Shillapoo Wildlife Area and Mt. St. Helens Wildlife Area Fish Passage and Diversion Screening Prioritization Inventory

Habitat Program
Technical Applications Division
Habitat and Passage Projects Section

Submitted by

Jason P. Kunz
Dave Caudill

Washington Department of FISH and WILDLIFE

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Additional data requests should be made to the Habitat and Passage Projects Section, Data Manager, Habitat Program, WDFW, 600 Capital Way N, Olympia, Washington 98501. Phone: 360-902-2411.

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INTRODUCTION

The Washington State Department of Fish and Wildlife (WDFW) is committed to providing leadership in restoring salmon and trout (salmonid) populations in Washington State.
WDFW conducts Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization projects, which address two factors limiting salmonid populations:

- ?? Human-made barriers to fish passage such as culverts and dams
- ?? Salmonid mortality from unscreened water diversions

When culverts and dams are barriers to fish migration, productive habitat becomes inaccessible. Both adult and juvenile salmonids need to move freely up and downstream to find suitable spawning gravel or disperse from the redd into rearing habitat. Even resident trout need full access to all habitat types to spawn, rear, maximize genetic interchange and survive varying flow conditions.

Juvenile mortality occurs in unscreened or inadequately screened diversions. Water diversion ditches resemble side channels in which juvenile salmonids normally find refuge. When diversion headgates are shut, access back to the main channel is cut off and the channel goes dry. Mortality can also occur with inadequately screened diversions from impingement on the screen, or mutilation in pumps where gaps or oversized screen openings allow juveniles to get into the system.

Inventories of fish passage barriers and water diversions are being conducted on each of the Wildlife Areas owned or managed by WDFW. The inventories and habitat surveys document and prioritize for correction all human-made fish passage barriers and unscreened or inadequately screened diversions to ensure compliance with Washington State laws (RCW 77.55.060, RCW 77.55.040).

For this report, the location of a fish passage or safety structure is referred to as a site. The structure at that site is referred to as a feature.

Features affecting fish passage include:

- ?? Culverts
- ?? Dams
- ?? Fishways
- ?? Others

Features affecting fish safety include:

- ?? Gravity diversions
- ?? Pump diversions

A site may have one or more features associated with it, such as a gravity diversion with a dam to impound water and direct it to the diversion. A dam may be equipped with a fishway to facilitate fish passage around the dam. An overflow levee with a water control structure is a common site associated with wetland enhancement and is treated as an “other” feature.

This report summarizes the results of the Shillapoo and Mt. St. Helens Wildlife Area inventories.

WILDLIFE AREA DESCRIPTION

The Shillapoo Wildlife Area (SWA) and Mt. St. Helens Wildlife Area (SHWA), which includes 16 satellite properties, are managed as a complex. Because of this and their relative small size, they were collectively inventoried and combined in this report.

Shillapoo Wildlife Area

The Shillapoo Wildlife Area, comprised of three units totaling 2,371 acres, is located in southwest Washington near the city of Vancouver and is situated within the Vancouver Lowlands. These lowlands are essentially lower Columbia River flood plain. The North Unit and South Unit are northwest of Vancouver Lake, between Lake River and Columbia River, and encompass Shillapoo Lake. The Vancouver Lake Unit is located on the southern shore of Vancouver Lake (figure 1). The lowland area surrounding the SWA encompasses lands owned primarily by Clark County, City of Vancouver, Port of Vancouver and several private landowners.

Over the past 50 years, human activity has heavily altered the landscape of this area. The most significant change was the draining of Shillapoo Lake and its development as agricultural land. This was made possible by the construction of dikes (also referred to as levees) around the area and drainage ditches to route the interior runoff to a sump location. A large expulsion pump and culvert (fitted with a tide gate) are used to discharge the runoff into Lake River.

“Shillapoo Lake was historically interconnected with the Columbia River, Lake River, Vancouver Lake, and fluctuated seasonally with the rise and fall of the Columbia” (US Army Corps 1998). The Columbia and Lake River connection channels are visible today. The Vancouver Lake connection is not discernible and will not be discussed further in this report.

“The construction of dams upstream on the Columbia River has reduced water fluctuations and virtually eliminated periodic flooding that once occurred [in and around the SWA]. This drier condition has allowed both agricultural and industrial development to expand further into the area, which has also been altered by the construction of dikes throughout the area. The dams and dikes have not completely eliminated the potential for flooding as was seen during the 1996 flood. This event broke dikes in two major locations and had both positive and negative impacts on [the flood plain] habitats. The flooding and duration were sufficient to kill reed canary grass in many wetland areas allowing native plants, including wapato, spike rush, smartweed and others, to re-colonize in some areas. The flood also had negative effects on pastures and other areas by eliminating some desirable plants allowing weeds to increase in some instances” (SWA Work Plan 2001).

“Prior to agricultural development, the Vancouver Lowlands, where the SWA is located, were a diverse mixture of both herbaceous and forested wetlands, oak woodland, and riparian habitat. Shillapoo Lake was a dominant feature of the landscape” (SWA Work Plan 2001).

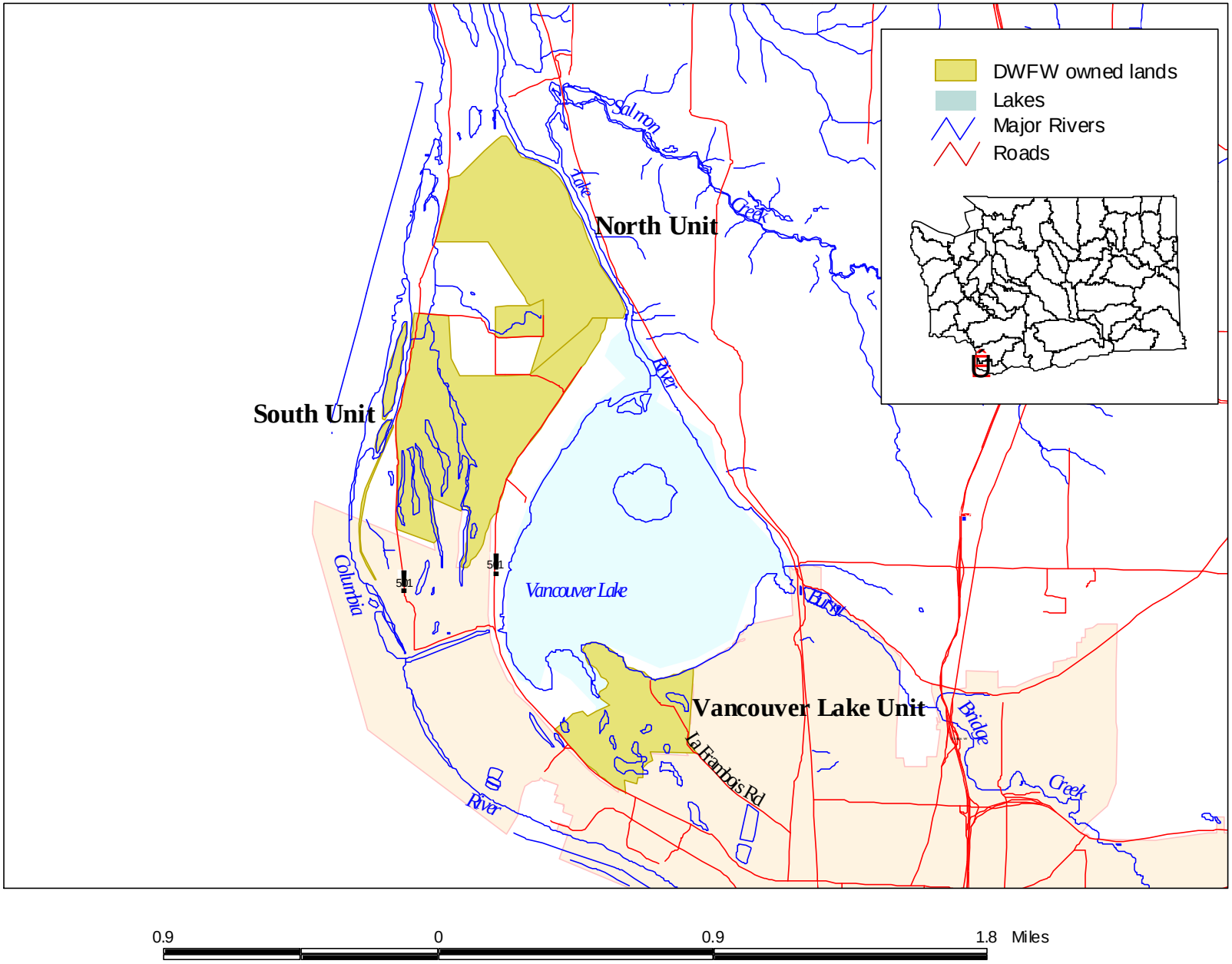

Figure 1. Shillapoo Wildlife Area

North Unit (882 acres)

This unit is located within the northern and central portions of the drained Shillapoo Lake, with the exception of a small separate parcel along Lake River. The majority of the lake basin within this unit is used for agriculture. Several drainage ditches and the site of the diking district's expulsion pump and discharge culvert used to drain the lakebed are associated with this unit. A cross dike between the Lake River and Columbia River levees forms the northern property boundary and cuts off the connection channel between Lake River and Shillapoo Lake. Prior to draining the lake, this channel served as one of the two lake inlets, and the only outlet. This outlet receded during summer low flows leaving a 950 acre lake. During high water and flood periods, the lake swelled to approximately 1,200 acres.

Located primarily on private property, portions of the historic Columbia River connection channel have been filled in with Columbia River dredge spoils and silage. The channel is also cut off by the Columbia River levee, which is also Lower River Road.

With only the collection of standing rainwater and interior runoff in the drains, none of these water bodies are considered suitable salmonid habitat at this time. The small upland parcel of land along Lake River has a seasonal 10–12 acre wetland pond referred to by the locals as Blaker Lake. However, there is no open channel connection with Lake River.

"Major enhancement efforts will be focused here to restore wetland and riparian habitats and improve the remaining [post 1996 flood] pasture areas to maintain their value to wintering waterfowl populations. Some continued level of agricultural use is also envisioned at least to the extent that interested lessee's can be found. …WDFW has not undertaken any significant enhancements on this unit although funds have been received in partnership with the Columbia Land Trust and Ducks Unlimited (DU) to restore a wetland area of approximately 80 acres by installing ditch plugs with water control structures" (SWA Work Plan 2001).

South Unit (1,012 acres)

This unit includes properties that historically were used for dairy production. A large great blue heron rookery with well over 100 active nests is located on this unit. In the past, management activities on this unit have varied between waterfowl and upland bird hunting. Since the early 90's management has focused on providing goose wintering habitat. The release of pheasants still occurs and waterfowl use increases substantially during late winter and early spring (SWA Work Plan 2001).

This unit encompasses a diverse mixture of agricultural, pasture, wetland and riparian habitat. The southern portion of the drained lakebed and associated drainage ditches are located on this unit. Several bodies of water lie south and west of historic Shillapoo Lake. The named bodies of water include Matthews Slough, Buckmire Slough, Hart Lake, Bass Lake, and Pencil Lake. Only Buckmire and Matthews Sloughs, which are connected to Lake River, have the potential to support salmonids. Through the use of aerial photos and topographic maps it has been determined that the non-fish bearing bodies of water are remnant flood plain features that have become hydraulically isolated.

A wetland restoration project, which includes pumping water from the Columbia River onto the west side of the unit, was completed in the recent past. "Different vegetation management techniques are being employed and closely monitored, as part of a regional study, to determine the most effective means to manage wetlands for native plant communities. Both avian and plant response are being studied by the U.S. Fish and Wildlife Service, DU and the University of Idaho" (SWA Work Plan 2001).

Vancouver Lake Unit (477 acres)

This unit is located at the south end of Vancouver Lake and includes a large portion of the southern shoreline. Also, "approximately half of this unit consists of willow-dominated, forested wetland in the Mulligan Slough area. The Mulligan Slough area is unique as it represents one of the largest non-diked flood plain areas in the Vancouver Lowlands. Even though regulation of the Columbia [River] has affected water levels the remaining periodic flooding has allowed native wetland communities to maintain a foothold here" (SWA Work Plan 2001).

During the 1996 flood, the combination of increased water depth and duration of flooding demonstrated an effective way to remove reed canary grass (non-native) and promote the re-colonization of native plant communities. Based on those observations, "a wetland restoration project where water control structures [and levees] were put in place to restore hydrology to approximately 65 acres was partially completed here in 1998." The additional water supply needed to augment inundation is still being developed (SWA Work Plan 2001).

Mt. St. Helens Wildlife Area

The 2,773 acre Mt. St. Helens Wildlife Area (SHWA) is one contiguous piece of property located within the North Fork Toutle River valley, in Cowlitz County, WA (figure 2). This property is part of 150 square miles of prime fish and wildlife habitat that was devastated by enormous mudflows and debris avalanches from the May 18, 1980 eruption of Mt. St. Helens.

During the 1996 flood, over 200 acres (8-10 feet deep) of land was eroded by the North Fork Toutle River and washed downstream (Brian Calkins, WDFW, personal communication, March 2002). The SHWA is still impacted from the loss of the forested habitat and the existing volcanic sediments that still cover this area. The recovery of this landscape and it's geologic, hydrologic and other natural functions will be a long and ongoing process.

Fish bearing streams on this wildlife area include the North Fork Toutle River, Hoffstadt Creek, Bear Creek, and a short section of Deer Creek in the southeast portion of the Wildlife area (figure 2). No fish passage or fish safety issues were identified during the inventory.

Managed in conjunction with the SHWA are 17 satellite units that total approximately 1,223 acres. No fish passage or fish safety issues were identified during the inventory of these of these units. No map figures will be included in the report because unit locations are small and dispersed over a large area.

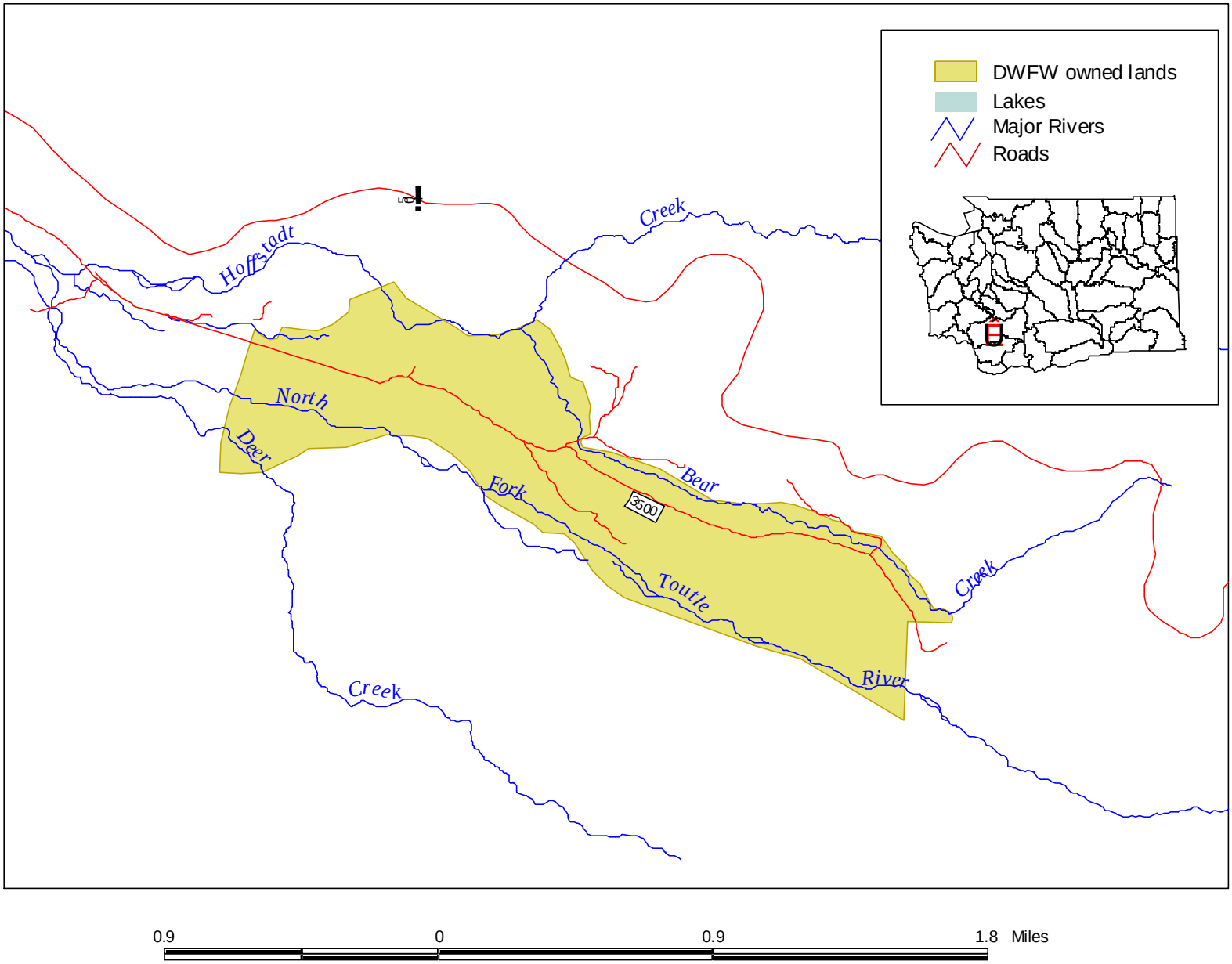

Figure 2. Mt. Saint Helens Wildlife Area

METHODS

Inventory/Feature Evaluation

The inventory encompassed the Shillapoo Wildlife Area (SWA), Mt. St. Helens Wildlife Area, and additional lands associated with stream habitat surveys. Regional WDFW staff provided assistance with identifying fish bearing waters and the location of known fish passage and water diversion features on the wildlife areas.

The field crews conducted the inventory by driving all roads and walking along known and potential fish bearing waters. All features found in these waters were assigned a Site ID number and their geographical locations were recorded using a global positioning system (GPS) or determined from maps. Data collection and evaluation methodologies for all features are described in the *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* (WDFW, 2000).

In addition to the information provided by the WDFW regional staff, the potential for fish presence is determined based on stream size, gradient, flow duration, and direct fish observation. On the SWA, there were no streams, only tidally influenced water bodies and connected wetland habitat. Each potentially fish bearing stream or water body is walked to measure the habitat, locate additional features not found during the road inventory, and determine the extent of potential fish use. Detailed notes of the habitat, referenced by hip chain distance, are recorded during the habitat survey. All human-made features associated with fish bearing waters are evaluated for fish passage or fish safety.

Expected fish species utilization includes those species currently inhabiting the stream or water body, and those that historically used or potentially used the stream or water body. Expected fish species utilization was determined by direct observation and by using resources such as the Washington State Salmon and Steelhead Stock Inventory (WDF et. al. 1992), Washington State Salmonid Stock Inventory Bull Trout/Dolly Varden Appendix (WDFW 1997), Streamnet, and by personal communication with WDFW regional biologists.

Fish Passage Priority Index

The Fish Passage Priority Index (PI) model consolidates factors which affect a project's potential benefit, (species utilization, passage improvement, production potential, habitat gain, project cost, and fish stock mobility and health) resulting in a numeric indicator of relative priority. On streams where fish passage barriers were identified, habitat assessments, data analysis and barrier prioritization were completed per the *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* (WDFW 2000).

Screening Priority Index

The Screening Priority Index (SPI) model consolidates the variables relevant to water diversions, (species utilization, volume of flow, production potential, project cost, and fish stock mobility and health) resulting in a numeric indicator of relative priority. PI and SPI are not comparable, because the PI reflects potential production and the SPI reflects potential mortality. In the SPI, the passage improvement value is replaced with volume of diverted flow as an estimate of the number of adult equivalent salmonids potentially killed by the unscreened or inadequately screened diversion. The SPI is described in the *Fish Passage Barrier and Surface Water Diversion Screening Assessment and Prioritization Manual* (WDFW 2000).

Prioritization

The PI and SPI values are intended to be used as a guide to prioritizing projects. Expected species utilization anticipates correction of all downstream human-made barriers preventing anadromous access, but may be refined to reflect the feasibility of restoring anadromous access or habitat. Production values used in the PI assume all upstream human-made barriers will be corrected. The PI and SPI values are dynamic, allowing for modification as new information becomes available.

Winter Rearing

Fish passage barriers often associated with dikes or water control structures impede fish access to valuable rearing habitat during typical winter periods of higher flows. As these flows recede, fish that do pass these structures are also at risk of becoming stranded. For these situations, it is important to properly identify and correct passage and/or safety issues associated with fish bearing waters.

The Shillapoo Wildlife Area (SWA) contains a substantial amount of winter rearing (flood plain, slough and tidally influenced) habitat blocked by human-made features. Habitat gains were calculated using the area of inundation that occurs during ordinary high water. The PI model used to prioritize fish passage barriers for correction does not account for winter rearing habitat. Other factors will need to be considered in order to prioritize the barrier features for correction. For these reasons, no particular ranking will be made at this time.

RESULTS

No fish passage or water safety features were identified on the Mt. St. Helens Wildlife Area or satellite units.

Within the Shillapoo Wildlife Area (SWA) boundaries, 22 features at 21 sites were evaluated on fish bearing waters or waters with unknown fish use (see table 1). These waters included sloughs, flood plain habitats inundated by tides and high river flows, and a drained lakebed. Of

the 22 features, 19 are partial or total barriers to fish passage and one is an unscreened pump diversion. Habitat surveys determined that 10 of the 20 problem features require repair and two have a limited amount of habitat (LHG). Features with LHG will not be considered for repair at this time. Eight problem features have a repair status of undetermined.

Along with the unscreened pump diversion, the 9 fish passage features requiring repair or modification include: three culverts, five others (levees with water control structures), and one dam feature (see table 1).

Outside the SWA, 5 fish bearing features were evaluated during the habitat surveys. These features are listed in Appendix A.

The total potential habitat gain that could be realized from repair of all barriers on the Shillapoo Wildlife Area, along with restoring the Columbia River connection to Shillapoo Lake and correcting the downstream (non-WDFW) barriers, would amount to approximately 4,228,040.5 square meters or 1,044.77 acres of winter rearing habitat. The majority of this gain would stem from restoring Shillapoo Lake (950 acres).

The following four tables detail these results. Table 1 summarizes the number of fish passage and diversion features in each unit. Table 2 lists all fish bearing sites within the Wildlife Area with a description of the feature type, repair status and owner type. Table 3 lists all fish passage barriers requiring repair or repair undetermined within the Shillapoo Wildlife Area. Table 4 lists the unscreened water diversion that would require repair or modification if the lake were to be restored.

For each wildlife area and unit, Appendix A lists the inventoried features by site identification, latitude/Longitude, stream, tributary to, fish use, WRIA, feature type, and owner type. Figures 6 through 32 referenced in the following discussion can be found at the end of the discussion section.

Table 1. Number of fish passage and water diversion features within the wildlife areas listed by unit.

Feature Type	Wildlife Area Units					Total
	Feature Status	**North**	**South**	**Vancouver Lake**	**St. Helens**	
Culvert	Fish Bearing	10	2			12
	Fish Barriers	9	2			11
	Repair Required	3				3
	Repair Undetermined	6	2			8
Dam	Fish Bearing	1				1
	Fish Barriers	1				1
	Repair Required	1				1
	Repair Undetermined					
Pump	Fish Bearing	1	1			2
	Screened Compliant		1			1
	Unscreened[1] Non-compliant	1				1
	Repair Undetermined					
Other	Fish Bearing		2	5		7
	Fish Barriers		2	5		7
	Repair Required		2	3		5
	Repair Undetermined					
Total Fish Bearing Features[2]						**22**
Total Fish Barriers[3]						**19**
Total Unscreened Diversions						**1**
Total Fish Barriers and Unscreened Diversions Requiring Repair						**10**

[1] Indicates the number of water diversions requiring installation or modification of an existing screen.
[2] Includes features on streams, for which fish bearing status has not been determined.
[3] Includes barriers with Limited Habitat Gain (LHG).

Table 2. Features located within the Shillapoo Wildlife Area on fish bearing waters. The codes in the Repair Status column indicate the feature status where RR - repair required, LHG – limited habitat gain, OK – feature is not a barrier or a safety issue; no repair required, UD – repair status undetermined. Species Codes: CK – chinook salmon, CO – coho salmon, SH – steelhead trout, SO – sockeye salmon, CH – chum salmon, SCT – searun cutthroat trout, RT – resident trout including rainbow and cutthroat trout.

Tributary	WRIA	Expected Species Utilization	Feature Type	Owner	Barrier	% Fish Pass	Repair Status
NORTH UNIT							
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	Dike Dist. 14	yes	0	RR
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	dam	WDFW	yes	0	RR
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	yes	67	RR
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	yes	67	UD
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	yes	67	UD
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	pump/culvert	Dike Dist. 14	yes	33	RR
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	yes	67	UD
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	yes	0	UD
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	yes	67	UD
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	yes	67	UD
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	no	100	OK
SOUTH UNIT							
Matthews Sl	28.0001	CK/CH/SO/CO/SH/SCT/RT	pump	WDFW			OK
Lake R	28.0136	CO/SH/SCT/RT	other	WDFW	yes	67	RR
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	yes	67	UD
Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	WDFW	yes	67	UD
Matthews Sl	28.0137	CO/SH/SCT/RT	other	WDFW	yes	0	RR
VANCOUVER LAKE UNIT							
Mulligan Sl	28	CK/CH/SO/CO/SH/SCT/RT	other	WDFW	yes	0	LHG
Vancouver Lk	28	CK/CH/SO/CO/SH/SCT/RT	other	WDFW	yes	0	RR
Vancouver Lk	28	CK/CH/SO/CO/SH/SCT/RT	other	WDFW	yes	0	RR
Mulligan Sl	28	CK/CH/SO/CO/SH/SCT/RT	other	WDFW	yes	0	LHG
Lake River	28.0020	CK/CH/SO/CO/SH/SCT/RT	other	WDFW	yes	0	RR

Table 3. Fish passage barriers requiring repair within the Shillapoo Wildlife Area listed by unit. Fish passage barriers requiring repair or repair undetermined within the Shillapoo Wildlife Area listed by Wildlife Area Unit. All features are associated with winter rearing habitat. Species Codes: CK – chinook salmon, CO – coho salmon, SH – steelhead trout, SO – sockeye salmon, CH – chum salmon, SCT – searun cutthroat trout, RT – resident trout including rainbow and cutthroat trout. [2] Features are associated with lake basin area.

SITE ID	STREAM	TRIBUTARY	WRIA	Expected Species Utilization[1]	Feature Type	% Fish Pass	Additional Barriers		Survey Length (m)	Rearing Area (m^2)
							Downstream	Upstream		
NORTH UNIT										
981451	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	0	0	NA[2]	4,350	3,844,484
981452	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	dam	0	NA	NA	NA	3,844,484
981453	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	67	NA	NA	NA	3,844,484
981454	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	67	NA	NA	NA	3,844,484
981455	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	67	NA	NA	NA	3,844,484
981457	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert/pump	0	NA	NA	NA	3,844,484
981864	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	67	NA	NA	NA	3,844,484
981865	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	0	NA	NA	NA	3,844,484
981866	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	67	NA	NA	NA	3,844,484
981867	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	67	NA	NA	NA	3,844,484
SOUTH UNIT										
981459	Buckmire Sl	Lake R	28.0136	CO/SH/SCT/RT	other	67	3	1	2,750	117,398
981468	Unnamed	Matthews Sl	28.0137	CO/SH/SCT/RT	other	0	0	0	NA	40,470
981861	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	33	NA	NA	NA	3,844,484
981862	Shillapoo Lk	Lake R	28.0132	CK/CH/SO/CO/SH/SCT/RT	culvert	33	NA	NA	NA	3,844,484
VANCOUVER LAKE UNIT										
981470	Mulligan Sl	Vancouver Lk	28	CK/CH/SO/CO/SH/SCT/RT	other	0	0	0	450	62,000
981471	Mulligan Sl	Vancouver Lk	28	CK/CH/SO/CO/SH/SCT/RT	other	0	0	0	450	62,000
981473	Vancouver Lk	Lake R	28.0020	CK/CH/SO/CO/SH/SCT/RT	other	0	0	1	NA	204,159

Table 4. Unscreened water diversions requiring repair within the Shillapoo Wildlife Area.

Site ID	WLA Unit	Stream	Tributary	WRIA	Ownership Type	Diversion Type	Associated with	Flow (gpm)	SPI
981457	North	Shillapoo Lk	Lake R	28.0132	private	pump	culvert	10008.94	61.71

DISCUSSION

Shillapoo Wildlife Area

The Shillapoo Wildlife Area (SWA) was historically part of the active Columbia River flood plain and salmonids likely used the available habitat. Over time, this area has undergone major changes due to human development. Examples include mainstem Columbia River flood control and construction of dikes and drains and their maintenance for industrial and agricultural purposes. The periodic flooding necessary to maintain habitat that would be accessed by salmonids no longer occurs. Currently, salmonids inhabit Vancouver Lake and Lake River. Also, Buckmire Slough becomes inundated by Lake River during high flows and salmonid fish use can be expected. (Steve Manlow, WDFW, personal communication, 01/03).

Restoring Shillapoo Lake to it's original state would be difficult because of multiple property owners and varied land uses within or adjacent to the lake basin. Enhancing the existing conditions of the lake on the SWA to accommodate salmonid fish use is more feasible. Utilizing the existing Lake River connection, drainage canals, and the current lake discharge location for enhancement would create a more fluvial system, which is more conducive of salmonid habitat. With this in mind, the features associated with Shillapoo Lake were evaluated for fish passage using the current physical parameters at each site. Depending upon restoration objectives the barrier features associated with drainage ditches that are within the lake bottom will require additional evaluations in order to determine what remedial action, if any, is taken.

The potential habitat gain of a more fluvial system, which would ultimately include some pond habitat is unknown at this point, therefore no quantified habitat figures will be generated. Instead, the potential amount of rearing habitat gained from restoring Shillapoo Lake (3,844,484 m^2) to its original state will be quoted.

A U.S. Army Corps of Engineers report (1998), "Columbia River Ecosystem Restoration at Shillapoo Lake: Hydrologic and Hydraulic Analyses", covers in detail the potential for reconnecting Shillapoo Lake with the Columbia and Lake Rivers.

This report documents the inventory of human-made features, current hydrology, fish habitat conditions, and potential habitat gains associated with fish passage barriers. Water bodies identified as once providing fish habitat are treated as potentially restorable. In addition to the survey data collected during this inventory, detailed information on Shillapoo Lake and the associated human-made features was acquired from the U.S. Army Corps of Engineers (1998) restoration report described above. Engineering site plans for wetland enhancement project

structures were used to obtain invert elevations (height of structure above sea level) of human-made features and pond area information on the Vancouver Lake Unit.

North Unit:

The majority of the North Unit lies within the drained lake basin. For the purpose of this discussion, the inventoried portion of the South Unit that also lies within the lake basin will be included in this section. No problem features were identified outside the lake basin on the North Unit.

The surface water in Shillapoo Lake is generated from rainfall and groundwater inflow. The two sources of groundwater inflow include a perennial spring at the southern end of the drained lake basin and an artesian well. Additional groundwater inflows to the lake basin can be expected when the Columbia River water levels are high (U.S. Army Corps of Engineers 1998). During a typical winter when the lake is not actively drained, four to five feet of runoff collects in the lake bottom.

To the north of the unit, the Lake River connection channel extends to a cross dike and barrier culvert site 981451 (figure 3). A tide gate attached to the downstream end of the culvert is partially buried and is a total barrier (figures 6 and 7). No additional features were identified downstream of site 981451 and fish access was verified.

Features located inside the dike and associated with the interior drainage of the lake basin include: one dam, ten culverts and a site with a pump and culvert. All of these features were evaluated for fish passage or fish safety. Sites 981453, 981455, 981864, 981866 and 981867 on the North Unit (figure 3) and sites 981861 and 981862 on the South Unit (figure 4) are undersized culverts that will create velocity barriers. Culvert sites 981454 and 981865 are barriers due to slope greater than 1%. Culvert site 981456 is a non-barrier. Additional site-specific information for these features will be included in the figure (photo) captions at the end of the discussion section.

Dam site 981452 was identified about 580 meters due south of 981451 (figure 3). This feature is located at a low point where a natural drainage begins to flow south, through a meandering draw towards the lake bottom. The purpose of the dam is to retain standing water that collects to the north to attract waterfowl. A 0.25 meter culvert, blocked off at the upstream end, and a 0.15 meter standpipe are used as the spillway (figures 8 and 9) and create a total barrier.

The pump and culvert at site 981457 (figure 16 and 17, respectively) are used to expel surface water from the lake into Lake River at approximately river mile 10.5. The pump is unscreened and the culvert is fitted with a tide gate. The purpose of this culvert is to provide gravity discharge from Shillapoo Lake. However, the active management of the pump and the high water levels of Lake River typically prevent actual discharge from this culvert.

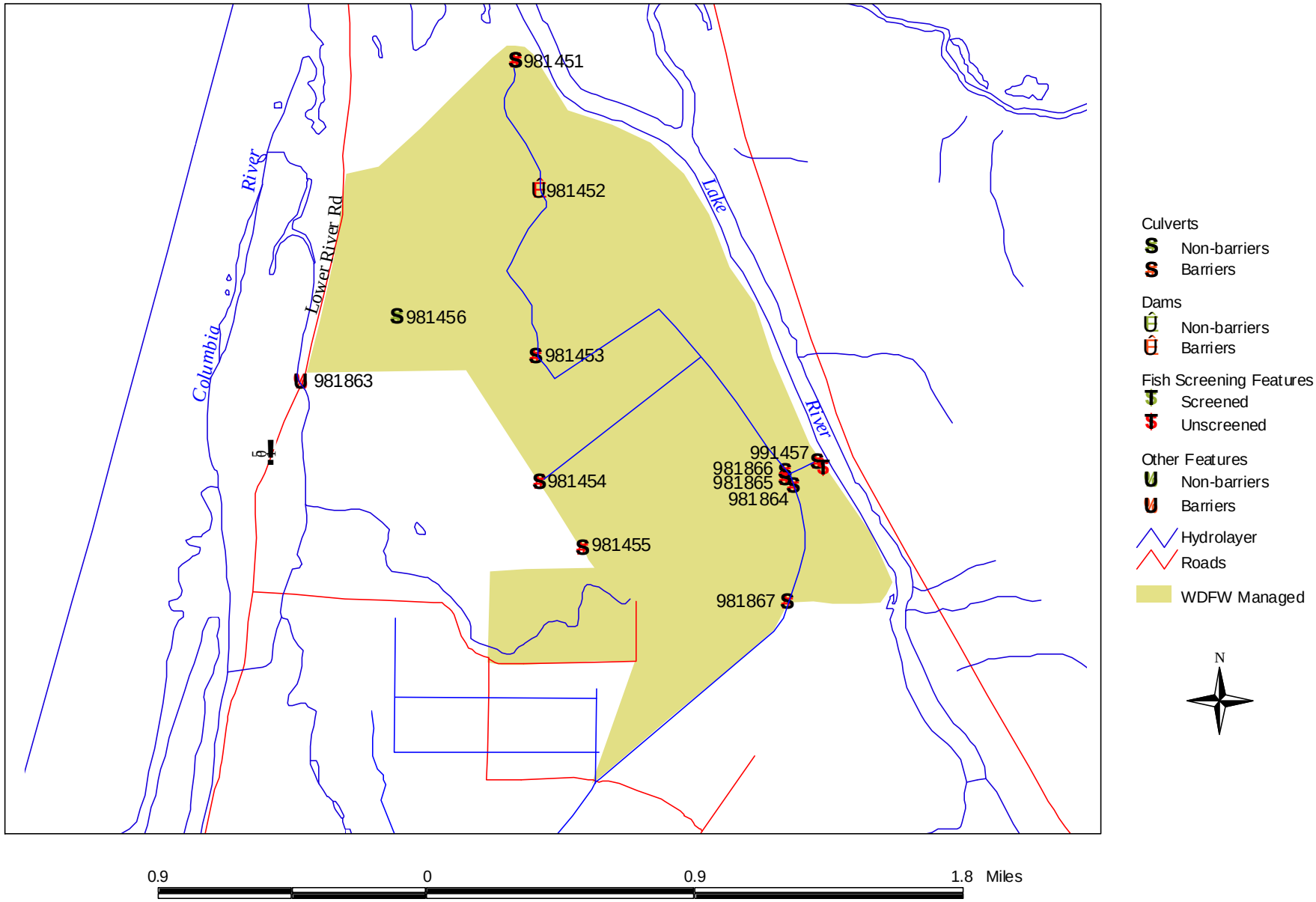

Figure 3. Shillapoo Wildlife Area, North Unit

When the pump is inactive during the fall and winter, the accumulation of surface runoff reportedly reaches four to five feet. As a result, the culvert at this site becomes inundated and a physical connection between Lake River and Shillapoo Lake exists. Fish passage and fish safety issues will need to be considered at this site.

Due to denied access the Columbia River connection channel was not surveyed outside the wildlife area.

South Unit:

Fish bearing feature sites identified during the inventory of this unit include: 981458, 981459, 981861, 981862, 981853, 981854, 981855 and 981856 (figure 4). Sites 981861 and 981862 are culverts located within the Shillapoo Lake basin and are included in the North Unit discussion. Additional features on private property and within the lake basin drainage were not inventoried due to denied access. Site 981458 is an adequately screened pump diversion.

The Buckmire and Matthews slough habitat on this unit is behind the State Route 501 levee and two tide-gated culverts and is essentially cut off from tidal and flood interactions. Although the current condition of this habitat is poor, physical characteristics and the drainage connection to Lake River indicate salmonid fish use would occur if access were restored.

Access and rearing opportunities of lower Buckmire Slough occur during the higher flows and increased tidal influence that typically occur during late fall, winter and spring (November through May). During the summer the lower portion of Buckmire Slough typically dries up and creates unfavorable habitat conditions for salmonids. Warm stagnant water, predation and disease occur on the SWA during this period. This limits potential salmonid fish use to winter rearing only.

Matthews Slough and Buckmire Slough are connected via a connection channel. This connection channel appears to be human-made. Barrier site 981459 was identified at an abandoned road that crosses this channel (figure 4). Treated as an "other" feature, this structure is a large 1.14 meter span by 1.02 meter rise concrete box culvert with a water control structure (figures 20 and 21). Placing dam boards in the water control structure to hold back the water creates an outfall barrier. During both site visits the water control structure was not is use and fish passage was possible.

During the downstream survey for site 981459, four culvert sites were identified outside the SWA (figure 4). Sites 981853 and 981854 each have a barrier tide gate (figure 22 &23, respectively). Site 981855 has two culverts, which become inundated during high tide. The larger mid-channel pipe (0.76 meters round corrugated steel, figure 24) is rusted out and both protruding ends have collapsed. The condition of this pipe can be attributed to the fact that it receives the majority of the cross flow during the out-going tide, which creates a velocity problem. This culvert also has a 1.16% slope and is velocity barrier.

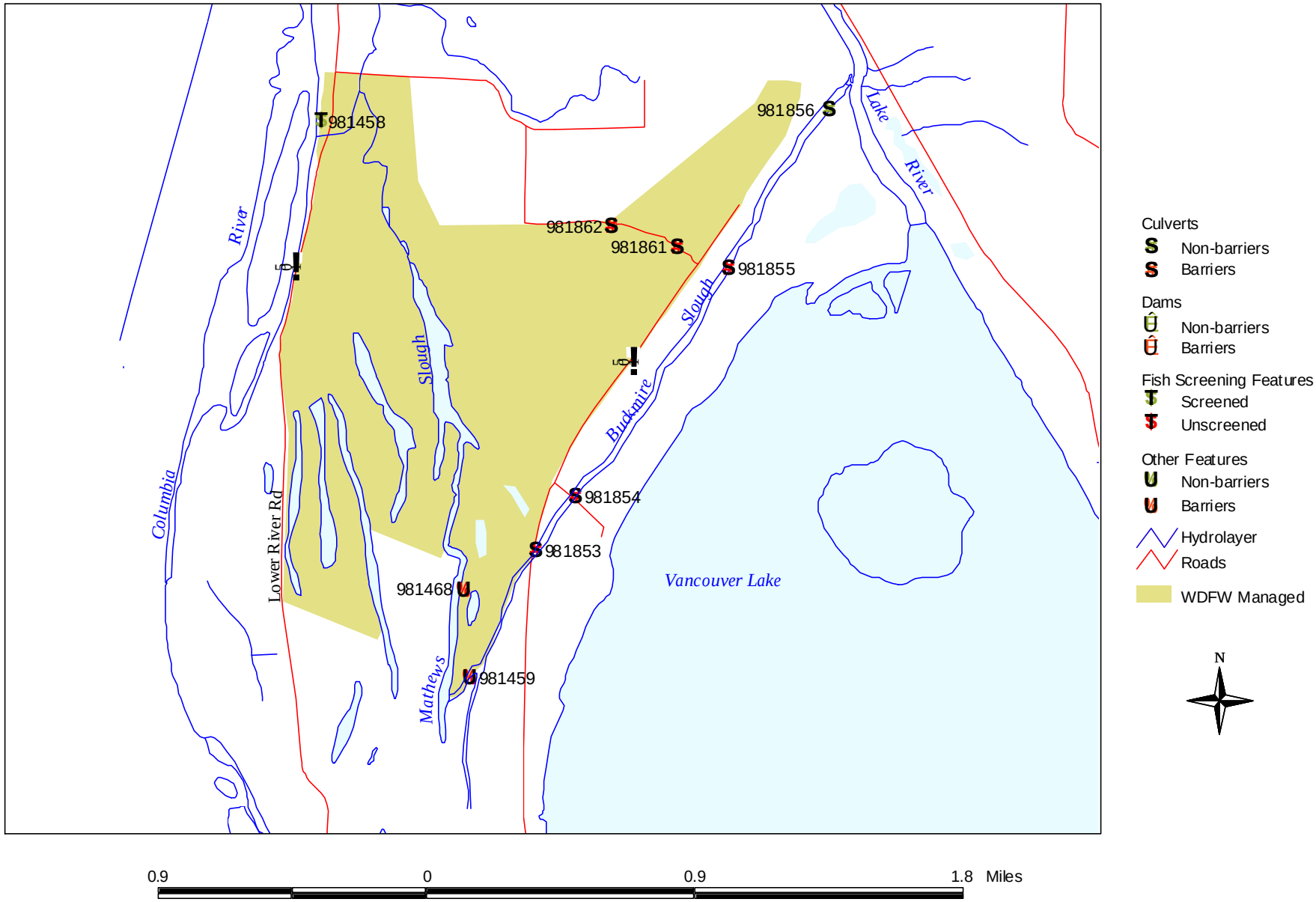

Figure 4. Shillapoo Wildlife Area, South Unit

The second pipe (0.55 meter round smooth steel, figure 25), located near the right bank, becomes dry and impassible during the lower tidal stages.

The last downstream feature identified on Buckmire Slough is non-barrier culvert site 981856. The overall quality of the slough habitat downstream of 981459 continually improved with increased proximity to Lake River and increased tidal exchange.

During the upstream physical survey for barrier site 981459, site 981468 was identified approximately 780 meters upstream on the left bank (figure 4). This feature exists because, prior to WDFW ownership, a channel connecting Matthews slough and a lowland depression was dug creating a seasonal pond. Currently, the installation of a water control structure and levee (site 981468) help to manage the off channel pond habitat, but results in a fish passage barrier. Dry during the survey, the pond area is heavily vegetated and relatively shallow during inundation. The potential habitat gain amounts to 27,115 square meters and fish use is unknown at this time.

The overall amount of winter rearing habitat upstream of the barriers on the SWA South Unit is approximately 117,397.50 square meters. This habitat figure includes a 33% reduction due to the lack of instream and canopy cover and can only be realized if the non-WDFW barriers downstream are corrected. Determining the quantity of winter rearing habitat upstream of the barrier features was measured using aerial photos and digital mapping software.

Vancouver Unit:

A wetland enhancement project entailing three ponds, eight levees (five with water control structures) and an additional water supply is currently being developed on this unit. Only the water supply is yet to be constructed. The main purpose of this project is to enhance the native plant community by controlling the hydrology to eradicate the non-native Reed Canary grass. Controlling the hydrology entails placing dam boards (a.k.a. stop logs) in the water control structure (WCS) to impound water. As a result, the WCS becomes an outfall barrier.

The five levees with water control structures are fish bearing (sites 981469, 981470, 981471, and 981472) and create passage barriers. An additional fish passage barrier, site 981857, was identified outside the SWA during a physical survey. The locations of these sites are shown on map figure 5.

On the southwest portion of the Vancouver unit, the tidal influence of Mulligan Slough (Vancouver Lake) during winter and spring high flows creates a physical connection to sites 981469, 981470, 981471 and 981472. The access points for immigration (fish movement) into the project area are at sites 981470 (figures 26 and 27) and 981471 (figure 28). The location of sites 981469 and 981472 (figures 29 and 30, respectively) are at or near the upper extent of natural inundation. Because regular inundation doesn't extend far enough beyond these sites to meet the 200 meter habitat gain threshold, repairing these site for fish passage isn't required at this time. If and when wetland enhancement (augmented inundation from the additional water supply) takes place, these limited gain sites should be evaluated again.

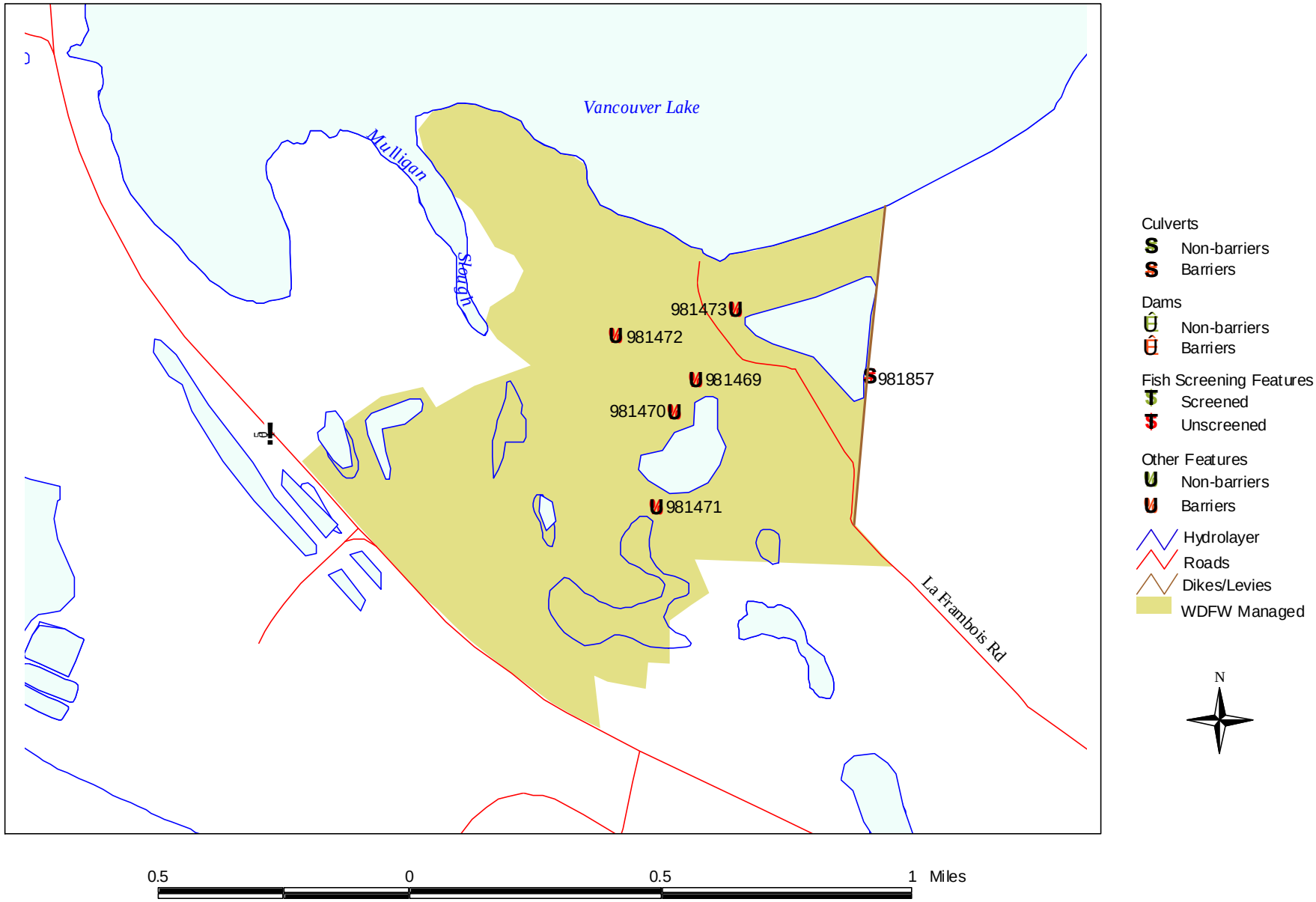

Figure 5. Shillapoo Wildlife Area, Vancouver Lake Unit

Correcting sites 981470 and 981471 would allow fish access to approximately 62,000 square meters (15.32 acres) of winter rearing habitat. This amount of habitat gain reflects the current conditions. If controlled inundation and unimpeded fish passage (at all four sites) can be managed, the amount of available habitat would be approximately 263,043.60 square meters (65 acres).

On the northeast portion of the unit, site 981473 is approximately 125 meters inland from the low water shoreline of Vancouver Lake, but well within the extent of tidal influence (figure 5). During the evaluation of this barrier site the water control structure was completely clogged by beaver activity (figures 31 and 32) and a 15 meter section of the overflow levee was breeched. Upstream of both locations, unidentified juvenile fish were observed.

While conducting the upstream physical survey, site 981857, which is a culvert fitted with a tide gate, was identified as a partial barrier. The location of this site is on the seven to eight meter high dike that runs north to south and constitutes the eastern property boundary of the unit. Owned by Vancouver/Clark County Parks, the dike eroded in two locations, 70 and 110 meters south of site 981857, during the 1996 flood. Although tidewater can pass freely through the dike, the breeches become dry during lower flows creating a partial barrier.

Winter rearing habitat totaling 204,159 square meters would be gained if the barrier features mentioned above become resolved.

Figure 6. Site 981451, Shillapoo Lake to Lake River. This barrier culvert is fitted with a tide gate and has a 2.64% slope. Photo shows inundation from Lake River at high tide.

Figure 7. Site 981451 continued. Taken at low tide, this photo shows the sedimentation of the tide gate.

Figure 8. Site 981452, Shillapoo Lake to Lake River. Upstream view of dam spillway. Plywood is used to block inlet and a small standpipe is used to maintain the level of standing rainwater.

Figure 9. Site 981452 continued. Downstream view of spillway. This site is a total barrier.

Figure 10. Site 981453, Shillapoo Lake to Lake River. This undersized culvert creates a velocity barrier. The culvert is rusted out and the upper section of the pipe is disconnected.

Figure 11. Site 981454, Shillapoo Lake to Lake River. Located in a drain canal, this culvert has a 2.39% slope and is a partial barrier.

Figure 12. Site 981864, Shillapoo Lake to Lake River. Looking at the upstream end, this metal culvert is rusted out, undersized and a partial barrier due to velocity. The larger concrete round may have been dumped there.

Figure 13. Site 981865, Shillapoo Lake to Lake River. This culvert has a 2.67% slope and is a total barrier.

Shillapoo Wildlife Area / North Unit / Barrier Features

Figure 14. Site 981865 continued. View of culvert inlet, which has been boarded off.

Figure 15. Site 981866, Shillapoo Lake to Lake River. This undersized (0.80 meter round metal) culvert has a larger concrete round placed at the outlet and is a partial barrier due to velocity. Scoured fill was observed at the upstream side and on top of the crossing.

Figure 16. Site 981457, Shillapoo Lake to Lake River. View of 'expulsion' pump and sump area. The pump is unscreened and there is wire fencing being used as a trash rack.

Figure 17. Site 981457 continued. Upstream view of tide-gated discharge pipe. Flow and fish access through this pipe is unknown. This location is a human made outlet for Shillapoo Lake.

Figure 18. Site 981861, Shillapoo Lake to Lake River. Located on a ditch that is fed by a natural spring, this undersized culvert is a partial barrier due to velocity.

Figure 19. Site 981862, Shillapoo Lake to Lake River. This undersized culvert is a partial barrier due to velocity. The upstream end of the pipe was partially clogged when surveyed. Grazing livestock have also created water quality issues.

Figure 20. Site 981459, Buckmire Slough (28.0136) to Lake River. Downstream view of site. Evidence of a pre-existing tide gate was observed. The crushed rock and water control structure were recently added to this site.

Figure 21. Site 981459 continued. View of water control structure upstream With no dam boards installed and a water depth of 0.51 meter, the culvert is passable under these conditions. When water is held back, a barrier outfall drop is created.

Figure 22. Site 981853, Buckmire Slough (28.0136) to Lake River. Under State Route 501, this crossing is a barrier culvert due to the tide gate. The flap style tide gate is currently propped open with LWD.

Figure 23. Site 981854, Buckmire Slough (28.0136) to Lake River. This site is a barrier culvert due to the tide gate. The hinges on the tide gate are rusted, but appear operable.

Figure 24. Site 981855, Buckmire Slough (28.0136) to Lake River. Downstream view of the mid-channel culvert at this crossing. With a slope of 1.16% and receiving the majority of the flow, this undersized culvert is a partial barrier. The sides and bottom of the culvert are rusted out. Both ends of pipe are collapsed as well.

Figure 25. Site 981855 continued. Downstream view of smaller sequencer pipe near the right bank. No flow was observed during the out-going tide. While both pipes become inundated during high tide, this smaller pipe is set at a higher elevation and becomes dry during low tides.

Figure 26. Site 981471, Mulligan Slough to Vancouver Lake. View of the inlet and water control structure. Placement of dam boards to impound water creates an outfall barrier. This site is the principal location of tidal influence.

Figure 27. Site 981471 continued. View looking downstream.

Figure 28. Site 981470, Mulligan Slough to Vancouver Lake. Set a foot higher than 981471, this site has a barrier water control structure too. This site is also a location where Mulligan Slough inundates the flood plain regularly.

Figure 29. Site 981469, Unnamed to Mulligan Slough. View of inlet and barrier water control structure.

Figure 30. Site 981472, Unnamed to Mulligan Slough. View of inlet and barrier water control structure.

Figure 31. Site 981473, Vancouver Lake to Lake River. Beaver routinely plug this structure. The overflow levee associated with this site has a 15m wide breech that also impedes fish passage.

Figure 32. Site 981473 continued. Downstream view of site shows daily inundation from the tidally influenced Vancouver Lake.

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APPENDIX A

Features evaluated during the Fish Passage and Water Diversion Inventories of both the Shillapoo and Mt. St. Helens Wildlife Areas. List sorted by Site ID. Latitude / Longitude are in decimal degrees (WGS84).

Appendix 1. A comprehensive list of all features evaluated during the Shillapoo and Mt. St. Helens Wildlife Area Fish Passage Barrier and Surface Water Diversion Inventories. Features are listed by Wildlife Area Units, tributaries, and streams.

Site ID	LAT	LONG	Stream	Tributary	WRIA	Fish Use	Feature Type	Owner Type	Barrier	% Fish Pass	Repair Status	Screened/ Compliant
North Unit												
981451	45.728152999	-122.74479619	Shillapoo Lk	Lake R	28.0132	yes	culvert	private	yes	0	RR	
981452	45.723118300	-122.74330969	Shillapoo Lk	Lake R	28.0132	yes	dam	state	yes	0	RR	
981453	45.716637900	-122.74325179	Shillapoo Lk	Lake R	28.0132	yes	culvert	state	yes	67	RR	
981454	45.711703700	-122.74286060	Shillapoo Lk	Lake R	28.0132	yes	culvert	state	yes	67	UD	
981455	45.709209299	-122.74033880	Shillapoo Lk	Lake R	28.0132	yes	culvert	state	yes	67	UD	
981456	45.7180548	-122.7510453	Shillapoo Lk	Lake R	28.0132	unknown	culvert	state	no	100	OK	
981457	45.712530100	-122.7282522	Shillapoo Lk	Lake R	28.0132	yes	culvert/pump	private	yes	33	RR	no
981864	45.711884	-122.7287305	Shillapoo Lk	Lake R	28.0132	yes	culvert	state	yes	67	UD	
981865	45.7121117	-122.7291637	Shillapoo Lk	Lake R	28.0132	yes	culvert	state	yes	0	UD	
981866	45.712420100	-122.7292119	Shillapoo Lk	Lake R	28.0132	yes	culvert	state	yes	67	UD	
981867	45.707342500	-122.7288261	Shillapoo Lk	Lake R	28.0132	yes	culvert	state	yes	67	UD	
South Unit												
981463	45.693248799	-122.75542489	Hart Lk	Bass Lk	28	no	other	state				
981462	45.695833499	-122.75831850	Unnamed	Bass Lk	28	no	other	state				
981466	45.694596699	-122.76139129	Unnamed	Columbia R	28	no	other	state				
981467	45.694727499	-122.76177189	Unnamed	Columbia R	28	no	culvert	state				
981459	45.677835799	-122.74816599	Buckmire Sl	Lake R	28.0136	yes	other	state	yes	67	RR	
981861	45.6990713	-122.7346726	Shillapoo Lk	Lake R	28.0132	yes	culvert	state	yes	67	UD	
981862	45.7000545	-122.7392647	Shillapoo Lk	Lake R	28.0132	yes	culvert	state	yes	67	UD	
981458	45.704642499	-122.75958780	Columbia R	Matthews Sl	28.0001	yes	pump	state				yes
981460	45.702510099	-122.75622690	Unnamed	Matthews Sl	28	no	other	state				
981461	45.701339400	-122.75495499	Unnamed	Matthews Sl	28	no	other	state				
981468	45.682110100	-122.74878300	Unnamed	Matthews Sl	28.0137	unknown	other	state	yes	0	RR	
981464	45.690874000	-122.75610749	Unnamed	Pencil Lk	28	no	other	state				
981474	45.689030799	-122.75227040	Bass Lk	Unnamed	28	no	culvert	state				
981465	45.694116399	-122.75954029	Unnamed	Unnamed	28	no	other	state				
Vancouver Lake Unit												
981858	45.6557373	-122.7159027	Mulligan Sl	Vancouver Lk	28	no	other	state				

981859	45.658152800	-123	Unnamed	Vancouver Lk	28	no	culvert	state				
981868	45.6636446	-122.7183357	Unnamed	Mulligan Sl	28	no	other	state				
981473	45.662498900	-122.71557559	Vancouver Lk	Lake R	28.0020	yes	other	state	yes	0	RR	
981469	45.660437299	-122.71715450	Unnamed	Mulligan Sl	28	yes	other	state	yes	0	LHG	
981472	45.661623300	-122.72049289	Unnamed	Mulligan Sl	28	yes	other	state	yes	0	LHG	
981852	45.6611154	-122.718491	Unnamed	Mulligan Sl	28	no	other	state				
981470	45.659506499	-122.71794239	Mulligan Sl	Vancouver Lk	28	yes	other	state	yes	0	RR	
981471	45.656723700	-122.71859800	Mulligan Sl	Vancouver Lk	28	yes	other	state	yes	0	RR	
981860	45.6608316	-122.7132926	Unnamed	Vancouver Lk	28	no	culvert	state				
Mt. St. Helens												
981482	46.307691499	-122.42878229	Unnamed	Bear Cr	26	no	culvert	state				
981483	46.307185400	-122.42740969	Unnamed	Bear Cr	26	no	culvert	state				
981485	46.304456899	-122.41922399	Unnamed	Bear Cr	26	no	culvert	state				
981489	46.301912600	-122.40867129	Unnamed	Bear Cr	26	no	culvert	state				
981494	46.300551699	-122.39186990	Unnamed	Bear Cr	26	no	culvert	state				
981481	46.315441900	-122.45240959	Unnamed	NF Toutle R	26	no	culvert	state				
981486	46.304027900	-122.41735660	Unnamed	NF Toutle R	26	no	culvert	state				
981484	46.305267800	-122.42137619	Unnamed	SF Toutle R	26	no	culvert	state				
981487	46.303081099	-122.41408450	Unnamed	Unnamed	26	no	culvert	state				
981488	46.302639100	-122.41225269	Unnamed	Unnamed	26	no	culvert	state				
981490	46.302174700	-122.40306689	Unnamed	Unnamed	26	no	culvert	state				
981491	46.302142299	-122.40176230	Unnamed	Unnamed	26	no	culvert	state				
981492	46.302047199	-122.39944130	Unnamed	Unnamed	26	no	culvert	state				
981493	46.301244799	-122.39506769	Unnamed	Unnamed	26	no	culvert	state				
981495	46.299538699	-122.39000110	Unnamed	Unnamed	26	no	culvert	state				
Outside of Wildlife Area Boundary												
981853	45.6841292	-122.7438767	Buckmire Sl	Lake R	28.0136	yes	culvert	state	yes	67	RR	
981854	45.6867918	-122.7412289	Buckmire Sl	Lake R	26.0136	yes	culvert	county	yes	0	RR	
981855	45.698110400	-122.7310674	Buckmire Sl	Lake R	28.0136	yes	culvert	county	yes	67	RR	
981856	45.7060388	-122.7246124	Buckmire Sl	Lake R	28.0136	yes	culvert	unknown	no	100	OK	
981857	45.660675	-122.7100174	Vancouver Lk	Lake R	28.0020	yes	culvert	county	yes	67	RR	

Repair Status Codes: RR - repair required ; UD - repair status undetermined ; LHG - limited habitat gain ; OK - repair not required