Okanogan Monitoring and Evaluation Program

Field Manual

Redd Survey Methodology

Final Draft

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INTRODUCTION

The Colville Confederated Tribes developed this field manual to provide specific guidance related to anadromous fish population monitoring in the Okanogan Subbasin for the 2005 Okanogan Basin Monitoring and Evaluation Program (OBMEP). This monitoring program was designed to collect data related the long-term status and trends needed to feed into future adaptive management. Therefore, this field manual should be considered a "living document" with the following methods potentially subject to some level of modification over time as new information becomes available.

The methods contained within this manual are closely aligned with the recommendation made by the Pacific Northwest Aquatic Monitoring Partnership and the Upper Columbia Monitoring and Evaluation Strategy (Hillman 2004). These protocols were further refined to address the specific program needs of the Colville Tribes and help to inform the National Marine Fisheries Service about the changes in abundance of summer steelhead spawners over time within the Okanogan River basin and Upper Columbia summer steelhead ESU in order to complete the adaptive management loop.

ACKNOWLEDGEMENTS

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METHOD FOR DETECTING STEELHEAD REDDS

PURPOSE

Estimates of adult spawner abundance and/or redd counts will allow investigators to monitor changes in the spawner abundance and redd distributions over time. Summer Chinook and sockeye salmon redd surveys in the Okanogan River basin have occurred for years using index sites by BioAnalyst Inc./Washington Department of Fish and Wildlife and Okanagan Nation Alliance (ONA) respectively and these surveys are expected to continue under a separate set of protocols not included in this document. The protocols herein will be used by the Colville Tribes and ONA specifically to conduct surveys for summer steelhead redds throughout the Okanogan River basin as part of the OBMEP. These protocols may require some modification if applied to other species or locations.

This information is useful to:

- Determine if the spatial distribution of spawning fish changes over time;
- Determine if the abundance of returning adults is changing over time;
- Identify and map preferred spawning habitat areas;

- Conduct surveys that provide census level precision and accuracy at the lowest possible cost.

SITE SELECTION

The Upper Columbia Strategy (Hillman 2004) calls for conducting a census of redds in the target watershed, if possible, but also provides for conducting these surveys at established index areas or using a random sample of fixed length reaches. In the Okanogan River basin a mixture of these approaches is most appropriate (i.e. index surveys for sockeye salmon and random samples for habitats that may become available in the future). To establish potential spawning areas first you need to established the distribution of redds across all habitats and eliminate areas that fail to meet basic habitat parameters (Bjornn and Reiser 1991). It would be wasteful to continue to survey habitats that represent large areas where redds would not be constructed and this condition is unlikely to change significantly over time (i.e. substrate is >60% fines and dominated by particles less than 0.6 cm in diameter, water depths are greater than 6cm but less than 300cm, velocities are less than 10cm/s, and gradients are less that 0.1%).

The lower 23-miles of the Okanogan River consist of waters created from the influence from the Well's pool and represent a good example of habitats with no spawning potential. The inundated reach represents considerable logistic challenges due to large area, and abundance of depth water, and poor visibility. The consensus of local biologist's is that no spawning is likely to occur in this reach and provides a solid scientific basis for eliminating from the potential sampling universe for redd surveys. The upper extent of the Wells pool effect is agreed to be located at the confluence with Chiliwist Creek. The same logic can be used to eliminate all lake habitats from further consideration. The Okanogan River from Tonasket (Washington) to upstream of the town of Ellisforde (Washington) represents an extremely low gradient reach with mostly fine sediment substrates and provides virtually no potential spawning habitat. The reach from Salmon Creek downstream to the town of Malott (Washington) represents a reach with very minimal spawning habitat resulting from low gradient and either large cobble/boulder or fine sediment substrates. Extremely small patches of spawning habitats do represent some minor spawning potential but these areas represent less than 1% of all potential habitats available along the Okanogan River main-stem.

Based upon the best available scientific data the areas presented in Table 1 should be considered a complete census for the Okanogan River and Similkameen River main-stem reaches in the United States. Reaches in Canada will be determined in the future as more information is collected and most tributaries will be sampled in there entirety unless pre-existing index areas exist (i.e. Omak Creek below Mission Falls). Steelhead redd count surveys will be conducted at EMAP sites located in areas that have the potential to be accessed by fish in the near future in order to establish a before treatment baseline. Redd surveys in areas using EMAP sites will use the downstream extent of the randomly selected EMAP site as the farthest point downstream to begin a 1km reach. As additional information becomes available we will focus on reducing costs where a census design can be maintained through reduced field efforts.

Table 1: Long-term redd survey reaches in the United States for the Okanogan Basin Monitoring and Evaluation Program.

Reach	Reach (rkm)	Reach length
Code	**Main-stem Habitats**	**(km)**
S1/S2	Similkameen/Okanogan Confluence(0) up to Enloe Dam (14.6)	14.6
O1	Okanogan River at Chiliwist Creek(24.4) up to Malott bridge (26.5)	2.1
O2	Okanogan River at Salmon Creek(41.4) up to CCT F&W Office(52.3)	10.9
O3	Okanogan River at CCT F&W Office(52.3) up to Riverside(66.1)	13.8
O4	Okanogan River at Riverside(66.1) up to Janis Bridge(84.6)	18.5
O5	Okanogan River at Janis bridge(84.6) up to Tonasket bridge(91.6)	7.0
O6	Okanogan River at Oxbow Lake(106.6) up to Confluence with Similkameen(119.5)	12.9
O7	Okanogan River at confluence(119.5) up to Zoesel dam(127.0)	7.5
	Tributary Habitats	
TU1	Tunk cr @Okanogan river Confluence (0) up to High water mark (0.2)	0.2
B1	Bonaparte Creek/Okanogan River confluence (0) up to Bonaparte Falls (1.6)	1.6
N1	Ninemile Creek/Okanogan River confluence (0) up to Eder land (1.7)	1.7
OM1	Omak Creek/Okanogan River confluence (0) to Omak Lake Road Bridge (2.0)	2.0
OM2	EMAP Site 19 lower (5.1) up to Mission Falls (8.2)	3.1
OM12	Jim Cr rd bridge(29.4) up to EMAP Site 12 lower (30.4)	1.0
OM48	Staploop cr (26.8) up to 500 meters below site 48 lower (27.8)	1.0
OM366	end of forest road at Dutch Anderson bridge (21.5) up to Dutch Anderson bridge.(22.5)	1.0
OM361	Above Mission Falls(10.75) up to EMAP site 361 upper (11.75)	1.0
TO1	Tonasket Creek/Okanogan River confluence (0) up to Tonasket Falls (3.5)	3.5

SAMPLING DURATION

Sampling should occur beginning with the earliest anticipated spawning for the target species (steelhead) and should continue until the end of the normal spawning period unless prohibited by environmental conditions (i.e. high flows, increased turbidity, etc.). The spawning period for summer steelhead typically begins when water temperatures reach 39◦F and concludes shortly after water temperatures reach 49◦F (typically the last week in March in the Okanogan subbasin). Surveyors should be aware that stream flow conditions can alter the timing, visibility, and distribution of spawning activity from one year to the next and spawner distribution within a stream system may be different for early versus late spawners. Redd life (visibility) estimates should not normally be needed if main stem surveys are conducted frequently enough so that new redds are readily distinguishable and these issues are addressed in the protocols that follow. Main-stem surveys will be conducted at intervals of no greater than once every two weeks. Main-stem surveys will begin in March but likely will be completed due to visibility restrictions and the ascending limb of the hydrograph in a normal water year prior to May 1.

Based upon information from previous survey years (Arterburn and Fisher 2005, 2004) tributary surveys are most likely to be conducted in mid to late May. Fish collection at the Omak Creek weir/trap will be used to determine the most appropriate time to conduct tributary surveys. Redd surveys will be conducted 2-weeks after the number of kelt steelhead observed is greater than the number of upstream migrating adults at the permanent weir and trap located on Omak Creek (rkm 1.5). Single pass surveys conducted during the peak spawning period in the tributary habitats are not likely to capture information regarding either early or late spawners and therefore will represent only a conservative estimate. However, the costs associated with collecting these data are reduced by two thirds by using this method and the total number of redds observed in the tributaries will not be significantly different from the single pass approach.

EQUIPMENT

- Thermometer
- Waders with non-slip soles
- Multi-colored flagging
- Field notebook
- Pencils and sharpie
- Waterproof field record form
- Trimble GPS data logger
- Vest or day pack
- Polarized glasses
- Stream map to indicate location of spawning activity
- Drinking water and food
- 2-one man Skookum cata-rafts
- 2-way radios

ANATOMY OF A REDD

Summer Steelhead redds are considered to typically cover 4.4 to 5.4 square meters (Bjorn and Reiser 1991). Redds are typically found in areas of down-welling (where water is hydraulically forced into the substrate) and where water depths are $\geq$24 cm (Smith 1973), with velocities of 40 to 91 cm/sec (Smith 1973) and substrate diameters range from 0.6 to 10.2 cm (Hunter 1973). The investigator should be familiar with the size of the redds produced by other species of fish that may be spawning at the time the surveys are conducted (Figure 1).

Figure 1: Steelhead Redd on the Okanogan River near Driscoll Island dug on 4/22/05. Note: This photo clearly illustrates tail spill, pit, substrate size, and area of disturbance if these terms are unfamiliar please reference page 93 of Meehan 1991.

MULTIPLE PASS MARKED REDD SURVEY METHOD

Summation of the number of new redds counted throughout the entire spawning season will be the method used on the main-stem Okanogan and Similkameen Rivers. By marking redds, old but still visible redds are not counted twice. Individual redds (or groups of redds, in the case of superimposition) are to be flagged and documented. Redds are marked by GPS and by flagging tied to bushes or trees on the stream bank adjacent to the area were redds are observed. Each flag will be marked with the date, coordinate (direction to redd, distance (distance from flag to redd), flag number, total number of redds represented by the flag, and surveyor initials. This same information will be captured electronically by entering it into a Trimble data logger. Redds will be flagged and numbered consecutively as they are encountered during each survey. The color of the flagging should be changed for each survey. Incomplete redds or test digs should not be flagged and not counted. On subsequent surveys, all redds should be counted and every attempt should be made to locate all flags. Potential biases can result from redd superimposition or removal of flagging by people. Surveyors will check all flags from previous surveys as they search for new redds and note missing flags by a gap in the numbering sequence. If a flag is found to be missing, the surveyor will note it on the field form and re-flag redds based on the previous GPS location if possible. Re-flagged redds will not be counted as new redds.

PEAK REDD COUNT METHOD

The Peak Redd Count Method is the primary method used on tributary habitats. This method is most often used where individual redds are unlikely to be missed due to high visibility resulting from narrow width, shallow depths and good water clarity characteristic of most small tributaries. Under The peak count method, all redds are simply counted during a single foot survey. The total redd count per stream or stream reach is used to estimate total redd deposition in that reach. However, this method is likely to be biased low due to two factors; 1) redds constructed earlier in the spawning season will not be counted because they are no longer discernable or, 2) redds constructed after the survey is completed by late spawning fish will be missed (Hahn et al. 2001).

FOOT SURVEYS

Under most conditions foot surveys are the most appropriate method for counting redds and detecting adult spawners. Where possible, foot surveys will be conducted on all sites where water depths do not explicitly require a boat to obtain complete counts of live and/or dead spawners and redds.

Observations are made from the banks and by walking into the stream as needed to confirm redds and/or species of fish. The observer should wear **Polaroid sunglasses**, carry a "write-in-the-rain" notebook, Trimble data logger to record data, and use surveyor's plastic **flagging** to mark redds. Weather conditions, water clarity and visable marks on fish observed are also recorded.

BOAT /RAFT SURVEYS

A boat will be required to conduct redd surveys in large deep stream reaches that cannot be safely waded. In areas where boat access is limited, surveyors should exit the boat and conduct foot surveys where safe to do so. The reaches surveyed along the Okanogan River (Table 1) will also be used in the analysis of data collected. When conducting redd surveys using boats; two people in two 1-man, 10' Skookum Steelheader cata-rafts are recommended as the most cost effective use of resources. .

FISH OBSERVATION

During redd surveys all fish observed need to be documented. If the summer steelhead is dead please see carcass survey protocols below. Live summer steelhead observed need to be documented to the greatest extent possible so observers need to be careful to not spook fish before data can be collected. To help this all foot surveys are to be conducted working upstream. Steelhead observed should be identified to species, adipose fin observed to determine if it has been clipped or is present. Gender determination is typically not possible unless fish are observed actively spawning (females are identified by digging activity and males are identified by chasing and milting activity).

CARCASS SURVEYS

Generally this procedure applies only to salmon spawner surveys. However, steelhead carcasses may be occasionally encountered during redd count surveys in which case the following protocol should be used.

Carcass sampling should be conducted as part of any adult spawner survey in order to obtain an accurate estimate of the total abundance of males and females. Carcass surveys consist of counting dead steelhead or impinged kelts. The belly of the carcass will be opened to observe gonad condition and this open belly is also used to keep from recounting the same carcasses. Carcass counts should be conducted concurrently with redd counts throughout the sampling period. Specific information to be collected from carcasses, include the location of where the carcass was found, length, sex, condition of gonads (spent, unspent), adipose fin (present or absent).

The otoliths of the fish should be removed from the head and placed in a container with a tag documenting the date, stream and reach collected, collectors initials, the presence or absence of an adipose fin. Each container should be labeled with a number that starts with the last two digits of the year, month and day, then the reach code from Table 1 and lastly the number of the sample collected that day (i.e. 050505S11 would represent the first sample collected from the Similkameen River on May 5, 2005). If you are surveying main-stem habitats keep other parties informed when samples are collected to keep from having duplicate sample numbers. If the heads of fish are brought back to the office remove the otoliths immediately upon return and place into vial with ethyl alcohol.

QA/QC PROCEDURES

In general, steelhead spawning areas can be surveyed by foot or rafts. In the Okanogan basin redds enumerated during surveys will be ground verified by at least two trained, knowledgeable staff until consensus is reached in order to maintain quality control. In the event that disagreements arise, disputed redds will be recorded by GPS and revisited by an additional senior biologist to make a final determination.

REMOVAL OF FLAGGING

Flagging used to mark redds should be removed at the conclusion of each field season. This can be accomplished either during the final redd count survey or during summer habitat or snorkel surveys. Biodegradable flagging, which will not require manual removal, may be used as an alternative.

ESTIMATING TOTAL REDDS AND ESCAPMENT

Because all redds are marked, they represent a total count and not an estimate. However this count only represents the area examined. Data can be extrapolated after all counts are concluded to develop a number of redds for each sub-watershed and these combined to estimate total redds for the Okanogan River. However, caution should be used in deriving these estimates as often spawning areas are not evenly distributed throughout a river reach. Total redd estimates in combination with spawner escapement sex ratio data can be further expanded to provide estimates of total spawner escapement for the

watershed or sub-watershed. The number of redds is also critical in deriving production estimates based upon fecundity and survival estimates.

Spawning escapement estimates for summer steelhead can be estimated as the number of redds times a "fish-per-redd" estimate. WSRFB (2003) uses 1.23 chinook per redd, assuming one redd per female. For steelhead, they assume 1.23 redds per female. A more accurate method currently used by WDFW in the Upper Columbia Basin is based on the sex ratio of broodstock (not recovered carcasses) collected randomly over the run (A. Murdoch, personal communication, WDFW). For example, if the sex ratio of a random sample of the run is 1.5:1.0, the expansion factor for the run would be 2.5 fish/redd. This method is used for all supplemented summer steelhead stocks within the Upper Columbia Basin. Another method, which can be used if the sex ratio is unknown, is the "Modified Meekin Method" (A. Murdoch, WDFW, personal communication). This method takes the 2.2 adults/redd (from Meekin 1967) and increases it by the proportion of jacks in the run. For example, if jacks make up 10% of the run, the modified adults/redd would be 2.42 (2.2 x 1.1 = 2.42 adults/redd).

Summer-run steelhead spawning escapement estimates will be calculated under the OBMEP based upon sex ratios as described above. Sex ratios will be obtained from the Well's dam broodstock collection efforts and from data collected at the Omak Creek weir. If these data vary then escapement values will be calculated and reported using both ratios. Both total redds and spawning escapement will be reported as "whole" numbers. Redds will be reported in number and density by reach code. Fish data collected during redd surveys will be used to supplement data collected from other sources (i.e. traps and video counts) to help determine age, origin, sex, pre-spawn mortality, and other estimates for each population.

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APPENDIX A

I. Instructions for Completing Redd Survey data from on the Trimble GEO hand held computer.

1. Turn on Trimble GEO, tap the Microsoft flag next to the word Start, tap programs, tap TerraSync, tap the drop down arrow next to the word Status, and select Data. Rename File Name to Redd-Date-Surveyors initials (ex: redd42007KDK). Select Redd Surveys 2007 as the Dictionary Name, tap create. Enter antenna height as 1, tap OK, when new screen pops up make sure Redd Surveys 2007 is highlighted and tap create.

2. **Stream Name**-Select the appropriate stream from the drop down list

3. **Crew** - Select the names of the persons doing the survey

4. **Reach Code** - Select the reach code to be surveyed.

5. **Date of survey** – Select today's date: YYYY/MM/DD

6. **Start_Temp C** –Enter water temperature in degrees Celsius at the beginning of the survey.

7. **StartVisM-** Measure the depth you can see, with a meter stick, vertically in the water column before the survey.

8. **Weather** –Choose the appropriate weather code (Clear, Partly Cloudy, Overcast or Rain).

9. **Flag color** - Record the color of flagging used to mark new redds in the current survey.

10. **Flag Number**-Start numbering at one and number each redd sequentially as your survey the reach.

11. **Number of Redds**-Enter the number of redds seen at this location.

12. **FOR-AD-Present, FOR-NO-Ad, FOR-AD-Unknown-** If you see a fish or a group of fish on a redd record the number of fish you see with an Adipose fin (FOR-AD-Present) or no adipose fin (FOR-NO-Ad) or if you can't tell (FOR-AD-Unknown).

13. **Max-Redd-Depth-**Measure and record the vertical depth at the deepest redd seen at this location**.**

14. **DirToRedd-**Record the cardinal direction (example: N, S, SE..) from the flag to the redd or group of redds.

15. **DistToRedd-** Record the distance in meters from the flag to the redd or group of redds.

16. **Comments**-Record any comments about the site

17. **EndVisM-** Measure the depth you can see, with a meter stick, vertically in the water column after the survey.

II. Instructions for Completing EMAP Site Redd Survey Field Form

1. **Stream -** Print the stream name

2. **Observers -** Enter the names of the persons doing the survey

3. **Reach Code** - Enter the reach code to be surveyed.

4. **Date of survey -** Enter the day's date: YYYY/MM/DD

5. **Water temperature -**Water temperature is taken in degrees Celsius at the beginning of the survey.

6. **Data Logger File Name**-If you are using a Trimble data logger or a data logger that just records GPS locations write down the file name.

7. **Vertical Water Visibility (meters)-** Measure the depth you can see, with a meter stick, vertically in the water column before and after the survey.

8. **Weather** –Circle the appropriate weather code (Clear, Partly Cloudy, Overcast or Rain).

9. **GPS waypoint**-Record the Latitude/Longitude of each new redd or group of redds from your GPS unit in decimal degrees.

10. **Flag #-**Start numbering at one and number each redd sequentially as your survey the reach.

11. **Flag color** - Record the color of flagging used to mark new redds in the current survey.

12. **FOR-AD-Present, FOR-NO-Ad, FOR-AD-Unknown-** If you see a fish or a group of fish on a redd record if they have an Adipose fin (FOR-AD-Present) or no adipose fin (FOR-NO-Ad) or if you can't tell (FOR-AD-Unknown).

13. **Max-Redd-Depth-**Measure and record the vertical depth at the deepest redd seen**.**

14. **Direction to Redd-**Write down the cardinal direction (example: N, S, SE..) from the flag to the redd or group of redds.

15. **Distance to Redd-** Write down the distance in meters from the flag to the redd or group of redds.

16. **Number of live fish observed** - Enter the number of live steelhead. If positive identification is not possible, record the fish as an unknown.

17. **Number of carcasses examined** - Identify all carcasses to:

    a. Species (Assumed to be steelhead unless otherwise notes) and sex,
    b. The presence or absence of gametes and note pre-spawn mortality or fully spawned out.
    c. Examine all carcasses for adipose fin clips or any other fin clip.
    d. By opening up the carcasses along the abdomen to check for the presence or absence of gametes all the carcasses will be marked after examination.

18. **Number of skeletons observed** - Any fish that cannot be measured, or any identifiable parts of fish found are considered skeletons.- If it is possible to identify the species, record it appropriately; if not, record it as unknown.

19. **Remarks** - Add any, information discovered during the. survey such as barriers, landslides, etc. Include any information necessary to clarify other entries on the field form. Note that if a complete barrier exists that would prohibit adult steelhead passage then enter a zero in the count section of the field form and fill-out information as if the survey were completed but note no water or other reason for the barrier. In main-stem sites where the river bottom can not be clearly observed in riffle or side channel areas note visibility precludes survey and peak count method applies. Note if this is likely to change in the future and describe reason for visibility difficulty (i.e. too deep, turbidity, …, etc.)

Example data form to be completed for each EMAP site redd survey.

		REDD SURVEY FORM				Page _____of_____
Stream Name	_____	**OBSERVERS**_____				
Reach Code	_____	**DATE(M/DD/YYYR)**_____				
Water Temperature	**Start (°C)** _____	**DATA LOGGER FILE NAME**_____				
Vertical Water Visibilty (meters)	**Start** _____	**End** _____	**Weather**	Clear	Partly Cloudy	Overcast	Rain

REDD INFORMATION					**REDD INFORMATION**				
GPS way point	**Flag #**	**Flag color**	**# Redds**	**FOR-AD-Present**	**FOR-NO-AD**	**FOR-AD-Unknown**	**Max-Redd-Depth**	**Direction to Redd**	**Dist to Redd**

FISH/CARCASS OBSERVATIONS

Species	Live or Dead	Sex (M/F)	Spawned (Y/N)	Adipose Fin Present (Y/N)	Other marks or tags	Length (mm)	DNA #	Otolith #