	**# Unmarked Near Redd**	**% Unmarked Near Redd**
LMJDR	18	10	6	60.0	1	16.7	4	40.0	1	25.0
UMJDR	2	0	0	0.0	0	0.0	0	0.0	0	0.0
NFJDR	4	3	1	33.3	0	0.0	2	66.7	2	100.0
MFJDR	8	4	0	0.0	0	0.0	4	100.0	1	25.0
SFJDR	0	0	0	0.0	0	0.0	0	0.0	0	0.0
BASIN TOTAL	**32**	**17**	**7**	**41.2**	**1**	**14.3**	**10**	**58.8**	**4**	**40.0**

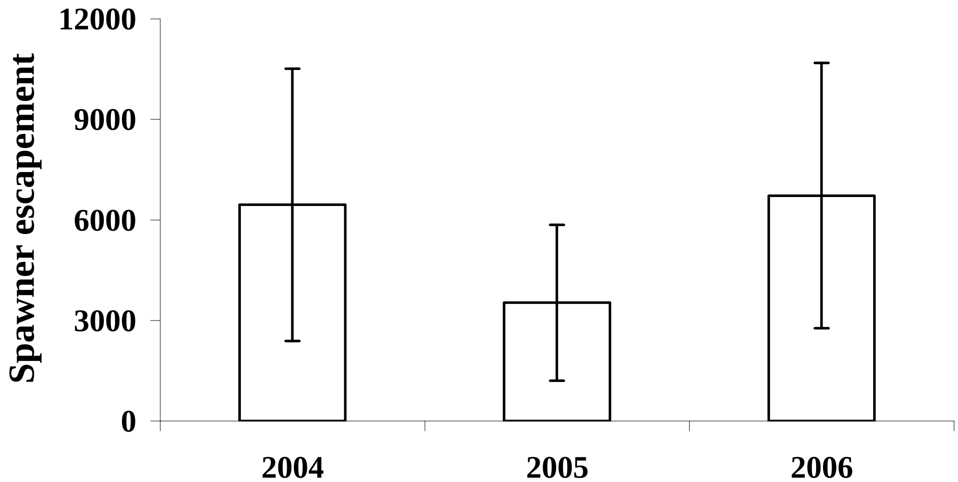


Figure 9. Annual adult steelhead escapement estimates for the John Day River basin from 2004 to 2006. Error bars indicate 95% C.I.

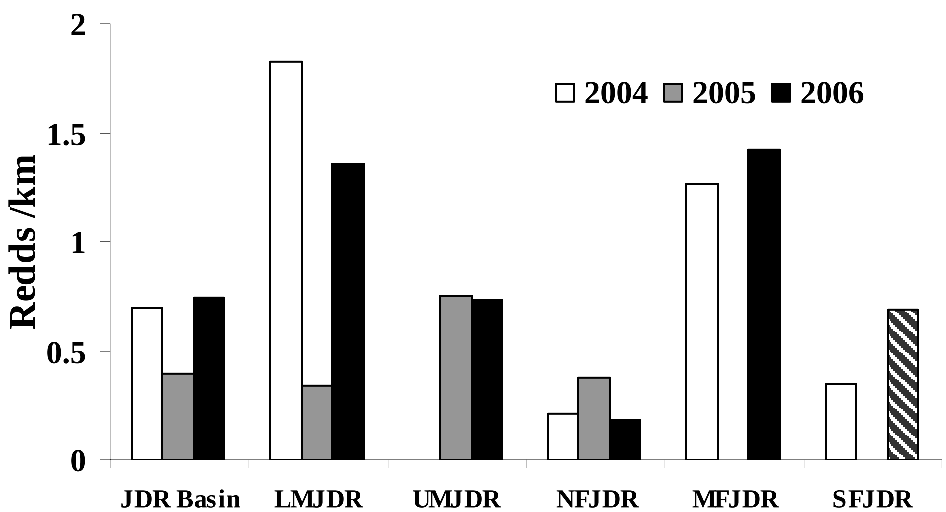


Figure 10. Average redd densities (redds/km) observed in the John Day River basin (JDR Basin), Lower Mainstem subbasin (LMJDR), Upper Mainstem subbasin (UMJDR), North Fork subbasin (NFJDR), Middle Fork subbasin (MFJDR), and South Fork subbasin (SFJDR) from 2004 to 2006. Data for 2006 SFJDR (diagonally striped bar) are from additional (n=14) subsample spawning sites surveyed that year in the subbasin.

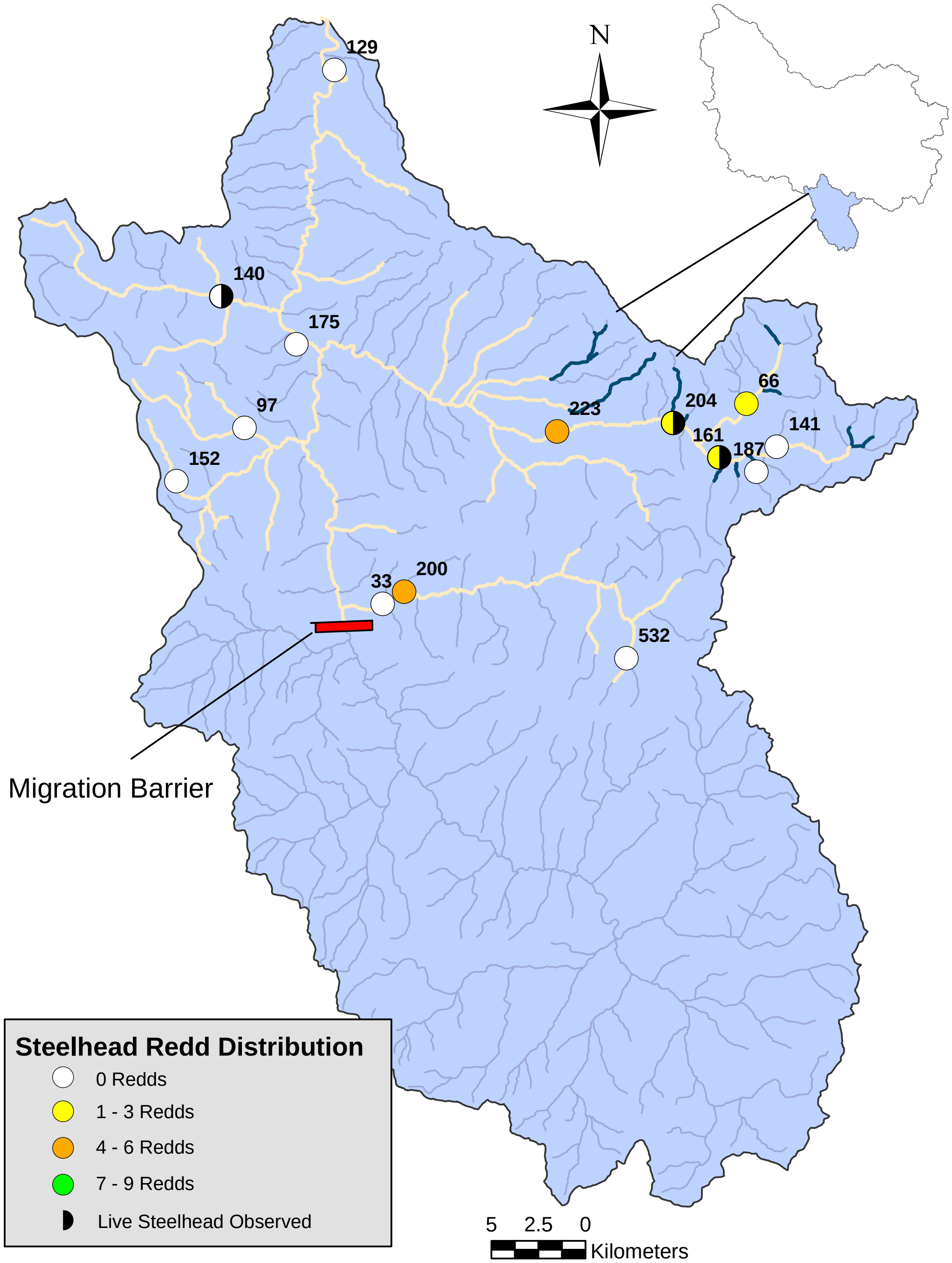


Figure 11. Map of the location and number of redds and live steelhead spawners observed in the South Fork John Day River during subbasin spawning surveys conducted in 2006. Site identification numbers are shown next to each point for reference.

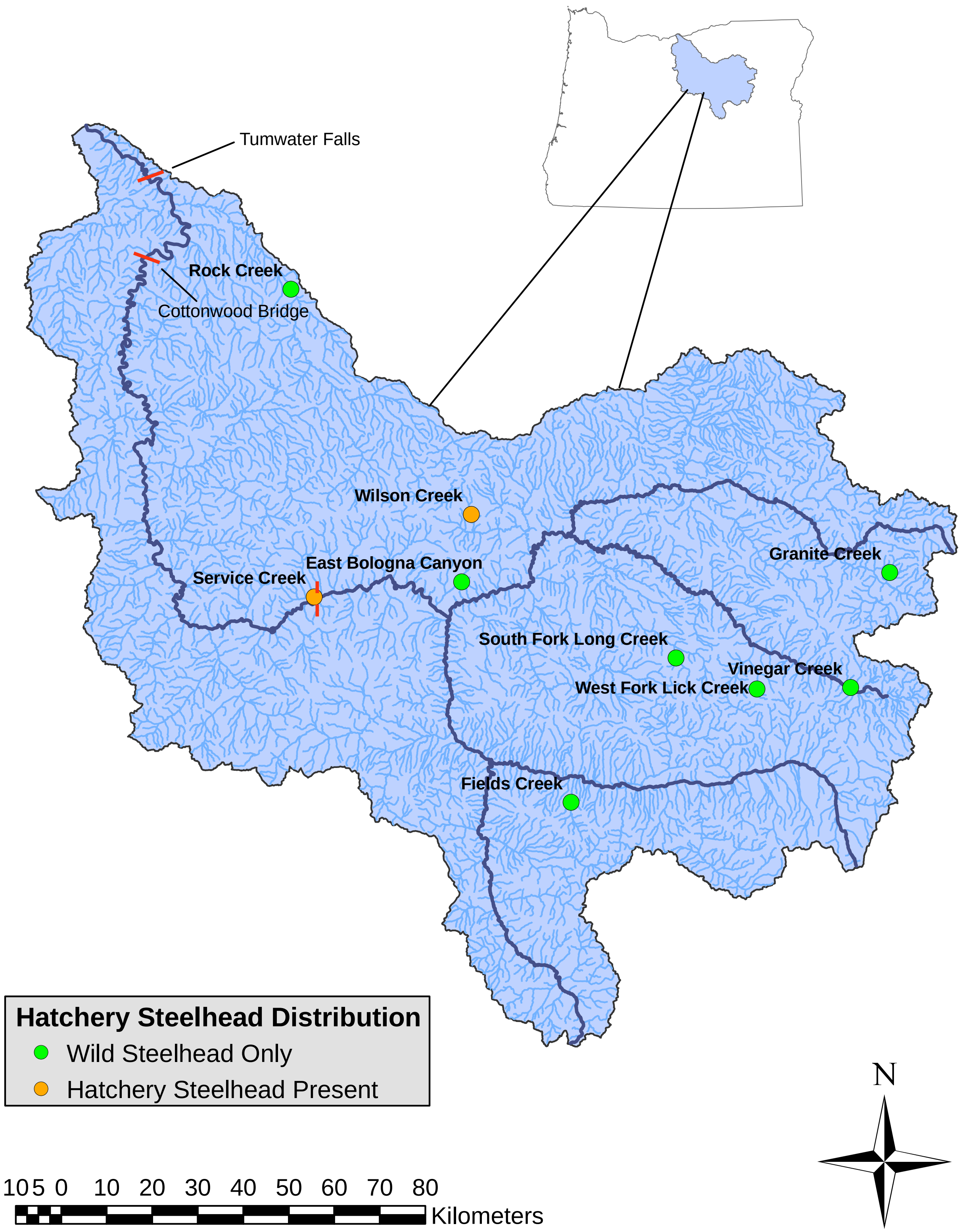


Figure 12. Distribution of live hatchery and wild steelhead observations in the John Day River basin during spawner surveys conducted between 27 February and 14 June, 2006. Red bars indicate mainstem John Day River sections used to describe the distribution of marked steelhead adults and steelhead coded wire tag recoveries.

Juvenile Salmonid Surveys

During the summer of 2006, 46 sites were sampled to assess salmonid distribution and abundance in the John Day River basin. All sites were either electrofished (27 sites) or snorkeled (19 sites; Table 10). Salmonids were observed at 39 of 46 sites sampled during this period. Steelhead were the most abundant salmonid observed occurring at 38 of 46 sites (Table 9) with both adult (>152 mm) and juvenile (<152 mm) steelhead co-occurring at 32 sites (Table 10). Chinook salmon were the second most abundant salmonid occurring at seven of 46 sites (Table 11). Juvenile Chinook were present at all seven sites and adult Chinook were observed at four of the seven sites (Table 12). Adult (>152 mm) westslope cutthroat trout *O. clarki* were observed at five sites and juvenile (<152 mm) westslope cutthroat trout occurred at three sites (Table 11). No adult bull trout *Salvelinus confluentus* were observed in 2006, although juvenile bull trout and adult *Salvelinus* spp. were observed at one site each (Table 11). No adult (>152 mm) or juvenile (<152mm) Eastern brook trout *S. fontinalis* were observed during 2006.

In the Lower Mainstem, steelhead were the only salmonid observed occurring at 8 of 11 sites (Figure 13). Steelhead were observed at nearly all sites in the Upper Mainstem (Figure 14) and North Fork (Figure 15) and at all sites in the Middle Fork (Figure 16). In the South Fork, steelhead were observed at one of two sites surveyed for juvenile salmonids in the subbasin (Table 12; Figure 17). Spring Chinook occurred in the Upper Mainstem (Figure 14), the North Fork (Figure 15), and the Middle Fork (Figure 16) but were absent at sites in the Lower Mainstem and South Fork (Figure 17; Table 12). Westslope cutthroat trout were found in both the Upper Mainstem and North Fork subbasins (Figure 18) while bull trout were only observed in the Upper Mainstem (Table 12; Figure 19).

Pool abundance for the four salmonid species observed at sites where the respective species was present varied by subbasin and species. Although steelhead were the most common salmonid observed at all sites, they only occupied 68% of pools at sites where they were present (Table 13). However, Chinook salmon, when present, occupied almost 80% of pools at sites where they were observed (Table 14). Westslope cutthroat trout and bull trout were present in 34% and 42% of pools, respectively, at sites where they were observed (Tables 15 and 16). In the North Fork subbasin, westslope cutthroat trout were present at one site (Clear Cr., Site 16) and only in one pool (5.9%) at that site (Table 15).

Density estimates for steelhead (Figure 20) and spring Chinook (Figure 21) at annual sites surveyed from 2004 to 2006 showed variability from year to year. Two sites in the Lower Mainstem (Rock Creek, Site IDs 6 & 9) which declined in densities of steelhead in 2005, increased in 2006 to similar levels observed in 2004 (Table 17). However, two other sites which had apparently lower densities in 2005 had even lower densities of steelhead in 2006 (Service Cr., Site ID 11 and West Fork Lick Cr., Site ID 17; Table 17). All other annual sites showed similar steelhead densities between years (Table 17). Despite this, average densities of steelhead at annual sites show a declining trend (Figure 20). Spring Chinook density estimates were considerably lower at sites where they were observed (Camas Cr., Clear Cr., and Granite Cr.) in 2006 compared to both 2004 and 2005 (Table 17; Figure 21).

Seven incidental species were observed during salmonid surveys in 2006 (Table 18). Dace *Rhinichthys* spp., sucker *Catastomus* spp., sculpin *Cottus* spp., and redside shiner *Richardsonius balteatus* were the most common incidental species, occurring at 11 to 16 sites in the basin (Table 18). Although less frequently encountered, Northern pikeminnow *Ptychocheilus oregonensis*, smallmouth bass *Micropterus dolomieu*, and mountain whitefish *Prosopium williamsoni* were also observed during salmonid surveys (Table 19).

Table 10. Stream, site identification number, sampling method, number of pools surveyed, and percentage of pools with salmonids present at juvenile survey sites in the John Day River basin in 2006. For sampling method, one denotes electrofishing and two denotes snorkeling. LMJDR=Lower Mainstem John Day River, UMJDR=Upper Mainstem John Day River, NFJDR=North Fork John Day River, MFJDR=Middle Fork John Day River, SFJDR=South Fork John Day River.

Stream	Site ID	Sampling Method	# Pools	Steelhead	Spring Chinook	Cutthroat Trout	Bull Trout	Brook Trout
LMJDR								
Cottonwood Creek	65	1	20	95.0	0.0	0.0	0.0	0.0
East Bologna Canyon	128	1	11	18.2	0.0	0.0	0.0	0.0
Lost Valley Creek	56	1	15	40.0	0.0	0.0	0.0	0.0
Milk Creek	497	1	20	65.0	0.0	0.0	0.0	0.0
Rock Creek	9	2	13	30.8	0.0	0.0	0.0	0.0
Rock Creek	6	2	15	100.0	0.0	0.0	0.0	0.0
Rock Creek	539	2	23	87.0	0.0	0.0	0.0	0.0
Service Creek	11	1	17	70.6	0.0	0.0	0.0	0.0
Unnamed Creek	63	1	18	0.0	0.0	0.0	0.0	0.0
Unnamed Creek	126	1	3	0.0	0.0	0.0	0.0	0.0
Willow Creek	528	1	1	0.0	0.0	0.0	0.0	0.0
LMJDR Total			**156**	**58.3**	**0.0**	**0.0**	**0.0**	**0.0**
UMJDR								
Cummings Creek	116	1	23	73.9	0.0	0.0	0.0	0.0
Fields Creek	493	1	20	100.0	0.0	0.0	0.0	0.0
John Day River	547	2	6	50.0	16.7	0.0	0.0	0.0
Rail Creek	13	1	19	0.0	0.0	21.1	42.1	0.0
Reynolds Creek	549	2	21	85.7	0.0	0.0	0.0	0.0
Standard Creek	58	1	20	40.0	0.0	75.0	0.0	0.0
Standard Creek	51	1	20	40.0	0.0	60.0	0.0	0.0
Tinker Creek	5	1	20	50.0	0.0	0.0	0.0	0.0
Vance Creek	15	1	20	75.0	0.0	5.0	0.0	0.0
UMJDR Total			**169**	**58.6**	**0.6**	**18.9**	**4.7**	**0.0**
NFJDR								
Battle Creek	535	2	18	50.0	0.0	0.0	0.0	0.0
Bull Run Creek	50	2	21	100.0	95.2	0.0	0.0	0.0
Camas Creek	4	2	8	87.5	0.0	0.0	0.0	0.0
Clear Creek	16	2	17	100.0	100.0	5.9	0.0	0.0
Deerlick Creek	543	1	6	83.3	0.0	0.0	0.0	0.0
Fivemile Creek	62	2	6	100.0	0.0	0.0	0.0	0.0
Fivemile Creek	124	1	4	0.0	0.0	0.0	0.0	0.0
Gilmore Creek	7	1	23	17.4	0.0	0.0	0.0	0.0
Granite Creek	490	2	12	50.0	50.0	0.0	0.0	0.0
Granite Creek	52	2	11	100.0	100.0	0.0	0.0	0.0
Granite Creek	533	1	18	50.0	0.0	0.0	0.0	0.0
Lick Creek	548	1	15	26.7	0.0	0.0	0.0	0.0

Table 10. (cont.)

Stream	Site ID	Sampling Method	# Pools	Steelhead	Spring Chinook	Cutthroat Trout	Bull Trout	Brook Trout
NFJDR								
Meadow Creek	531	2	20	15.0	0.0	0.0	0.0	0.0
North Fork John Day River	61	2	1	0.0	0.0	0.0	0.0	0.0
Sugarbowl Creek	540	1	4	0.0	0.0	0.0	0.0	0.0
Trout Creek	529	2	15	66.7	0.0	0.0	0.0	0.0
Wilson Creek	132	2	20	100.0	0.0	0.0	0.0	0.0
NFJDR Total			**219**	**60.3**	**24.7**	**0.5**	**0.0**	**0.0**
MFJDR								
Davis Creek	122	1	28	64.3	0.0	0.0	0.0	0.0
Middle Fork John Day River	534	2	16	25.0	31.3	0.0	0.0	0.0
South Fork Long Creek	538	1	16	100.0	0.0	0.0	0.0	0.0
Vincent Creek	2	1	11	90.9	0.0	0.0	0.0	0.0
Vinegar Creek	536	2	21	100.0	100.0	0.0	0.0	0.0
West Fork Lick Creek	17	1	21	81.0	0.0	0.0	0.0	0.0
Whisky Creek	10	1	20	90.0	0.0	0.0	0.0	0.0
MFJDR Total			**133**	**78.2**	**19.5**	**0.0**	**0.0**	**0.0**
SFJDR								
South Fork Deer Creek	532	1	20	75.0	0.0	0.0	0.0	0.0
South Fork John Day River	129	2	10	0.0	0.0	0.0	0.0	0.0
SFJDR Total			**30**	**50.0**	**0.0**	**0.0**	**0.0**	**0.0**
Basin Total			**707**	**62.4**	**11.5**	**4.7**	**1.1**	**0.0**

Table 11. Number and percentage of sites with juvenile (<152 mm) and adult ($\geq$152 mm) salmonids collected during juvenile surveys in the John Day River basin from 5 July to 4 October, 2006.

Salmonids	# Sites Present	% Sites Present	# Sites w/Juveniles	% Sites w/Juveniles	# Sites w/Adults	% Sites w/Adults
Oncorhynchus mykiss	38	82.6	38	82.6	33	71.7
Spring Chinook salmon	7	15.2	7	15.2	4	8.7
Westslope Cutthroat trout	5	10.9	3	6.5	5	10.9
Oncorhynchus spp.	9	19.6	5	10.9	8	17.4
Bull trout	1	2.2	1	2.2	0	0.0
Brook trout	0	0.0	0	0.0	0	0.0
Salvelinus spp.	1	2.2	0	0.0	1	2.2

Table 12. Stream, site identification number, and abundance of juvenile and adult salmonids at juvenile survey sites in the John Day River basin in 2006. For sampling method, one denotes electrofishing and two denotes snorkeling. LMJDR=Lower Mainstem John Day River, UMJDR=Upper Mainstem John Day River, NFJDR=North Fork John Day River, MFJDR=Middle Fork John Day River, SFJDR=South Fork John Day River.

			Adult (>152 mm)				Juvenile (<152 mm)				Spring Chinook	
Stream	**Site ID**	**Sampling Method**	**Steelhead**	**Westslope Cutthroat**	**Bull Trout**	**Brook Trout**	**Steelhead**	**Westslope Cutthroat**	**Bull Trout**	**Brook Trout**	**Juvenile**	**Adult**
LMJDR												
Cottonwood Cr.	65	1	7	0	0	0	82	0	0	0	0	0
East Bologna Canyon	128	1	0	0	0	0	4	0	0	0	0	0
Lost Valley Cr.	56	1	45	0	0	0	1	0	0	0	0	0
Milk Cr.	497	1	1	0	0	0	18	0	0	0	0	0
Rock Cr.	9	2	0	0	0	0	306	0	0	0	0	0
Rock Cr.	6	2	0	0	0	0	345	0	0	0	0	0
Rock Cr.	539	2	5	0	0	0	325	0	0	0	0	0
Service Cr.	11	1	7	0	0	0	19	0	0	0	0	0
Unnamed Cr.	63	1	0	0	0	0	0	0	0	0	0	0
Unnamed Cr.	126	1	0	0	0	0	0	0	0	0	0	0
Willow Cr.	528	1	0	0	0	0	0	0	0	0	0	0
LMJDR Total			**65**	**0**	**0**	**0**	**1100**	**0**	**0**	**0**	**0**	**0**
UMJDR												
Cummings Cr.	116	1	4	0	0	0	25	0	0	0	0	0
Fields Cr.	493	1	9	0	0	0	68	0	0	0	0	0
John Day River	547	2	1	0	0	0	15	0	0	0	2	0
Rail Cr.	13	1	0	1	0	0	0	3	8	0	0	0
Reynolds Cr.	549	2	22	0	0	0	142	0	0	0	0	0
Standard Cr.	58	1	2	3	0	0	8	16	0	0	0	0
Standard Cr.	51	1	1	4	0	0	13	10	0	0	0	0
Tinker Cr.	5	1	3	0	0	0	9	0	0	0	0	0
Vance Cr.	15	1	0	1	0	0	31	0	0	0	0	0
UMJDR Total			**42**	**9**	**0**	**0**	**311**	**29**	**8**	**0**	**2**	**0**
NFJDR												
Battle Cr.	535	2	2	0	0	0	20	0	0	0	0	0
Bull Run Cr.	50	2	32	0	0	0	180	0	0	0	171	0
Camas Cr.	4	2	6	0	0	0	10	0	0	0	0	0
Clear Cr.	16	2	64	2	0	0	316	0	0	0	485	2

Table 12. (Cont.)

Stream	Site ID	Sampling Method	Adult (>152 mm) Steelhead	Adult (>152 mm) Westslope Cutthroat	Adult (>152 mm) Bull Trout	Adult (>152 mm) Brook Trout	Juvenile (<152 mm) Steelhead	Juvenile (<152 mm) Westslope Cutthroat	Juvenile (<152 mm) Bull Trout	Juvenile (<152 mm) Brook Trout	Spring Chinook Juvenile	Spring Chinook Adult
NFJDR												
Deerlick Cr.	543	1	20	0	0	0	7	0	0	0	0	0
Fivemile Cr.	62	2	27	0	0	0	112	0	0	0	0	0
Fivemile Cr.	124	1	0	0	0	0	0	0	0	0	0	0
Gilmore Cr.	7	1	12	0	0	0	3	0	0	0	0	0
Granite Cr.	490	2	17	0	0	0	41	0	0	0	21	1
Granite Cr.	52	2	38	0	0	0	89	0	0	0	273	6
Granite Cr.	533	1	5	0	0	0	11	0	0	0	0	0
Lick Cr.	548	1	0	0	0	0	4	0	0	0	0	0
Meadow Cr.	531	2	3	0	0	0	33	0	0	0	0	0
North Fork John Day	61	2	0	0	0	0	0	0	0	0	0	0
Sugarbowl Cr.	540	1	0	0	0	0	0	0	0	0	0	0
Trout Cr.	529	2	13	0	0	0	18	0	0	0	0	0
Wilson Cr.	132	2	38	0	0	0	493	0	0	0	0	0
NFJDR Total			**277**	**2**	**0**	**0**	**1337**	**0**	**0**	**0**	**950**	**9**
MFJDR												
Davis Cr.	122	1	5	0	0	0	29	0	0	0	0	0
Middle Fork John Day	534	2	1	0	0	0	4	0	0	0	5	4
South Fork Long Cr.	538	1	11	0	0	0	104	0	0	0	0	0
Vincent Cr.	2	1	10	0	0	0	24	0	0	0	0	0
Vinegar Cr.	536	2	3	0	0	0	147	0	0	0	225	0
West Fork Lick Cr.	17	1	3	0	0	0	31	0	0	0	0	0
Whisky Cr.	10	1	10	0	0	0	46	0	0	0	0	0
MFJDR Total			**43**	**0**	**0**	**0**	**385**	**0**	**0**	**0**	**230**	**4**
SFJDR												
South Fork Deer Cr.	532	1	1	0	0	0	35	0	0	0	0	0
South Fork John Day	129	2	0	0	0	0	0	0	0	0	0	0
SFJDR Total			**1**	**0**	**0**	**0**	**35**	**0**	**0**	**0**	**0**	**0**
Basin Total			**428**	**11**	**0**	**0**	**3168**	**29**	**8**	**0**	**1182**	**13**

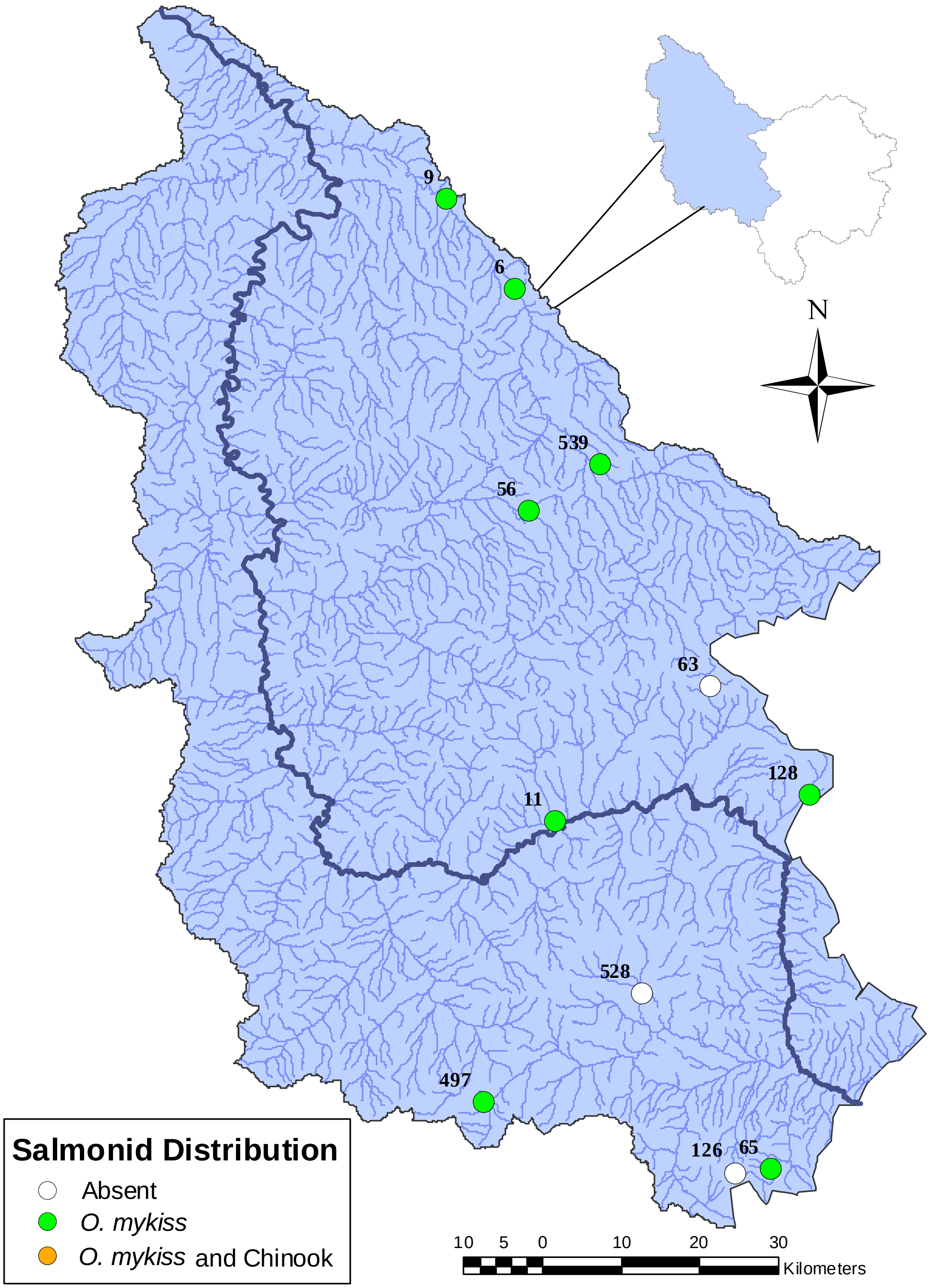


Figure 13. Distribution of juvenile steelhead and spring Chinook observations in the Lower Mainstem John Day River from snorkeling and electrofishing surveys conducted between 5 July and 4 October, 2006. Site identification numbers are shown next to each point for reference.

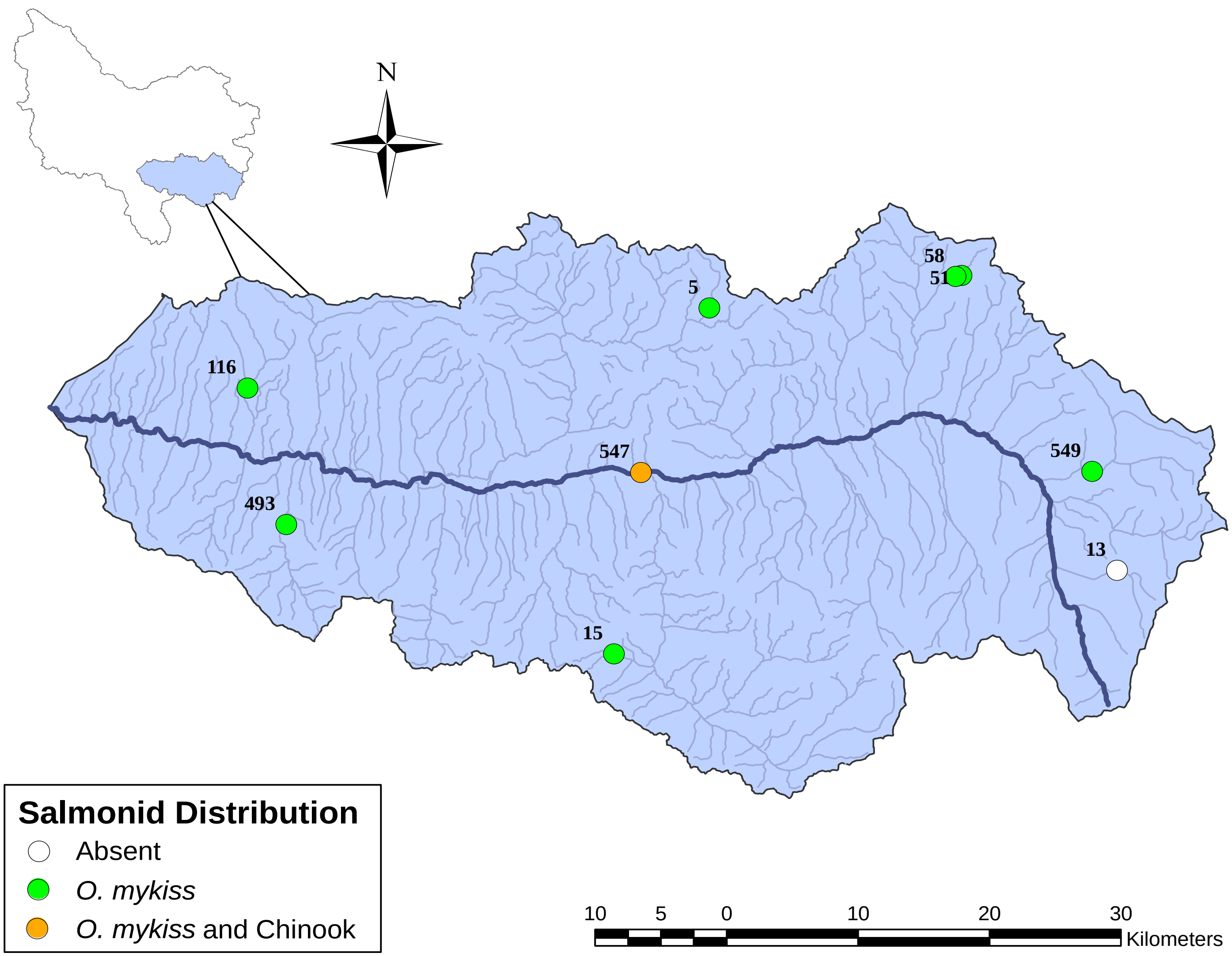


Figure 14. Distribution of juvenile steelhead and spring Chinook observations in the Upper Mainstem John Day River from snorkeling and electrofishing surveys conducted between 5 July and 4 October 2006. Site identification numbers are shown next to each point for reference.

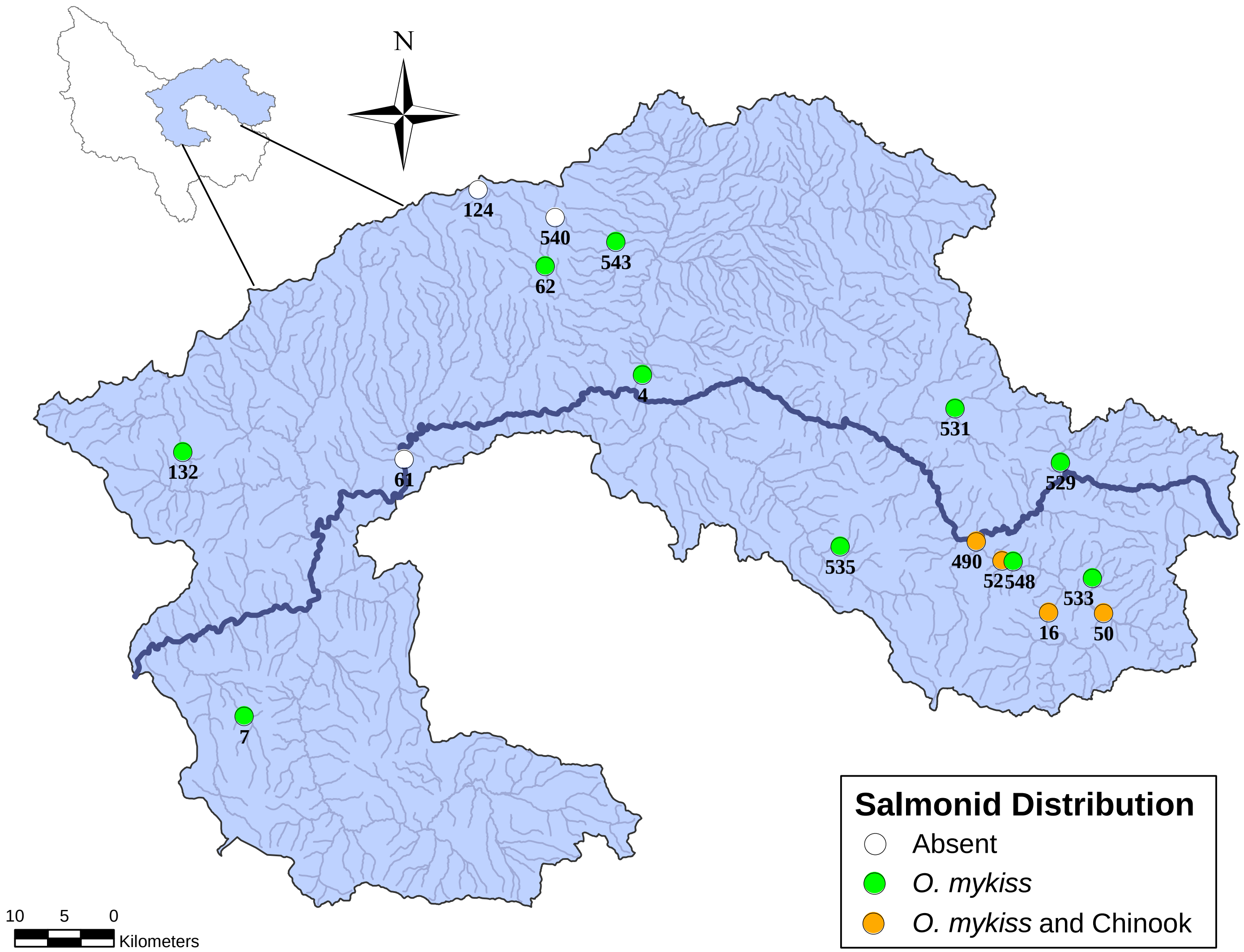


Figure 15. Distribution of juvenile steelhead and spring Chinook observations in the North Fork John Day River from snorkeling and electrofishing surveys conducted between 5 July and 4 October 2006. Site identification numbers are shown next to each point for reference.

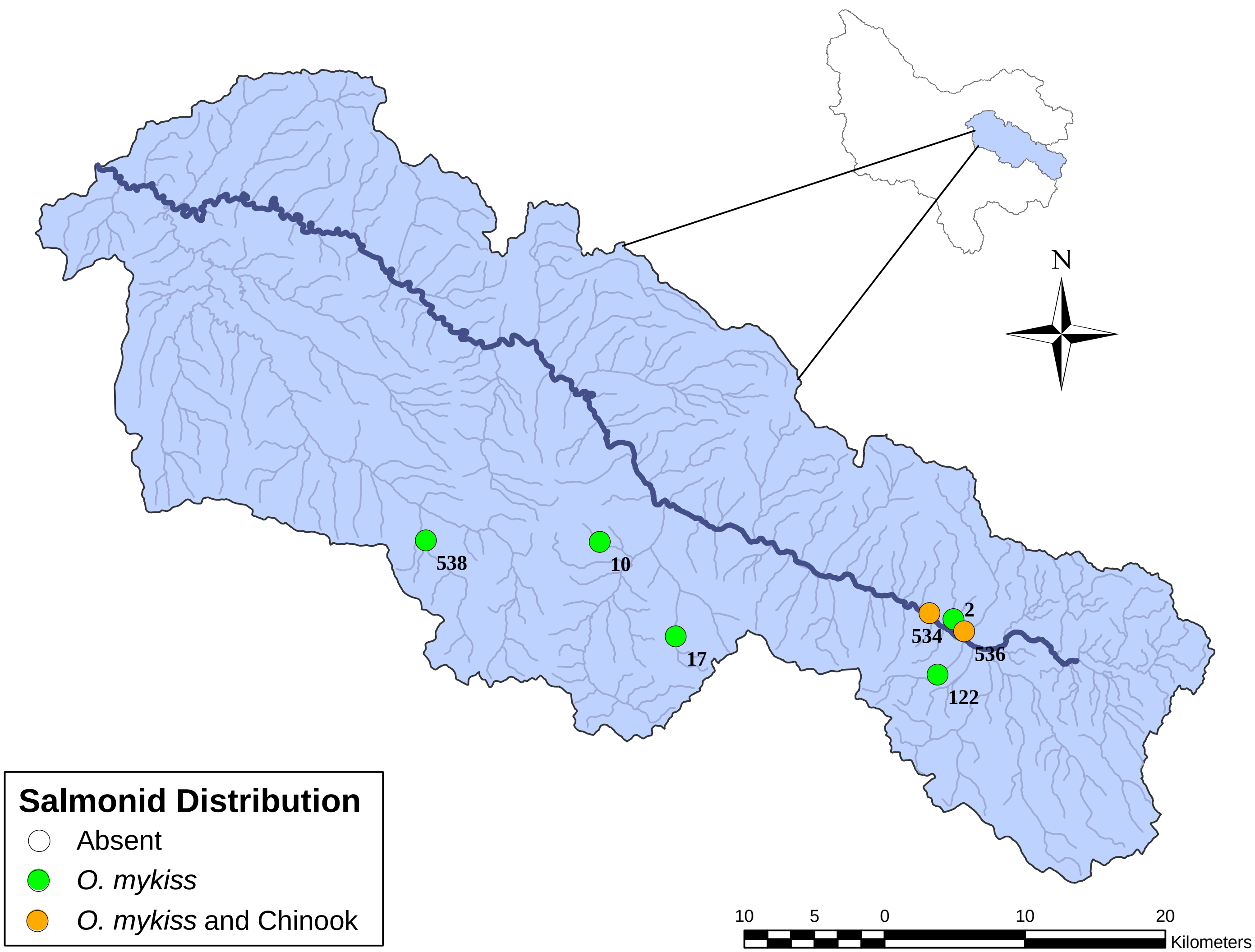


Figure 16. Distribution of juvenile steelhead and spring Chinook observations in the Middle Fork John Day River from snorkeling and electrofishing surveys conducted between 5 July and 4 October 2006. Site identification numbers are shown next to each point for reference.

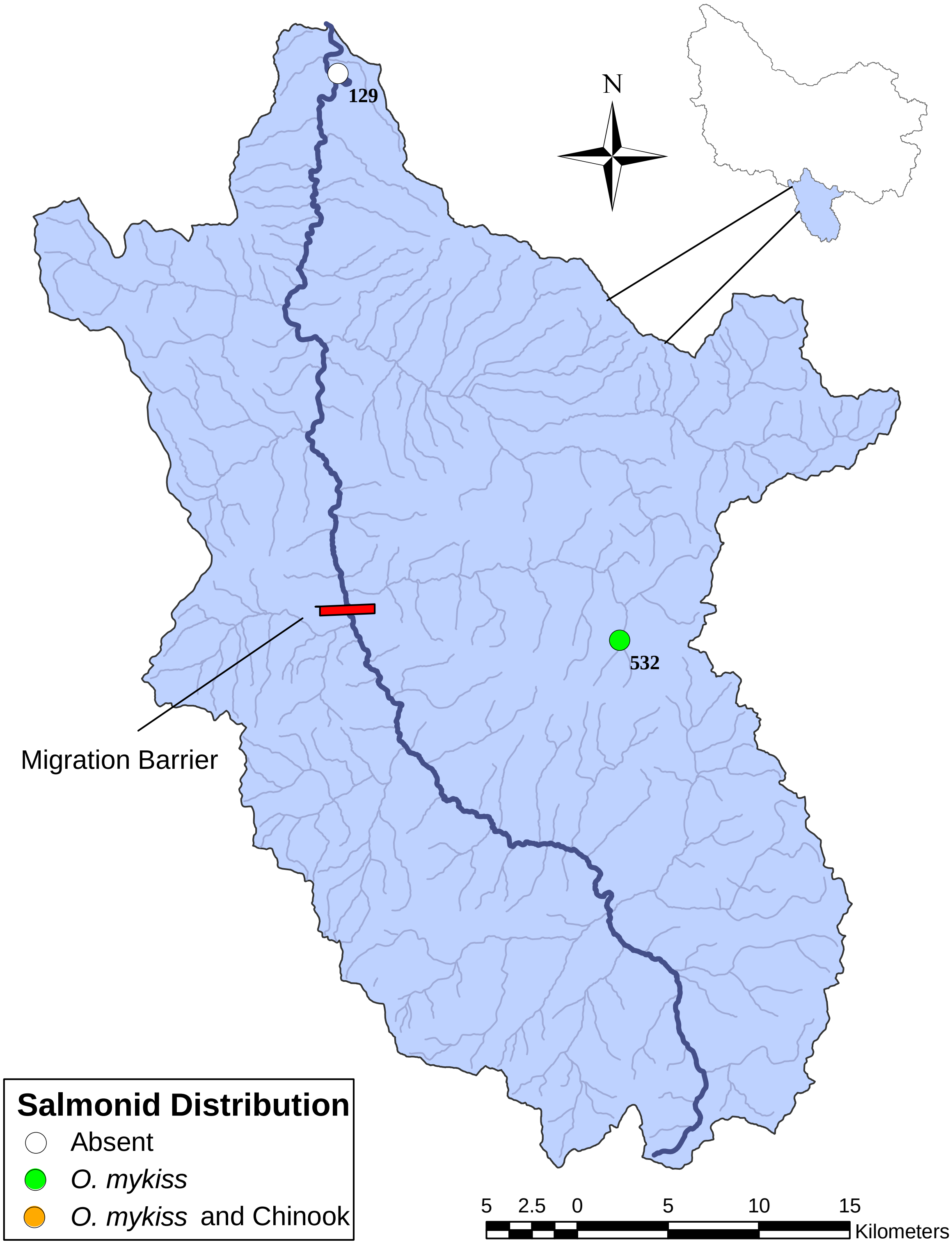


Figure 17. Distribution of juvenile steelhead and spring Chinook observations in the South Fork John Day River from snorkeling and electrofishing surveys conducted between 5 July and 4 October 2006. Site identification numbers are shown next to each point for reference.

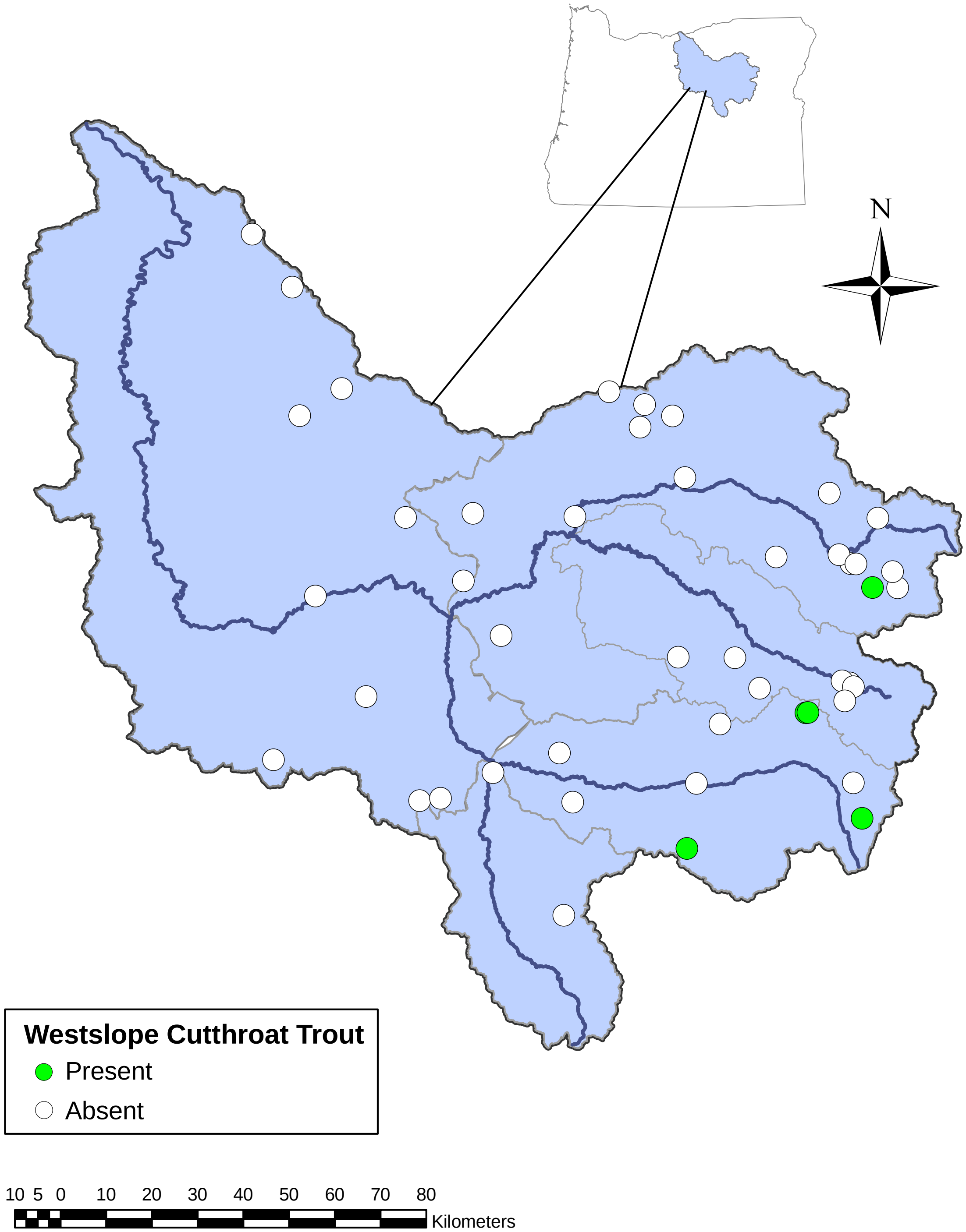


Figure 18. Distribution of westslope cutthroat trout observations in the John Day River basin from snorkeling and electrofishing surveys conducted between 5 July and 4 October, 2006.

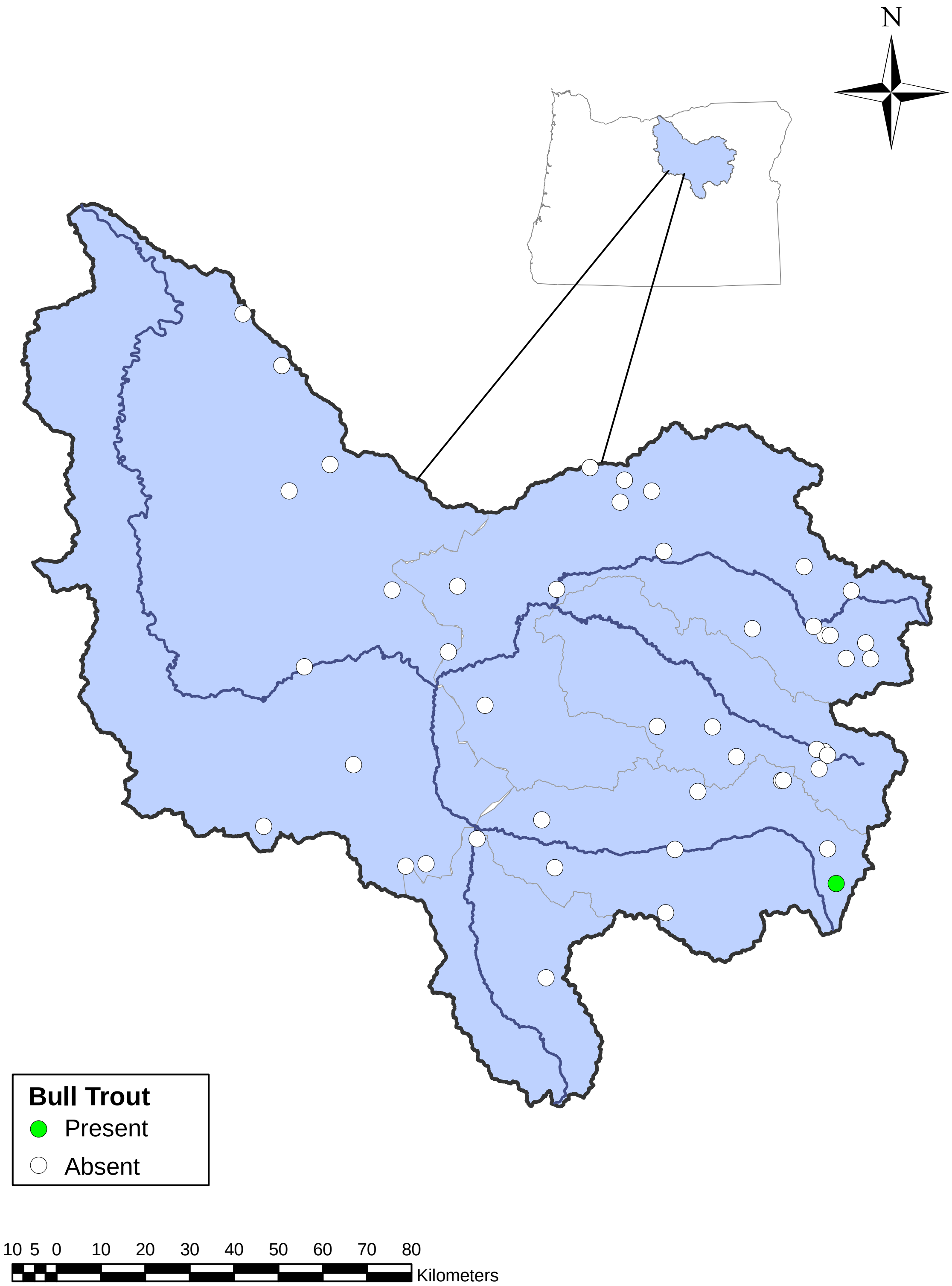


Figure 19. Distribution of bull trout observations in the John Day River basin from snorkeling and electrofishing surveys conducted between 5 July and 4 October, 2006.

Table 13. Number and percentage of pools with steelhead present at juvenile survey sites in the John Day River basin in 2006. Only sites where juvenile steelhead were present are included.

Subbasin	# of Pools	# Pools w/ Steelhead	% Pools w/ Steelhead
Lower Mainstem John Day River	134	91	67.9
Upper Mainstem John Day River	150	99	66.0
North Fork John Day River	210	132	62.9
Middle Fork John Day River	133	104	78.2
South Fork John Day River	20	15	75.0
John Day River Basin	**647**	**441**	**68.2**

Table 14. Number and percentage of pools with spring Chinook present at juvenile survey sites in the John Day River basin during 2006. Only sites where spring Chinook were present are included.

Subbasin	# of Pools	# Pools w /Chinook	% Pools w/ Chinook
Lower Mainstem John Day River	0	0	0.0
Upper Mainstem John Day River	6	1	16.7
North Fork John Day River	61	54	88.5
Middle Fork John Day River	37	26	70.3
South Fork John Day River	0	0	0.0
John Day River Basin	**104**	**81**	**77.9**

Table 15. Number and percentage of pools with westslope cutthroat trout present at juvenile survey sites in the John Day River basin during 2006. Only sites where westslope cutthroat trout were present are included.

Subbasin	# of Pools	# Pools w/ Cutthroat	% Pools w/ Cutthroat
Lower Mainstem John Day River	0	0	0.0
Upper Mainstem John Day River	79	32	40.5
North Fork John Day River	17	1	5.9
Middle Fork John Day River	0	0	0.0
South Fork John Day River	0	0	0.0
John Day River Basin	**96**	**33**	**34.4**

Table 16. Number and percentage of pools with bull trout present at juvenile survey sites in the John Day River basin during 2006. Only sites where bull trout were present are included.

Subbasin	# of Pools	# Pools w/ Bull Trout	% Pools w/ Bull Trout
Lower Mainstem John Day River	0	0	0.0
Upper Mainstem John Day River	19	8	42.1
North Fork John Day River	0	0	0.0
Middle Fork John Day River	0	0	0.0
South Fork John Day River	0	0	0.0
John Day River Basin	**19**	**8**	**42.1**

Table 17. Variability in density (fish/m^2) estimates for steelhead and spring Chinook at annual sites surveyed from 2004 to 2006.

		Steelhead Density (#/m^2)			Spring Chinook Density (#/m^2)		
Stream	**Site ID**	**2004**	**2005**	**2006**	**2004**	**2005**	**2006**
Battle Creek	535	N/A	N/A	0.064	N/A	N/A	0.000
Camas Creek	4	0.004	0.002	0.002	0.002	0.004	0.000
Clear Creek	16	0.128	0.080	0.107	0.190	0.211	0.137
Fields Creek	493	0.406	0.425	0.187	0.000	0.000	0.000
Gilmore Creek	7	0.044	0.074	0.055	0.000	0.000	0.00000
Granite Creek	490	0.052	0.079	0.044	0.103	0.141	0.017
M.F. John Day	534	N/A	N/A	0.001	N/A	N/A	0.001
Milk Creek	497	0.240	0.386	0.174	0.000	0.000	0.000
Rail Creek	13	0.000	0.000	0.000	0.000	0.000	0.000
Rock Creek	6	0.098	0.000	0.072	0.000	0.000	0.000
Rock Creek	9	0.074	0.000	0.101	0.000	0.000	0.000
Service Creek	11	1.106	0.283	0.125	0.000	0.000	0.000
S.F. Deer Creek	532	N/A	N/A	0.239	N/A	N/A	0.000
Trout Creek	529	N/A	N/A	0.067	N/A	N/A	0.000
Tinker Creek	5	0.283	0.454	0.174	0.000	0.000	0.000
Vance Creek	15	0.098	0.375	0.150	0.000	0.000	0.000
Vincent Creek	2	0.310	0.356	0.237	0.000	0.000	0.000
WF Lick Creek	17	0.309	0.181	0.104	0.000	0.000	0.000
Whisky Creek	10	0.282	0.394	0.495	0.000	0.000	0.000

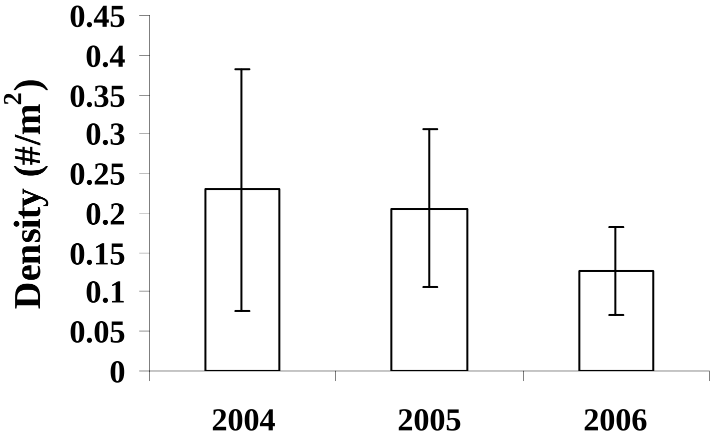


Figure 20. Average density of juvenile steelhead observed at EMAP annual sites from 2004-2006. Error bars indicate 95% C.I. bounds.

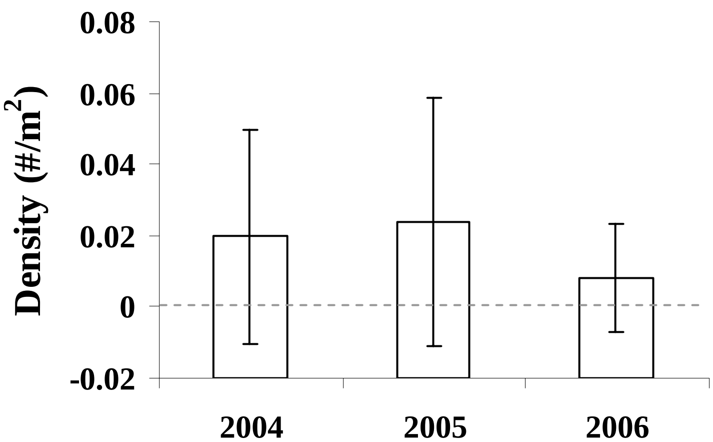


Figure 21. Average density of juvenile spring Chinook observed at EMAP annual sites from 2004-2006. Error bars indicate 95% C.I. bounds. Dashed line is included for reference of zero fish/m^2.

Table 18. Stream, site identification number, sampling method, number of pools surveyed, and presence (X) of incidental species collected during juvenile fish surveys in the John Day River basin during 2006. For sampling method, one denotes electrofishing and two denotes snorkeling. LMJDR=Lower Mainstem John Day River, UMJDR=Upper Mainstem John Day River, NFJDR=North Fork John Day River, MFJDR=Middle Fork John Day River, SFJDR=South Fork John Day River.

Stream	Site ID	Sampling Method	# Pools	Mountain Whitefish	Northern Pikeminnow	Redside Shiner	Smallmouth Bass	*Catostomus* spp.	*Cottus* spp.	*Ictalurus* spp.	*Rhynichthys* spp.
LMJDR											
Cottonwood Creek	65	1	20								
East Bologna Canyon	128	1	11								
Lost Valley Creek	56	1	15					X			X
Milk Creek	497	1	20								
Rock Creek	9	2	13		X	X		X			X
Rock Creek	6	2	15			X		X			X
Rock Creek	539	2	23		X	X		X	X		X
Service Creek	11	1	17				X				
Unnamed Creek	63	1	18								
Unnamed Creek	126	1	3								
Willow Creek	528	1	1			X		X			X
UMJDR											
Cummings Creek	116	1	23								
Fields Creek	493	1	20						X		
John Day River	547	2	6		X	X		X	X		X
Rail Creek	13	1	19								
Reynolds Creek	549	2	21						X		
Standard Creek	58	1	20								
Standard Creek	51	1	20								
Tinker Creek	5	1	20								
Vance Creek	15	1	20								
NFJDR											
Battle Creek	535	2	18								
Bull Run Creek	50	2	21			X		X	X		X

Table 18. (Cont.)

Stream	Site ID	Sampling Method	# Pools	Mountain Whitefish	Northern Pikeminnow	Redside Shiner	Smallmouth Bass	*Catostomus* spp.	*Cottus* spp.	*Ictalurus* spp.	*Rhynichthys* spp.
NFJDR											
Camas Creek	4	2	8		X	X		X	X		X
Clear Creek	16	2	17					X	X		X
Deerlick Creek	543	1	6								
Fivemile Creek	62	2	6						X		X
Fivemile Creek	124	1	4								
Gilmore Creek	7	1	23								
Granite Creek	490	2	12								
Granite Creek	52	2	11	X		X					X
Granite Creek	533	1	18								
Lick Creek	548	1	15								
Meadow Creek	531	2	20								
North Fork John Day River	61	2	1		X		X	X			
Sugarbowl Creek	540	1	4								
Trout Creek	529	2	15								
Wilson Creek	132	2	20								X
MFJDR											
Davis Creek	122	1	28								
Middle Fork John Day River	534	2	16		X	X		X	X		X
South Fork Long Creek	538	1	16			X		X	X		X
Vincent Creek	2	1	11								
Vinegar Creek	536	2	21					X			X
West Fork Lick Creek	17	1	21								
Whisky Creek	10	1	20								
SFJDR											
South Fork Deer Creek	532	1	20								
South Fork John Day River	129	2	10		X	X	X	X	X		X

Table 19. Number and percentage of sites with incidental species collected during juvenile surveys in the John Day River basin (JDR) during 2006. LMJDR=Lower Mainstem John Day River, UMJDR=Upper Mainstem John Day River, NFJDR=North Fork John Day River, MFJDR=Middle Fork John Day River, SFJDR=South Fork John Day River.

	JDR		% Sites Present				
Incidental Species	**# Sites Present**	**% Sites Present**	**LMJDR (n= 11)**	**UMJDR (n= 9)**	**NFJDR (n= 17)**	**MFJDR (n= 7)**	**SFJDR (n= 2)**
Catostomus spp.	14	30.4	45.5	11.1	23.5	42.9	50.0
Cottus spp.	11	23.9	9.1	33.3	23.5	28.6	50.0
Ictalurus ssp.	0	0.0	0.0	0.0	0.0	0.0	0.0
Rhinichthys spp	16	34.8	45.5	11.1	35.3	42.9	50.0
Redside Shiner	11	23.9	36.4	11.1	17.6	28.6	50.0
Northern Pikeminnow	7	15.2	18.2	11.1	11.8	14.3	50.0
Smallmouth Bass	3	6.5	9.1	0.0	5.9	0.0	50.0
Mountain Whitefish	1	2.2	0.0	0.0	5.9	0.0	0.0

Habitat and Riparian Surveys

We surveyed 44.0 km of stream habitat (primary & secondary channels) in the John Day River basin in 2006. Grazing was the dominant land use at many sites and was concentrated in the Lower Mainstem and the Middle Fork subbasins (Table 20). In the riparian zone, grass (both perennial and annual) and shrub were common dominant vegetation constituents, occurring at 29 sites (Table 20). Most streams had a constrained channel form with terraces, hillslopes, or land use as the constraining feature (Table 20). Only the South Fork subbasin had no constraining features (Table 20). In the Lower Mainstem, nearly half of the sites surveyed had puddled or dry flows with the remaining site having low flows (Table 20).

Few statistical differences were observed in the selected habitat characteristics tested. Only percent gravel, percent gravel in riffles, percent bank erosion, and number of hardwood trees per 1,000 ft had any statistically detectable differences (P<0.05; Table 21) across subbasins. *Post hoc* analysis identified the Middle Fork as having higher percent gravel than the North Fork, both overall and in riffles (Table 21; Table 22). Additional *Post hoc* analysis of the remaining significant models indicates that bank erosion is greater in the Lower Mainstem compared with the North Fork and hardwood densities (#/1,000 ft) are greater in the Upper Mainstem in comparison to both the Lower Mainstem and North Fork (Table 21; Table 22).

Table 20. Stream, site identification, channel length surveyed, channel type, land use, and reach information for habitat surveys conducted in the John Day River basin during 2006. Description of codes used for channel form, land use, riparian vegetation, and stream flow are located in Appendices A - D. LMJDR=Lower Mainstem John Day River, UMJDR=Upper Mainstem John Day River, NFJDR=North Fork John Day River, MFJDR=Middle Fork John Day River, SFJDR=South Fork John Day River.

Stream	SiteID	Channel Length (m)		Channel Form	Dominant Land Use	Riparian Veg	Active Channel Width (m)	Gradient (%)	Stream Flow	Temp (C)	% of Site w/Pools	Depth (m)	
		Primary	Secondary									Resid. Pool	Riffle
LMJDR													
Cottonwood Creek	65	990	63	CH	HG	C15	5.0	4.8	PD	7.0	10.4	0.37	0.13
East Bologna Canyon	128	587	106	CA	LG	G	2.6	4.2	PD	12.0	7.4	0.13	0.09
Lost Valley Creek	56	1039	0	CA	HG	G	6.7	1.8	PD	14.0	16.7	0.32	0.10
Milk Creek	497	543	27	US	HG	C3	2.5	3.7	LF	9.0	20.0	0.24	0.09
Rock Creek	6	991	87	CT	AG	B	13.7	0.5	LF	20.5	62.5	0.69	0.17
Rock Creek	539	1029	278	CA	LG	D3	13.8	0.7	LF	17.0	58.3	0.64	0.19
Rock Creek	9	990	11	CA	AG	G	10.3	0.6	LF	24.0	47.2	0.66	0.21
Service Creek	11	1111	0	CT	RR	S	4.9	1.8	LF	16.5	8.8	0.19	0.22
Unnamed Creek	126	558	4	CH	HG	C30	2.7	7.2	DR	7.0	0.1	0.25	
Unnamed Creek	63	637	7	CA	LG	P	2.1	1.8	LF	14.0	15.8	0.24	0.09
Willow Creek	528	613	12	US	HG	G	2.5	-0.3	PD	9.0	7.1	0.79	
UMJDR													
Cummings Creek	116	577	0	CA	LG	G	3.0	2.8	LF	15.0	14.9	0.19	0.15
Fields Creek	493	995	17	CA	LT	S	6.0	3.1	MF	11.0	20.7	0.35	0.15
John Day River	547	1019	21	CT	IN	D30	21.5	1.0	MF	16.0	28.4	0.98	0.54
Rail Creek	13	965	278	CA	LT	S	10.0	4.1	MF	8.0	9.4	0.30	0.27
Reynolds Creek	549	1000	554	UA	LG	D3	9.1	1.6	MF	8.0	28.0	0.34	0.21
Standard Creek	51	500	33	CA	LT	D3	4.3	1.8	MF	13.0	21.9	0.20	0.09
Standard Creek	58	653	137	UA	ST	S	5.7	1.7	MF	10.0	32.6	0.21	0.10
Tinker Creek	5	544	12	CH	LT	S	5.3	2.6	LF	14.0	13.3	0.18	0.08
Vance Creek	15	492	1	CL	NU	S	4.3	1.5	LF	9.0	25.4	0.27	0.12
NFJDR													
Battle Creek	535	1080	192	CH	ST	C3	7.2	3.8	LF	8.0	13.3	0.26	0.12
Bull Run Creek	50	1044	0	CL	MI	C3	5.7	0.8	LF	16.5	52.6	0.48	0.17
Camas Creek	4	994	83	CH	FF	S	32.1	1.0	LF	17.0	49.6	0.63	0.22
Clear Creek	16	1018	326	CL	MI	G	14.1	1.0	LF	14.0	36.7	0.53	0.25

Table 20. (cont.)

Stream	SiteID	Channel Length (m)		Channel Form	Dominant Land Use	Riparian Veg	Active Channel Width (m)	Gradient (%)	Stream Flow	Temp (C)	% of Site w/Pools	Depth (m)	
		Primary	Secondary									Resid Pool	Riffle
NFJDR													
Deerlick Creek	543	1059	382	UA	PT	D3	6.3	3.7	PD	13.0	1.6	0.29	0.02
Fivemile Creek	124	501	121	US	ST	P	4.6	0.3	DR	16.0	1.2		
Fivemile Creek	62	1043	83	CH	YT	C3	12.5	1.9	LF	11.0	12.0	0.51	0.10
Gilmore Creek	7	1010	16	CA	ST	S	3.5	1.8	LF	21.0	21.8	0.29	0.07
Granite Creek	490	1091	130	CH	WA	S	20.9	1.7	LF	13.0	12.2	0.42	0.36
Granite Creek	533	507	209	US	YT	G	3.4	3.9	MF	14.5	23.4	0.35	0.24
Granite Creek	52	1070	112	CL	WA	G	16.0	0.6	LF	12.0	36.7	0.35	0.32
Lick Creek	548	505	16	US	YT	P	1.3	6.6	MF	11.0	12.0	0.17	
Meadow Creek	531	1019	167	US	YT	G	9.4	0.6	LF	9.0	58.4	0.33	0.11
North Fork John Day River	61	1000	0	CH	NU	C15	53.0	1.0	LF	22.0	14.5	2.12	0.54
Sugarbowl Creek	540	562	10	US	NU	G	5.2	0.9	PD	9.0	10.7	0.17	0.08
Trout Creek	529	968	39	CH	WA	S	7.8	6.8	LF	13.5	11.0	0.53	
Wilson Creek	132	1078	87	CH	NU	C15	18.6	1.6	LF	15.0	57.1	0.69	0.10
MFJDR													
Davis Creek	122	550	12	CT	ST	D3	4.1	2.9	LF	13.0	19.8	0.25	0.14
Middle Fork John Day River	534	1108	8	US	EX	G	19.7	0.4	LF	19.5	61.1	0.58	0.30
South Fork Long Creek	538	973	77	CT	HG	G	8.4	2.1	LF	6.0	24.8	0.34	0.18
Vincent Creek	2	997	112	US	MI	G	4.3	2.3	PD	14.5	9.0	0.40	0.08
Vinegar Creek	536	1192	152	US	LT	S	9.3	2.0	LF	15.0	18.7	0.27	0.19
West Fork Lick Creek	17	1002	43	CA	LG	S	4.6	3.0	LF	9.0	20.5	0.27	0.10
Whisky Creek	10	982	141	CH	HG	G	5.1	6.6	LF	12.0	9.8	0.27	0.10
SFJDR													
South Fork Deer Creek	532	493	17	US	LG	D1	3.0	1.4	LF	7.5	31.5	0.25	0.11
South Fork John Day River	129	1027	184	US	AG	D3	20.9	0.9	LF	18.0	38.0	0.56	0.36

Table 21. Test for statistical significance of selected habitat parameters collected in 2006 across John Day River subbasins. *P*-values ≤ 0.05 indicate statistically significant differences.

Habitat Variable	*P*	Differences
Gradient (%)	0.911	
Active Channel Width (m)	0.231	
Pools (%)	0.969	
Riffle Depth (m)	0.861	
Organics (%)	0.121	
Gravel (%)	**0.001**	MFJDR greather than NFJDR
Riffle Organics (%)	0.433	
Riffle Gravel (%)	**0.031**	MFJDR greater than NFJDR
Shading (%)	0.117	
Bank Erosion (%)	**0.008**	LMJDR greater than NFJDR
Bank Undercut (%)	0.133	
Wood Pieces (#/100 m)	0.199	
Wood Volume (m3/100 m)	0.436	
Key Wood Pieces (#/100 m)	0.391	
Residual Pool Depth (m)	0.462	
Boulders (#/100 m)	0.177	
Conifers (#/1000 ft)	0.350	
Hardwoods (#/1000 ft)	**0.010**	UMJDR greater than LMJDR and NFJD

Table 22. Average, minimum, and maximum values of habitat parameters at survey sites in the John Day River basin during 2006. LMJDR=Lower Mainstem John Day River, UMJDR=Upper Mainstem John Day River, NFJDR=North Fork John Day River, MFJDR=Middle Fork John Day River, SFJDR=South Fork John Day River.

							Substrate					Large Woody Debris			Riparian Trees	
Subbasin	**Total Length Surveyed (km)**	**ACW (m)**	**Gradient %**	**Temp (°C)**	**% of Site w/ Pools**	**Large Bldrs /100 m**	**% Fines**	**% Gravel**	**% Shade**	**% Bank Erosion**	**% Bank Undercut**	**# /100 m**	**Volume /100 m**	**# Key Pieces /100 m**	**Conifers /1000 ft**	**Deciduous /1000 ft**
LMJDR	9.7															
Average		6.1	2.4	13.6	23.1	0.3	35.8	27.5	46.2	26.3	4.2	8.1	0.5	10.5	525	39
Min		2.1	-0.3	7.0	0.1	0.0	8.0	3.1	6.2	1.9	0.0	0.4	0.0	0.1	0	0
Max		13.8	7.2	24.0	62.5	1.1	91.6	63.0	78.6	72.3	13.0	24.9	1.8	36.0	1768	142
UMJDR	7.8															
Average		7.7	2.2	11.6	21.6	0.4	31.8	32.4	62.0	10.4	10.1	11.5	0.6	12.9	691	409
Min		3.0	1.0	8.0	9.4	0.0	3.5	16.9	37.6	0.0	0.4	3.5	0.0	1.0	41	0
Max		21.5	4.1	16.0	32.6	1.8	61.4	48.7	84.6	20.1	36.9	20.8	1.2	23.7	1402	1687
NFJDR	17.5															
Average		13.0	2.2	13.9	25.0	1.4	25.5	18.7	45.8	7.0	3.9	12.2	0.2	8.4	911	103
Min		1.3	0.3	8.0	1.2	0.0	0.1	0.0	15.7	0.0	0.0	0.3	0.0	0.0	0	0
Max		53.0	6.8	22.0	58.4	7.7	100.0	28.4	67.1	37.1	23.1	40.6	1.0	26.3	2134	406
MFJDR	7.3															
Average		7.9	2.8	12.7	23.4	0.4	11.4	42.7	54.9	9.3	5.1	5.2	0.3	5.3	552	261
Min		4.1	0.4	6.0	9.0	0.1	2.2	29.4	20.8	0.0	0.0	0.4	0.0	0.4	81	0
Max		19.7	6.6	19.5	61.1	0.8	30.2	76.3	77.1	22.0	16.2	11.4	1.0	11.4	1321	691
SFJDR	1.7															
Average		11.9	1.2	12.8	34.7	0.1	35.8	35.9	51.3	13.4	11.1	6.7	0.3	8.8	437	396
Min		3.0	0.9	7.5	31.5	0.0	13.0	32.8	41.4	0.0	6.5	0.9	0.1	0.9	0	183
Max		20.9	1.4	18.0	38.0	0.2	58.5	39.0	61.3	26.9	15.8	12.5	0.6	16.6	874	610

DISCUSSION

We fell short of our goal of surveying 50 sites in 2006 as a result of logistic and access constraints; 47 sites were surveyed for steelhead spawning and 46 sites were surveyed for juvenile salmonid distribution and habitat/riparian conditions. Although we only surveyed a small percentage of the total sampling universe (~2%), the random site selection process allowed us to produce a statistically defined estimate of steelhead escapement to the John Day River basin and provide baseline data for juvenile salmonids and habitat conditions throughout the basin. In addition, we evaluated trends in abundance and distribution of steelhead redds, juvenile salmonids, and habitat conditions within the basin by comparing our results from 2004, 2005, and 2006.

The adult steelhead escapement estimate for 2006 was the highest observed since initiation of the EMAP sampling protocol. Annual variation in steelhead escapement estimates has been partially attributed to differences in run size of summer steelhead passing over John Day Dam (Wiley et al. 2005). Index survey redd counts conducted by ODFW district fish biologists show a fairly strong relationship between redd abundance in the John Day River basin and passage of adult steelhead (hatchery and wild) over John Day Dam (R^2=0.59), however, this relationship is not yet apparent with EMAP estimates (R^2=0.22; Appendix E). EMAP adult steelhead escapement estimates for 2004 and 2006 were similar (6,449 and 6,725, respectively) despite the fact that adult passage over John Day Dam was apparently higher in 2003 compared with 2005 (286,176 versus 232,103, respectively). It should be noted that summer steelhead migrate upstream during the previous summer and early fall (i.e. 2005) then spawn during the following spring (i.e. 2006). In addition, there was an apparent difference in steelhead spawner escapement to the John Day River basin in 2006 compared to 2005 (6,725 and 3,529, respectively; although the difference is not statistically significant) while no appreciable differences were observed in adult passage over John Day Dam for those years (232,103 and 227,199, respectively). Observations of live steelhead in the John Day River basin also show similar discrepancies.

The spatial intensity of the current EMAP sampling regime may be too limited to detect recent short-term (i.e <5yrs) trends in steelhead escapement within the basin. Our limited sampling intensity is illustrated by the large confidence intervals around our annual escapement estimates. The observed limited spawning distribution is probably influenced by small run sizes, a lack of productive spawning habitat, or a combination of both. It may also result from our misunderstanding of the spatial extent of steelhead spawning habitat in the John Day River basin. When our sampling universe was first defined we erred on the conservative side by including all wadeable habitat not blocked from anadromy where juvenile steelhead were previously observed. Further, steelhead redd longevity influenced by high flow events may also limit our ability to identify previously constructed redds. Our sampling design of multiple site visits approximately every two weeks enhances our ability to observe transient redds. Future data collection from this project, in conjunction with PIT-tag data by the John Day River smolt monitoring program, will allow for a better assessment of productivity and smolt-to-adult estimates in the basin.

Historically, the John Day River basin has been managed exclusively for wild steelhead while low hatchery stray rates have been reported (4%–8%; ODFW 1990). Recent data, however, suggests that hatchery stray rates may be much higher. Since 2004, hatchery : wild ratios reported from our EMAP surveys indicate that out-of-basin hatchery fish composed 36% of all live fish observed (range: 28.6-41.2%). While more than half (~60%) of the live steelhead are identified to origin in any given year, the limited number of observations and the spatial distribution of observations suggests caution in applying our results to the entire John Day River basin. However, observations from the Spring Chinook Salmon Escapement and Productivity Monitoring project have reported similar levels of hatchery stray rates based on catches of steelhead kelts in seines and rotary screw traps (Ruzycki et al. 2002; Carmichael et al. 2002; Wilson et al. 2002; Wilson et al. 2005; Appendix F). Claire and Gray (1992) also found a high number of hatchery steelhead in the 1992 steelhead fishery upstream of Kimberly, where a 29% hatchery stray rate was reported from fisherman in the lower North Fork. Creel surveys at LePage Park near the mouth of John Day river indicate hatchery steelhead were 2.6 times more frequent in angler catches compared to wild steelhead during 2006 and almost three times more frequent during 2005 (Wendy Martin, ODFW, unpublished data). It is uncertain to what extent hatchery fish are contributing to natural steelhead production in the John Day basin, or if they are having a negative impact on wild fish production, but it appears that their presence is much greater than previously measured and the potential for influence is highly likely.

In addition to low water flows during the summer, fish community composition and water temperatures appear to be potential limiting factors for juvenile salmonid distribution in the John Day River basin. Habitat surveys in 2006 identified nine sites with puddled or dry flows. At four of these survey sites we observed no juvenile salmonids. Additionally, three sites characterized with low flow conditions were locations where we had no juvenile salmonid observations. Two of these were larger 4th order streams (South Fork John Day River, Site ID 129 and North Fork John Day River, Site ID 61) that had multiple incidental species present including smallmouth bass (a non-native) and northern pikeminnow, which are known predators of salmonids (Fritts and Pearsons 2006). Water temperatures at these two sites were 18°C and 22°C, respectively. The third site with low flows, located in the Lower Mainstem (Unnamed Cr., Site ID 63) had no observed fish species, salmonid or incidental, despite a water temperature of 14°C. While all of the aforementioned sites possess biotic and/or abiotic characteristics that could limit salmonid distribution in the John Day River basin, additional sites where salmonids were present also possess these potentially “limiting” qualities, suggesting that a complex suite of factors are affecting the overall distribution in the basin. With only three years of EMAP data available, it is difficult to accurately evaluate significant factors associated with current salmonid distributions. However, future surveys will allow for a more comprehensive evaluation regarding the status and trend in salmonid distribution and abundance over a variety of biotic and abiotic conditions throughout the basin.

Habitat characteristics related to human impacts and land management continue to dominate habitat survey observations. Grazing was a dominant land use observed at a large percentage of sites in 2006 which is consistent with previous year’s observations (Wiley et al. 2005). This is not unusual, given the history of agriculture and ranching throughout the basin. Beyond land use, a majority of habitat surveys from 2004 to 2006 were categorized as possessing channels constrained either by terraces, hillslopes, or land use. Constrained channels have a lower connectivity between the terrestrial and aquatic environment compared to unconstrained channels and incised channels often result from land management practices. Potential effects of constrained channels on stream characteristics generally result in increased bank erosion, increased flow rates in the stream channel during high water events, and reduced exchange of nutrients and organic matter between the riparian zone and stream channel. Future data collection will allow for a more comprehensive evaluation to be made regarding the impact of different land uses on habitat and salmonids throughout the basin and may allow managers and habitat biologists to target rehabilitation efforts in areas with the best potential for positive response. In the future, we intend to alert managers of sites where restoration should result in the greatest benefits to salmonid habitat in the basin.

CONCLUSIONS

A lower density of steelhead redds were observed at EMAP sites within the basin compared to those observed during index surveys conducted by ODFW biologists. This suggests that index surveys, if used to estimate escapement, may overestimate the population of steelhead returning to the basin because they are biased towards frequently used habitats. However, EMAP estimates may not have adequate precision given the large percentage of sites with no observed redds and consequent large confidence intervals. In addition, results from the South Fork subbasin indicates that the original sample sites (South Fork John Day River Site ID#129 and South Fork Deer Cr. Site ID#532) were not representative of spawning in the subbasin when compared to the 12 additional sites we visited during 2006. Overall, declines in redd densities at EMAP sites over the past three years are consistent with the declines observed during index surveys (Appendix G). Taken together, index and EMAP surveys will yield a more complete picture of the status and trends in steelhead redd abundance and escapement within the basin. Additional years of concurrent EMAP and Index surveys should help clarify the relationship of these two survey approaches. An apparently significant number of hatchery steelhead have been detected in the John Day River basin. Further more, some of these fish have been observed spawning with wild steelhead. Future research on steelhead in the John Day River basin should highlight these observations and attempt to identify introgression with wild stocks and any influence hatchery steelhead may have on natural production in the John Day basin. Finally, we have completed three years of baseline data collection on juvenile salmonids and habitat and riparian conditions. Future project efforts should focus on identifying and calibrating potential models (e.g. HabRate [see Burke et al. 2001] and Habitat Limiting Factors Model [HLFM; see Nickelson 1998]) that may be useful in integrating and drawing conclusions from the combined habitat and juvenile salmonid data.

REFERENCES

Burke, J.L., K.K. Jones, and J.M. Dambacher. 2001. HabRate: A stream habitat evaluation methodology for assessing potential production of salmon and steelhead in the middle Deschutes River basins. Oregon Department of Fish and Wildlife, Corvallis, OR.

Carmichael, R., G. Claire, J. Seals, S. Onjukka, J. Ruzycki, W. Wilson. 2002. "John Day basin spring Chinook salmon escapement and productivity monitoring; fish research project Oregon", 2000-2001 annual report, project no. 199801600, 63 electronic pages, (BPA Report DOE/BP-00000498-2), http://www.efw.bpa.gov/Publications/A00000498- 2.pdf

Claire, E. W., and M. E. Gray. 1992. Oregon Department of Fish and Wildlife, John Day Fish District, Canyon City, Oregon.

Flesher, M. W., G. R. Vonderohe, G. C. Grant, D. L. Eddy, and R. W. Carmichael. 2005. Lower Snake River Compensation Program: Oregon Summer Steelhead Evaluation Studies. Oregon Dept. of Fish and Wildlife, Salem, Oregon, http://www.fws.gov/lsnakecomplan/ODFW_Reports.html

FPC (Fish Passage Center). 2006. Adult salmon passage at John Day Dam as of March 6, 2006. Retrieved from http://www.fpc.org/adultsalmon/adulthistory/YTD-JDA.html

Fritts, A.L., and T.N. Pearsons. 2006. Effects of predation by nonnative smallmouth bass on native salmonid prey: the role of predator and prey size. Transactions of the American Fisheries Society 135:853-860.

Jacobs, S., J. Firman, G. Susac, E. Brown, B. Riggers, and K. Tempel. 2000. Status of Oregon coastal stocks of anadromous salmonids. Monitoring program report number OPSW-ODFW-2000-3, Oregon Department of Fish and Wildlife, Portland, Oregon.

Jacobs, S., J. Firman, and G. Susac. 2001. Status of Oregon coastal stocks of anadromous salmonids, 1999-2000. Monitoring program report number OPSW-ODFW-2001-3, Oregon Department of Fish and Wildlife, Portland, Oregon.

Mackey, G., J. E. McClean, and T. P. Quinn. 2001. Comparisons of run timing, spatial distribution, and length of wild and newly established hatchery populations of steelhead in Forks Creek,Washington. North American Journal of Fisheries Management 21:717-724.

Moore, K., K. Jones, and J. Dambacher. 2002. Methods for stream habitat surveys. Oregon Department of Fish and Wildlife, Aquatic Inventories Project. Corvallis, Oregon.

Nicholas, J. W., and L. Van Dyke. 1982. Straying of adult coho salmon to and from private hatchery at Yaquina Bay, Oregon. Oregon Department of Fish and Wildlife, Information report (fish) 82-10, Portland, Oregon.

Nickelson, T.E. 1998. A habitat-based assessment of coho salmon production potential and spawner escapement needs for Oregon coastal streams. Oregon Department of Fish and Wildlife, Information Report, 98-4, Salem, OR.

OGDC (Oregon Geospatial Data Clearinghouse). 2004. Draft public land ownership data as of June 23, 2003. Retrieved from http://www.gis.state.or.us/data/alphalist.html

Oregon Department of Fish and Wildlife. 1990. John Day River subbasin salmon and steelhead production plan. Oregon Department of Fish and Wildlife, Portland, Oregon.

Pacific States Marine Fishery Commission (PSMFC). 2006. Regional mark information system as of December 14, 2005. Retrieved from http://www.rmis.org/index.html.

Ruzycki, J., W. Wilson, R. Carmichael, B. Jonasson. 2002. "John Day basin spring Chinook salmon escapement and productivity monitoring; fish research project Oregon", 1999 - 2000 annual report, project no. 199801600, 41 electronic pages, (BPA Report DOE/BP-00000498-1), http://www.efw.bpa.gov/Publications/A00000498-1.pdf

Susac, G. L., and S. E. Jacobs. 1999. Evaluation of spawning ground surveys for indexing the abundance of adult winter steelhead in Oregon coastal basins. Oregon Department of Fish and Wildlife. Annual Progress Report F145-R-08. Portland, Oregon.

Wiley, D., M. Garriott, J. Ruzycki. 2004. "Implementation of the Environmental Monitoring and Assessment Program (EMAP) protocol in the John Day subbasin of the Columbia Plateau Province", 2003-2004 technical report, project no. 199801600, 56 electronic pages, (BPA Report DOE/BP-00015113-1), http://www.efw.bpa.gov/Publications/A00015113-1.pdf

Wiley, D.J., M.L. Garriott, J.R. Ruzycki, R.W. Carmichael. 2005. Implementation of the Environmental Monitoring Program (EMAP) protocol in the John Day subbasin of the Columbia Plateau Province: Annual Progress Report. 2004-2005 Technical report, project no. 199801601, 90 electronic pages, (BPA Report DOE/BP-00015113-2), http://www.efw.bpa.gov/Publications/A00015113-2.pdf

Wilson W., T. Seals, J. Ruzycki, R. Carmichael, S. Onjukka, G. O'Connor. 2002. "John Day basin spring Chinook salmon escapement and productivity monitoring", 2001-2002 annual report, project no. 199801600, 124 electronic pages, (BPA report DOE/BP-00005840-1), http://www.efw.bpa.gov/Publications/A00005840-1.pdf

Wilson, W., T. Schultz, T. Goby, J. Ruzycki, R. Carmichael, S. Onjukka, G. O'Connor. 2005. "John Day basin Chinook salmon escapement and productivity monitoring", 2002-2003 annual report, project no. 199801600, 165 electronic pages, (BPA Report DOE/BP-00005840-2), http://www.efw.bpa.gov/Publications/A00005840-2.pdf

Wilson, W. H., J. R. Ruzycki, R. W. Carmichael, and I. A. Tattam. 2004. John Day River basin steelhead *Oncorhynchus mykiss* data and information compilation. Annual progress report to Bonneville Power Administration. Project No. 98-016-00.

APPENDIX

Appendix A. Description of codes used to classify stream channel form during habitat and riparian surveys.

Code	Description
CA	Constrained by Alternating terraces and hill slope. The stream channel is confined by contact with hill slopes and high terraces.
CB	Constrained by Bedrock (bedrock dominated gorge)
CF	Constrained by alluvial Fan
CH	Constrained by Hill slope
CL	Constrained by Land use (road, dike, landfill)
CT	Constraining Terraces. (terrace height > floodprone height and floodprone width < 2.5 X active channel width).
UA	Unconstrained-Anastomosing (several complex, interconnecting channels)
UB	Unconstrained-Braided channel (numerous, small channels often flowing over alluvial deposits)
US	Unconstrained-predominantly Single channel.

Appendix B. Description of codes used to classify land use (beyond the riparian zone) during habitat and riparian surveys.

Code	Description
AG	Agricultural crop or dairy land.
BK	Bug Kill. Eastside forests with > 60% mortality from pests and diseases.
CR	Conservation area or wildlife Refuge.
EX	Exclosure. Fenced area that excludes cattle from a portion of range land
FF	Forest Fire. Evidence of recent charring and tree mortality.
GN	Green way. Designated Green Way areas, Parks (city, county, state).
HG	Heavy Grazing Pressure. Broken banks, well established cow paths. Primarily bare earth or early successional stages of grasses and forbs present.
IN	Industrial
LG	Light Grazing Pressure. Grasses, forbs and shrubs present, banks not broken down, animal presence obvious only at limited points such as water crossings. Cow pies evident.
LT	Large Timber (30-50 cm dbh)
MI	Mining
MT	Mature Timber (50-90 cm dbh)
NU	No Use identified.
OG	Old Growth Forest. Many trees with 90+ cm dbh and plant community with old growth characteristics.
PT	Partial cut Timber. Selection cut or shelterwood cut with partial removal of large trees. Combination of stumps and standing timber.
RR	Rural Residential
ST	Second growth Timber. Trees 15-30 cm dbh in generally dense, rapidly growing, uniform stands.
TH	Timber Harvest. Active timber management including tree felling, logging, etc. Not yet replanted.
UR	Urban
WA	Designated Wilderness Area
WL	Wetland.
YT	Young Forest Trees. Can range from recently planted harvest units to stands with trees up to 15 cm dbh.

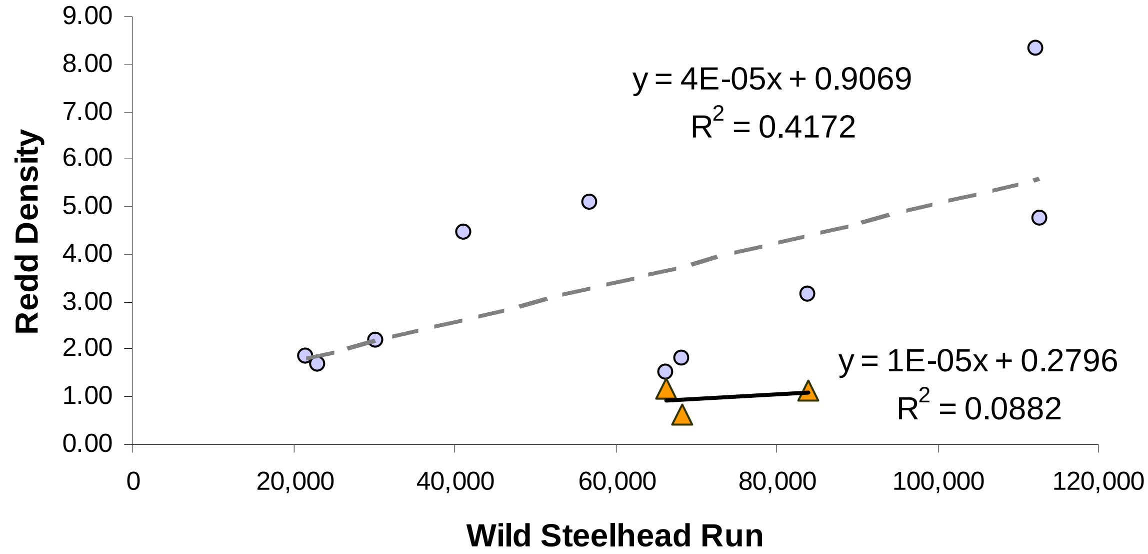
Appendix C. Description of codes used to classify riparian vegetation during habitat and riparian surveys.

Code	Description
B	SageBrush (sagebrush, greasewood, rabbit brush, etc.)
C1	Coniferous Dominated (canopy more than 70% conifer) Size class: Seedlings and new plantings.
C15	Coniferous Dominated (canopy more than 70% conifer) Size class: Typical sizes for second growth stands.
C3	Coniferous Dominated (canopy more than 70% conifer) Size class: Young established trees or saplings.
C30	Coniferous Dominated (canopy more than 70% conifer) Size class: Mature timber. Developing understory of trees and shrubs.
C50	Coniferous Dominated (canopy more than 70% conifer) Size class: Mature timber. Developing understory of trees and shrubs.
C90	Coniferous Dominated (canopy more than 70% conifer) Size class: Old growth. Very large trees, nearly always conifers. Plant community likely to include a combination of big trees, snags, down woody debris, and a multi-layered canopy.
D1	Deciduous Dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other deciduous spp.) Size class: Seedlings and new plantings.
D15	Deciduous Dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other deciduous spp.) Size class: Typical sizes for second growth stands.
D3	Deciduous Dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other deciduous spp.) Size class: Young established trees or saplings.
D30	Deciduous Dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other deciduous spp.) Size class: Large trees in established stands.
D50	Deciduous Dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other deciduous spp.) Size class: Mature timber. Developing understory of trees and shrubs.
D90	Deciduous Dominated (canopy more than 70% alder, cottonwood, big leaf maple, or other deciduous spp.) Size class: Old growth; very large trees, nearly always conifers.
G	Annual Grasses, herbs, and forbs.
M1	Mixed conifer/deciduous (approx. a 50:50 distribution). Size class: Seedlings and new plantings.
M15	Mixed conifer/deciduous (approx. a 50:50 distribution). Size class: Typical sizes for second growth stands.
M3	Mixed conifer/deciduous (approx. a 50:50 distribution). Size class: Young established trees or saplings.
M30	Mixed conifer/deciduous (approx. a 50:50 distribution). Size class: Mature timber. Developing understory of trees and shrubs.
M50	Mixed conifer/deciduous (approx. a 50:50 distribution). Size class: Mature timber. Developing understory of trees and shrubs.
N	No Vegetation (bare soil, rock)
P	Perennial grasses, sedges and rushes
S	Shrubs (willow, salmonberry, some alder)

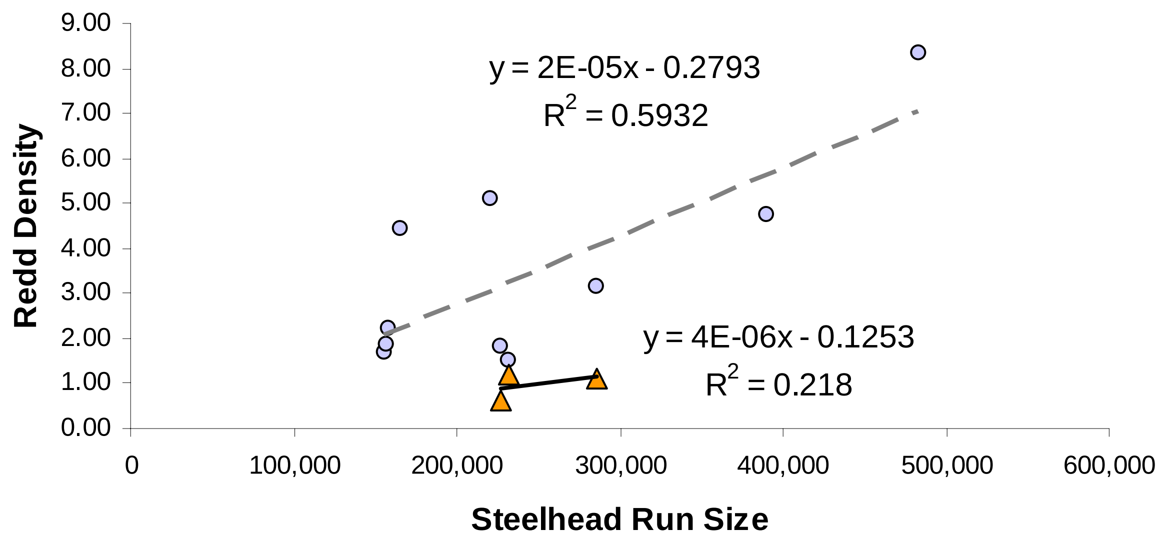
Appendix D. Description of codes used to classify stream flow during habitat and riparian surveys.

Code	Description
BF	Bankfull Flow. Stream flowing at the upper level of the active channel bank.
DR	Dry
FF	Flood Flow. Stream flowing over banks onto low terraces or flood plain.
HF	High Flow. Stream flowing completely across active channel surface but not at bankfull.
LF	Low Flow. Surface water flowing across 50 to 75 percent of the active channel surface. Consider general indications of low flow conditions.
MF	Moderate Flow. Surface water flowing across 75 to 90 percent of the active channel surface.
PD	Puddled. Series of isolated pools connected by surface trickle or subsurface flow.

a.)



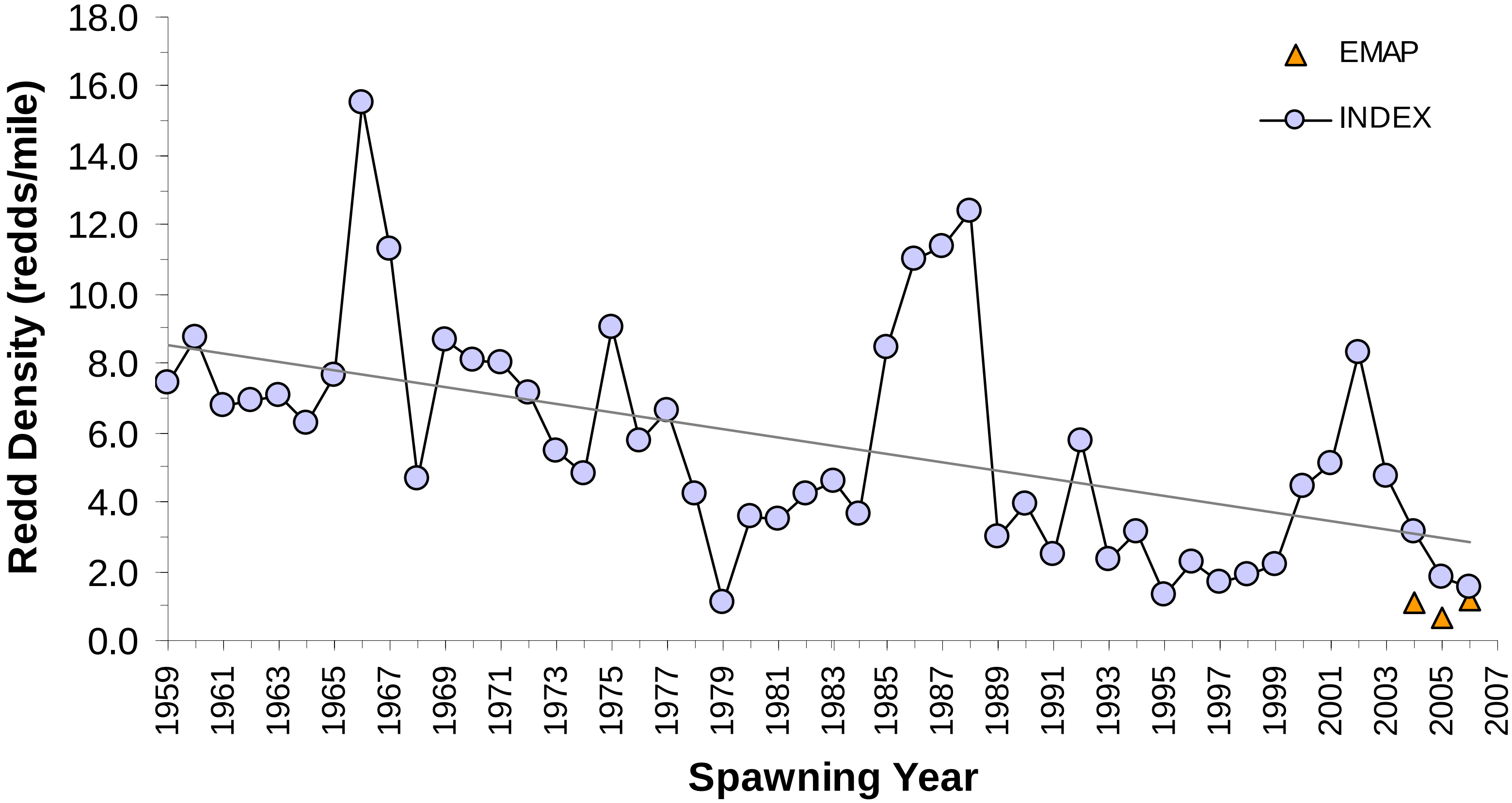
b.)



Appendix E. Relationship between passage of wild steelhead (a) and all steelhead (b; wild and hatchery combined) at John Day Dam and index (circles) and EMAP (triangles) steelhead redd counts conducted by ODFW personnel in the John Day River basin from 1996 to 2006 (Index) and 2004 to 2006 (EMAP).

Appendix F. Recovery year, number of wild steelhead, number of hatchery steelhead, and percent hatchery steelhead observed during index steelhead spawning surveys in the John Day River basin (Tim Unterwegner, unpublished data), seining in the Mainstem John Day River between Kimberly (rkm 298) and Spray (rkm 274), and operation of rotary screw traps in the Middle Fork, South Fork, and Mainstem John Day River. Seining and rotary screw trap data (includes both live fish and carcass observations) were compiled from the John Day Basin Spring Chinook Salmon Escapement and Productivity Monitoring Project (Ruzycki et al. 2002; Carmichael et al. 2002; Wilson et al. 2002; Wilson et al. 2005).

		Index			Spring Chinook Monitoring Project	
Recovery Year	**# of Wild Steelhead**	**# of Hatchery Steelhead**	**% Hatchery Steelhead**	**# of Wild Steelhead**	**# of Hatchery Steelhead**	**% Hatchery Steelhead**
2006	22	4	15.4	10	5	33.3
2005	15	1	6.3	8	4	33.3
2004	12	1	7.7	16	6	27.3
2003	27	2	6.9	11	2	15.4
2002	173	16	8.5	20	13	39.4
2001				8	2	20.0
2000				11	1	8.3
TOTAL	249	24	8.8	84	33	28.2



Appendix G. Decline (*P*<0.001) in summer steelhead redd density (redds/mile) observed at index survey sites (circles) sampled by ODFW personnel in the John Day River basin from 1959 to 2005. Redd densities observed at EMAP sites (triangles) are shown for comparison.