

Lake Terrell and Tennant Lake Wildlife Area Fish Passage and Diversion Screening Prioritization Inventory

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Lake Terrell



Tennant Lake



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INTRODUCTION

The Washington 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 or inadequately screened 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. However, 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

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.

This report summarizes the results of the Lake Terrell and Tennant Lake Wildlife Area inventory with preliminary plans and recommendations to correct the problems identified.

SITE DESCRIPTIONS

Lake Terrell and Tennant Lake Wildlife Area

The Lake Terrell and Tennant Lake Wildlife Area is comprised of two main units: Lake Terrell and Tennant Lake, which cover approximately 4,650 acres (See Figure 1). Both units are located in Whatcom County, Washington northwest of Bellingham (WDFW 1998). Other smaller units include: Pine and Cedar Lakes, Lummi Island, Dick, Norderum, Haywood, Swanson, Johnson and Point Roberts.

Lake Terrell Unit

The Lake Terrell unit is located ten miles northwest of the city of Bellingham in gently rolling farmland and rural residential area. Four dairy farms, purchased in the 1940s using Federal Aid in Wildlife Restoration funds, became the 1,500 acre Lake Terrell Unit. The farms were acquired for waterfowl habitat restoration and preservation and to provide recreational opportunities (WDFW 1998).

Located in the Pacific Flyway, Lake Terrell is the first food source for waterfowl on migration from the Fraser River Delta in British Columbia each fall. With the growth and development of the Puget Sound region, Lake Terrell Wildlife Area provides critical feeding habitat for wintering and migratory waterfowl. Besides waterfowl, the 500-acre lake provides habitat for spiny-ray fish, rainbow and cutthroat trout. The surrounding habitat types include emergent and submergent wetlands, grasslands and upland deciduous/coniferous mixed forest (WDFW 1998).

Two major landowners, The ARCO Products Company, (a division of Atlantic Richfield Company) and INTALCO (Intalco Aluminum Corporation) have agreements with the Wildlife Area to co-manage portions of their land as wildlife habitat and allow limited public access. Co-management of the ARCO Products Company satellite area is continued under the new owners, BP (British Petroleum). These satellite areas are considered part of this unit and are located in the general area of Lake Terrell (WDFW 1998). Much of Terrell Creek flows through BP property providing a stable habitat with minimal human alterations.

Prioritized Management Zones for the Lake Terrell Unit include: bald eagle, common loon, warm water fish, pileated woodpecker, dabbling duck, eastern cottontail rabbit, riparian and emergent wetland habitats (WDFW 1998). The fish passage features located during the inventory conducted in March and April, 2003 are described in the Terrell Creek section beginning on page 9.

Tennant Lake Unit

The 720-acre Tennant Lake Unit was acquired in 1974 with Interagency Committee for Outdoor Recreation (IAC) funds in a cooperative agreement with Whatcom County Parks. Located adjacent to Hovander County Park, the Tennant Lake unit features an interpretive center, observation tower, upland interpretive trail and an elevated wetland boardwalk. Opportunities also exist for spiny-ray fishing and waterfowl and deer hunting.

Figure 1. Lake Terrell and Tennant Lake Wildlife Area with Surrounding Satellite Units.

Habitat types on the unit consist of wetlands, riparian shrub, mixed deciduous and coniferous forests and about 100 acres of agricultural land farmed for wildlife. Most of the area is in the Nooksack River floodplain and some of the lower portions flood annually. Tennant Lake is an 80-acre shallow peat bog. Also within the unit is Claypit Pond, developed as a result of the removal of clay used for brick and glass manufacturing prior to department ownership (WDFW 1998).

Prioritized Management Zones for the Tennant Lake Unit include: bald eagle, salmon, warm water fish, pileated woodpecker, dabbling duck, eastern cottontail rabbit, riparian and emergent wetland habitats (WDFW 1998). The features located during the inventory conducted in February and March, 2003 are described in the Tennant Creek section beginning on page 21.

Pine and Cedar Lakes, Lummi Island, Dick, Norderum, Haywood, Swanson, Johnson and Point Roberts Units

All of these units are located in western Whatcom County. No features were found on any of these units inventoried between February and May 2003.

METHODS

Inventory/ Feature Evaluation

The inventory encompassed all units of the Lake Terrell and Tennant Lake Wildlife Area and additional lands associated with the stream habitat surveys. The Wildlife Area (WLA) manager provided assistance with the location of the various units, private lands co-managed by the WLA and known fish passage features within the WLA.

A road inventory was conducted by driving or walking all roads along known and possibly fish bearing streams within the WLA. All culverts found in potentially fish bearing waters were assigned a Site ID number and their geographical locations were recorded using 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).

The potential for fish presence is determined based on stream size, gradient, fish observation and flow duration. Streams that are greater than 0.61 meters (2 feet) wide measured at the ordinary high water mark, are less than 20 percent gradient and maintain three continuous months of flow or streams in which fish are observed are considered fish bearing. Each potentially fish-bearing stream 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 (culvert, dams, fishways) or fish safety (water diversions).

Expected fish species utilization not only includes those species currently inhabiting the stream, but also those that potentially could or have been known to use the stream. Expected fish species utilization is determined by direct observation and by using resources such as the Washington State Salmon and Steelhead Stock Inventory (WDFW *et. al.* 1992), Washington State Salmonid Stock Inventory Bull Trout/Dolly Varden Appendix (WDFW 1998), Streamnet, and by personal communication with WDFW regional biologists.

Fish Passage Priority Index

The Fish Passage Priority Index (PI) model consolidates variables which affect a project's potential resource 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 volume of diverted flow is used to estimate 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 downstream human-made barriers preventing anadromous access, but may be refined to reflect the feasibility of restoring anadromous access or habitat. Production values predicted for 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.

INVENTORY RESULTS

Within the Wildlife Area boundaries, five features were evaluated as fish passage barriers on potentially fish bearing streams (Table 1). All five features within the Wildlife Area requiring repair are dams.

On property owned by British Petroleum (BP) or Intalco Aluminum and co-managed with the WLA, there are 13 dams and one culvert that are fish passage barriers and one inadequately screened pump diversion.

Table 1. Number of fish passage and water diversion features requiring repair within the Lake Terrell and Tennant Lake Wildlife Area listed by unit.

Wildlife Area Units	Number of Features Requiring Repair			Unit Totals
	Culverts	Dams	Diversions	
Lake Terrell	0	3	0	3
Tennant Lake	0	2	0	2
Managed by WLA ¹	1	13	1	15
Dick	0	0	0	0
Pine & Cedar Lakes	0	0	0	0
Lummi Island	0	0	0	0
Norderum	0	0	0	0
Haywood	0	0	0	0
Swanson	0	0	0	0
Johnson	0	0	0	0
Point Roberts	0	0	0	0
Feature Totals	1	18	1	20

¹ Land is owned by British Petroleum or Intalco Aluminum but co-managed by WDFW.

Table 2 lists all sites on fish bearing waters owned or managed by WDFW. This list is sorted by owner, unit and repair status. Table 3 is a prioritized list of all fish passage barriers requiring repair and Table 4 lists the unscreened or inadequately screened water diversions requiring repair on land owned and/or managed by WDFW.

Fish passage barriers with limited habitat gain (LHG) are lower priority and will be considered for correction after the higher priority barriers are fixed. A complete list of all sites inventoried during the Lake Terrell and Tennant Lake Wildlife Area inventory, including sites outside the Wildlife Area, is in Appendix A. Detailed descriptions of each stream surveyed start on page 9.

Table 2. Features located on fish bearing streams within the Lake Terrell and Tennant Lake Wildlife Area or on BP and Intalco land co-managed by WDFW. The codes in the Repair Status column indicate the feature status where RR = Repair Required, OK = feature is not a barrier or safety issue, no repair required, LHG = Limited Habitat Gain and UD = repair status is undetermined.

Site ID	Stream	wria	Feature Type	Repair Status	Unit	Owner Type
01.0089 8.70	Terrell Creek	01.0089	dam	RR	Lk Terrell	Wildlife Area
981798	Unnamed tributary to Terrell Cr.	01.0000	dam	RR	Lk Terrell	Wildlife Area
981779	Unnamed tributary to Terrell Cr.	01.0000	dam	RR	Lk Terrell	Wildlife Area
981777	Unnamed tributary to Terrell Cr.	01.0000	culvert	OK	Lk Terrell	Wildlife Area
981778	Unnamed tributary to Terrell Cr.	01.0000	culvert	OK	Lk Terrell	Wildlife Area
981786	Unnamed tributary to Terrell Cr.	01.0000	dam	RR	Lk Terrell	INTALCO
981785	Unnamed tributary to Terrell Cr.	01.0000	dam	RR	Lk Terrell	INTALCO
981780	Unnamed tributary to Terrell Cr.	01.0000	dam	RR	Lk Terrell	INTALCO
981781	Isolated pond	01.0000	dam	LHG	Lk Terrell	INTALCO
981783	Isolated pond	01.0000	dam	LHG	Lk Terrell	INTALCO
981787	Isolated pond	01.0000	dam	LHG	Lk Terrell	INTALCO
981796	Isolated pond	01.0000	dam	LHG	Lk Terrell	INTALCO
981792	Unnamed tributary to Terrell Cr.	01.0000	dam	RR	Lk Terrell	BP
981793	Unnamed tributary to Terrell Cr.	01.0000	dam	RR	Lk Terrell	BP
981794	Unnamed tributary to Terrell Cr.	01.0000	culvert	LHG	Lk Terrell	BP
981821	Unnamed tributary to Terrell Cr.	01.0000	dam	LHG	Lk Terrell	BP
981822	Unnamed tributary to Terrell Cr.	01.0000	pump div.	RR	Lk Terrell	BP
981823	Unnamed tributary to Terrell Cr.	01.0000	dam	RR	Lk Terrell	BP
981825	Unnamed tributary to Terrell Cr.	01.0092	dam	RR	Lk Terrell	BP
981832	Unnamed tributary to Terrell Cr.	01.0092	dam	RR	Lk Terrell	BP
981833	Unnamed tributary to Terrell Cr.	01.0092	culvert	OK	Lk Terrell	BP
981834	Unnamed tributary to Terrell Cr.	01.0092	culvert	OK	Lk Terrell	BP
981835	Unnamed tributary to Terrell Cr.	01.0092	culvert	OK	Lk Terrell	BP
981815	Unnamed tributary to Terrell Cr.	01.0093	dam	OK	Lk Terrell	BP
981812	Tennant Creek	01.0131	culvert	OK	Tennant	Wildlife Area
981813	Tennant Creek	01.0131	culvert	OK	Tennant	Wildlife Area
981814	Claypit Pond	01.0000	dam	RR	Tennant	Wildlife Area
981811	Unnamed tributary to Tennant Cr.	01.0000	dam	RR	Tennant	Wildlife Area

Table 3. Fish passage barriers requiring repair within the WLA or on land managed by WDFW sorted by PI (Priority Index) value.

Site ID	Stream	Tributary to	Expected Species Utilization ¹	Feature Type	% Pass-able	Additional Barriers		Habitat Gain			Priority Index (PI)
						Up-stream	Down-stream	Survey Length (m)	Spawning (m ²)	Rearing (m ²)	
Lake Terrell Unit											
01.0089 8.70	Terrell Creek	Birch Bay	CH/CO/SH/SCT/RT	dam	0	10	4	8,335	2,101	70,596	43.97
981825	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	dam	0	5	0	2,528	355	18,203	30.61
981798	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	dam	0	4	5	1,985	0	16,841	23.65
981786	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	dam	0	2	7	1,141	0	12,396	21.91
981785	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	dam	0	1	8	505	0	6,081	18.33
981792	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	dam	0	2	5	767	0	4,084	16.60
981832	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	dam	0	0	5	664	0	3,370	15.82
981779	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	dam	0	0	5	269	0	3,364	15.82
981780	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	dam	0	0	9	262	0	2,893	15.23
981793	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	dam	0	1	1	574	0	2,613	14.85
981794	Unnamed	Terrell Creek	CH/CO/SH/SCT/RT	culvert	33	0	2	179	0	176	6.85
981821	Unnamed	Terrell Creek	RT	dam	0	0	0	104	0	5,368	4.56
981823	Unnamed	Terrell Creek	RT	dam	0	0	0	102	0	2,392	4.12
981796	Isolated Pond		RT	dam	0	0	0	60	0	1,407	3.61
981781	Isolated Pond		RT	dam	0	0	0	35	0	1,219	3.48
981787	Isolated Pond		RT	dam	0	0	0	41	0	1,126	3.41
981783	Isolated Pond		RT	dam	0	0	0	42	0	788	3.12
Tennant Lake Unit											
981811	Tennant Creek	Silver Creek	CO/SH/SCT/RT	dam	67	0	0	849	0	14,677	17.32
981814	Claypit Pond	Tennant Creek	CO/SH/SCT/RT	dam	67	0	0	475	0	9,033	15.33

¹ Species Codes:

CH - Chum, CO - Coho, SH - Steelhead, SCT – Sea run cutthroat, RT - Resident trout.

Table 4. Inadequately screened water diversions requiring repair within the WLA or on land managed by WDFW.

Site ID	Stream	Tributary to	Ownership Type	Diversion Type	Associated Dam	Flow (gpm)	Screening Priority Index
Lake Terrell Unit							
981822	Unnamed	Terrell Cr	BP	Pump Diversion	No	UD ¹	

¹ Flow and SPI could not be determined as there was no pump attached at the time the feature was evaluated.

The following descriptions detail the fish passage barriers, water diversions and physical habitat of each stream surveyed. Refer to tables 2, 3 and 4 for feature, habitat and priority index information and the map figures for site locations.

Lake Terrell Unit

Terrell Creek – WRIA 01.0089 (Map on page 11, Figure 2)

Terrell Creek was surveyed from its mouth at Birch Bay to the end of fish use at river mile (RM) 12.75. Lake Terrell dam, site 01.0089 8.70 (Figures 3 & 4), is the only barrier on Terrell Creek within the WLA. The dam at this site is a total barrier due to outfall drop. With a Priority Index value (PI) of 43.97, this site has the highest PI of any site within the WLA. Potential habitat gain from barrier correction is 70,596 square meters of rearing and 2,101 square meters of spawning habitat (8.34 kilometers of stream including tributaries). Four downstream barriers and ten upstream barriers would need to be repaired in order to realize the potential habitat gain.

The following table summarizes the features evaluated during the Terrell Creek physical survey. The features are in order from the outlet into Birch Bay, upstream to the headwaters. Tributaries A and B enter the southern end of Lake Terrell.

Table 5. Features evaluated during the Terrell Creek physical survey. The codes in the Repair Status column indicate the feature status where RR = Repair Required, OK = feature is not a barrier or safety issue, no repair required, LHG = Limited Habitat Gain and UD = undetermined, PI = Priority Index and RM = river mile.

Site #	Location	Owner	Feature Type	Repair Status	PI	RM
Terrell Creek, WRIA 01.0089						
981788	SR 548/Blaine Rd	WSDOT	Culvert	RR	51.38	5.02
981789	Kickerville Rd	What. Co.	Culvert	RR	43.52	6.69
01.0089 0.0	Just E of Kickerville Rd	Private	Dam	RR	40.28	6.71
990429	SR 548/Grandview Rd	WSDOT	Culvert	RR	45.29	7.49
981808	N of Brown Rd	Private	Culvert	OK		8.41
981791	Brown Rd	What. Co.	Culvert	OK		8.48
981790	Aldergrove Rd	What. Co.	Culvert	OK		9.18
01.0089 8.7	Lake Terrell dam	WDFW	Dam	RR	43.97	9.37
981809	North Star Rd	What. Co.	Culvert	RR	7.45	10.73
981816	E of North Star Rd	Private	Culvert	OK		10.82
981817	S of Aldergrove Rd	Private	Culvert	OK		11.29
981818	Farm Rd	Private	Culvert	RR	8.24	12.11
981819	W of Olson Rd	Private	Culvert	RR	8.24	12.48
981820	Olson Rd	What. Co.	Culvert	RR	7.45	12.52
Unnamed Tributary (A), WRIA 01.0000						
981798	S of Lake Terrell	Intalco	Dam	RR	23.65	0.28
981797	Mt View Rd	What. Co.	Culvert	RR	16.68	0.63
981786	S of Lake Terrell	Intalco	Dam	RR	21.91	0.80
981785	S of Lake Terrell	Intalco	Dam	RR	18.33	1.20
981780	S of Lake Terrell	Intalco	Dam	RR	15.23	1.35
Isolated ponds on Intalco property near tributary A.						
981781	S of Lake Terrell	Intalco	Dam	LHG	3.48	
981782	S of Lake Terrell	Intalco	Culvert	NFB		

Site #	Location	Owner	Feature Type	Repair Status	PI	RM
981783	S of Lake Terrell	Intalco	Dam	LHG	3.12	
981784	S of Lake Terrell	Intalco	Culvert	NFB		
981787	S of Lake Terrell	Intalco	Dam	LHG	3.41	
981796	S of Lake Terrell	Intalco	Dam	LHG	3.61	
Unnamed Tributary (B), WRIA 01.0000						
981777	S of Lake Terrell	WDFW	Culvert	OK		0
981778	S of Lake Terrell	WDFW	Culvert	OK		0
981779	S of Lake Terrell	WDFW	Dam	RR	15.82	0.12

Three other Terrell Creek tributaries that are on BP owned land (co-managed by WDFW) are also managed as waterfowl habitat. Ponds were created for waterfowl by damming the streams. These tributaries enter Terrell Creek downstream of Lake Terrell near Jackson road. The following table summarizes the features evaluated on the tributaries labeled as C, D and E on the map of Terrell Creek and some isolated ponds near tributary C.

Table 6. Features evaluated during the inventory of streams on BP owned land. The codes in the Repair Status column indicate the feature status where RR = Repair Required, OK = feature is not a barrier or safety issue, no repair required, LHG = Limited Habitat Gain and UD = PI is undetermined. PI = Priority Index and RM = river mile.

Site #	Location	Owner	Feature Type	Repair Status	PI	RM
Unnamed Tributary (C), WRIA 01.0000						
981792	NW of Lake Terrell	BP	Dam	RR	16.60	0.00
981793	NW of Lake Terrell	BP	Dam	RR	14.85	0.15
981794	NW of Lake Terrell	BP	Culvert	LHG	6.85	0.36
981821	NW of Lake Terrell	BP	Dam	LHG	5.46	
981822	NW of Lake Terrell	BP	Pump Div.	RR	UD	
981823	NW of Lake Terrell	BP	Dam	RR	4.12	
981831	Grandview Rd.	What. Co.	Culvert	NFB		
Unnamed Tributary (D) WRIA 01.0092						
981825	W of Jackson Rd.	BP	Dam	RR	30.61	0.09
981826	Grandview Rd.	What. Co.	Culvert	RR	21.03	0.33
981827	W of Jackson Rd.	Trillium Corp.	Dam	RR	25.85	0.62
981828	W of Jackson Rd.	Trillium Corp.	Dam	RR	25.16	0.70
981829	Brown Rd.	What. Co.	Culvert	OK		1.00
981830	Jackson Rd.	What. Co.	Culvert	RR	11.98	1.23
981832	E of Jackson Rd.	BP	Dam	RR	15.82	1.25
981833	E of Jackson Rd.	BP	Culvert	OK		1.42
981834	E of Jackson Rd.	BP	Culvert	OK		1.54
981835	E of Jackson Rd.	BP	Culvert	OK		1.66
Unnamed Tributary (E) WRIA 01.0093						
981815	E of Jackson Rd.	BP	Dam	OK		0.00
Other unassociated sites.						
981795	N of Grandview Rd.	BP	Culvert	NFB		

Figure 2. Map of Terrell Creek.

The following photographs, maps and captions describe the barrier sites located on WDFW owned or managed lands.



Figure 3. Site 01.0089 8.70, Lake Terrell Dam, is a total barrier to fish passage. Within the WLA, this is the only barrier on Terrell Creek. This dam blocks access to 8.3 km (5.2 miles) of stream habitat. The PI value for this barrier is 43.97.

Photographs of features on an unnamed tributary (A) to Terrell Creek (see map on page 13).



Figure 4. Site 981798 features an earthen dam with a vertical standpipe. This total barrier to fish passage blocks access to 2.0 km (1.23 miles) of stream containing 0 square meters of spawning habitat and 16,841 square meters of rearing habitat. The PI for this barrier is 23.65.



Figure 5. This photo shows a portion of the pond created by the previous feature, site 981798, and is typical of all the waterfowl ponds created. The photo, taken from site 981797 at Mt View Road, is owned by Whatcom County. It consists of a totally submerged culvert that is a partial barrier due to a 1.16% slope. The PI value for this barrier is 16.68.

Figure 6. Map of tributaries A and B to Terrell Creek and isolated ponds near tributary A.

Photographs of features on an unnamed tributary (A) to Terrell Creek (continued).



Figure 7. Site 981786 features an earthen dam with a headgate on a culvert. This total barrier to fish passage blocks access to 1.14 km (0.71 miles) of stream containing 12,396 square meters of rearing habitat. The PI value for this barrier is 21.91.



Figure 8. Site 981785 consists of an earthen dam with a standpipe. This total barrier to fish passage blocks access to 0.50 km (0.31 miles) of stream containing 6,081 square meters of rearing habitat. The PI value for this barrier is 18.33.



Figure 9. Site 981780, features an earthen dam with a vertical standpipe. This total barrier to fish passage blocks access to 0.26 km (0.16 miles) of stream containing 2,893 square meters of rearing habitat. The PI value for this barrier is 15.23.

Four ponds exist close to this tributary (A) but lack a fish-bearing stream connecting them to the system. They were not included in the habitat gain for tributary A. The PI values include only the upstream pond habitat for each pond. Only resident trout were assumed to utilize these isolated ponds.



Figure 10. Site 981781. An earthen dam with a 0.21 meter overflow culvert creates a small pond. The pond has 1,219 square meters of potential rearing habitat. The PI value for this barrier is 3.48. The tip of the meter rod points to the overflow culvert.



Figure 11. Site 981783. An earthen dam with a 0.21 meter overflow culvert creates a small isolated pond. The pond has 788 square meters of potential rearing habitat. The PI value for this total barrier is 3.12.



Figure 12. Site 981787. An earthen dam with a small (0.21m) overflow culvert creates a small isolated pond. The pond has 1,126 square meters of potential rearing habitat. The PI value for this total barrier is 3.41.



Figure 13. Site 981796. An earthen dam with a spillway. Pond water spills over the top of the earth dam into an overflow channel. Rarely, if ever, is there enough flow for fish to use the channel. The pond has 1,407 square meters of potential rearing habitat. The PI for this total barrier is 3.61.

Photographs of features on an unnamed tributary (B) to Terrell Creek (see map for location).



Figure 14. Site 981779 features an earth dam with a vertical standpipe to control water level. The photo shows a small portion of the earth dam at the bottom left and the pond created by the dam. The dam is a total barrier to fish passage. Fish use of the pond is likely limited to winter rearing due to high water temperature in summer. The pond has 3,364 square meters of potential rearing habitat. The PI value is 15.82.

Photographs of features on an unnamed tributary (C) to Terrell Creek (see map on page 17). This tributary is on land owned by BP and co-managed by WDFW.



Figure 15. Site 981792. This concrete dam is just upstream of the confluence with Terrell Cr. Water spilling over the dam falls 0.90 meters onto a concrete apron. There is 4,084 square meters of potential rearing habitat upstream. This barrier has a PI value of 16.60.



Figure 16. Site 981793. This site has an earthen dam with a concrete spillway and slots for stop boards. The spillway has a 1.54 meter outfall drop. There is 2,613 square meters of potential rearing habitat upstream. The PI value is 14.85.

Figure 17. Map of Tributaries C, D and E.

Photographs of features on an unnamed tributary (C) to Terrell Creek (continued).



Figure 18. Site 981794. The two culverts at this site, a corrugated steel and a concrete pipe are a barrier to fish passage. This limited habitat gain site has only 179m of fish bearing stream upstream of this barrier. At 179 meters upstream, the stream flows through reed canary grass with no defined channel. The PI value is 6.85.



Figure 19. Site 981821 features an earth dam with a vertical standpipe (hidden behind cattails). This pond could provide 5,368 square meters of rearing habitat. The PI value is 4.56.

Sites 981821, 981822 and 981823 are upstream of the previous sites but are inaccessible due to a lack of a defined channel that could be utilized by fish. The flow spreads out and trickles through dense reed canary grass. BP is currently trying to control the reed canary grass. Dams further upstream prevent sufficient flow to maintain a channel. Should a channel be restored, substantial pond habitat exists upstream.



Figure 20. Site 981822 has a screened pump diversion, located in the pond created by site 981821. The screen is not compliant due to the size of the screen openings. This pump diversion supplies water during summer and fall to newly planted trees on the BP mitigation project about 250 meters to the north. No PI value could be generated because the pump was not present at the time of the evaluation.



Figure 21. Site 981823 is an earth dam with a flow control structure in the dam. This pond could provide 2,392 square meters of rearing habitat. The PI value is 4.12.

Photographs of features on an unnamed tributary (D) entering Terrell Creek just west of Jackson Road. Portions of this tributary are on land owned by BP and co-managed by WDFW.



Figure 22. Site 981825 features an earthen dam with a concrete spillway at a 30% slope. This total barrier to fish passage blocks access to 2.5 km (1.57 miles) of stream containing 355 square meters of spawning habitat and 18,203 square meters of rearing habitat. The PI for this barrier is 30.61. This site is on BP land.



Figure 23. Site 981830, on Jackson Road, is a 0.76 m (2.50 ft) culvert. Because the upstream end is inside a high security area of the BP refinery there is a security grate installed. The worm-like mesh bag is a pollution control device. This culvert is a partial barrier due to a 2.26% slope and the PI value is 11.98. This site is owned by Whatcom County.

There are two barrier dams on Trillium Corporation land between sites 981825 and 981830. Site 981827 features an earthen dam with a concrete spillway at a 30% slope similar to site 981825. The outfall drop off the end of the spillway is 1.40 meters. This total barrier to fish passage blocks access to 1.66 km (1.03 miles) of stream containing 132 square meters of spawning habitat and 10,031 square meters of rearing habitat. The PI for this barrier is 25.85. Site 981828 consists of a similar earthen dam with a concrete spillway. The outfall drop off the end of the spillway is 0.85 meters. This total barrier to fish passage blocks access to 1.53 km (0.95 miles) of stream containing 132 square meters of spawning habitat and 8,766 square meters of rearing habitat. The PI for this barrier is 25.16.



Figure 24. Immediately upstream of site 981830 is site 981832, which is a pollution control device consisting of hay bales inside of an expanded wire mesh cage. This feature acts as a dam blocking access to 0.66 km of stream and pond habitat. There is no spawning habitat upstream but there is 3,370 square meters of rearing habitat in beaver ponds and wetlands. The PI for this barrier is 15.82. This site is on BP land.

\$\$\$Figure 25. Map of Tennant Creek. \$\$\$

Tennant Lake Unit

Tennant Creek – WRIA 01.0131 (Map on page 20, Figure 20)

Tennant Creek is a low gradient stream flowing through wooded and open wetlands in the old floodplain east of the Nooksack River. Much of the stream and all of Tennant Lake is within the boundaries of the wildlife area or Hovander County Park. Multiple beaver dams create Tennant Lake and the wetlands to the southeast.

Plans to breach the dike on the east side of the Nooksack River will restore floodplain habitat in the section of land between the Nooksack, Tennant Creek, Slater Road and Marietta Road, providing off channel rearing for Nooksack River juvenile salmon. This may also alleviate flooding problems in Hovander County Park.

Tennant Creek was surveyed from the confluence with Silver Creek to the headwaters. Silver Creek was surveyed from the confluence with Tennant Creek downstream to the Marine Drive, bridge crossing. Four culvert crossings located on Tennant Creek are passable. Sites 981812 and 981813 are downstream of Slater Road, site 981810 is at Slater Road and site 981806 is at Neilsen Road.

Two tributary ponds are located within the wildlife area north of Slater road. The first tributary pond north of Slater road is Claypit Pond, created by a clay mining operation. The dam, site 981814, for Claypit Pond extends along the pond's southern and western boundaries and is a partial barrier to fish passage.



Figure 26. Site 981814 at Claypit Pond. This earthen dam has an overflow channel that empties into Tennant Creek. The photo shows the dam spillway and the direction of the overflow channel. At the outlet of the channel is a culvert that carries some flow but has no apparent function. Claypit pond provides 9,033 square meters of potential rearing habitat. The PI value is 15.33.

The second tributary pond lies to the north between Claypit Pond and Tennant Lake.



Figure 27. Site 981811. This vertical concrete culvert set in an earthen dam has slots for stop boards inside. Submerged corrugated culverts extend into and out of the vertical culvert up and downstream. There is no discernible flow going through the structure. Beaver dams divert flow around this dam making it passable during high flows. This dam partially blocks access to 14,677 square meters of rearing habitat. The PI value is 17.32.

DISCUSSION

Dams constitute the majority of the fish passage problems within the area managed as part of the WLA. These dams were constructed to create waterfowl habitat, and a spiny-ray fishery in Lake Terrell. Installing fishways on these dams would significantly increase the amount of rearing habitat available, particularly winter and spring rearing habitat. The pond habitat may get too warm in summer and fall to support salmonids. If the dams are removed the amount of available stream habitat would be considerably reduced.

Several factors affect the potential benefit of providing salmon access into Lake Terrell.

- ?? Managed as a spiny-ray fishery, juveniles entering Lake Terrell would encounter significant predation and competition from the bass, crappie, bluegill, perch, pumpkinseed and catfish in the lake.
- ?? Water temperatures at the lake outlet measured in July 2002 averaged 20.5 degrees Celsius. At the Jackson Road crossing, 9.8 kilometers downstream, water temperature averaged 17.2 degrees Celsius during the same period (NSEA 2002).
- ?? Salmon runs in Terrell Creek have been extirpated by harvest at the mouth of the stream and supplemental planting of salmonids may be necessary to re-establish runs.
- ?? Terrell Creek no longer flows year round upstream of the dam nor in some sections downstream. Upstream of the dam, beginning at North Star Road, 2.9 kilometers of stream has been dredged and straightened since 1905. This section of stream has extremely little value to salmon due to a lack of cover, spawning gravel, summer flow and channel complexity (pools and riffles). In this same section, a large wetland locally known as Elk Lake was drained leaving no trace of its existence. This likely stored and slowly released water helping to maintain summer flow.

A similar situation occurs downstream of Lake Terrell in the 1.4 kilometers of stream between the dam and Brown Road. This section has been dredged, diked and straightened, lowering the streambed elevation and causing the creek and the adjacent wetlands to drain quickly in the spring, instead of gradually throughout the summer and fall. Much of the channel is now three to four meters deeper than the adjacent wetlands. This precludes the recharging of the wetlands during winter and spring high flows. In places, it appears that the streambed “seal”, the layer of clay that prevents infiltration of water into the ground, has been cut through because of dredging. Elimination of the streambed seal speeds water loss and downcutting of the channel.

Lake Terrell dam likely contributes to the lack of year round flow by holding back water. Natural variation between winter and summer flows occurs in stream systems fed exclusively by winter rains especially when wetland storage has been reduced by dredging.

Land use changes affecting summer flow include conversion of historic old growth forest to ditched and drained farmland. In some portions of Terrell Creek,

landowners regularly remove streamside vegetation and woody debris and prevent beaver activity.

?? While Terrell Creek has some problems, it also runs through large tracts of land owned or co-managed by WDFW, which provides protection and opportunities for habitat enhancement projects. Approximately 7.2 kilometers of Terrell Creek from Birch Bay State Park to the Burlington Northern Railroad (BNRR) crossing are protected by the State Park, WLA land and British Petroleum property, co-managed by WDFW.

According to several landowners, sea-run cutthroat, coho and chum salmon historically inhabited Terrell Creek as far upstream as Olson Road (river mile 12.52). Attempts to restore coho and chum salmon using egg boxes had limited success. It is believed that low oxygen levels due to stagnant water and predation by warm water fish escaped from Lake Terrell resulted in a high mortality rate when the fry left the egg boxes (Ecalbarger and Granger 2003). About 2000 adult coho were observed in Terrell Creek within Birch Bay State Park about three to four years after the egg box project. A smolt trap was placed in the creek in the state park in a joint effort between the WDFW and the Nooksack Salmon Enhancement Association (NSEA). The “2000 Terrell Creek Smolt Trap Report” prepared by NSEA (2000) listed 1,997 coho and 8 steelhead smolts caught in the trap that year, (along with perch, pumpkinseed, bluegill, crappie, catfish, sticklebacks, sculpin and flounder).

RECOMMENDATIONS

Of the 19 fish passage barriers identified on WDFW-managed lands during the Lake Terrell and Tennant Lake WLA inventory, all 19 of the barriers are prioritized for correction. One inadequately screened diversion could not be prioritized for repair since the pump was not installed. The pump intake should be properly screened with openings that do not exceed the maximum allowable size as per WDFW screening criteria. This temporary structure will likely be removed once the newly planted trees it is used to irrigate are established.

WDFW is committed to removing fish passage barriers and installing screens on diversions on WDFW lands. The factors described in the discussion can be resolved and habitat enhancement opportunities abound in the Terrell Creek system.

The next step for WDFW, after identifying and prioritizing fish passage barriers and inadequately screened diversions, is project scoping which will determine the feasibility of barrier correction and diversion screening.

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APPENDIX A

A comprehensive list of all features evaluated during the Lake Terrell and Tennant Lake Wildlife Area Fish Passage Barrier and Surface Water Diversion Inventory. Features are sorted by Site ID number.

Site ID	Location	RM	Feature Type	Repair Status	% Pass.	Owner Type
01.0089 0.00	Just US of Kickerville Rd.	6.71	dam	RR	67	Private
01.0089 8.70	Lake Terrell dam	9.37	dam	RR	0	Wildlife Area
981777	S of Lake Terrell	0.00	culvert	OK	100	Wildlife Area
981778	S of Lake Terrell	0.00	culvert	OK	100	Wildlife Area
981779	S of Lake Terrell	0.12	dam	RR	0	Wildlife Area
981780	S of Lake Terrell	1.35	dam	RR	0	INTALCO
981781	S of Lake Terrell		dam	LHG	0	INTALCO
981782	S of Lake Terrell		culvert	NFB		INTALCO
981783	S of Lake Terrell		dam	LHG	0	INTALCO
981784	S of Lake Terrell		culvert	NFB		INTALCO
981785	S of Lake Terrell	1.20	dam	RR	0	INTALCO
981786	S of Lake Terrell	0.80	dam	RR	0	INTALCO
981787	S of Lake Terrell		dam	LHG	0	INTALCO
981788	SR 548/Blaine Rd.	5.02	culvert	RR	0	WSDOT
981789	Kickerville Rd.	6.69	culvert	RR	33	Whatcom Co.
981790	Aldergrove Rd.	9.18	culvert	OK	100	Whatcom Co.
981791	Brown Rd.	8.48	culvert	OK	100	Whatcom Co.
981792	E of Jackson Rd.	0.00	dam	RR	0	BP
981793	E of Jackson Rd.	0.15	dam	RR	0	BP
981794	BP access rd off Grandview Rd.	0.36	culvert	LHG	33	BP
981795	N of Grandview Rd.		culvert	NFB		BP
981796	S of Lake Terrell		dam	LHG	0	INTALCO
981797	S of Lake Terrell	0.63	culvert	RR	67	Whatcom Co.
981798	S of Lake Terrell	0.28	dam	RR	0	Wildlife Area
981808	Private Dr N of Brown Rd.	8.41	culvert	OK	100	Private
981809	North Star Rd.	10.73	culvert	RR	67	Whatcom Co.
981810	Slater Rd.		culvert	OK	100	Whatcom Co.
981811	N of Slater Rd.		dam	RR	67	Wildlife Area
981812	S of Slater Rd.		culvert	UD		Wildlife Area
981813	S of Slater Rd.		culvert	UD		Private
981814	N of Slater Rd.		dam	RR	67	Wildlife Area
981815	E of Jackson Rd	0.00	dam	OK	100	BP
981816	Private Dr E of North Star Rd.	10.82	culvert	OK	100	Private
981817	Private Dr S of Aldergrove Rd.	11.29	culvert	OK	100	Private
981818	Farm Rd.	12.11	culvert	RR	67	Private
981819	Private Dr W of Olson Rd.	12.48	culvert	RR	67	Private
981820	Olson Rd.	12.52	culvert	RR	33	Whatcom Co.
981821	N of Grandview Rd.		dam	LHG	0	BP

Site ID	Location	RM	Feature Type	Repair Status	% Pass.	Owner Type
981822	N of Grandview Rd.		pump div.	RR	NC	BP
981823	N of Grandview Rd.		dam	RR	0	BP
981825	W of Jackson Rd.	0.09	dam	RR	0	BP
981826	Grandview Rd.	0.33	culvert	RR	67	Whatcom Co.
981827	W of Jackson Rd.	0.62	dam	RR	0	Private
981828	W of Jackson Rd.	0.70	dam	RR	0	Private
981829	Brown Rd.	1.00	culvert	OK	100	Whatcom Co.
981830	Jackson Rd.	1.23	culvert	RR	67	Whatcom Co.
981831	Grandview Rd.		culvert	NFB		Whatcom Co.
981832	Just E of Jackson Rd.	1.25	dam	RR	0	BP
981833	E of Jackson Rd.	1.42	culvert	OK	100	BP
981834	E of Jackson Rd.	1.54	culvert	OK	100	BP
981835	E of Jackson Rd.	1.66	culvert	OK	100	BP
990429	SR 548/Grandview Rd.	7.49	culvert	RR	0	WSDOT
991061	SR 548/Grandview Rd.		culvert	OK	100	WSDOT
994229	SR 548/Grandview Rd.		culvert	OK	100	WSDOT

The codes in the Repair Status column indicate the feature status where RR = Repair Required, OK = feature is not a barrier or safety issue, no repair required, LHG = Limited Habitat Gain, NFB = Not Fish Bearing and UD = PI is undetermined. BP = British Petroleum Corporation, NC = Not Compliant and RM = river mile.