Reconnaissance Survey of
Tide Gates in
Tillamook Bay Vicinity

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Background

The Tillamook Bay watershed has lost most of its tidal marshes and wetlands[1]. These areas are critical habitat for several species of fish, most notably Chinook and Coho Salmon. Much of this land has been converted to agricultural uses. Construction of a dike along the main river channel, with a culvert and tide gate placed through the dike to permit upland drainage, is a common conversion technique. This survey was conducted to determine how many tide gates were installed in the Tillamook Bay area, what condition they are in, and what opportunities might exist for modification of these tide gates to enhance the habitat value of the upland areas protected by the tide gates.

Hydromodified systems

The Tillamook Bay estuary is an extensively hydromodified system. One aspect of this modification is the outlet to the ocean, which has been altered by the jetties installed earlier in this century. The temporary breach of Bayocean spit in the 1950s is an extreme but relevant example of the consequences of hydromodification. That breach was caused in part by changes in marine sediment transport created when only the north jetty was present at the inlet. The large quantity of sediment that washed into the bay during the breach has had serious and lasting negative consequences for the users of the bay.

A less dramatic but equally damaging aspect of the hydromodification of the estuary is the diking and draining of tidal wetlands along the fringes of the bay. The wetlands and their channels provided important habitat to many species of fish. The wetlands and floodplain areas also absorbed sediments from the uplands, and attenuated floodwaters. Those lands have been converted to agricultural uses, mostly pasture for cattle, by constructing dikes and levees along the rivers and larger sloughs, and placing tide gates or pumps along the dikes to move water off the fields. Along with the elimination of tidal wetlands and sloughs, the removal of riparian vegetation, trees, shrubs, and herbaceous plants, reduces the food resources in the aquatic ecosystem and increases the temperature of the water through increased insolation. Drainage pumps, which pump water over dikes, also create hazards to resident and migratory fish.

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[1] Exact acreage of lost wetlands is not known. Between 1910 and 1949, 7 drainage districts drained a reported 5,643 acres of marsh and wetland.

Tide Gate Database

Table 1 contains data on the 49 tide gates located in the Tillamook Bay watershed. The tide gates were located by boat and on foot, and located using non-differential GPS and USGS quadrilateral maps. Position error is unknown, since absolute position cannot be easily determined. In general, the positon data should locate the tide gate within 100-200 feet. The database indicates the water body, identification number, GPS reference, size, condition, number of photographs, estimated potential habitat value, approximate location (longitude and latitude), and brief description of each tide gate location.

Tide gate size is reported as a number, diameter in feet, or as large, medium, or small. Large gates are generally 4 feet in diameter or greater. Medium gates are in the 3 foot range. Small gates are 2 feet or less in size. Tide gate size is an indicator of upland drainage area; large gates drain larger areas. Larger lids also afford more opportunities for fish passage modifications.

Tide gate condition is reported as good, fair, or poor. Poor condition indicates that the tide gate is silted in or otherwise appears to be non-functional. Low water quality in the immediate vicinity of the tide gate is an indicator of restricted flow and hence poor working condition. Fair condition tide gates are dirty or excessively rusty, and generally appear to not be functioning well. Good condition tide gates appear clear of debris and mud, and look like they are draining well. Modification opportunities will be sought generally among the fair and good condition locations.. Broken or poorly maintained tide gates may offer opportunities to improve tide gate function above current conditions while installing habitat improvement features. Silted tide gates are likely to have heavily silted upland drainage channels, and so represent poor habitat areas.

Photographs of tide gates and their surroundings are contained in the accompanying photo album (Appendix A). Only two tide gate locations, a small gate on Dougherty Slough and the tide gate on Vaughn Creek, do not have at least one photograph.

Potential habitat value upland from each tide gate location is estimated from USGS quadrilateral maps and survey notes. For this report, habitat value is assessed based on the length and character of the upland water body. A flowing stream or large system of drainage channels indicates the possible presence of spawning or rearing areas, or both. Potential value is expressed as Excellent, Good, Fair, Poor, or Unknown. Detailed estimates of current or potential habitat value are difficult, involved processes. Water quality, food resources, surrounding land use, variations in water level (seasonal and tidal), and riparian zone condition all contribute to aquatic habitat value. Habitat value will be further investigated for those tide gate locations which have good modification potential. In particular, since any modification may represent a first of its kind project in the Tillamook area, detailed before and after information on the upland water body will be required to document the effects of the tide gate modification.

Tide gate location is documented in the database (Table 1) by noting the water body (river, slough, or bay) and the longitude and latitude of the site. Longitude and latitude are based on non-differential GPS positions for most locations, so the positions are approximate. There is no value in precisely locating the tide gates in any reference system. What is important is that the tide gates be described so that they may be discussed and investigated without confusion.

The descriptions in the database (Table 1) are brief and pertain primarily to the size and condition of the tide gates. Inspection for function was cursory. Many of the gates could not be reached by boat, so only a visual inspection was possible. For those tide gate locations which show promise for modification, more thorough inspections will be made as part of the project design.

In Table 1, only individual tide gate locations are distinguished. One location may be composed of two or more separate culverts and lids. Details on individual culverts and lids are beyond the scope of this survey. Such data will be collected for tide gate locations where repair or modification projects are contemplated.

Recommendations

Two basic modification strategies are recommended for the Tillamook estuary and rivers. For any tide gate of medium size or larger, a block and tackle system (see below) should be installed to facilitate active management of the tide gate for enhanced agricultural and ecosystem management. For tide gates which offer suitable opportunities in terms of size, upland drainage area, and water level, a bottom hinge (pet door) or top hinge (trap door) access hole should be installed to increase aquatic species' access to the upland waterways. These modifications are described in detail later in this report.

Which modification is made to a particular tide gate is dependent upon the individual circumstances of each tide gate, and specific recommendations on modifications at this point would be premature. Table 2 lists those tide gates that appear good candidates for further study. Figure 1 gives a broad sequence of events in the development of a modification proposal. A key element is to get the landowner involved early in the process. Rural landowners typically resent even discussions about their land of which they are not aware.

Tide gate is large enough

Landowner is willing

Tide gate upland drainage is or could be good fish habitat

Select an appropriate alternate tide gate design based on land characteristics, use, and hydrology

Figure 1. Sequence of events in locating suitable tide gate modification sites.

When selecting modification sites, it should be remembered that both summer and winter rearing areas are needed, as is greater migratory passage to and from upland spawning sites. It should also be kept in mind that modifications to tide gates may require that more attention is paid to them in the future.

Tide Gate Discussion

Tide gate design

Tide gates exist to keep tidally or seasonally rising waters off land that had been regularly flooded in the past. This land is kept dry to suit human needs, for living space or, more frequently, for agricultural use. Tide gates are very efficient, requiring no outside power, little maintenance, and virtually no active management. Tide gate longevity and performance can be improved with regular maintenance and management, but in general a tide gate can be forgotten for long periods of satisfactory operation. To achieve this maintenance and management-free condition, tide gates are commonly built to be far more effective than is required. In theory, tide gates maintain the upland waterway at a water level equal to the lowest low tide. The upland-side water level rises only due to upland runoff which is held back by the tide gate during high tides, or by leakage, which is common to all tide gates. It is rare, however, that the land use or topography upland of the tide gate is such that maintenance of extreme low water is required. More often, some higher water level is tolerable, at times even desirable, in the upland channels. A process called "sub-irrigation" is often employed with a tide gate (tide gate number 22 was sub-irrigating when observed during the survey). Using this technique, the tide gate is propped open, allowing water to flow more freely through the culvert, raising the water level in the upland sloughs, and raising the water table under the adjacent land.

Modifications to the basic tide gate configuration can serve two purposes: improve the ease and benefits of active management for the landowner, and reduce the obstruction in the aquatic ecosystem. Modifications which achieve the first goal may be used in such a way that they aid in the second. Modifications that achieve the second goal involve allowing the upland water level to rise above that permitted by a standard tide gate. This may be done, however, while maintaining the basic tide gate function, to keep diked lands dry enough for productive use.

<u>Tide gate effect on the aquatic ecosystem</u>

Fish habitat

Tide gates are generally constructed by hanging a large lid, either cast iron, aluminum, or wood, over a culvert. The intent is for the tide gate to be closed when the water is higher on the channel side of the culvert than it is on the upland side, keeping the water level in the upland drainage channel as low as possible. In order to function correctly, a tide gate lid must be closed and effectively sealed unless water is flowing from the uplands through the culvert. When this occurs, the weight of the tide gate lid assures that the lid will not move very far (i.e., will not open very wide), and the current through any opening will be quite strong. (The new thin aluminum lids may provide some relief from this tendency to not open very far. They will, however, retain the tendency to remain closed most of the time, and always when the tide is rising.)

Fish which are resident in or migrating through the lower rivers and sloughs of an estuary like Tillamook Bay would typically make use of the upland streams and channels on which tide gates are installed. The upland slack water areas are critical habitat for rearing salmonids, and the streams often lead to high quality spawning areas for adults. Rearing and resident fish would move into these off-channel areas when the tide rises to fill the channels and flood the tidal wetlands. Tide gates, because they remain closed, particularly during flood tides, or generate strong currents through their openings when draining, create an almost impassable barrier to juvenile salmonids and other fish. Thus, the upland slack water areas and streams are lost to the fish, reducing their habitat quality and quantity.

A further complication occurs when the tidally influenced water outside the tide gate is saline. It has been suggested that resident fish time their movements into and out of side channels and sloughs by the salinity in the water. Rising salinity at a point signals an incoming tide, and hence higher water, so fish will move into the side channel areas when salinity increases. Similarly, dropping salinity signals a drop in water level, so the fish move back toward the main channel. Tide gates, which allow significant leakage, have an unusual salinity pattern where salinity near the tide gate rises and falls *twice* during a single rise and fall of the tide in the main channel. The mid-cycle fall in salinity can signal to fish in the slough that it is time to return to the main channel. The tide gate remains closed at this time, however, and the fish are trapped at the upland end of the culvert. These fish are often easy prey for predatory birds.

Sediment accumulation

As mentioned above, tide gates remain closed most of the time, particularly those gates that do not have a significant upland drainage area. Water immediately upland of tide gates rarely moves very fast, so most of the sediment transported to this area settles out of the water column. In a process similar to the way lakes created by dams gradually fill with sediment, the streams and sloughs upland of tide gates fill with sediment. Tide gates are often installed away from the main channel of the waterway they drain into. This protects the tide gate lid from debris in the waterway. This back channel area, like the area just upland of the tide gate, often sees very little water flow, and can collect sediment, eventually blocking the tide gate and rendering it useless (for an extreme example, see tide gate number 1 in the survey). The potential habitat value of the upland waterway is lost, as is the small side-channel area below the tide gate. The drainage channel must be periodically dredged, disturbing the biota which do inhabit the channel. The need for dredging also discourages the restoration of riparian vegetation along the channels.

Hydromodified System Enhancement

Alternate Tide Gate Designs

Pet door

A schematic picture of a tide gate equipped with a “pet door” is depicted in Figure 2. A pet door is a small tide gate lid which is attached by hinges to a larger lid along the smaller lid’s lower edge. The larger lid has an opening above the hinges that can be completely covered by the smaller lid. At the upper end of the smaller lid is a float that remains at or below the water level. The small lid opens at low water levels and closes at high water levels. Thus, for a short time, once or twice a day, there is an opening in the tide gate's main lid that is large enough to permit fish and other aquatic organisms to pass freely through the tide gate.

Trap door

An alternative to the pet door described above again involves placing a small lid on the larger lid over a hole in the larger lid, but hinging the small lid at the top (Figure 3). This small, light lid will open wider during periods of freshwater outflow than the larger, heavier main lid will, creating an opening sufficient to allow fish to pass through the tide gate. This design has been used effectively for several years in the Humboldt Bay area.

Side mount

An innovative alternate tide gate design has been built along the Tillamook River to protect Beaver Creek from tidal action and high river flows (tide gate number 23 in this survey). This tide gate has two large doors, which are hinged at their sides, much like a typical house door. The doors are mounted such that they tilt slightly downwards toward the center. This tilt provides a slight closing force, so that in the absence of any water movement the doors will swing shut. The angle is slight, however, so the closing force is easily overcome by even a light outflow from Beaver Creek. These doors have been observed to be wide open during typical summer outflows, providing easy access for salmonids to Beaver Creek. One drawback to this tide gate design is that it is difficult and expensive to install doors in this manner.

Block and tackle system

Figures 4 and 5 depict side and front views of a "block and tackle" system for a typical tide gate. The block and tackle system connects the tide gate lid to a cable running through a block (a pulley) and back to the top of the dike, where it is anchored to a post or large mass. The tide gate lid can be easily held open by pulling on the rope and anchoring it. This would eliminate the need to handle the lids by hand, propping them open with pieces of wood or rocks. Holding the tide gate lids open during winter, when the fields are flooded and unusable, or during summer when river water levels are too low to create a problem, would greatly improve fish access to the upland waterways. The use of combination flap gates and sluice gates would accomplish the same goals.

Non-tide gate tools

Modifications to tide gates are not all that can be done to improve aquatic habitat in hydromodified areas. Two other ideas, fish bridges and freshwater inflow systems, are described below.

Fish bridge

Figures 6 and 7 depict schematic views of a “fish bridge.” The concept is similar to the fish ladders used with dams. Fish are enticed with a fresh-water signal to jump from pool to pool up the artificial falls. When the final pool is reached, the fish are again attracted over a waterfall. Instead of landing in a pool, however, the fish land on a slide which carries them down to the slough. From there, the fish are free to follow the natural scent of the water upstream to the spawning grounds. Fish exit the spawning habitat sub-basin through the tide gate.

Fish bridges require active management. Unlike a fish ladder, the water for the pools must be pumped up to the top of the ladder. The fish ladder structure, placed alongside the riverbank, is also directly in the path of winter floods, and may require removal and replacement each year. Maintenance of the bridge, in particular the structural integrity of the pools and assurance of a strong flow of water to the slide, is also vital to their success and the safety of the fish.

Windmill-driven slough flushing

Pastureland often contains sizable sloughs protected by tide gates. Many of these sloughs are long backwater channels that have no source of fresh water during dry seasons. Water in these back channels becomes warm and of generally poor quality, unsuitable for use by cold-water fish.

Three options exist for creating a supply of fresh water in the back channel. Initially, the simplest and least impacting is to place a pump and fire hose between the river, or other source of ‘fresh’ water, and the channel (Figure 8). This pump could be run for several hours a day, or continuously, for several days, and the effects on the channel measured. The fire hose option offers one additional degree of desirable flexibility. Multiple input points could be tried (Figure 8, plan view) to determine the effects of this configuration relative to a single point. If the effects on the biota of the slough of fresh water introduction are positive, two additional options exist. Figure 9 depicts a pipe buried in the pasture at an angle which would allow river water at high tide to be gravity fed into the channel, which is maintained near low tide by the tide gate. This fresh water influx would operate for a few hours each day, during tides high enough to reach the pipe opening. A more ambitious alternative, shown in Figure 10, involves a windmill which runs a pump supplying river water to the channel almost continuously (depending on the wind).

Summary

Tide gates have a significant influence on the hydrology and habitat value of Tillamook Bay. This survey identified 49 tide gate locations, mainly along the Tillamook and South Branch Trask Rivers, and Kilchis River floodplain sloughs (i.e., Hathaway and Squeedunk). The location and condition of these tide gates are given in Tables 1 and 2, with further information in the appendices. Many tide gates offer opportunities for modification that can both retain needed tide gate function and provide enhanced aquatic habitat values. Guidance in the selection of alternate tide gate designs is provided in this document, and in the companion "Tide Gate Modifications for Fish Passage and Water Quality Enhancement."

Figures

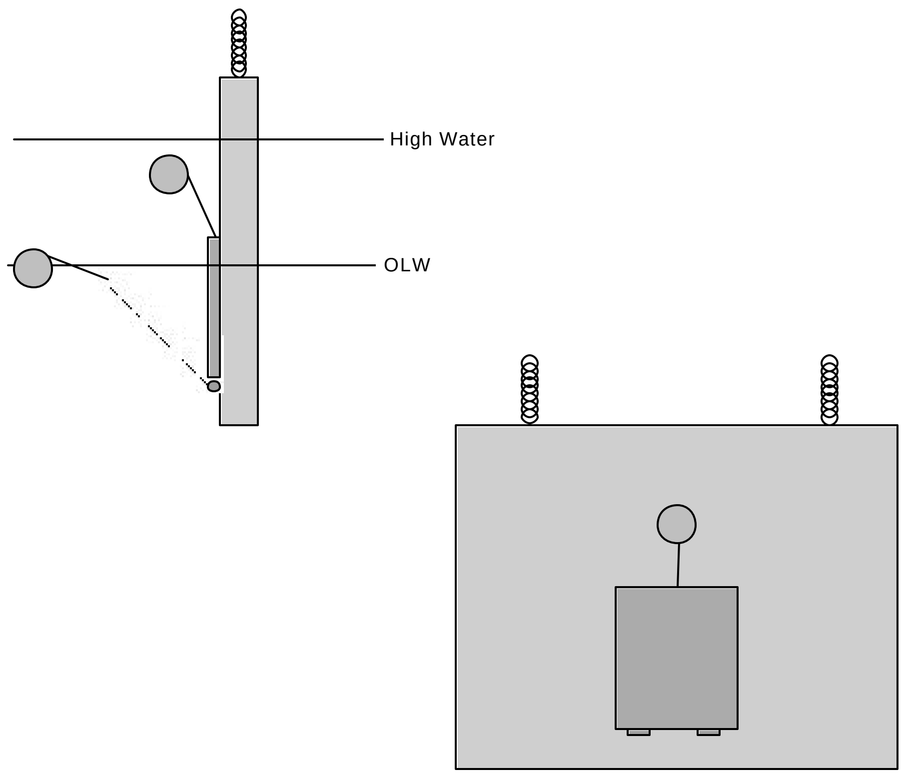


Figure 2. A pet door consists of a small door, hinged at the bottom witha float at the top, which covers a hole in the larger, main tide gate lid.

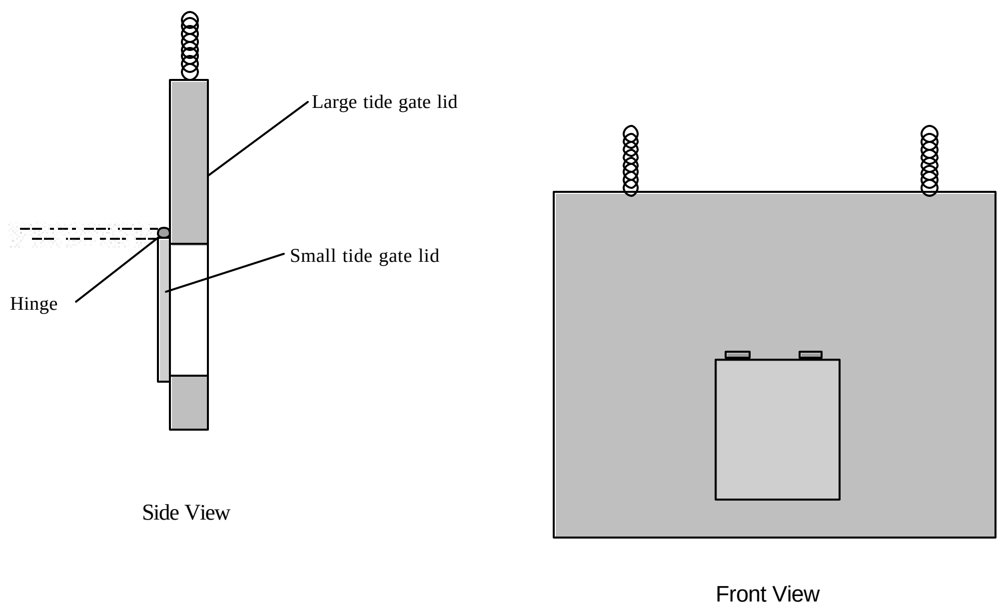


Figure 3. A trap door consists of a small door, hinged at the top, which covers a hole in the larger, main tide gate lid.

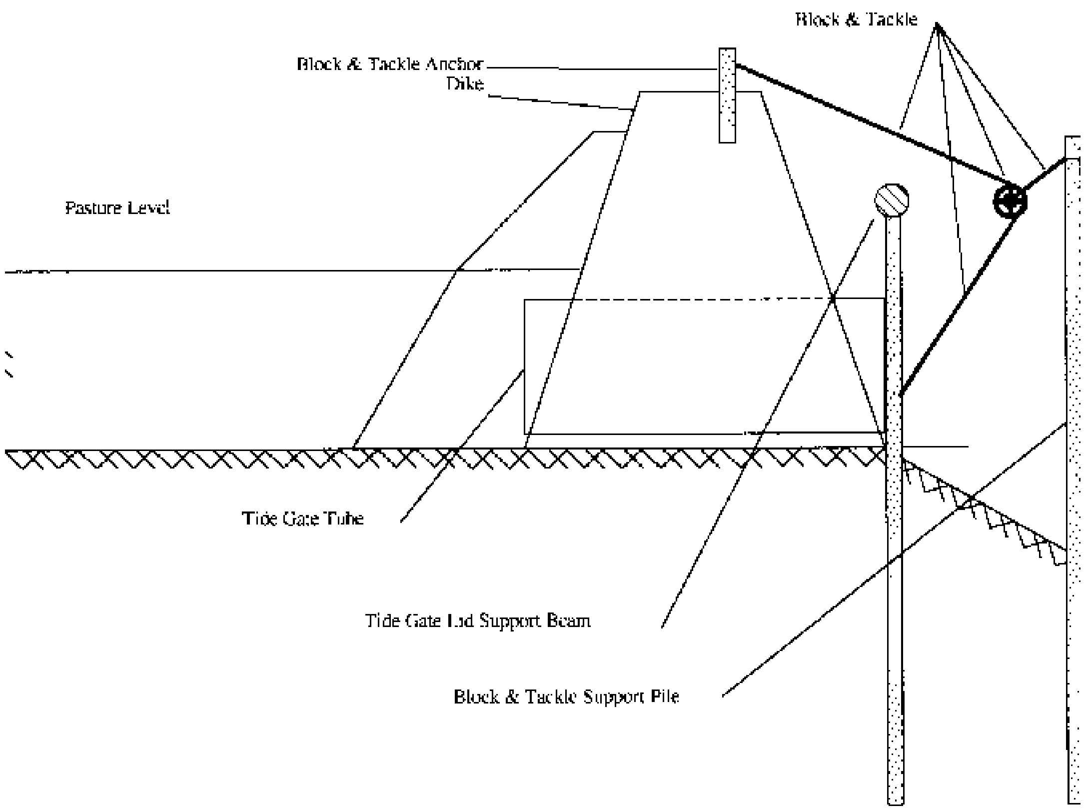


Figure 4. Side view of a block and tackle system.

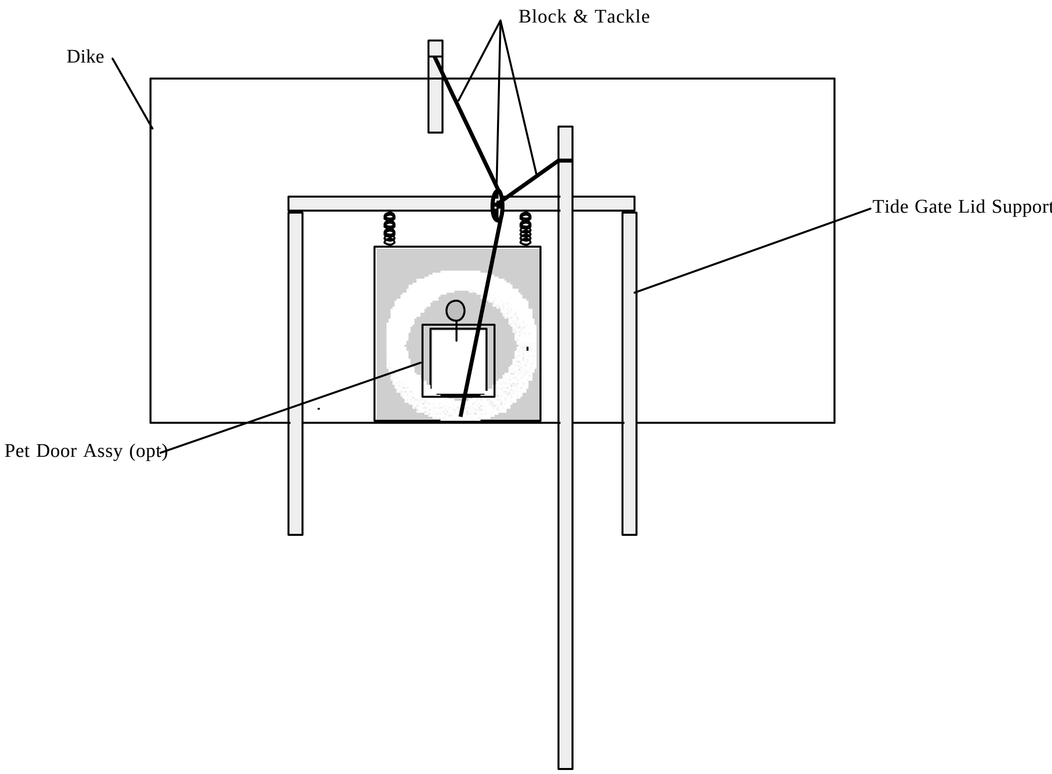


Figure 5. Front view of a block and tackle system.

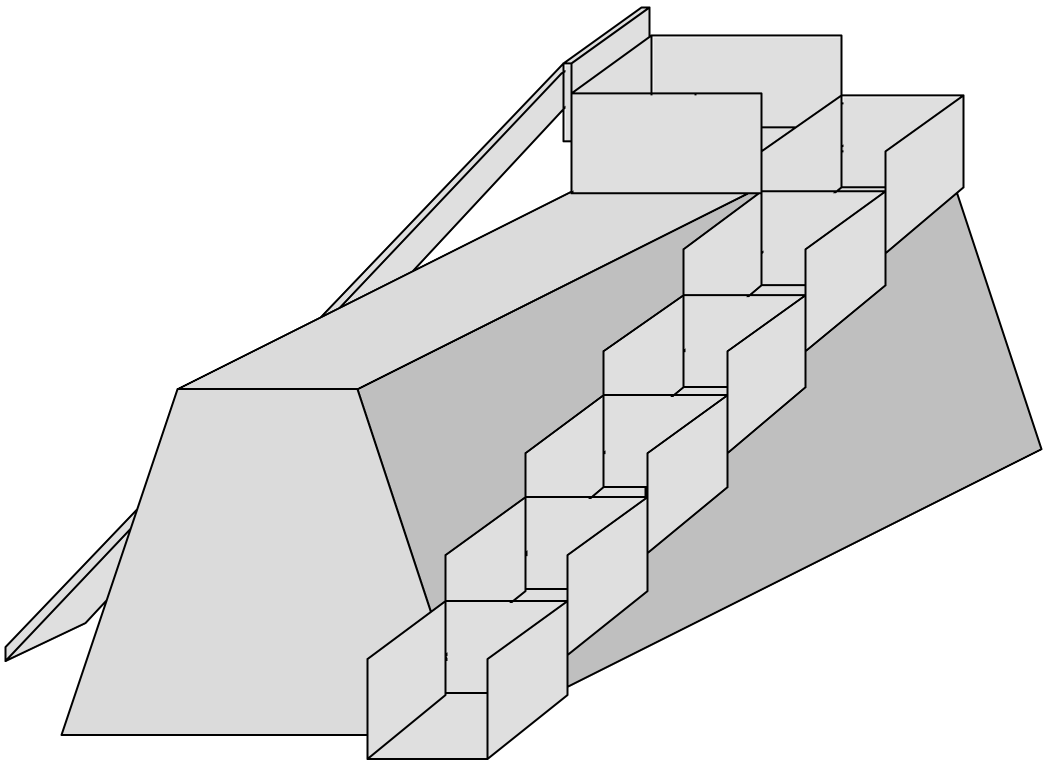


Figure 6. A schematic view of a fish bridge installed across a dike.

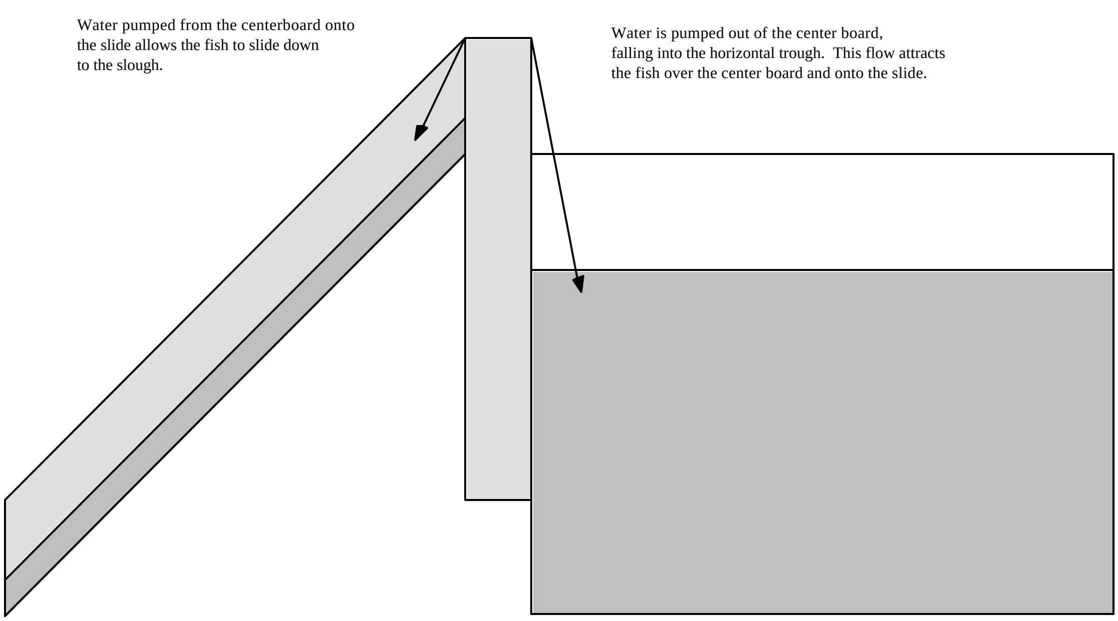
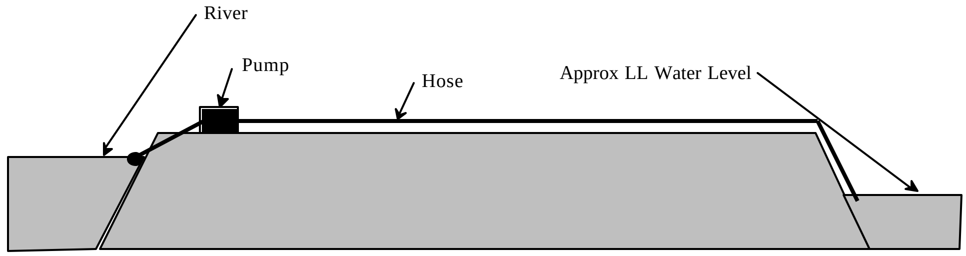


Figure 7. The top of a fish bridge, where water is pumped into the pools (right) and onto the slide (left).



Pump-driven, temporary system to allow fresh river water to enter the upland drainage system at the uppermost (or multiple) point(s) of the ditch system during selected times. This will provide flushing of the backwater areas during dry seasons.

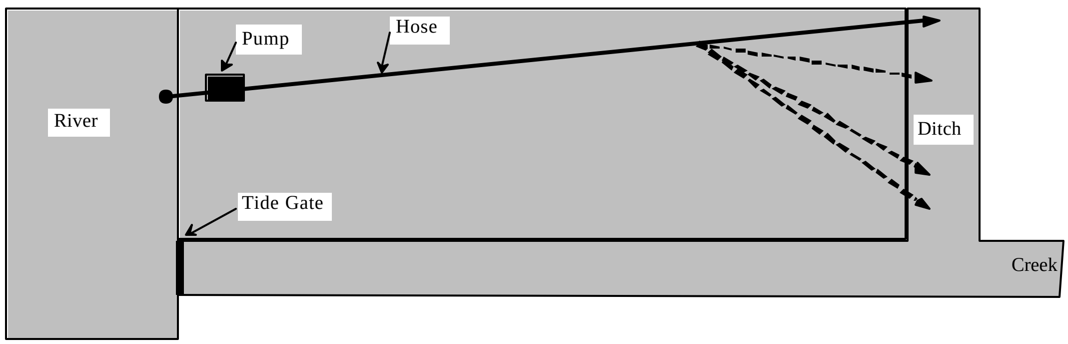
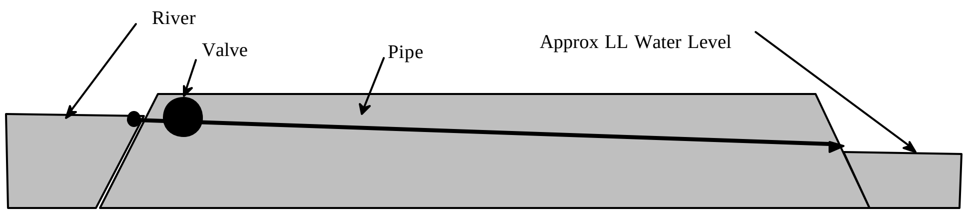


Figure 8.



Gravity fed system to allow fresh river water to enter the upland drainage system at the uppermost (or multiple) point(s) of the ditch system during selected times of very high water. This will provide flushing of the backwater areas during dry seasons.

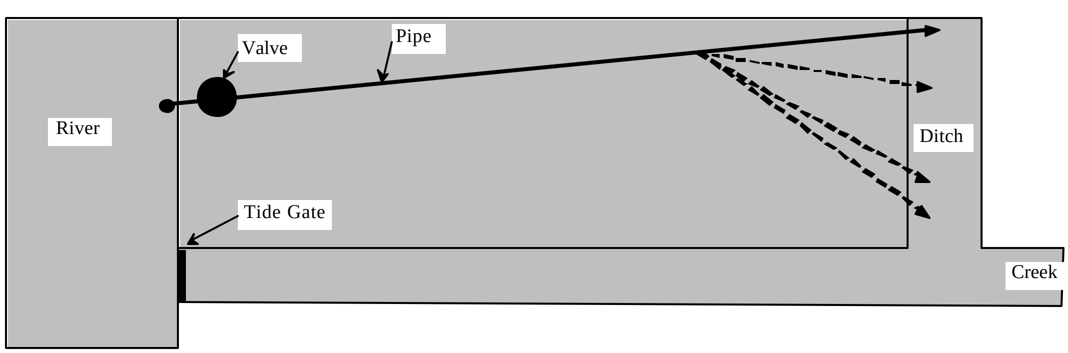
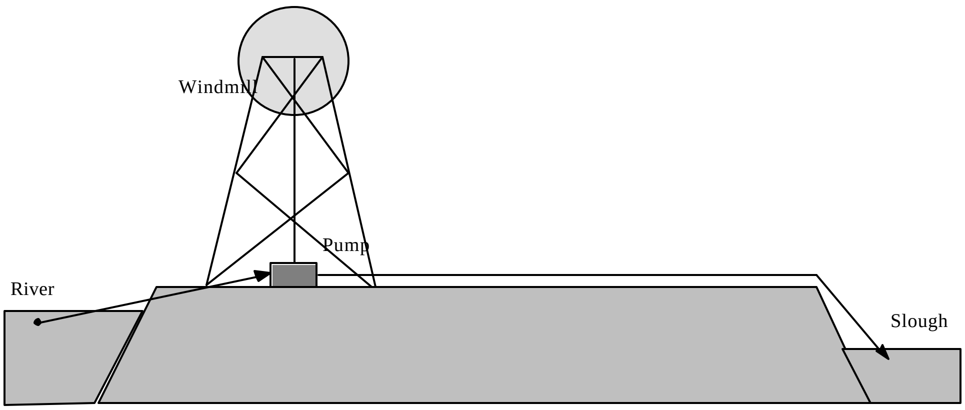


Figure 9. Gravity fed system, allowing water to flow at high tide.



Windmill drives a pump which supplies water to the upper-most reaches of drainage ditches to provide fresh water flushing of these backwater areas.

Figure 10. Windmill driven pump option.

Table 1.

Waterway	Survey ID	Reference	Size	Condition	Photos	Habitat Poten.	North Lat Degrees	Minutes	West Long Degrees	Minutes	Notes
Tillamook	1	5-22 18	3	Poor	3	Unk	45	27.073	123	52.664	Old gate, well off channel. Pat V took close up photos. 3 photos.
Tillamook	2	5-22 19	Large	Good	2	Excellent	45	26.878	123	52.544	Big system, 2 side by side plus 1. At fence and power line.
Tillamook	3	5-22 20	Large	Good	1	Good	45	26.492	123	52.632	1 tide gate plus ditches. Condition unknown.
Tillamook	4	5-22 21	4	Fair	4	Unk	45	26.465	123	52.624	2 small gates, both jammed but leaking. 4 photos. Also bridge phot
Tillamook	5	5-22 22	5	Good	2	Unk	45	26.429	123	52.598	West side, 3' dia metal lid, well maintained.
Tillamook	6	5-22 23	4	Fair	1	Fair	45	26.305	123	52.530	Not working? Well off channel. Appears silted.
Tillamook	7	5-22 24	Small	Fair/Poor	1	Unk	45	26.272	123	52.558	Small lids, open but do not swing freely.
Tillamook	8	5-22 25	4	Fair	1	Unk	45	26.241	123	52.534	Gate set deep in water, unable to tell if it works.
Tillamook	9	5-22 26	4	Fair	1	Good	45	26.137	123	52.442	East side, large lid well off channel and high.
Tillamook	10	5-22 26	1	Good	1	Fair	45	26.137	123	52.442	West side, small lid out of water.
Tillamook	11	5-22 nr	1	Good	1	Unk	45	26.189	123	52.488	Small lid, out of water. No GPS (position approx)
Tillamook	12	5-22 28	6	Good	1	Unk	45	25.956	123	52.111	2 large side by side, may work, can't tell for certain.
Tillamook	13	5-22 29	1	Good	1	Unk	45	25.952	123	52.144	Small broken gate (very close by 028)
Tillamook	14	5-22 30	Large	Good	1	Unk	45	25.960	123	51.914	West side, submerged lid. Picked up broken lid here.
Tillamook	15	5-22 30	1	Good	1	Unk	45	25.960	123	51.914	Small lid, out of water
Tillamook	16	5-22 33	Med	Good	3	Fair	45	25.937	123	51.485	Submerged, road side. Seems ok. Out of water on 7-3 trip.
Tillamook	17	7-3 036	Med	Fair	1	Unk	45	26.016	123	51.269	Off channel in retaining wall. Looks silted in, but cannot be sure.
Tillamook	18	7-3 037	4	Fair	3	Unk	45	25.869	123	50.959	Small gate, road side.
Tillamook	19	7-3 038	4	Fair	1	Unk	45	25.844	123	50.870	East side, looks silted but opens.
Tillamook	20	7-3 039	4	Poor	2	Fair	45	25.809	123	50.684	At bridge. Totally silted in.
Tillamook	21	7-3 040	Large	Good	1	Unk	45	25.613	123	50.509	4x, side by side. Off channel.
Tillamook	22	7-3 041	4	Good	1	Unk	45	25.317	123	50.590	Sub-irrigating when seen. Off channel and well protected.
Tillamook	23	7-3 042	Large	Good	1	Excellent	45	25.133	123	50.704	Double doors under bridge. Beaver Creek.
Tillamook	24	5-7 4	Large	Good	1	Unk	45	27.648	123	52.551	Steel Door, 4' dia Not working
Bay	25	5-7 3	Large	Good	2	Good	45	28.486	123	53.592	Steel Door, 4' dia
SF Trask	26	5-7 5	4	Good	3	Good	45	27.428	123	52.628	Double, side by side. 4' diameter. Concave lids.
SF Trask	27	5-7 6	6	Good	1	Good	45	27.266	123	52.530	Wood lid with weight, seems to work.
SF Trask	28	5-7 6	6	Good	1	Good	45	27.266	123	52.530	Large lid, 5-6' dia, out of water.
SF Trask	29	5-7 7	4	Good	1	Good	45	27.190	123	52.266	5' diameter, submerged. Also location of pump outfall. Inside large inlet.

SF Trask	30	5-7 8	1	Good	1	Poor	45	26.880	123	52.110	side channel, 2 very small lids.
SF Trask	31	5-7 9	1	Good	1	None	45	26.877	123	51.922	Small gate, 1' dia
SF Trask	32	5-7 10	1	Good	1	None	45	26.976	123	51.644	small, out of water. 2' dia metal lid
Trask	33	7-14 043	Large	Good	1	Good	45	28.010	123	52.182	Large metal lid
Trask	34	Tone Rd				Fair	45	26.796	123	50.617	New, aluminum lids. Have not seen yet.
Trask	35	7-24 nr	3	Good	1	Poor	45	boat ramp	123	boat ramp	Small, wooden lid, very near 5th street boat ramp
Dough. Sl	36	7-23 A	Small	Good	0	None	45	27.864	123	50.493	Small, 1 ft dia lid. No photo.
Wilson River	37	7-24 044	1	Good	1	None	45	28.770	123	50.905	Small, 1 ft dia lid, way out of water.
Wilson River	38	7-24 047	1	Good	1	None	45	29.004	123	52.063	Small lid, way out of water in grass. South side of river.
Hall Sl	39	Fri 1	4	Good	1	Poor	45	28.546	123	52.136	4' diameter, unblocked and working (Chilonga)
Hall Sl	40	Fri 2	4	Fair	1	Poor	45	28.616	123	51.977	Blocked channel, may not work (Chilogna)
Hall Sl	41	Bridj	Med	Fair	1	Poor	45	28.243	123	51.714	Wooden lid by bridge. Works but lots of woody debris.
Squeedunk Sl	42	8-1 051	Large	Good	2	Good	45	29.302	123	52.343	Under water, good condition. Dike setback area.
Squeedunk Sl	43	8-1 A	Large	Good		Good	45	29.441	123	52.236	Under water, well off channel.
Squeedunk Sl	44	8-1 052	Large	Good		Good	45	29.259	123	52.091	Very deep set, by rail car bridge. Large.
Hathaway Sl	45	7-30 A	Small	Fair	2	Poor	45	30.065	123	51.571	Small, 2' dia metal lid, well off channel.
Hathaway Sl	46	7-30 B	Large	Fair	2	Poor	45	30.091	123	51.627	Right fork, penninsula side. Looks poorly maintained.
Hathaway Sl	47	7-30 C	Large	Fair	2	Fair	45	30.091	123	51.671	Large, 4' diameter, plastic culvert w/ metal lid.
Hathaway Sl	48	7-30 049	Large	Poor	2	Fair	45	30.074	123	51.622	Large, metal lid. Completely busted, knocked out of place
Vaughn Cr.	49	N/A	Large	Poor	0	Good	45	30.208	123	51.884	Large metal lid, non functioning. Saw otters in vicinity.

Miami R. — There are no tide gates along the Miami River.

Kilchis R. — There are no tide gates along the mainstem of the Kilchis River.

Table 2.

Waterway	Survey ID	Size	Condition	Mod. Poten.
Tillamook	1	3	Poor	None
Tillamook	2	Large	Good	Good
Tillamook	3	Large	Good	Good
Tillamook	4	4	Fair	Good
Tillamook	5	5	Good	Good
Tillamook	6	4	Fair	Poor
Tillamook	7	Small	Fair/Poor	Poor
Tillamook	8	4	Fair	Good
Tillamook	9	4	Fair	Fair
Tillamook	10	1	Good	None
Tillamook	11	1	Good	None
Tillamook	12	6	Good	Good
Tillamook	13	1	Good	None
Tillamook	14	Large	Good	Fair
Tillamook	15	1	Good	None
Tillamook	16	Med	Good	Good
Tillamook	17	Med	Fair	Fair
Tillamook	18	4	Fair	Fair
Tillamook	19	4	Fair	Fair
Tillamook	20	4	Poor	Poor
Tillamook	21	Large	Good	Good
Tillamook	22	4	Good	Good
Tillamook	23	Large	Good	None
Tillamook	24	Large	Good	Good
Bay	25	Large	Good	Good
SF Trask	26	4	Good	Fair
SF Trask	27	6	Good	Good
SF Trask	28	6	Good	Fair

SF Trask	29	4	Good	Fair
SF Trask	30	1	Good	None
SF Trask	31	1	Good	None
SF Trask	32	1	Good	None
Trask	33	Large	Good	Good
Trask	34			None
Trask	35	3	Good	None
Dough. Sl	36	Small	Good	None
Wilson River	37	1	Good	None
Wilson River	38	1	Good	None
Hall Sl	39	4	Good	Poor
Hall Sl	40	4	Fair	Poor
Hall Sl	41	Med	Fair	Poor
Squeedunk Sl	42	Large	Good	Good
Squeedunk Sl	43	Large	Good	Good
Squeedunk Sl	44	Large	Good	Good
Hathaway Sl	45	Small	Fair	None
Hathaway Sl	46	Large	Fair	Fair
Hathaway Sl	47	Large	Fair	Poor
Hathaway Sl	48	Large	Poor	Poor
Vaughn Cr.	49	Large	Poor	Good
Miami R.				
Kilchis R.				