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Steelhead Spawning Surveys Near Locke Island, Hanford Reach of the Columbia River

R. P. Mueller
D. R. Geist

October 1999

Prepared for the U.S. Department of Energy
Contract DE-AC06-76RLO 1830

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Executive Summary

In 1997, the National Marine Fisheries Service (NMFS) listed upper Columbia River steelhead trout (*Oncorhynchus mykiss*) as endangered. This action affected management of land-use activities along and within the Hanford Reach of the Columbia River, which flows through the U.S. Department of Energy (DOE) Hanford Site. Steelhead covered in this listing include all naturally spawned populations of steelhead and their progeny in streams in the Columbia River Basin upstream from the Yakima River to the United States/Canada border. The NMFS has identified a general listing of activities that could potentially result in harm to steelhead (62 FR 43937, August 18, 1997). One of these concerns includes land-use changes resulting in mass wasting or surface erosion.

Landslide activity along the White Bluffs on the east side of Locke Island has redirected river flow into the island where substantial erosion has occurred. This erosion has exposed important anthropological and archaeological resources that were previously buried on the island. The DOE is working with affected tribes and other agencies to develop a plan for addressing the erosion of Locke Island. As part of this effort, the U.S. Army Corps of Engineers has prepared an assessment of potential alternatives to stabilize the erosion, including a no-action alternative. Steelhead historically spawned in the vicinity of Locke Island, but recent information on the occurrence of steelhead spawning or availability of spawning habitat was lacking. Therefore, the purpose of this study was to determine if steelhead spawned in the vicinity of Locke Island erosion and to evaluate the composition of substrate in the affected area.

Surveys to document the occurrence of steelheads redds were conducted in Spring 1999. The surveys were conducted from the air as well as with the use of an underwater video camera. Neither aerial nor underwater surveys documented steelhead spawning within the survey area. Habitat surveys were conducted in July 1999. The survey area was divided into an area adjacent to the erosion zone and an area immediately upstream of this zone. The majority of the survey area was composed of gravel and medium cobble (particle sizes 0.6 to 15.2 cm). Aquatic vegetation (milfoil) was found in the upstream section, indicating lower water velocities not conducive to steelhead spawning. Based on the available substrate within the entire survey area, we estimate 81% of survey site could be used by adult steelhead for spawning.

Acknowledgments

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1.0 Introduction

Locke Island is located within the Hanford Reach of the Columbia River at river kilometer 595.4 (Figure 1). During the last 5 years, a significant amount of bank erosion has occurred on the eastern portion of Locke Island. This erosion is due, in part, to the recent slumping of the White Bluffs shoreline and resultant displacement of flow toward the northeast side of Locke Island. The main impact on the island erosion is the loss of archeological resources that have significant cultural importance. To help prevent continued erosion of Locke Island, an erosion control plan was developed by the U.S. Army Corps of Engineers (USACOE 1998). The plan lists several alternatives (including no-action) that have the potential to affect steelhead (*Oncorhynchus mykiss*), which currently are listed as endangered under the Endangered Species Act (ESA).

Information on the quantity and location of steelhead spawning is sketchy because aerial surveys of steelhead spawning are difficult, if not impossible, because of high, turbid spring runoff that obscures visibility. Steelhead likely spawn in the Hanford Reach between February and early June, with peak spawning in mid-May (Eldred 1970; Watson 1973; Becker 1985).

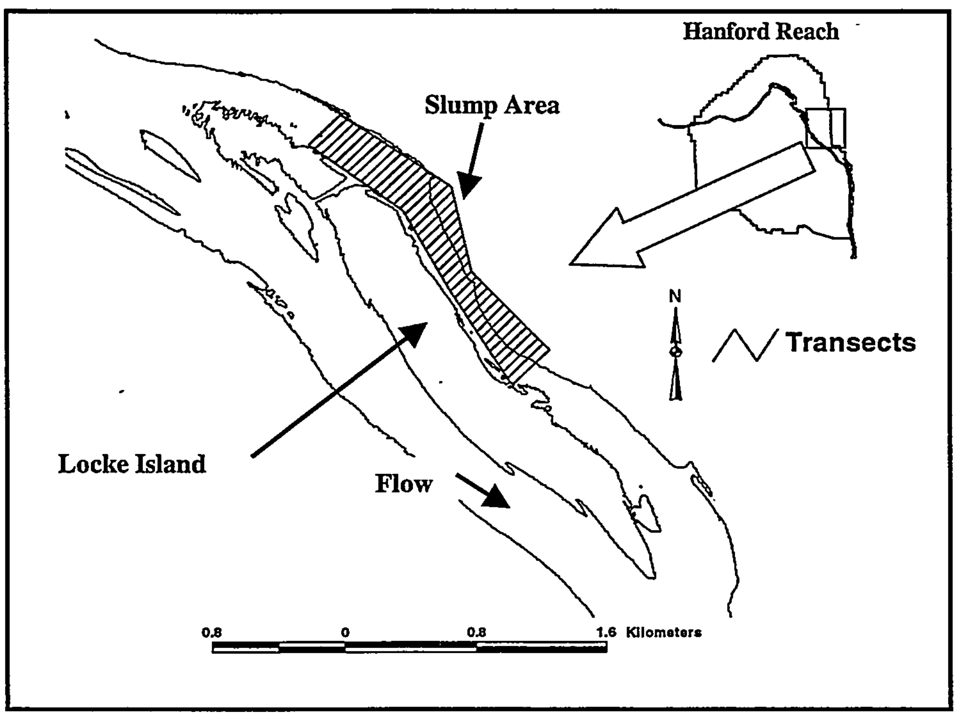

Figure 1. Map of Study Area and River Transects in Relation to the Hanford Reach and Locke Island

Key spawning areas reported from aerial surveys conducted in 1968 and 1970 included Vernita Bar, Coyote Rapids, Locke Island, 100-F islands, and Ringold (Tony Eldred, personal communication with D.R. Geist 9-28-89). A total of 220 redds were counted in 1968 and 95 in 1970; total steelhead spawning was estimated by Eldred to be approximately 2,200 to 25,000 in 1968 and 950 to 7,800 in 1970. Gray and Dauble (1976) collected gravid and ripe steelhead females in late April and early May and spent males in August within the Reach. Fickeisen et al. (1980) indicated steelhead trout likely spawned at Vernita Bar, Coyote Rapids, Locke Island, and Ringold.

Watson (1973) constructed a "steelhead budget" and compared the number of fish entering the Reach with fish remaining after taking into consideration steelhead counts at upstream dams, tributary escapement, natural mortality, and sport harvest. He estimated that of the 35,000 steelhead that annually passed McNary Dam from 1962 to 1971, approximately 13,000 (range -15,259 to 40,823) were unaccounted for and potentially spawned within the Hanford Reach. In a similar study for the period 1977 through 1996, an estimated 9,000 steelhead (range -15,259 to 40,158) may currently spawn within the Hanford Reach (PNNL unpublished data). Even after taking into consideration fall back at McNary Dam, this number could be several thousand.

Since 1970, there has been little effort to document steelhead spawning in the Hanford Reach. A limited survey was completed in 1998 by Pacific Northwest National Laboratory (PNNL). The aerial surveys found approximately 75 redds occurring near Ringold and F-Slough (D.D. Dauble, PNNL personal communication). High flows restricted the ability to confirm these sightings as steelhead redds using underwater video.

Since the listing of steelhead under the ESA in 1997, there has been a higher priority to document locations of any steelhead spawning that occurs in the Reach so Hanford Site activities can be managed to avoid impacts to listed species. Because the Locke Island erosion control plan includes alternatives that have the potential to affect steelhead habitat, additional information on steelhead habitat use in the vicinity of Locke Island was needed. Therefore, the purpose of this study was to locate steelhead spawning in the vicinity of Locke Island and to characterize the habitat in the area that could be impacted.

2.0 Methods

Aerial surveys to locate steelhead spawning in the Hanford Reach were conducted using a fixed-wing aircraft. An effort was made to conduct the surveys during the primary steelhead spawning period when flows were low. Researchers flew the entire Hanford Reach and noted any potential redds on a map. Special attention was given to areas where previous aerial surveys had documented redds. PNNL and the Washington Department of Fish and Wildlife (WDFW) conducted eight redd surveys during April and May 1999.

Two underwater surveys were conducted adjacent to Locke Island where shoreline slumping has occurred. The first survey occurred May 6 and 7, 1999, to determine if any steelhead redds existed within the survey area. The second survey was conducted on July 30, 1999, to characterize the potential spawning habitat (defined by water depth and substrate size). Over the two surveys, a total of 41 transects were run at 50-m intervals between Locke Island and the White Bluffs shoreline (Figure 1). The average transect length was 250 m. The data were grouped into two categories: (1) area upstream of the slump, and (2) area adjacent to the bank slumping.

The mobile underwater video system used was composed of a high-sensitivity remote camera (Sony, model HVM-352) attached to a weighted platform. Recordings were made using a Sony model CCD-FX710 Handycam located on the motorboat. Two high-resolution monitors were used during the surveys for better viewing of the video obtained by the remote camera. The location for each image (UTM X and UTM Y) was correlated to global positioning system (GPS) location by a time stamp.

Two lasers pointed downward, 18.4 cm apart were attached to the underwater platform and were used to provide a reference scale within the camera image (Figure 2). The distance from the camera lens to the substratum ranged from 0.9 to 1.4 m, providing an effective view path of 2.7 m^2. Changes in background contrast, bed elevation, or substrate composition were the primary criteria used to determine spawning activity. Recorded tapes were reviewed in detail at the PNNL computer lab using a high-resolution monitor.

An on-board, real-time GPS (Trimble Pathfinder™ Pro XR) was used to collect positional data as well as to navigate a pre-set transect grid during the surveys. The integrated GPS beacon receiver and antenna provided GPS corrections for calculating sub-meter accuracy (approximately 0.5 m) on a second-by-second basis, and thus eliminated the use of a surveyor to capture positional information of the boat during surveys. Longer data point acquisitions provided positions with greater than 0.5-m accuracy. The system's software (ASPEN) displayed a background map of the study site on a personal computer so researchers could navigate to site locations on a pre-determined transect line or visually verify data accuracy in the field.

The substratum mapping survey was conducted using the same grid as that used in the redd survey in May. Transects were conducted using a pre-set grid of 41 transects at 50-m intervals (Figure 1). A minimum of five locations along each transect were selected for substratum composition. Particle size was determined by taking an average of the dominant substrate type at each location. A circular 25-m

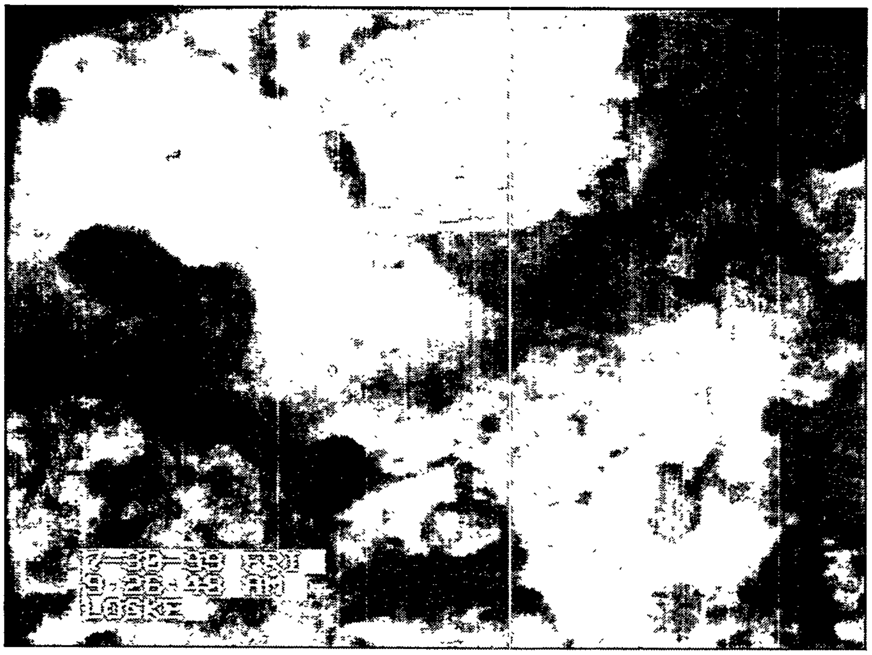

Figure 2. Digitized Image of Substrate and Laser Reference Markers. Distance between laser points is 18.4 cm.

buffer was used to extrapolate the particle size to the surrounding area. Because of uneven spacing on locations along each transect, some overlap of the 25-m circular buffer occurred. Each video image was assigned a dominant substrate class (Table 1) based on long-axis diameter. Dominant substrate was the predominant size class of substrate size based on surface area. The boundaries of each buffer and the corresponding substrate classification were traced and then digitized into the geographic information system (GIS).

To determine if substrate suitable for spawning occurred within the survey area, the data were compared to steelhead habitat previously described for the Clearwater River, Idaho (Orcutt et al. 1968). The preferred gravel sizes used by adult steelhead in this study ranged from 1.3 to 10.2 cm.

Table 1. Substrate Categories Used for Spawning Habitat Classification (modified from Platts et al. 1983)

Category	Sediment Classification	Long Axis Diameter of Individual Substrate (cm)
1	Gravel	0.6–7.6
2	Medium cobble	7.6–15.2
3	Large cobble	15.2–30.5
4	Boulder/bedrock	>30.5

3.0 Results and Discussion

This section reports results for both the aerial spawning surveys conducted by PNNL and WDFW and the habitat survey.

3.1 Aerial/Spawning Surveys

No steelhead redds were detected during any of the aerial surveys conducted by PNNL or WDFW during April and May 1999. During these surveys, the river flow measured at Priest Rapids Dam ranged from 143 to 190 kcfs (Table 2). To protect stranding of fall chinook salmon fry in the Hanford Reach, the outflow at Priest Rapids was more uniform than in previous years. These uniform flows hampered our ability to survey on weekends when flows normally drop. In addition, water clarity was estimated to be less than 1.8 m. A few patches of possible redds were noted near F-Slough and Ringold, but these were later discounted as underwater clay deposits.

Table 2. Conditions Observed During the Aerial Redd Surveys of the Hanford Reach Conducted by PNNL and WDFW in 1999

Survey Date (1999)	Organization Conducting Survey	Approx. River Q (kcfs) During Survey	Wind	Cloud Cover	Depth of Visibility	General Viewing Conditions
April 2	PNNL	144	Calm	Partial	<1.8 m	Good
April 8	WDFW	143	Light	Partial	<1.8 m	Good
April 22	PNNL	170	Light	Partial	<1.8 m	Good
April 26	WDFW	160	Light	Clear	<1.8 m	Good
May 5	PNNL	190	Light	Clear	<1.8 m	Good
May 13	PNNL	156	Light	Partial	<1.8 m	Good
May 19	WDFW	155	Calm	Clear	<1.8 m	Good
May 27	WDFW	175	Calm	Clear	<1.8 m	Good

The spawning survey using the underwater camera consisted of a total of 41 boat transects that ran perpendicular to the shoreline. The average river flow during these surveys was 168 kcfs. The water clarity was estimated at 1.2 m for the two underwater video surveys conducted on May 6 and 7, 1999. These surveys did not document any obvious redds within the survey area. A large area of very clean gravel and cobble occurred adjacent to the slump area close to Locke Island, but no evidence of recent spawning activity was observed. The limited water clarity resulted in having to run the camera closer to the river bottom, which made detection of redds difficult.

It is not clear if our inability to find redds was because no redds were present, or because conditions to see them were less than optimal. Based on aerial surveys, steelhead have been known to use the river channel around Locke Island (Eldred 1970); the majority of the spawning occurred on the eastern part of the Island (Figure 3). The 1968 surveys indicated that spawning occurred throughout the slump area but were confined to the Locke Island side of the river channel. The 1968 survey did not document redds in the area upstream of the slump. Thus, it seems likely that the Locke Island area could be used by steelhead for spawning. Our survey may not have been successful because discharge was high, and visibility was low. River discharge during our surveys ranged from 143 to 190 kcfs. For comparison, information on steelhead spawning from the 1968 survey was collected during unusually low flow conditions (40 to 76 kcfs). The higher discharge during our surveys may have masked potential spawning. Additional surveys under low flow conditions will likely be needed to conclusively demonstrate steelhead spawning in the channel on the northeast side of Locke Island.

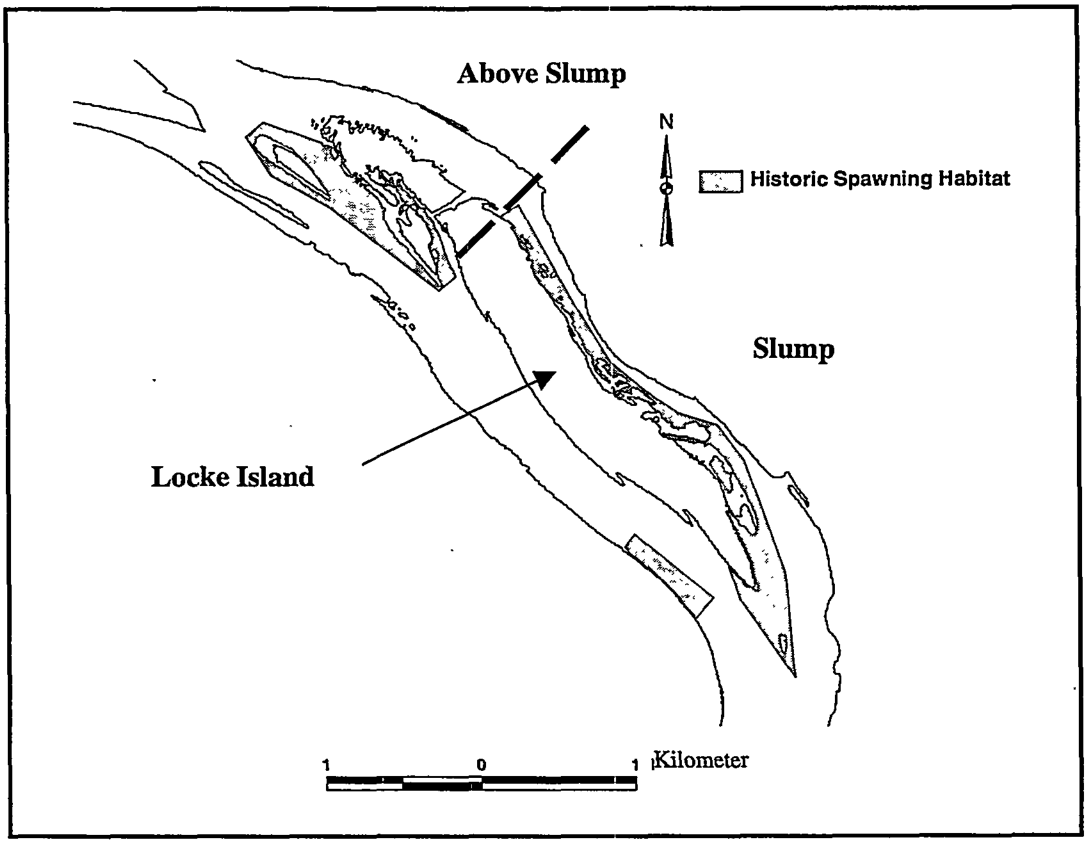

Figure 3. Location of Steelhead Redds Observed During Aerial Surveys in 1968 Near Locke Island (Eldred 1970)

3.2 Habitat Survey

The habitat survey was conducted on July 30, 1999. The survey was conducted using the same grid as that used for the spawning survey. The average river flow during the habitat survey was 103 kcfs. A total of 228 survey points were analyzed to characterize the substratum over the entire survey area. Using the 25-m buffers, the total substratum characterized was estimated to be 306,895 m^2. Approximately 37% of the entire survey area was not categorized due to water depth, variable data points, or the presence of milfoil. The water clarity for the July survey was estimated to be 2.8 m, which was considerably better than that observed during the spring surveys.

Of the area we could survey, approximately 52% was found to contain medium cobble as the dominant substrate followed by gravel and bedrock (Table 3). A comparison of the survey area influenced by the slump and the area surveyed upstream of the slump showed medium cobble as the most abundant substrate type in each area. Following medium cobble, gravel, large cobble, and bedrock were equally distributed in the area upstream of the slump while gravel was the second most abundant substrate type within the slump area. A plan view shows that the substrate type is mostly composed of medium cobble with bedrock along the eastern side where the river channel is wider (above slump) (Figure 4). In

Table 3. Estimated Distribution of Substrate by Location Within the Survey Area

Categories	Above Slump (area m^2)	%	Within Slump (area m^2)	%	Both Combined (area m^2)	%
Gravel	18,146	17	56,829	28	74,975	24
Medium Cobble	54,356	51	106,853	53	161,209	53
Large Cobble	14,512	14	12,124	6	26,636	9
Bedrock	19,883	19	24,192	12	44,075	14
Grand Total	106,897	100	199,998	100	306,895	100

contrast, substrate in the area adjacent to the slump is distributed more predictably across the channel with bedrock in the center and smaller-grained particles toward the margins of the channel. Water velocities likely affect this distribution of substrate.

We estimated milfoil occupied 48% of the upstream section that was surveyed (Figure 5). We were hindered in our ability to record substrate images within the milfoil; thus, the total available substrate area may be greater than what we estimated. The presence of milfoil in the upper study area leads us to believe that substrate particles are finer, velocity slower, and depths shallower. Although we did not measure velocity, we generally found this to be the case for depth. In general, in areas where milfoil was present, water depths at 100 kcfs were estimated to be less than 3 m (Figure 6).

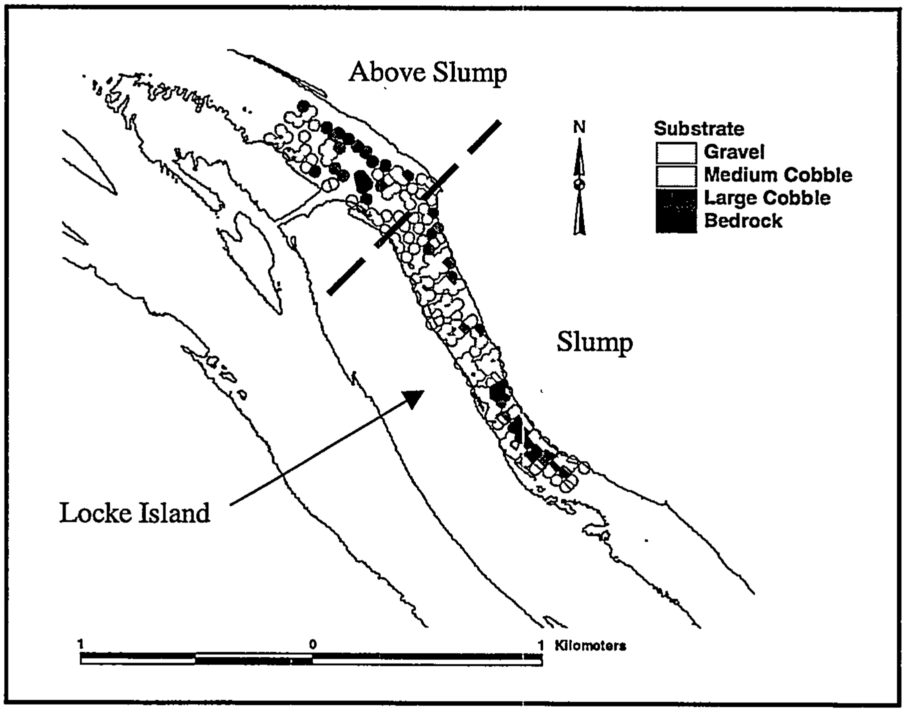

Figure 4. Estimated Distribution of Substrate Occurring Within the Eastern Portion of the Columbia River Near Locke Island

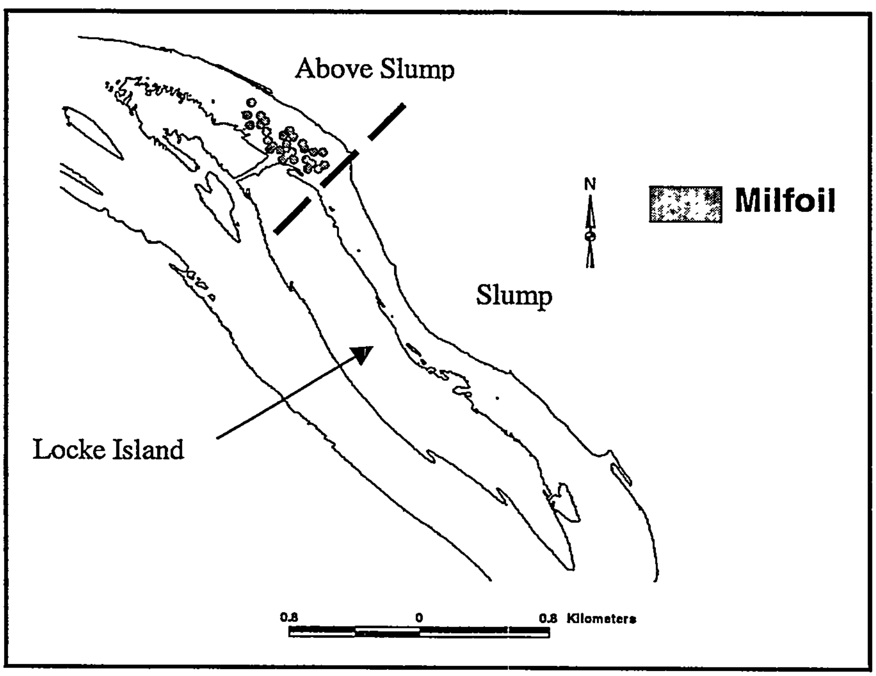

Figure 5. Estimated Distribution of Milfoil Occurring Within the Eastern Portion of the Columbia River Near Locke Island

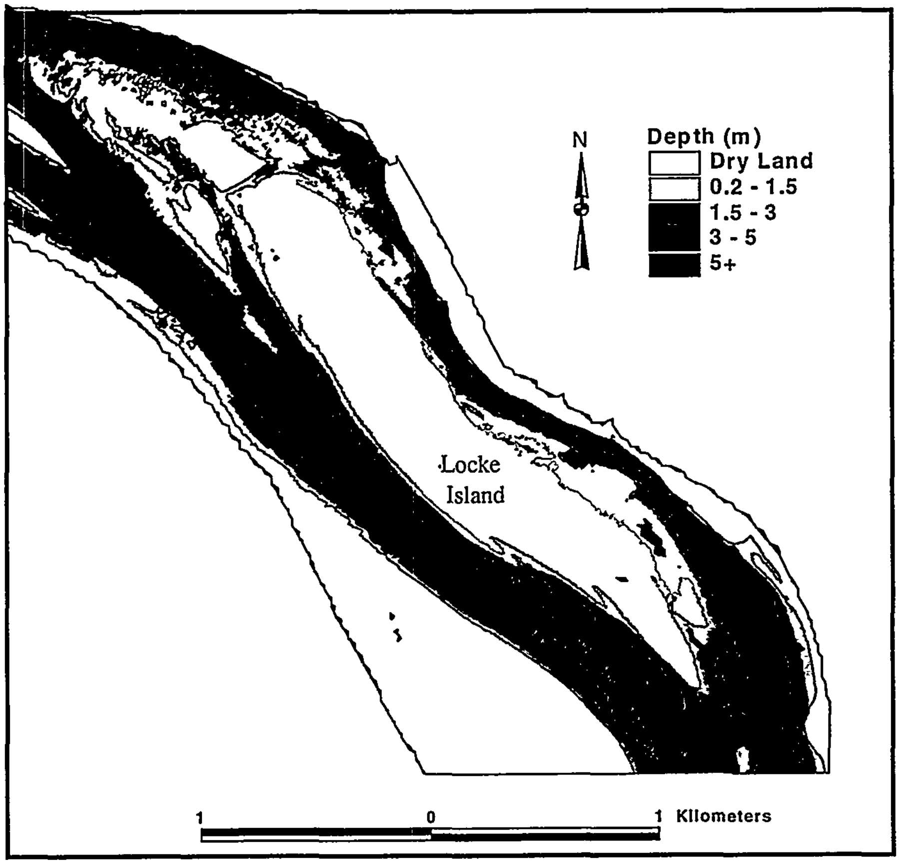

Figure 6. Water Depth Data Gathered Using a Scanning Hydrographic Operational Airborne Lidar Survey System. Data were gathered as part of another project by WDFW and the U.S. Geological Survey. An unsteady flow model was used to project a water surface through the study area at 100 kcfs. Depth was determined by subtracting the river bottom elevation from the elevation of the water surface.

Based only on substrate size, we estimated that the best locations for steelhead spawning would be in the middle to lower part of the survey area where substrate was classified as gravel or medium cobble. We estimate that 81%, or approximately 163,680 m^2, of the lower section (slump area) surveyed had substrate of suitable size for spawning by steelhead. There is no indication that the material entering the river from the slump is degrading steelhead habitat in the immediate vicinity of the slump. In fact, the slumping may be increasing available habitat by increasing the channel velocities, which in turn scours and cleans gravel and cobble substrate. However, we did not survey downstream of the slump; thus, we have no data on whether fine particles settle out once velocities are reduced. This would negatively affect potential spawning habitat further downstream by reducing streambed particle size, which creates detrimental conditions for salmonid spawning (Platts et al. 1989).

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