

San Juan Islands Salmonid Limiting Factors & Recommended Actions

-

Eight Basin report



Cascade Creek December 2017, Byron Rot

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June 27, 2019

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Foreword

There is a misconception in the San Juan Islands that our watersheds do not contain salmonids. San Juan Islands streams do contain salmonid fish; mainly cutthroat (resident and presumably anadromous), and in a few watersheds coho and chum (Barsh 2010, Glasgow et al. 2016, DeGroot 2018). There are many accounts of old-timers fishing in our creeks. However, past settlement and agriculture using older ideas for managing water have resulted in the degradation of our natural stream systems, especially with diversions, channelization, and the building of in-channel ponds. Watersheds that used to flow mostly perennially are now seasonal; watersheds that historically had salmonids may no longer contain native fish. In addition, we are in the midst of a human-caused warming climate. For freshwater ecosystems in the Puget Sound region, we will see increased fall-winter flows and decreased summer flows (CIG 2015), making salmonid recovery more difficult in our small watersheds.

This list of eight watersheds are the highest priority watersheds that recently or currently support salmonids. The San Juan County Salmon Technical Advisory Group (TAG) created a list of nine watersheds; we dropped Hummel Creek on Lopez during the course of this study, because it is the smallest and least likely watershed to respond to salmonid recovery actions. **The key question in terms of salmonid recovery is how do we further prioritize limited resources?** The intent for this report is to address that principal question.

Common themes across watersheds are:

1. numerous in-channel ponds that affect flows (delay fall freshets, reduce summer flows),
2. in-channel ponds and other structures that prevent salmonid access to habitat,
3. limited salmonid summer rearing pool habitat,
4. streams corridors with little to no trees or shrubs (poor water quality),
5. livestock with free access to streams (poor water quality),
6. invasive reed canary grass choking out stream habitat, and
7. non-native fish planted in unscreened ponds and lakes that allow migration into streams. These non-native fish may also serve as food sources to river otter, which puts further stress on cutthroat.

We present restoration and protection options and data gaps to study for the above common themes within each watershed.

San Juan County no longer allows the construction of in-channel ponds unless it is for fish or wildlife enhancement (SJCC 18.35.135), and that requires approval from the County, US Fish and Wildlife Service, Washington Department of Fish and Wildlife, Washington Department of Ecology, and other responsible jurisdictions (San Juan County 18.35.130-3i).

Non-native fish should no longer be stocked in ponds with direct connection to streams. The Technical Team asks San Juan County for a designation of salmonids and other native fish as *Species of Local Importance* to highlight their existence and critical stewardship need by private landowners and discourage stocking of non-native fish in priority watersheds.

Thank you for your concern to protect and restore the San Juan Islands' native freshwater fish habitats. We encourage you to reach out to the authors for more information.

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Funding: Funded through Environmental Protection Agency, National Estuary Program, NTA 2016-0136. Washington Department of Fish and Wildlife contract number 17-08279.

Project vetted by the San Juan County Local Integrating Organization as a 2016 Near Term Action. Grant managers were: Washington Department of Fish and Wildlife and Washington Department of Natural Resources. Thank you for your support.

Suggested citation: Rot, B., J. DeGroot, T. Waldo, J. Glasgow, K. Sundberg, R. Barsh, J. Meyer, M. Ramsey, M. Boyd, K. Dodd, M. Reaves. 2019. San Juan Islands salmonid limiting factors and recommended actions – eight basin report. San Juan County Public Works Environmental Resources. 52 pgs.

San Juan Island

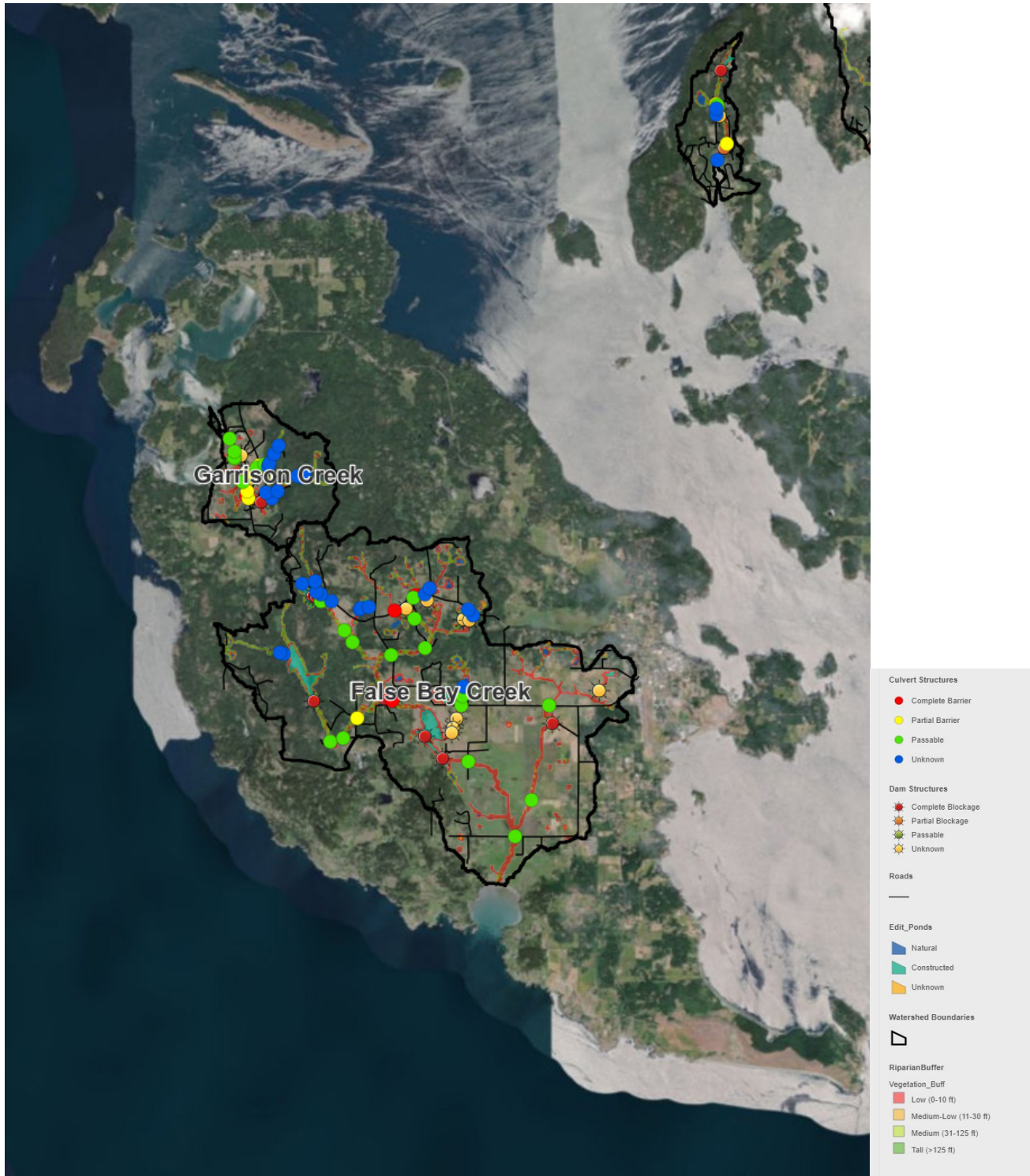


Figure 1. San Juan Island study watersheds, Garrison and False Bay Creeks.

False Bay Creek

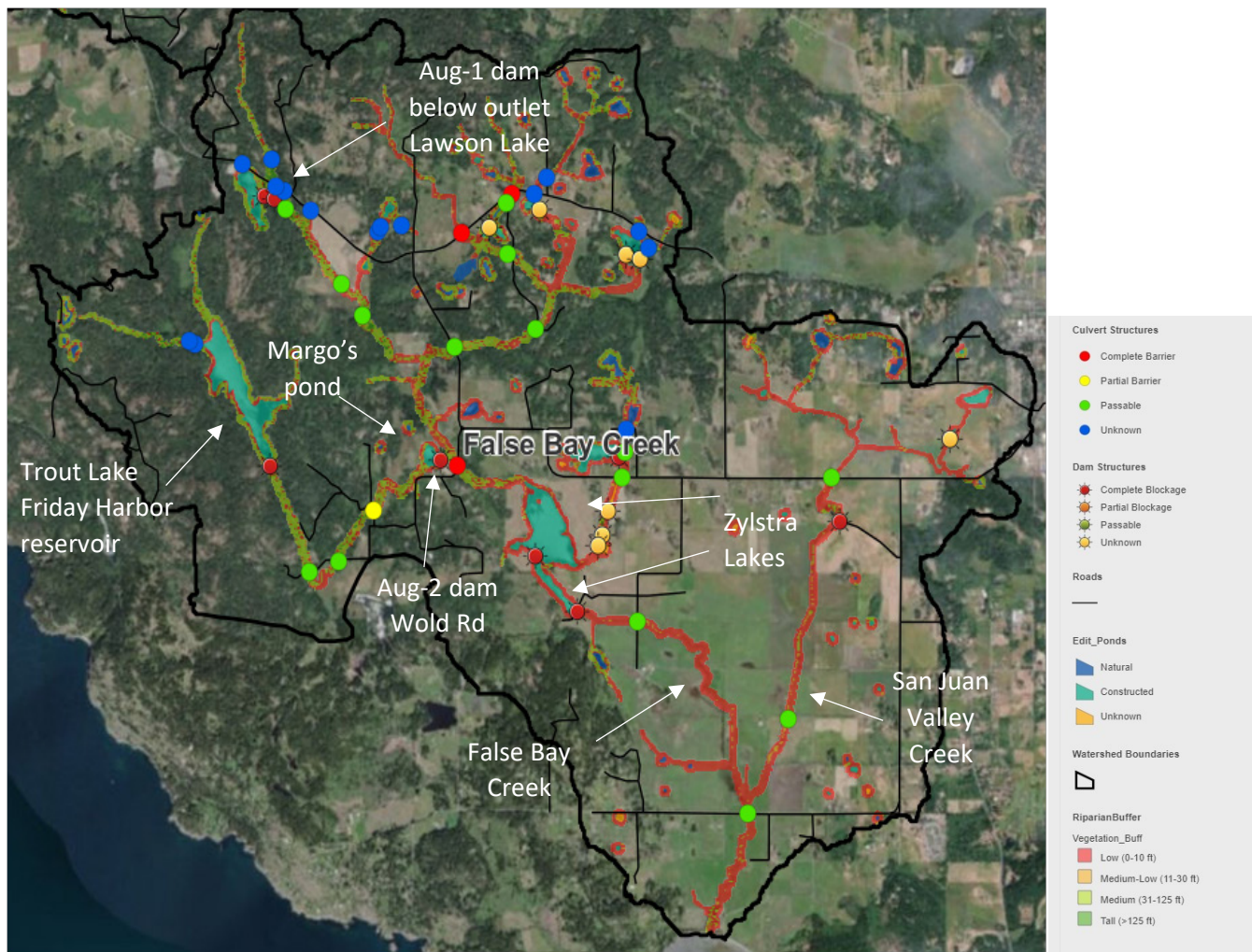


Figure 2. False Bay Creek watershed. Aug 1 and 2 are dams/pipes from where the town of Friday Harbor pumps water to Trout Lake. Aug-2 is a complete barrier to fish passage and blocks fish movement from Zylstra Lakes to the headwaters. Aug -1 and 2, Margo's pond, Trout Lake, and both Zylstra Lakes are all full fish-passage barriers. Buffer widths are based on the San Juan County Critical Areas Ordinance. See Appendix B for a description of the buffer analysis.

There are two intractable limiting factors to salmonid recovery in False Bay Creek and they both relate to flow. The first is the town of Friday Harbor plumbing of False Bay Creek watershed, which removes on average a daily 0.51 cfs (cubic feet per second) of flow from the watershed for drinking water (Hartley 2017). The second intractable limiting factor are the two impassable Zylstra Lakes, constructed for agricultural irrigation in 1961 and 1963 (Pratt 2016), and now currently owned by the San Juan County Land Bank. Lower False Bay Creek flows is dependent on releases from lower Zylstra Lake. In contrast, the 1859 Boundary survey team described lower False Bay Creek as a “creek of considerable size... this is the only creek which has a permanent flow” (Pratt 2016).

Limiting factors to salmonid recovery (data gaps are underlined):

1. *Hydrology*: Seasonal stream flows downstream Lake Zylstra, San Juan Valley Creek
 - a. The False Bay Creek (FBC) watershed upstream of Lake Zylstra is the source of the Town of Friday Harbor drinking water. The town has 3.98 cfs of claimed water from FBC dating from 1974, by far the largest in the basin (Cronin 2012). The town's water right is second in priority to the San Juan County Land Bank water right at Lower Lake Zylstra.
 - b. There are 63 ponds greater than ½ acre in the watershed (Cronin 2012). The largest lake not managed for drinking water is Wood Duck Lake (Cronin 2012). A coarse review by the author of 1932 aerial photos only showed Trout Lake and no other ponds or lakes.
 - c. False Bay Creek, under current flow management below Zylstra Lakes only consistently flows from mid-January through March (this is from a hydraulic model Hartley 2017, Wones et al 2017).
2. *Salmonid distribution and habitat connectivity* – Dams that block fish passage are the Upper and Lower Zylstra Lake dams, Aug-1 dam, Aug-2 dam, Margo's Lake, Trout Lake, and Lawson Lake (Figure 2). Margo's Lake Dam blocks access to highest quality anadromous and resident salmonid habitat in the Trout Lake Creek tributary. The Wold Rd/Aug 2 re-regulation system is on the mainstem and blocks resident cutthroat access to the majority of False Bay Creek watershed (WFC 2007, 2008). Besides blocking dams, a map of fish passable, partially passable, and blocking culverts and dams for False Bay Creek watershed is in Figure 2.
3. *Water Quality* – Water quality monitoring (2002-2005) at the culvert under Valley Farm Rd, found Class AA standards exceeded for temperature (<16°C) in 30% of the samples, low dissolved oxygen (DO, <9.5 mg/L) in 30% of the samples, elevated turbidity (>5 NTU over background) in 25% of the samples, and high fecal coliform counts (>50 colonies/100 mL) in more than 50% of the samples (SJICD 2005). Nine samples were collected from September-June. A second sampling site near the mouth found elevated water temperatures in 30% of the samples, and low DO in 30% of the samples.
 - a. Dissolved oxygen levels were low, 4-5 mg/L near Bailer Hill Rd in sampling done December 2016 and November 2018 (Stillwater Sciences 2018).
 - b. High summer stream temperatures in False Bay Creek downstream of Lake Zylstra due to the shallow depths of the two Zylstra Lakes, which warm in the summer, extensive stream ditching in the valley, and poor or absent riparian cover. San Juan Valley Creek dries up in summer.
 - c. Nutrient loading exceeds state water-quality guidelines for fecal coliform due to unfenced cattle access to False Bay Creek downstream Lake Zylstra, and in San Juan Valley Creek. Spread across four landowners, cattle have access to approximately 60% of the lower False Bay Creek riparian corridor. Lower False Bay Creek is 303-d listed for temperature and fecal coliform. Moist soil conditions within or adjacent to streams allow fecal bacteria to stay alive throughout the dry season, causing it to flush to the bay with the first fall rain (Kaufman personal communication 2019).
4. *Salmonid habitat* –
 - a. Intact salmonid habitat exists upstream of the Zylstra Lakes (WFC 2007, 2008, Rot 2018), while less intact to poor salmonid habitat is downstream of Zylstra Lakes and in San Juan Valley Creek (Wones et al 2017). The historical record indicates extensive wetlands in Lower False Bay Creek

- (Pratt 2016). Lower False Bay Creek likely was primarily salmonid rearing habitat, with the majority of historical spawning habitat underneath or upstream of the Zylstra Lakes.
- b. Riparian cover is substantially absent from the lower creek (Wones et al 2017, Figure 2).
 - c. In the 1920's, the County Soil Conservation Service encouraged farmers to plant reed canary grass (RCG) in the valley bottoms. RCG occupies an extensive portion of the riparian corridor, restricting woody shrubs and tree recolonization (Wones et al 2017).
 - d. There is extensive ditching of the stream channel throughout the valley (Wones et al 2017).
 - e. Open range management of the riparian corridor (i.e. streams unfenced) in lower False Bay Creek has created a significantly degraded riparian habitat in a majority of the lower 2.6 miles of False Bay Creek. For roughly 60% of channel length, Cattle have free access to the creek and there are several diversions of creek water into large muddy livestock watering holes.

Recommended Restoration, Protection and Data Collection Actions (Priority actions are **bolded, data gaps are underlined)**

1. *Hydrology* –

- a. Investigate whether there is interest or potential to use either Wood Duck Lake or Lawson Lake to supplement flows. These would be modest fall flow supplements to upper False Bay Creek and Zylstra Lakes.
- b. The Town of Friday Harbor has studied the potential for **adding dam capacity at Trout Lake**. The dam will need to be rebuilt in the coming years for maintenance and to increase height. **A portion of this additional storage could help augment flows for salmonids.**
- c. Lower Lake Zylstra water rights – The San Juan Preservation Trust purchased Zylstra Lakes and surrounding parcels in 2015, including their attached water rights.
 - i. The water rights for the two Zylstra lakes transferred from the Trust to the Land Bank when the title conveyed in 2017. **We recommend flow management of False Bay Creek below Lower Zylstra Lake be modified to favor salmonids and Land Bank priorities** (see below).
- d. Manage flow from upper and lower Zylstra Lakes for fall-winter salmon spawning (chum and cutthroat), and for salmon-outmigration in the spring.
 - i. As of October 17, 2018, leakage thru lower Zylstra dam headworks comprised the only “flow” released into the creek.
 - ii. Zylstra Lakes do not have sufficient volume/depth to fully meet recreation, wildlife, and salmon flow goals (NHC 2017, WWT 2016). There is insufficient water storage for summer salmon-flow releases (see f. below).
- e. False Bay Creek gaging. The lower creek has a gradient of less than 0.2%, finding a gauge site is difficult. A short distance below Bailer Hill Rd is the best site for a gauge in the lower creek, flow data was collected there in 1974.
- f. The minimum summer flows to support salmonids is 3.25-cfs in Land-Bank managed False Bay Creek Preserve upstream of Bailer Hill Rd (Wones et al 2017). By removing/controlling RCG and creating a defined channel, salmonids could be supported by 1-cfs, not currently achievable during the summer (Wones et al 2017). If salmon are to be reintroduced, chum may have the best chance of recovery in the lower creek if spawning habitat can be restored. The addition of one or more refugia ponds may support cutthroat during low flow periods.

- g. Consider raising the height of the Lower Zylstra dam to allow for more water storage, and then manage Lower Zylstra Lake to augment lower False Bay Creek flows for salmon.

2. *Salmonid Distribution and Habitat Connectivity*

- a. **Remove two flow diversions for stock watering ponds and replace with fencing, planting, and off-channel stock watering facilities** (4e below). This has been successfully accomplished on the upper San Juan Valley Creek tributary to False Bay Creek, and on the False Bay Creek Preserve. Fencing cattle out of the creek corridor and planting of trees is needed for the central San Juan Valley Creek on San Juan Preservation Trust land and much of False Bay Creek below Zylstra.
- b. **Introduced bass in Zylstra Lakes should be removed or otherwise screened from entering False Bay Creek.** Bass are known to be significant predators on salmonids. Cutthroats are thought to occur in Upper Zylstra Lake, but their population status and interactions with bass are unknown.
- c. Provide fish passage at the **Wold Rd., Aug-2 re-regulation reservoir on False Bay Creek** for salmonid movement upstream of Zylstra Lakes. 2b would need to precede this action.
- d. Investigate the cost to provide fish passage to Upper and Lower Zylstra Lakes to see if it is feasible and cost-effective.
- e. Survey the entire watershed for salmonids and identify stocks.
- f. **Consider chum reintroduction in lower FBC following implementation of bolded items and salmonid distribution survey.**

3. *Water Quality*

- a. **Fence livestock out of the floodplain to prevent further destruction of the channel bed and banks and to promote riparian recovery.** Provide off-stream watering facilities.
- b. The Washington Department of Ecology (WDOE) should enforce water quality regulations for all landowners to ensure compliance with state law. The San Juan Islands Conservation District (SJCD) has cost-share funding to assist with fencing and off-stream watering.

4. *Salmonid habitat*

- a. **Revegetate with native trees and shrubs to reduce stream temperatures.** Priority areas include:
 - i. Most of False Bay Creek from Zylstra Lakes downstream to Bailer Hill Rd.
 - ii. Portions of the private property downstream of Bailer Hill Rd (Reach F2, Wones et al 2017) to the UW-owned False Bay Biological Preserve.
 - iii. San Juan Valley Creek channel from confluence to near San Juan Valley Rd (Reaches S1-S5, Wones et al 2017).
 - iv. Plant conifers on the south and the west shores of Upper Zylstra Lake, leaving north and east shores of upper Zylstra open for recreation access.
 - v. Plant conifers and/or shrubs/wetland species along both shores of Lower Zylstra Lake.
- b. **Control noxious weeds**, there are extensive areas of RCG along with European Hawthorne and Himalayan Blackberry in the riparian corridor.
- c. **Protect high quality spawning habitat upstream of Zylstra**, portions of Lawson Lake tributary and Nettle Creek tributary. This will benefit resident cutthroat.
- d. Consider and manage portions of the channel network as degraded riverine wetlands, instead of a single-thread stream corridor. Much of False Bay Creek downstream of Lake Zylstra falls into this category.
- e. There is potential for spawning habitat rehabilitation downstream of Bailer Hill Rd that would following cattle fencing. A SJCD fencing project (currently funded but not yet implemented)

- includes revegetation of riparian trees and shrubs, off-stream watering, and placement of one or two cattle crossings. Stream gravel augmentation should be assessed.
- f. Consider **beaver reintroduction or installation of beaver analog log structures** to the riverine wetland portions of the channel network. Land Bank properties provide suitable demonstration sites.

Garrison Creek

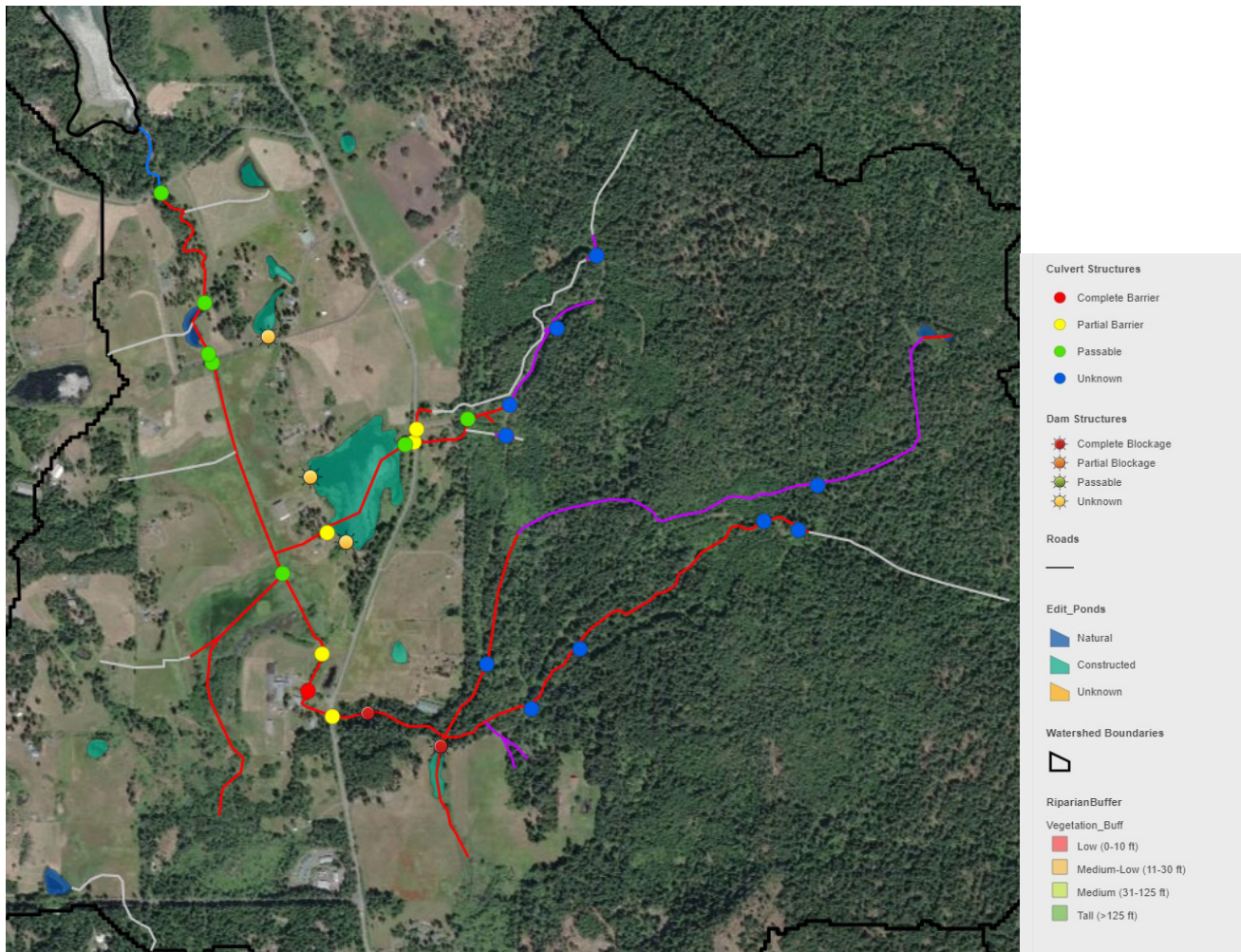


Figure 3. Garrison Creek watershed. Type “F” channels are mapped fish bearing with known fish presence or width/gradient characteristics for fish. Watershed assessment White (2010).

Up to the 1960’s, the Garrison Creek lowlands included several large ponded wetlands with nearby forested patches; it was managed as a 600-acre duck hunting club (August 2010, Sawyer personal communication 2018). The 600-acre duck club was purchased by a Seattle developer in the mid-1970’s who logged the property, burned it, grazed it with 300-400 cattle, and constructed the 12- acre Trout Lake. In the mid-1980’s he began excavating an unpermitted lake south of Blazing Tree Rd and north of The Clearing. Before regulators halted construction, an unknown amount of wetland was destroyed or modified (August 2010, in White 2010).

Maps show a ditched valley bottom wetland initially in 1894 (White 2010, see Rot 2018), and in aerial photos through 2016 (August 2010, in White 2010). A newly acquired 1932 aerial photo by San Juan County Public Works shows the valley-bottom creek distinctly ditched with the majority of the valley bottom in pasture or widely scattered shrubs or small trees. The cleared wetland area seen in the 1894 map and the 1970 aerial photo are similar in shape in 1932. There were no ponds visible in the watershed in 1932.

Garrison Creek is home to one of two *known* genetically unique cutthroat stocks in the San Juan Islands, .the other is Doe Bay Creek, Orcas, (Glasgow et al. 2016).

Limiting Factors to salmonid recovery:

1. Hydrology

- a. From 1970 through 2007, at least 13 ponds were constructed in the watershed. These ponds mostly capture flow from the east, draining Mitchell Hill. The ponds largest impact is to the lower creek, which is seasonally dry.
 - i. HECRAS flow models show no flow between June and October at the confluence of Trout Lake creek and Garrison Creek. Observationally, Garrison Creek is dry in the summer from Blazing Tree Rd upstream to States Inn (pg. 59-60., White 2010). The creek is perennial downstream of Blazing Tree Rd and upstream of West Valley Rd. (AESI 2010, in White 2010).

Table 1. Garrison Creek modeled peak flows for the County West Valley Rd and Yacht Haven culverts (McCarthy, in Appendix E, White 2010).

Flood return period (yrs.)	West Valley Rd. culvert (cfs, near The Clearing)	Yacht Haven Rd. culvert (cfs)
2	15	32
10	31	62
50	47	94
100	55	108

2. Water quality

- a. High stream temperatures are likely when the creek is still flowing in early summer. Fecal coliform or excessive nutrients are suspected impacts to water quality (Stillwater Sciences 2018). WA Dept. of Ecology list this watershed as a Category 2, *waters in this category have some evidence of a water quality problem, but not enough to show persistent impairment*. From Ecology 1997 DO measurements show some excursions above water quality standards. No more recent data for this watershed.

3. Salmonid Distribution and Habitat Connectivity

- a. During winter coastal cutthroat trout (CCT) rear from the lower valley around Blazing Tree Rd. to upstream of West Valley Rd. During the summer CCT are found on The Clearing property and

upstream of West Valley Rd. This upper habitat area may serve as low-flow refugia (Barsh 2010).

- b. Four CCT redds have been observed, two directly downstream of West Valley Rd and two upstream of West Valley Rd. Another adult carcass was observed just upstream of Yacht Haven Rd. Consider these two sites core-spawning areas (Glasgow et al 2016).
 - c. There were 13 ponds constructed in the watershed from 1970 through 2007, with the 12-acre Trout Lake as the largest. Trout Lake is shallow, unscreened, and has bass and introduced rainbow trout (White 2010).
 - d. Locals observe the channel goes dry upstream of Blazing Tree Rd in summer.
 - e. Thirty-four culverts were identified in the Garrison watershed, four culverts are barriers and 14 are partial barriers (p. 46, White 2010). Two of the barrier culverts are upstream of West Valley Rd. and upstream of the waterfall on the main channel. One barrier culvert is located on the north tributary upstream of the road. The fourth barrier is on a small tributary on Penny Ln. These four culverts are in portions of the stream network with low CCT impact. Two primary barriers to fish passage to consider are.
 - i. A blocking dam on the main channel a short distance upstream of the West Valley Road (Figure 3).
 - ii. Several partially to fully blocking culverts on The Clearing property (Figure 3).
 - iii. The W. Valley Rd. culvert above The Clearing is undersized and a partial barrier to fish passage. The bank full width at that crossing is roughly 7ft., WDFW would require a culvert at 10-11 ft. diameter. The existing culvert span is 2.5 ft., and is too undersized to pass large flood events (see Table 1, White 2010). Barsh (2010) described this culvert as partially collapsed. This becomes even more critical if the dam upstream from the crossing is removed, as sediment will mobilize when the channel adjusts (Glasgow, personal communication 2018).
4. *Salmonid habitat* Garrison Creek is channelized upstream of Blazing Tree Rd and downstream of the The Clearing through historic and current wetlands, and has been ditched for over 120 years (White 2010). Not coincidentally, the same reach between The Clearing and Blazing Tree Rd is the reach that flows seasonally each year. Despite ditching, this area was high quality waterfowl habitat through the 1960's, and used by a duck-hunting club. Currently this ditched and degraded wetland section of the Creek goes dry by June.

The channel downstream of Blazing Tree Rd has maintained natural meanders, otherwise salmonid habitat is poor-fair lacking large wood and adequate riparian cover

Recommended restoration or protection actions (**priority actions bolded**, data gaps underlined)

1. *Hydrology*

- a. **Increased flow from Trout Lake** A hydraulic analysis of Trout Lake showed that by raising lake levels from 1.1 to 2 ft., the best-case scenario increased flow from the lake by 0.1 cfs (vs. its current 0.01 cfs) from June to mid-July (McCarthy 2010, in White 2010). That is not enough by itself to benefit rearing salmon, but it could improve stream habitat (Obedzinski et al. 2018). A better flow strategy than summer release is a fall release from October and November to provide flows for fall spawning. A fall release would avoid summer higher temperatures and

potential stranding by cutting off flows in mid-July. This alternative by itself is a modest step towards enhancing flow. For serious consideration, invasive bass and hatchery rainbows must be screened from leaving the lake and entering Garrison Creek.

- b. More discussion on mitigating a dry channel reach in a small watershed with naturally low summer flows is found below.

- c. **Gauge stream flows and develop an instream-flow study for native CCT.**

2. *Water quality*

- a. Collect more water quality data. Two samples were collected and analyzed, more data is needed (Stillwater Sciences 2018).
- b. Temperature. Murphy (2010, pgs. 75-81, in White 2010) completed a revegetation plan to accompany a proposed re-meandered stream channel for the larger Garrison Creek restoration plan. As a **stand-alone complete riparian restoration for the current ditched channel in the valley, this is a low-cost option to improve water quality (temperature and nutrients) of a degraded channelized system.** This option by itself will also modestly improve salmonid habitat, mostly by shading out RCG.

3. *Salmonid Distribution and Habitat Connectivity:*

- a. **Remove the blocking dam upstream of West Valley Rd.** – the previous landowner was reportedly unsympathetic to removing this dam, and the property sold in May 2018. Recommend contacting the new owners to see if they are interested in dam removal. This dam is not in use and is a block to cutthroat access to the upper watershed. Cutthroat spawning and rearing are occurring just downstream of the dam (White 2010).
- b. Survey CCT throughout the watershed to determine their range. Work with the headwater landowner, the National Park Service, to investigate whether their upper range can be extended through blocking culvert replacement.
- c. **Replace The Clearing partially blocking culverts**
 - i. The two highest ranked culverts for replacement are seven feet apart, and downstream of the The Clearing at the property boundary. Each site has a 30% design completed to replace the culvert with a bridge (White 2010).
 - ii. The third highest ranked culvert for replacement (White 2010) is the The Clearing driveway culverts, which are actually four side-by side culverts, all perched. The culverts are fish barriers at lower flows. The pool formed downstream by the perched culverts is important summer refugia habitat so **carefully design this culvert replacement to retain forcing mechanisms that create the pool.** The pool inlet should have a perpendicular log or rock structure at grade that will continue to scour the pool below.
- d. **Replace San Juan County, West Valley Rd. culvert** (see 3.e.iii above).
- e. The other partial fish barriers in White (2010) were not a high priority for replacement.
- f. **Screen Trout Lake** to prevent escapement of planted bass and rainbow trout. A sharp-crested weir, a 2x12" board, regulates the pond level (White 2010). It is not clear if non-native fish have access to downstream areas (WFC 2007).

4. *Salmonid habitat:*

White (2010) presented three channel re-meandering alternatives for the area between Blazing Tree Rd and The Clearing. It is impossible to know exactly what historical conditions were at this site prior to ditching in the late 1800's (White 2010). When the restoration project was proposed for funding through the Salmon Recovery Funding Board (White 2010), digging a meandering channel to replace the

ditched channel was not locally supported. The biggest issue in this reach is the channel is seasonally dry and the technical group did not see the connection between this action and improving flows. The hydrogeologic report from Associated Earth Sciences also is silent on whether a re-meandered channel would improve flows (AESI 2010, in White 2010).

However, the record supports that what is now a ditched wetland was also historically a wetland (White 2010). In these relatively flat wetland complexes, the channel is undefined because there is very little stream power to create a defined channel bed. A more effective strategy for lower Garrison Creek would be wetland restoration rather than channel restoration at a site without sufficient stream power to maintain a single thread channel.

The easiest and lowest cost restoration strategy is to leave the ditch in place and enhance the current surrounding wetland habitat. One option is to **install log structures to create ponding coupled with riparian/wetland planting**. The ponds created by the log structures are limiting habitat in this part of the watershed. Woody vegetation planting on the wetland perimeter would create future shade, high temperatures is also another limiting factor. Landowners would need to approve this recommendation.

Orcas Island

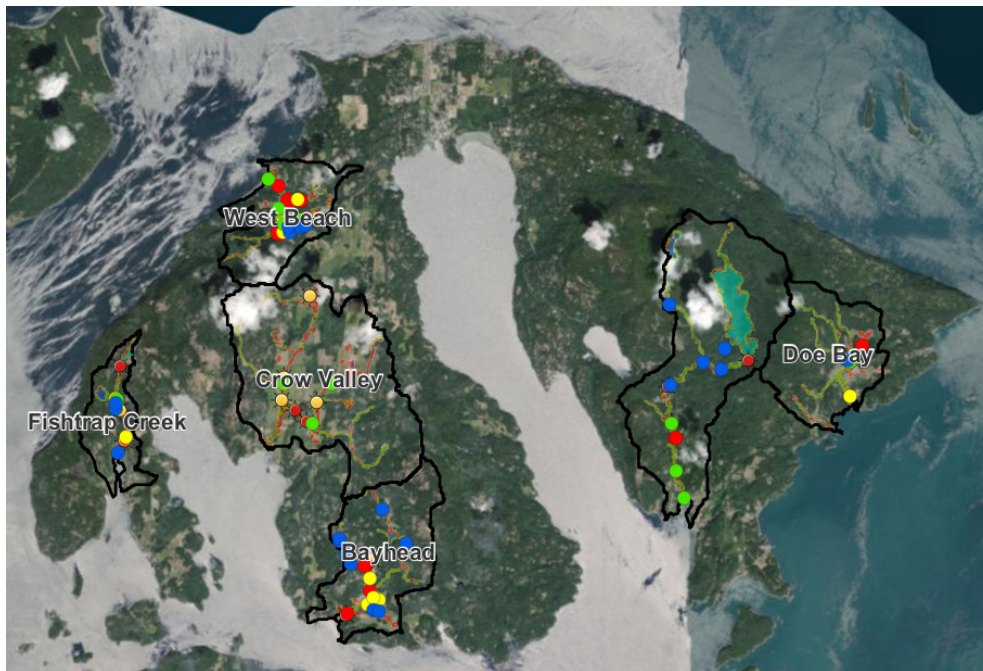


Figure 4. Orcas Island watersheds in order of discussion: West Beach, Fish Trap, Crow Valley, Cascade (name hidden), Doe Bay, Bayhead Creeks.

Table 2. Monthly **precipitation** in inches at Orcas Island station on the west side of Mt Constitution to put in context flow data collected 2017-2018 for five Orcas watersheds (West Beach, Fish Trap, Crow Valley, Cascade, and Doe Bay). **A.** November 2017-December 2018 (Weather Underground, Orcas airport weather station), **B.** Jan-Dec for 1974 (Russell 1975), with **C.** monthly averages from Olga (1981-2010, US Climate Data).

	Dry Year Nov 2017-Dec 2018 A	Average Year Jan-Dec 1974 B	Monthly Average (1981-2010) C
November	0.99		
December	1.06		
January	1.1	5.81	3.94
February	0.68	3.75	2.4
March	0.59	2.95	2.32
April	0.76	2.01	1.89
May	0.04	2.53	1.81
June	0.24	0.93	1.3
July	0.17	2.4	0.79
August	0	0.03	1.06
September	1.03	0.24	1.34
October	1.17	2.1	2.95
November	3.34	4.11	4.8
December	3.4	4.09	3.54
Jan-Dec total	12.52	30.95	28.14

West Beach Creek

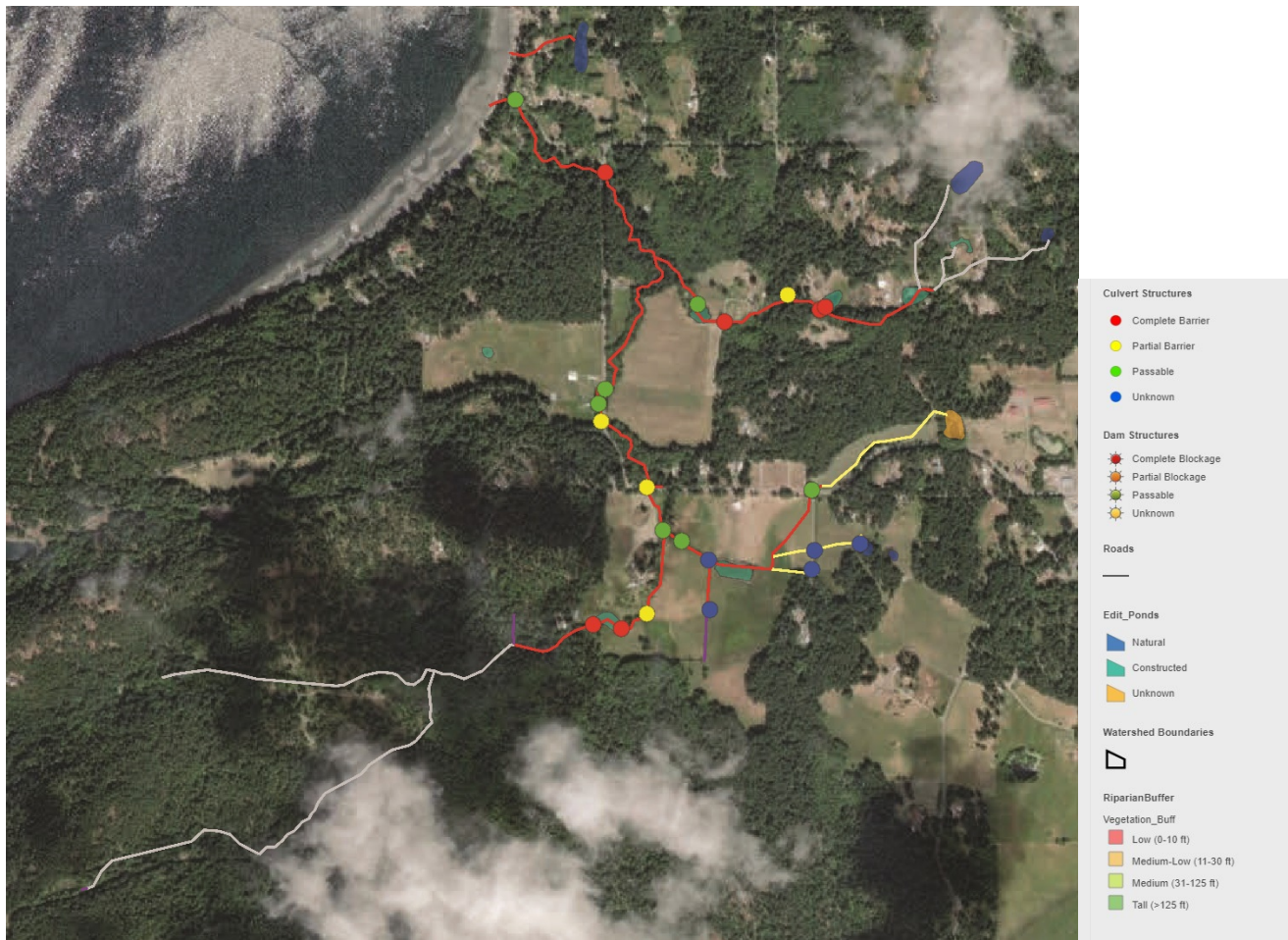


Figure 5. West Beach Creek watershed with mapped culverts and pond. “F” San Juan County Streams are fish-bearing or have fish-bearing potential. Culvert and channel typing assessment WFC (2008).

As recently as 2008, CCT were readily observed in lower West Beach Creek (Barsh 2010), however no cutthroat were observed during a survey of the same reach in 2014, following removal of the a perched culvert and downstream-most pond as part of a fish passage restoration project. It is unknown whether CCT still exist in West Beach Creek watershed.

Limiting Factors to salmonid recovery (data gaps underlined):

1. *Hydrology*: West Beach Creek is a small perennially flowing, spring-fed creek. A decade ago flows were observed year-round at creek mouth. A small amount of water flowed in the creek throughout summer of 2018, but the flows were too low to measure (Table 3, De Groot, personal communication 2018).

Table 3. West Beach Creek discharge (2017-2018 and 1974. The 2017-2018 flows were measured at RM 0.25, upstream of West Beach Rd. (STC 2018). The 1974 spot flows were measured at RM 0.1 (Russell 1975). "NM" means not measured.

Date	2017-2018 discharge (cfs)	1974 discharge (cfs)
November	0.06	NM
December	0.96	NM
January	NM	6.01
February	3.41	2.73
March	0.91	1.59
April	0.96	0.62
May	NM	NM
June	0.08	0.47, 0.05
July	trace	0.02
August	trace	0.01
September	trace	0.01
October	0.06	0.02
November	0.12	0.17
December	0.96, 0.67	0.24

- a. The most-downstream tributary from the east has five ponds, which passively trap fall rains until overflowing. Between three to all five of the ponds are constructed (Figure 5).
 - i. Working upstream, pond-1 is owned by a longtime area family.
 - ii. Can ponds 2-5 be adjusted to release flows before entirely full?
 - iii. The stream is brushy and indistinct upstream of pond-1 and Cadden Ln. driveway, and disappears upstream of pond-2 (Figure 5).
 - b. The only constructed pond on the main channel traps watershed runoff from the Land Bank Turtle Back Mtn. Preserve. This pond is fish impassable (Figure 5).
 2. *Water quality – this watershed is not monitored for water quality.*
 - a. Pond on second upstream tributary that flows from the east – cattle have access to this pond.
 3. *Salmonid Distribution and Habitat Connectivity*
 - a. Biologists observed 30-40 chum young of the year at the mouth of West Beach Creek in May 2008 (WFC 2008). Cutthroat were captured upstream and downstream of the lowest County West Beach Creek culvert, and a bass was caught near the fourth West Beach Rd culvert, up from the mouth (WFC 2008). Current salmonid fish distribution throughout the watershed is unknown.
 - b. There are 18 culverts in the Type F channel (fish bearing or potential fish bearing) portion of the watershed. Table 4 lists known fish passage barriers.

Table 4. West Beach Creek fish passage barriers.

Fish Passage barriers	Location	Status
West Beach Rd culvert, San Juan County	Lowest West Beach Rd. culvert.	2019 replacement
Two hydro generating stations dewater the channel for a short distance, private	Lowest tributary, one downstream of the first pond, 2nd just upstream of Caddis Ln.	Observed 2008, status unknown (WFC 2008)
2 nd pond upstream from main channel, very little flow above 2 nd pond, attributed to sand mining and channel alteration. 2 nd pond is 25 ft. deep. Both private	Lowest tributary, ponds numbered from downstream.	Observed 2008, status unknown (WFC 2008)
Private drive off of Cadden Ln., private	Between 1 st and 2 nd pond on lowest tributary.	Observed 2008, status unknown (WFC 2008)
Upper West Beach Rd culvert, San Juan County	3 rd upstream culvert in-group of three (Figure W1).	Low-flow barrier (WFC 2008)
The only pond on the main channel, upstream of West Beach Rd, and near Strugglers Hill Rd, private	Just downstream of Turtleback Mtn. property.	Three blocks. Both the pond inlet and outlet are blocking, as is the sheet metal-lined pond outlet channel (WFC 2008).

- c. In the second upstream tributary pond (see 2a), rainbow trout were planted here the 1920's, and it is possible these fish naturalized in the creek (Barsh personal communication). The road crossing just downstream was reportedly a good place to catch fish. Are rainbow trout still in this pond? With a fish-friendly outlet, the pond could be CCT rearing habitat (WFC 2008).
- d. Two culverts under West Beach Rd upstream of the lowest tributary and one driveway culvert are undersized at 3 ft., and the downstream two culverts are fish passable at low flows. They may be barriers at higher flows. The upper of the three culverts is in Table 4.

4. *Salmonid habitat*

- a. In 2014, a salmon restoration project removed the blocking culverts forming the lower pond on the main channel. Maintaining-pool refugia for CCT was not part of the fish-passage restoration design.
 - i. The former pond apparently provided summer refugia for CCT.
 - ii. The restoration project reportedly did not salvage salmonids and other fish from the pond prior to construction.
- b. Former pond at the outlet of West Beach Rd culvert. In 2007-2008, this pond was the main observed summer refugia for CCT. Between 2008 and 2014, the pond filled in with sediment and no longer provides refugia.
- c. Riparian cover is needed upstream of the fourth West Beach Rd culvert, on both mainstem and tributary (Figure 5).

*Recommended restoration or protection actions (priority actions **bolded**, data gaps underlined).*

1. *Hydrology*

- a. **Install log structures** on Turtleback Mtn. Land Bank property and private landowner (if willing) to increase fall-winter water storage and summer low-flow release.
- b. **Obtain adequate fall flows earlier from the highest constructed pond** on the main channel downstream of Turtleback Mtn. preserve. This is the only mainstem pond, a high priority.
- c. Do the two hydro stations on the first tributary have water rights (Table 4)?

2. *Water Quality*

- a. Channel very brushy upstream of West Beach Rd. **Plant trees and shrubs on West Beach Creek mainstem and tributary upstream of 4th West Beach Rd. culvert.** Fence cattle out of creek (suggest SJICD assistance, Figure 5).

3. *Salmonid Distribution and Habitat Connectivity*

- a. Survey watershed for CCT presence and distribution.
- b. Survey watershed for invasive fish such as bass.
- c. **On lowest tributary, improve fish passage to driveway upstream of lowest pond.** Lowest pond is fish passable.
- d. The three partially blocking culverts are a lower priority for replacement due to minimal additional benefit to salmonids.

4. *Salmonid Habitat*

- a. Create summer low-flow refugia. **Create a pool with a log forcing mechanism and/or rock near the mouth, at the lowest culvert replaced in 2014.**
- b. As part of the San Juan County West Beach Road culvert replacement project, **a refugia pool will be constructed** downstream .
- c. Survey ponds in watershed for location and capacity to retrofit for CCT access to increase summer refugia habitat.
- d. **Recommend riparian protection, such as Conservation Easement for properties upstream and downstream of West Beach Road culvert if property owners are willing.**

Fish Trap Creek

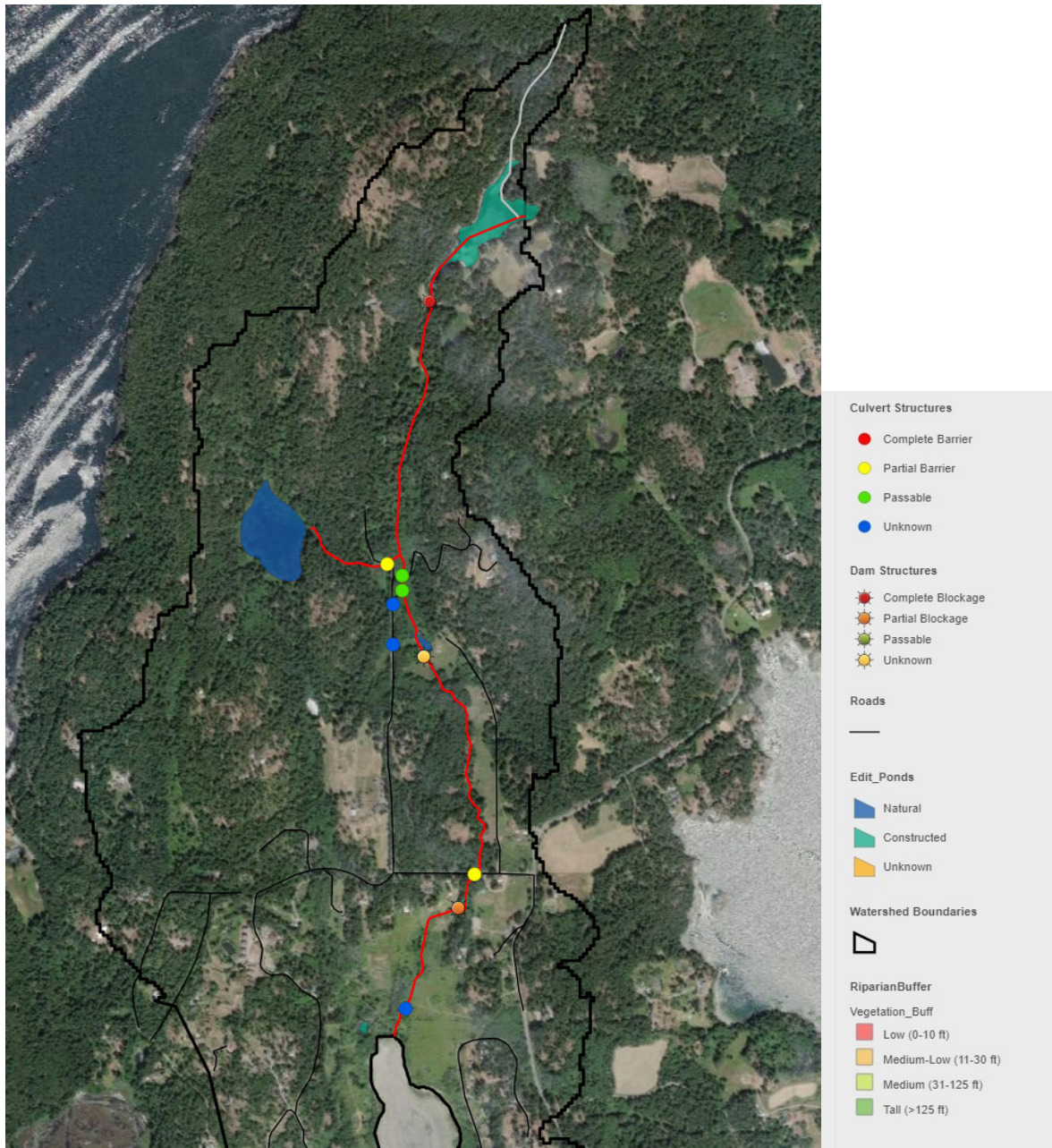


Figure 6. Fish Trap Creek watershed with mapped culverts and ponds. “F” San Juan County Streams are fish-bearing or have fish-bearing potential. Habitat and channel typing assessment WFC (2004).

About 150 years ago, Fish Trap Creek was reported as the *largest stream on Orcas Island* (Kennerly 1857). As recent as the 1940’s, residents remember “fish running thick up Fish Trap Creek” (Williams, in Deer Harbor

Restoration Project Team, 2005). The *Fish Trap* name comes from the historic Coastal Salish tidal fish trap located near the creek mouth, in Cayou Lagoon.

A large headwater bog was drowned in 1976 with the construction of a dam at that site, the dam was expanded in 2000. From 1976 to present, all of the flow from the headwaters of Fish Trap Creek was diverted into another watershed, Skull Creek. A 2018 mitigation agreement between the family that owns the dam and Washington Department of Ecology (WDOE) requires the return of fall and winter flows into Fish Trap Creek. A spillway culvert in the dam was installed in 2018, its elevation set below the outlet headworks to Skull Creek.

Limiting Factors to salmonid recovery (data gaps underlined):

1. *Hydrology:*

A stream gage installed in Fish Trap Creek below the Cormorant Rd. culvert, and spot flow measurements taken in Skull Creek at the Deer Harbor Rd. culvert show the impact of diverting Fish Trap Creek flows into Skull Creek. For the past 42 years, headwater flows from Fish Trap Creek were diverted into Skull Creek. As of December 25, 2018, flows from the headwater dam are still being diverted into Skull Creek (STC 2018, Table 5). Flows were reintroduced from the headwater pond into Fish Trap Creek in April 2019.

Table 5. Fish Trap Creek discharge (2017-2018) and Skull Creek discharge (2017-2018 and 1974, STC 2018 and Russell 1975). Fish Trap Creek measured with a continuously recording in-stream gauge just downstream of Cormorant Rd. and Skull Creek flows measured downstream of the Deer Harbor Rd culvert. Through this monitoring period, flow from the Fish Trap Creek headwater pond was diverted into Skull Creek. "NM" is not measured.

Date	Stream flow (cfs)		
	Fish Trap Creek 2018 (cfs)	Skull Creek 2018 (cfs)	Skull Creek 1974 (cfs)
January	NM	NM	3.73
February	NM	NM	0.93
March	0.35, 0.23	1.17, 0.54	0.93
April	NM	NM	0.31
May	0.19	0.91	NM
June	0.017	0.00	0.31, 0.02
July	0.00	0.00	0.00
August	0.00	0.00	0.00
September	0.00	0.00	0.00
October	0.00	0.00	trace
November	0.016	0.021	0.01
December	0.07	0.44	trace

- a. In addition to the headwater dam, three other ponds trap flows and regulate discharge to Fish Trap Creek:
 - i. Treacy's Pond, contributes flows as the only tributary to Fish Trap Creek (enters at about 4500 ft. from the creek mouth), and is also a natural historic bog similar to the bog the

existed before headwater dam. This pond is not a fish passage barrier, however the lower tributary below the pond has filled in with sediment and the stream flows are subsurface.

- ii. A large excavated private pond about 3750 ft. from the creek mouth exposes groundwater to surface temperatures (not a fish passage barrier)
 - iii. The lower private pond at about 1290 ft., below Cormorant Rd was repaired fall 2018 from a total barrier to a partial barrier.
2. *Water quality* – was measured near the mouth for 2003-2005. Class AA standards were met for DO, pH, turbidity, and fecal coliform. Elevated temperatures (>16°C) were found in 50% of the samples (SJICD 2005). Temperature was spot measured at 21°C at the outlet flow from Bullocks ponds on May 18, 2004. It is expected the other ponds have similar temperatures.
3. *Salmonid Distribution and Habitat Connectivity*

Table 6. Fish Trap Creek culverts. See Figure 6 for information on fish passability.

Culvert location	Dist. from mouth (ft)	Culvert diam. (ft.)	Culvert length (ft.)	Culvert grade (%)	Culvert type	Max pipe flow (King Cty 1979) ¹	Comments
Dam - private	6700	1.5	Unkwn.	Unkwn.	Unkwn.	Unkwn.	All fall-winter flows will be released to Fishtrap Ck. under 2.5 cfs
Tributary to west	4500	75-100 ft. plug of sediment near confluence	NA	NA	NA	NA	Buried channel on tributary
Penny Lane - private	4350	1.5	20	-0.3	CMP	8.6 cfs	
Private drive, 3 side by side culverts	4230	1.0 (x 3)	21	0.1	HDPE - smooth	10.5 cfs	3.5 cfs each
Cormorant Rd - County	1650	1.5	45	4.9	Concrete and CMP	8.6 cfs	
private dam – downstream of Cormorant Rd ¹	1290	NA	NA	NA	spillway	Unkwn.	Pond outlet repaired fall 2018, now partially fish passable
Private culvert near creek mouth			Unkwn.	Unkwn.	Unkwn.	Unkwn.	

¹ Projecting culvert capacity at upstream end, Hw/D=1.5 (King County 1979). This is max flow and not fish passable flow.

Just seven culverts are located in the watershed (Table 6), culvert fish passability is in Figure 6.

4. *Salmonid habitat*

For 42 years, Fish Trap Creek has not experienced the natural fall and winter high flows that are necessary to maintain salmon habitat. During that time, flows have been limited to dam seepage and groundwater input. Riparian leaf fall has undoubtedly created deposition within the historic defined channel. As a result, spawning gravels are virtually non-existent throughout the main channel. With the reintroduction of fall-winter flows, spawning gravels buried by leaf-fall should be re-exposed in the coming years.

Large woody debris, pools, and spawning gravels are sparse throughout the watershed (WFC 2004), likely the result of headwater flow diversion. Just three areas have spawning gravel totaling only 120 ft. of channel length (WFC 2004).

The lower 3000 ft. of channel has extensive ditching for what appears to be more than 50% of channel length. Channels are ditched to drain wet soils so they can be put to other uses, such as grazing.

A few areas of the main channel have horse/livestock access and/or poor riparian cover (Table 6). Most of this is downstream of 1450 ft., or from roughly 2250-3300 ft.

Table 7. Fish Trap Creek riparian cover

Distance (ft.) from mouth	Lack of riparian cover (via aerial photo, GIS, and WFC 2004)
3600	In-channel pond with poor riparian cover to south and narrow vegetated corridor for 230 ft. downstream along Fish Trap Creek.
3300	About 100 ft. ditched channel open to livestock and unvegetated.
2250-3300	Half dozen or so short ditched and grass/shrub vegetated areas, roughly 300 ft. Mostly young conifer and deciduous trees.
1200	Blackberry mostly cleared, needs to be replanted with trees and shrubs, about 200 ft.
900	Sparse riparian cover, ditched about 450 ft.
600	Sparse riparian cover, ditched, about 1400 ft.

Recommended restoration or protection actions (priority actions bolded, data gaps underlined).

1. *Hydrology:*

During Fall 2018, the family that owns the headwater dam and WDOE came to agreement to reintroduce flows into Fish Trap Creek. An 18-inch spillway culvert was installed into the dam to allow for passive releases. All flows up to the 5-year flood event (projected 2.5 cfs) are to discharge to Fish Trap Creek. Above 2.5 cfs, Fish Trap Creek flows are split with Skull Creek. For the past 42 years, all flows have been

diverted into Skull Creek watershed, a much smaller basin than Fish Trap Creek. WDOE estimates this will return all flows in 4 out of 5 years, with 90% of flows returning to Fish Trap Creek.

Washington Department of Fish and Wildlife (WDFW) has recommended to WDOE that the spill from the dam should begin at 1.5 cfs and ramp up over time as the channel weathers in. The TAG recommended a fish screen be installed prior to flow reintroduction, the screen was installed in March 2019. Flows at 0.5 cfs were released into Fish Trap Creek starting April 14 2019 (WDOE 2019).

a) Monitor flows at the dam to help the landowner follow WDFW recommendations

2. *Water quality* – plant at least a 50 ft. riparian buffer in the stream corridor lacking trees and shrubs (see 4b).
3. *Salmonid Distribution and Habitat Connectivity*
 - a) **Create full fish passage at lowest pond** (Table 5, Figure 6). As of Fall 2018 the pond outlet was retrofitted and yet is likely still a partial block to fish passage (at 1290 ft. upstream of the mouth). With further funding the owners are interested in creating fish passage to their pond.
 - b) **Cormorant Bay Rd culvert replacement** (Table 5, Figure 6). This is the lowest culvert in the system (at 1650 ft. from the mouth) and below relatively steeper habitat directly upstream. At about 4% grade, it is too steep to be fish passable per WDFW guidelines, and at 18 inches the culvert is undersized to pass flood flows (Smayda 2005) and should be replaced.
 - c) **Reopen Treacy Pond tributary buried channel** (Table 5, Figure 6). Reopen the buried channel just upstream of Deep Meadow Ln., about 75-100 ft. of buried channel. This tributary supplies a significant portion of flow into Fishtrap Creek
 - d) Two private culverts, Penny Ln and private drive directly downstream (Table 5, Figure 6). Monitor culverts as headwater flows are released. As funding is available, replace with larger culverts. Gauge landowners' interest
 - e) Look for funding as a package for 3a-d.
 - f) Determine fish species presence in the three watershed in-channel ponds.
 - g) Survey watershed for cutthroat presence and distribution.
 - h) Monitor channel geometry and connectivity as the channel accommodates newly restored flows.

The 2004 survey did not find any fish in this watershed due to lack of flows (WFC 2004). Once flows have been restored and 3a. is completed, there is an opportunity to return salmonids to this watershed. Potential species are chum, coho, and cutthroat. Discussion with Samish elders would be helpful to understand culturally important species and their restoration goals.

4. *Salmonid habitat*

Prioritized salmon habitat projects (some from WFC 2004).

- a) **Secure conservation easements from interested landowners.** Prioritize longest contiguous properties to the creek downstream of the dam. There are only a handful of Fishtrap Creek landowners in this basin.
- b) Assess availability of spawning gravels with return of flows.

- c) **Install Post Assisted Log Structures (PALS) by hand at multiple places** in the channel network, focusing in the lower 2200 ft. below the cascade. These will encourage scour and provide in-channel salmonid habitat.
- d) **Plant conifers and shrubs** downstream of Cormorant Rd to mouth, around the mid-watershed pond, and the other scattered places that lack riparian cover.
- e) **Plant salt-tolerant shrubs and small trees around Cayou Lagoon.** Seventy five percent of the lagoon is under conservation easement held by the San Juan County Land Bank. The first planting some years ago, did not survive. Currently the lagoon buffer is mowed, which should be modified to allow a second planting.

Crow Valley (West Sound) Creek

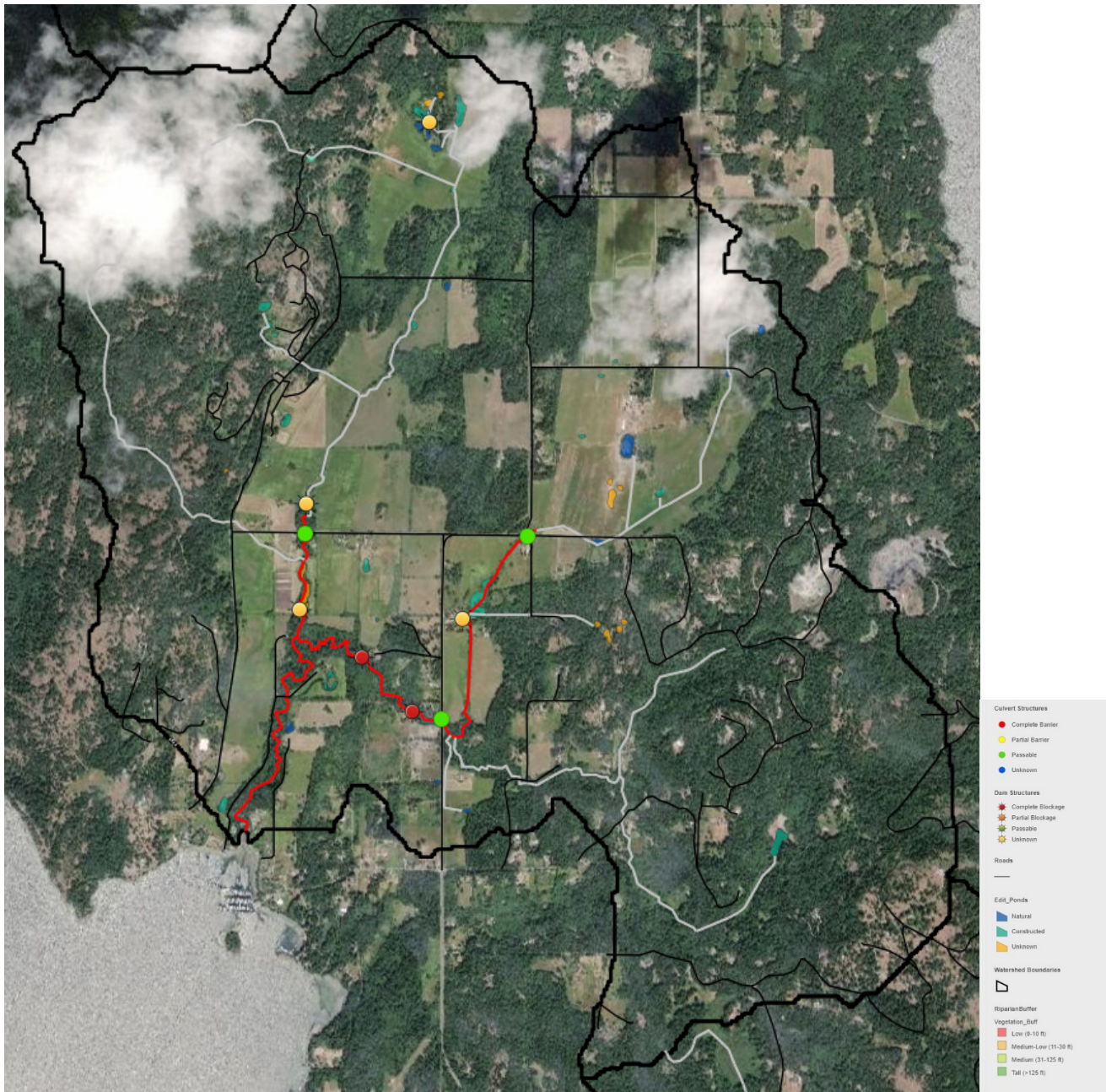


Figure 7. Crow Valley Creek watershed with mapped culverts and ponds. "F" San Juan County Streams are fish-bearing or have fish-bearing potential. Culvert and channel typing assessment WFC (2007).

The primary land use in Crow Valley is agriculture. This is the largest watershed on Orcas Island at 5.29 mi². Major limiting factors include agricultural water use, in-channel ponds that capture low flows, and poor water quality. The best salmonid habitat is the lower mile of stream.

Limiting Factors to salmonid recovery (data gaps underlined):

1. *Hydrology*: In a June 18, 1999 survey, all the flow in Crow Valley Creek was confined to the mainstem which originates on Mt. Woolard to the east (Endicott and Azous 1999). There was no flow coming out of the tributary to the north that originates off Turtleback Mtn. The first pond on the north tributary is Hungar's Pond. This pond captured all the flow on June 18, 1999. Estimated storage of Hungar's Pond, Old Trout Inn, and Shaeffer's Lake (upstream of Old Trout Inn) were a combined 400,000 ft³ (Endicott and Azous 1999). Old Trout Inn pond remains full all summer. The three ponds amount to 18 days of flow, at 0.25 cfs, if the three constructed ponds were fully drained. There is not enough storage to keep the creek flowing through the summer.

A continuous monitoring gage is located about 0.1 miles upstream of West Sound (Table 8). Crow Valley Creek is currently seasonal, and it is unknown whether Crow Valley Creek was historically seasonal or perennial. There are 10-12 constructed in-channel ponds, which increase evaporative losses in the summer, and delay initiation of flow in the fall (Figure 7).

Table 8. Crow Valley Creek discharge, 2017-2018 and 1974 (STC 2018 and Russell 1975).

Date	2017-2018 discharge (cfs)	1974 discharge (cfs)
November	0.25, 1.39	NM
December	0.79	NM
January	NM	17.01
February	8.29	11.29
March	1.75	3.55
April	1.44	1.09
May	NM	0.27
June	trace	0.01
July	NM	trace
August	trace	trace
September	trace	trace
October	trace	trace
November	0.05	trace
December	1.52	0.21

2. *Water quality* – this stream is listed as Category 2, Waters of Concern, on the WDOE list of impaired waterbodies (303-d list). Water bodies with a Category 5 require a TMDL (total maximum daily load) water quality improvement project. WDOE cited 1997 as the most recent data used to make their determination.

The San Juan Islands Conservation District collected data at the mouth of Crow Valley Creek. For 2002-2005, Class AA standards were met for pH and turbidity. Temperatures were elevated in 25% of the samples (Sept-June), low DO was in more the 40% of the samples, and high fecal coliform was in 25% of the samples (SJICD 2005).

A contractor for San Juan County monitored water quality near the mouth in February and April of 2018 (Stillwater Sciences 2018). February fecal coliform at 14 CFU/100 mL was within freshwater limits of 50 CFU/100 mL. The April sample was less than 2 CFU/100 mL. Water quality sampling should be conducted during high precipitation/flow events particularly “first flush” in the fall (Stillwater Sciences 2018).

3. *Salmonid Distribution and Habitat Connectivity* - At RM (river mile) 0.5, downstream of the forks, there is a 6-8 ft. natural bedrock cascade (Endicott and Azous 1999, Rot personal observation 2019). This is a potential anadromous barrier, at least to chum (Endicott and Azous 1999). On the main channel to the east, the first known fish passage barrier, a 10 ft. concrete dam is located, at RM 1.0, Elliott’s pond. At RM 1.5, a 25 ft. concrete dam is located at Old Trout Inn. This pond extends under Orcas Rd. Locals have stated that Hungar’s pond, on the north fork, is also impassable to salmonids.
4. *Salmonid habitat*
Wild Fish Conservancy (WFC 2007) was granted access to only the lower 0.25 miles of channel, and the rest of survey was from County right of way. Habitat was not surveyed by WFC for much of the watershed; Endicott and Azous (1999) indicated the best habitat occurred downstream of RM 1.0.

Recommended restoration or protection actions (priority actions bolded, data gaps underlined).

1. *Hydrology*: From our stream gauge data, the stream riffles are dry with pools containing water from early June through mid to late November, which mirrors the 2008 survey of Barsh (2010). The stream riffles re-wet in mid to late November, which is too late for spawning coho and likely chum as well. Cutthroat are February-March spawners, so spawning flows are assumed to be adequate for that species. However, cutthroat rearing flows are limiting in the summer. Earlier fall flows would help with fall spawning salmon.
 - a. Conduct an in-stream flow study to determine salmonid recovery flows
 - b. **Contact owners of Hungar, Elliott, Old Trout, and Shaeffer ponds to determine their interest in modifying pond outlets to release flows for spawning salmonids in the fall, and/or conserve irrigation water use.**
 - c. **Contact irrigation users to determine their interest in conserving or reducing water used for irrigation.**
2. *Water quality*: **Plant at least a 50 ft. buffer and fence cattle out in as much of the stream network that flows through agricultural areas as possible.** With the exception of the lower mile of channel, there are long stretches of stream with little to no riparian cover, with much of the north fork in poor quality riparian cover. A high priority is an adequate buffer around the east side of Hungar’s pond and the south side of Old Trout Inn pond. Monitor temperature in Hungar, Elliott, and Old Trout Inn pond.
3. *Salmonid Distribution and Habitat Connectivity*:
 - a. Assess whether and where wild salmonids exist in this watershed. Fidelis, a woman’s service organization in West Sound out-planted chum fry in the early 2000’s. Adult chum did return from that outplanting (DeGroot, from conversation with landowner at creek mouth, 2019).
 - b. Are introduced invasive fish present in any of the ponds? If present are the ponds screened?
 - c. Can Hungar’s pond on the North Fork be made fish passable? This pond could be summer refugia for cutthroat trout, if they are reintroduced or present, and warm water fish are not present. **If feasible, design fish passage to Hungar’s pond.**

- d. Observe the natural cascade at RM 0.5 to see if it will pass fish in winter flows. This will have to occur during fall flows.
4. *Salmonid habitat:*
- a. Conduct a habitat survey of the lower one mile of channel to determine limiting factors.
 - b. **If pool habitat is limiting, consider using WCC or volunteers to install PALS (Post Assisted Log Structures) or BDA (beaver dam analog) log structures to increase pool habitat and hydraulic complexity.**
 - c. Consider habitat restoration at lowest property where channel has been manipulated and riparian vegetation is lacking.
 - d. **Secure conservation easements from interested landowners within the lower mile of intact instream habitat.**

Cascade Creek

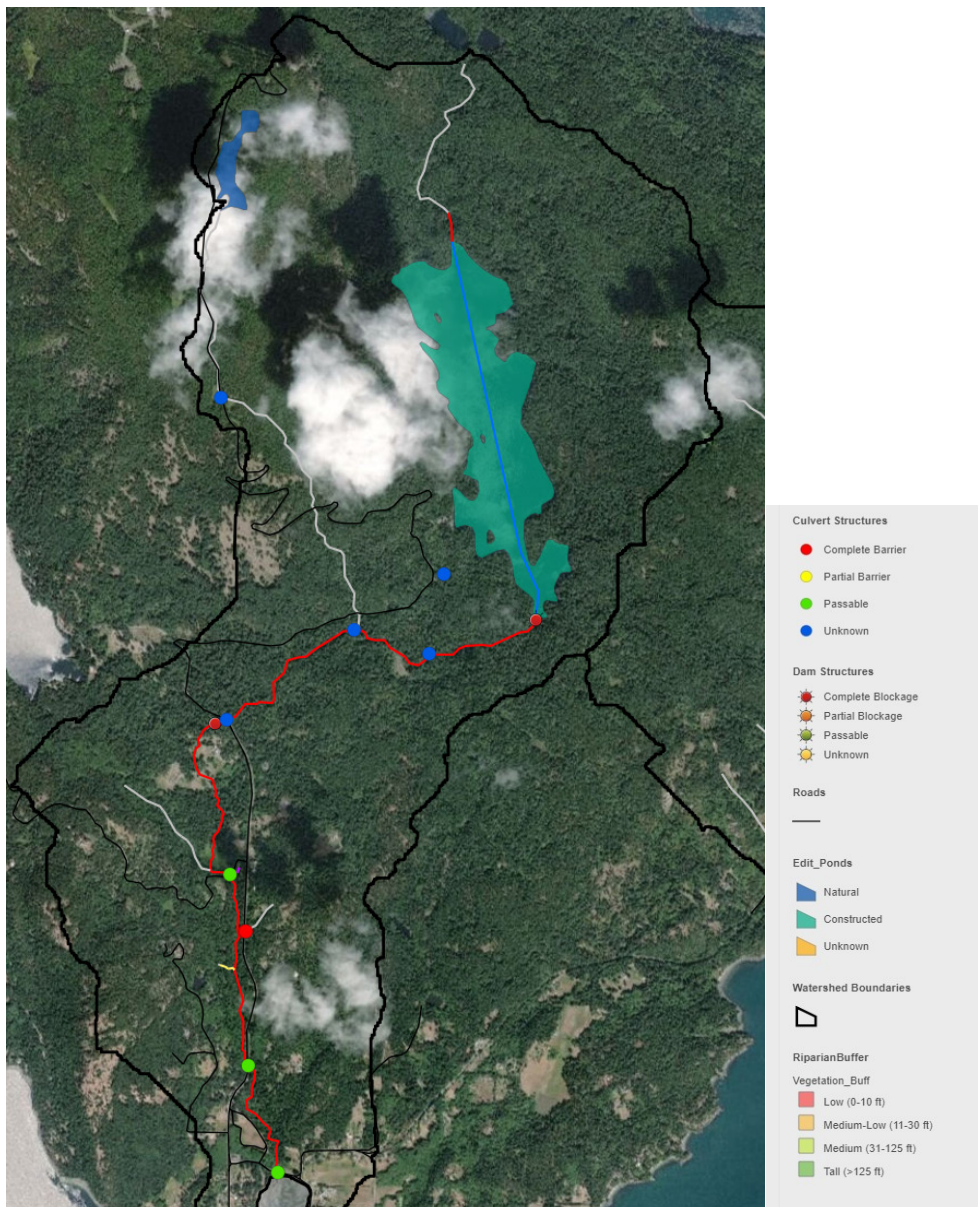


Figure 8. Cascade Creek watershed with mapped culverts and dams. “F” San Juan County Streams are fish-bearing or have fish-bearing potential. Culvert and channel typing assessment WFC (2004).

Flowing from mountainous Mt. Constitution, Cascade Creek is arguably the best freshwater system in the San Juans to support anadromous and resident salmonids. Cascade Creek probably supports more salmonid biomass than all the other watersheds in the San Juans combined, likely much of that biomass upstream of the Rosario outtake. Upper Cascade Creek is permanently protected in Moran State Park. Considerable salmon recovery funds have been expended to protect the intact lower Cascade Creek riparian zone (Land Bank Coho Preserve), in-stream summer flow for salmonids (Washington Water Trust, WWT) and restore fish passage and the estuary at Buck Bay bridge (SJC Public Works). Unfortunately, despite public expenditures and management focused on protecting salmonid habitat, the lower creek recently has failed to support salmonids, including

anadromous coho and CCT, due to consumptive water diversions that degrade instream flow year-around, especially during dry years of October through December. Several times over the summer of 2017, the channel in Coho Preserve went dry despite a modest instream flow water right that is junior to the Rosario water right (DeGroot personal communication, STC, 2017). These recent periods of channel dewatering likely caused 100% mortality of all the resident and anadromous salmonids in lower Cascade Creek.

Limiting Factors to salmonid recovery (data gaps underlined):

1. *Hydrology* - Cascade Creek is perennial due to the contribution of summer flows from the headwater Mountain Lake dam. Mountain Lake is a deep natural lake; the dam raises the lake level an additional 13 feet (the difference of the dam crest and outlet pipe, R2 2015). There are four major water rights on Cascade Creek (Table 9): Doe Bay (1945, outtake at the Mountain Lake dam), Olga (1908), Rosario Resort (1884), and the WWT water right (1884+1 second). Doe Bay, Rosario, and Olga water rights are consumptive; the WWT water right is for instream fish use.

Table 9. The four major water rights in Cascade Creek, starting at Mountain Lake in order of water diversion, with Rosario average water use. Doe Bay diverts flow at Mountain Lake dam. Olga and Rosario are upstream and downstream of Olga Rd, respectively.

Month	Doe Bay (cfs)*	Olga (cfs)**	Rosario (cfs)***	WWT (cfs, purchased from Rosario 2013)	Rosario monthly median outtake, 2015-2018 (cfs)***
January	0.90	0.56	3.0	0	2.88
February	0.90	0.56	2.0	0	2.08
March	0.90	0.56	2.0	0	1.64
April	0.90	0.56	1.0	0	1.13
May	0.90	0.56	1.0	0	0.9
June	0.90	0.56	0.75	0.25	0.9
July	0.90	0.56	0.25	0.25	0.41
August	0.90	0.56	0.25	0.25	0.35
September	0.90	0.56	0.5	0.5	0.44
October	0.90	0.56	1.5	0.5	1.48
November	0.90	0.56	3.0	0	2.86
December	0.90	0.56	3.0	0	2.88

*Doe Bay annual use from 1982-2014, ranged from 0.02 to 0.1 cfs (R2 2015). Water withdrawal is measured at Doe Bay's water plant, which is a mile from their outtake at Mountain Lake. It is unknown if the mile-long pipe leaks.

**Olga use 2001 to 2007, ranged from 0.04 to 0.07 cfs (R2 2015). Present use is 0.11 cfs (Sale 2019).

*** Rosario median outtake 2015-2018 (Sale 2019).

The Rosario water right is one-second senior to the instream water right granted to WWT in 2012. Rosario uses Cascade Creek water mostly to run a microhydropower system where the outflow exits into Eastsound, west of the Cascade Creek watershed. The WWT instream flows are insufficient to maintain a viable salmonid population downstream of Doe Bay and Rosario outtakes in Cascade Creek. Water depth in Coho Preserve near the mouth was 0.1 ft. on Oct 20, 2017 (Figure 9). Flows in El Nino dry years can be very low in May and November-December.



Figure 9. Less than 0.1 ft. depth in coho spawning, San Juan County Land Bank Coho Preserve, October 20, 2017. This flow is too low for coho spawning (photo by author).

The Rosario outtake was at best leaky and generally mostly broken prior up to 2012/2013, when Rosario installed a new outtake (Sale personal communication 2019). During the 2007-2008 R2 flow study, Rosario removed no water from Cascade Creek (R2 2015). The R2 flows below represent a very dry-year flow scenario for Cascade Creek (Figure 10); 2007 was one of the driest years in 114 years of records (R2 2015).

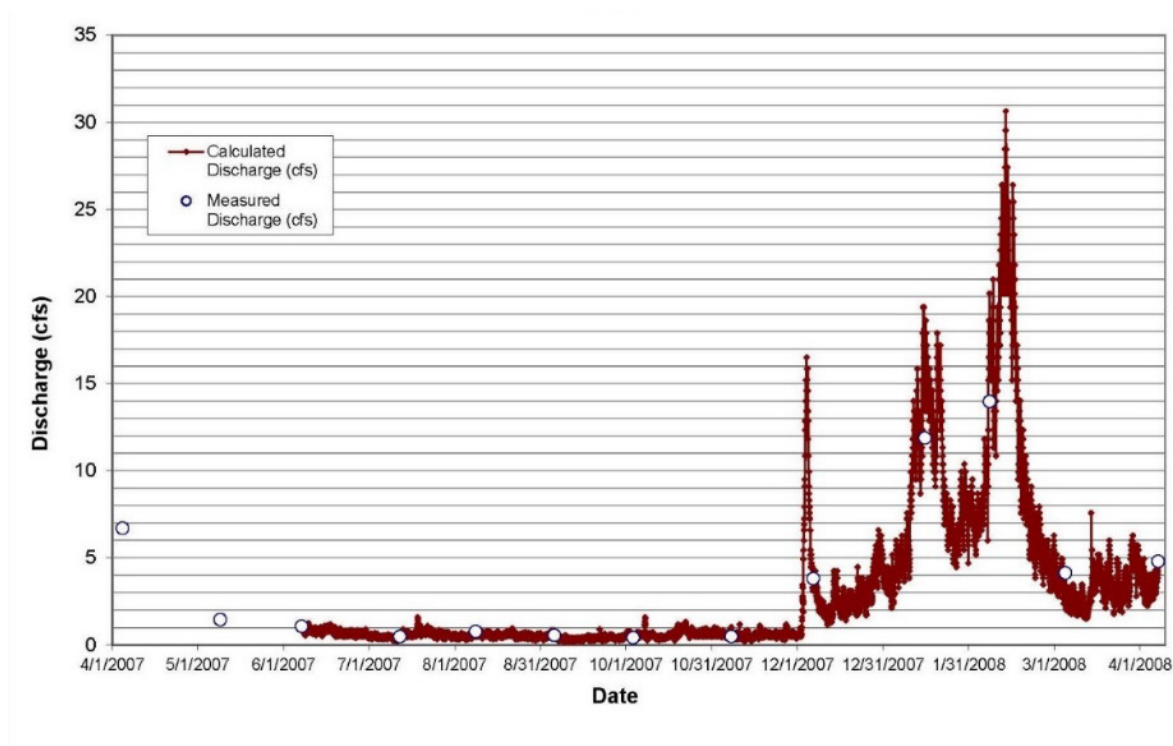


Figure 10. Cascade Creek discharge at Old Olga diversion weir. This discharge only reflects outtakes from Olga and Doe Bay. Rosario did not take any water out of the creek during the study (R2 2015).

During the past several summers, there was two instances where there was virtually no flow below the Rosario outtake (Rosario was taking their water right), despite the WWT instream flow water right (Table 10).

Table 10. Cascade Creek flow data in Coho Preserve near creek mouth (DeGroot 2019). The continuous gauge data is not yet analyzed. "NM" is not measured.

Date	2017 low-high flow by month (cfs)	2018 low-high flow by month (cfs)	1974 discharge (cfs)*
January	2.2	NM	35.72
February	6.3	NM	13.29, 5.89
March	13.2-24.5	5.4	5.43
April	3.1-7.2	5.2-13.3	2.9
May	2.2-2.8	2.9	NM
June	0-1.1	1.8	3.18, 0.92
July	0.4-0.6	NM	0.55
August	0.8	NM	0.4
September	0.8-1.0	0.6	0.18
October	0-0.7	3.2	0.28
November	NM	1.3-1.5	0.63
December	6.7	3.8	0.67

Note: "0" flow for three days, on June 23, 2017, and October 6-7, 2017.

* The 1974 data was measured 380 ft. upstream of Olga Rd in Moran State Park, and thus did not reflect Rosario or Olga outtakes.

A recently completed study by WDFW (Figure 11, draft, Boessow 2018) shows optimum spawning flows for coho are approximately 12 cfs. While this flow is unrealistic in this small, appropriated watershed, current coho spawning flows of less than 1 cfs are clearly insufficient, and likely limiting survival of Cascade Creek coho.

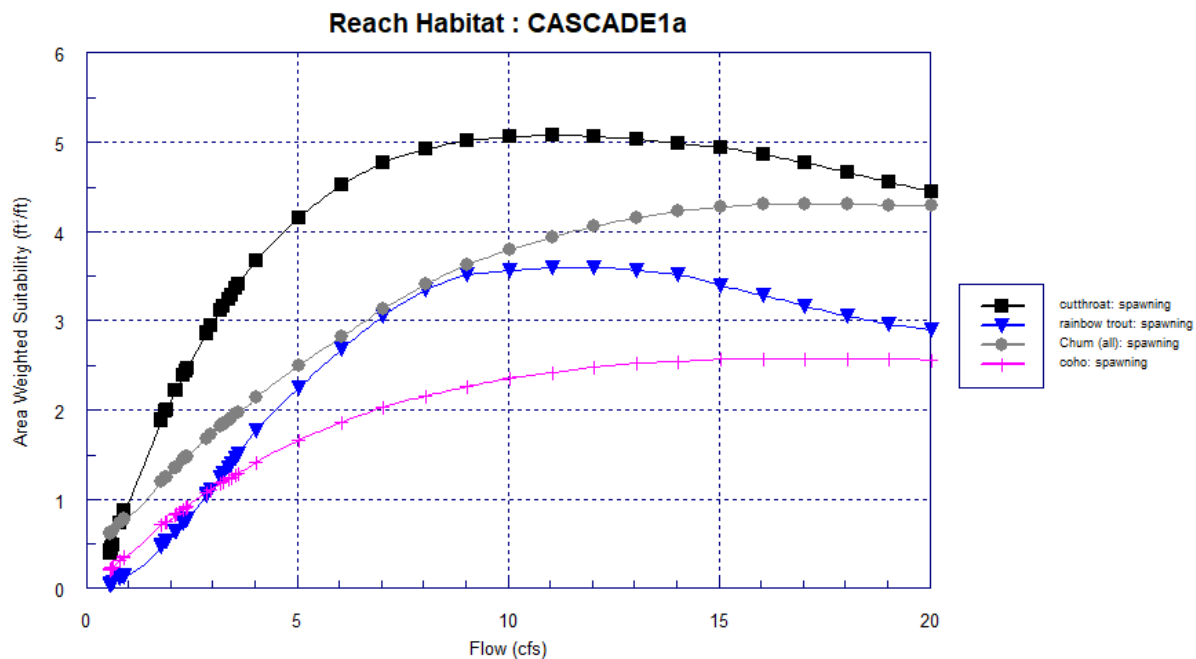


Figure 11. 2018 WDFW flow study for Coho Preserve, (Boessow, draft). Using physical habitat data collected on site, the model shows the most advantageous flows for spawning salmonids. Currently coho are spawning at the lower left corner of the figure, around 1 cfs.

2. *Water quality:*

Water quality data collected at the mouth of Cascade Creek from 2003-2005, found that class AA standards were met for water temperature, pH, turbidity, and fecal coliform. Low DO (< 9.5 mg/L) occurred in approximately 30% of samples

3. *Salmonid Distribution and Habitat Connectivity:*

Table 11. Cascade Creek fish passage barriers (WFC 2004).

Fish Passage barriers	RM (river mile)
3 separate natural falls, 8 ft., 8 ft., 4 ft.; anadromous boundary	0.1 to 0.16
5 ft. natural cascade	0.24
Series of natural falls (3-12 ft.) through bedrock canyon to first crossing under Olga Rd.	0.32-0.41
Constructed barrier dam, old Olga water intake, 7 ft.	0.57
Rosario water outtake, in Park	below Olga Rd
Olga outtake, in Park	above Olga Rd
There are three named natural falls upstream Olga Rd, Cascade, Rustic, and Cavern falls	In Park
Mountain Lake dam	In Park

All four constructed fish passage barriers are in the resident salmonid zone (Table 11), upstream of anadromy, which ends about RM 0.1 due to a natural falls.

Biologists did not observe coho spawning coho the fall 2007 to winter 2008 (WFC 2008), a very dry year. Coho juveniles were observed the spring of 2014, from a 2013 spawn. San Juan County Land Bank began coho spawning surveys the fall of 2015, sufficient spawning flows were observed in 2015 and 2016 (DeGroot 2019). Surveyors did not observe spawning coho the fall of 2017 or 2018 (DeGroot 2018). Adult coho entered the creek and then turned around to saltwater November 8, 2015, during emergency channel work by San Juan County Public Works (DeGroot 2018). The fall of 2016 was the most recent year with adult coho returns (DeGroot 2018), with nine adult coho returned to spawn November 9-16, 2016. In the Spring of 2017, biologists seined 228 juvenile coho. Since these juvenile coho remain in the river for 18 months, they were displaced or killed when the creek was dewatered October 6-7 2017. 100 coho fry were seined on November 1, 2017.

On May 20, 2004, surveyors observed juvenile coho, cutthroat, brook trout, and sculpin from the mouth to Kahboo Hill Rd (WFC 2004).

Adult coho have been reported in lower Cascade Creek since the 1940's, with the run likely a mix of native stock and Nooksack/Samish hatchery coho planted via RSI or egg boxes (Boessow 2018).

Adult chum historically were present in the stream, likely a combination of wild and hatchery fish. Locals hatched chum eggs and released juvenile chum below the falls, and there was documented natural spawning. Chum are no longer observed in the lower watershed.

In May 2014, biologists using electrofishing techniques captured a minimum of 10, and a maximum of 19 cutthroat (sea-run and resident), from each of five reaches from the mouth to upstream of Orcas Rd in the Park. Young of the year cutthroat have not been observed at Coho preserve 2016-2018 (DeGroot personal communication (2019)). Biologists have stocked Mountain Lake with cutthroat trout since 1934.

In the past, biologists also stocked Mountain Lake with kokanee and rainbow trout.

Non-native brook trout are distributed throughout the watershed; they are resident and were stocked in Mountain Lake. During the 2014 electrofish sample, multiple age classes of brook trout were captured, indicating they are naturalized to Cascade Creek.

4. *Salmonid habitat:*

The anadromous reach in Cascade Creek is only 0.2 miles in length. Upstream there are numerous natural barrier cascades and falls, with an additional four constructed barriers (Table 11). Approximately 2/3rd of the channel length is within Moran State Park. The lower watershed is lightly developed. The habitat in this basin is overall in better condition than the habitat of other San Juan Islands watersheds.

Recommended restoration or protection actions (priority actions bolded, data gaps underlined).

All the below recommendations require funding. A few of these projects (acquisition, water rights) can be proposed through the Salmon Recovery Funding Board. Some projects will require other funding sources.

1. *Hydrology: **Improving flows is the number one restoration action for this watershed.*** More water is needed May-November; **it is recommended a minimum 1 cfs instream flow year around (see Figure 11, Table 9, Table 10).** There are options here with all three water users. Both Doe Bay and Olga use roughly 10-20% of their water right. Rosario fully uses their water right to feed a small hydroelectric plant. The critical month is November, when the WWT water right ends and instream flows may be very low. Coho that are ready to spawn will be holding in the bay waiting for higher flows, and coho and cutthroat juveniles rear year around. Here are some suggestions. An advisory committee of the three water users, Clean Water Advisory Committee, WDFW, Ecology, Washington Water Trust, and interested citizens could explore the below options and create viable alternatives with which to pursue funding.
 - a. **Olga water users could ask the Park/Ecology to fully-release their water right year around or for key months. This could involve a purchase/lease to Washington Water Trust.**
 - b. **Ask for a purchase/lease of some portion of Doe Bay water rights.**
 - c. Alternatively, ask Rosario to **sell or lease an additional water right or long-term water lease to the Washington Water Trust. Additional water should be made available at minimum during May - December,** to include the critical October-December period when coho are likely to spawn in lower Cascade Creek. Another critical flow period is February-March when CCT spawn,

and coho and CCT juveniles rear all months. **The preferable water right or water lease is a year-round minimum 1 cfs flow, with winter flows substantially higher** (see Figure 10 and 11).

The key to restoring salmon in this watershed lies with sufficient instream flows. The most recent WDFW (Figure 11, Boessow draft 2018) flow study is a good starting point for determining needed flows to support salmon. The study from 2007-2008, when coho were observed in Cascade Creek, provides additional information for salmonid response to those flow levels (Figure 10, R2 2015).

2. *Water quality:* Low dissolved oxygen samples collected near the mouth would be improved by building small logjams as instream habitat (see 4a).
3. *Salmonid Distribution and Habitat Connectivity:*
 - a. Study on the effect of manmade fish passage barriers on resident cutthroat.
 - b. Investigate the need and feasibility of coho reintroduction.
4. *Salmonid habitat:*
 - a. **Install small log structures (PALS) in the anadromous portion of Cascade Creek to create pool habitat and salmonid refugia habitat from predators.** These structures are inexpensive and are easily be installed by a crew such as the Washington Conservation Corps.
 - b. **Remove the 7 ft. tall Old Olga diversion dam that is no longer in use at RM 0.57** (Table 11).
 - c. **Protect through acquisition or easement the property east of Cascade Creek across from Coho Preserve,** and other high quality riparian corridor to the Park boundary.

Doe Bay Creek

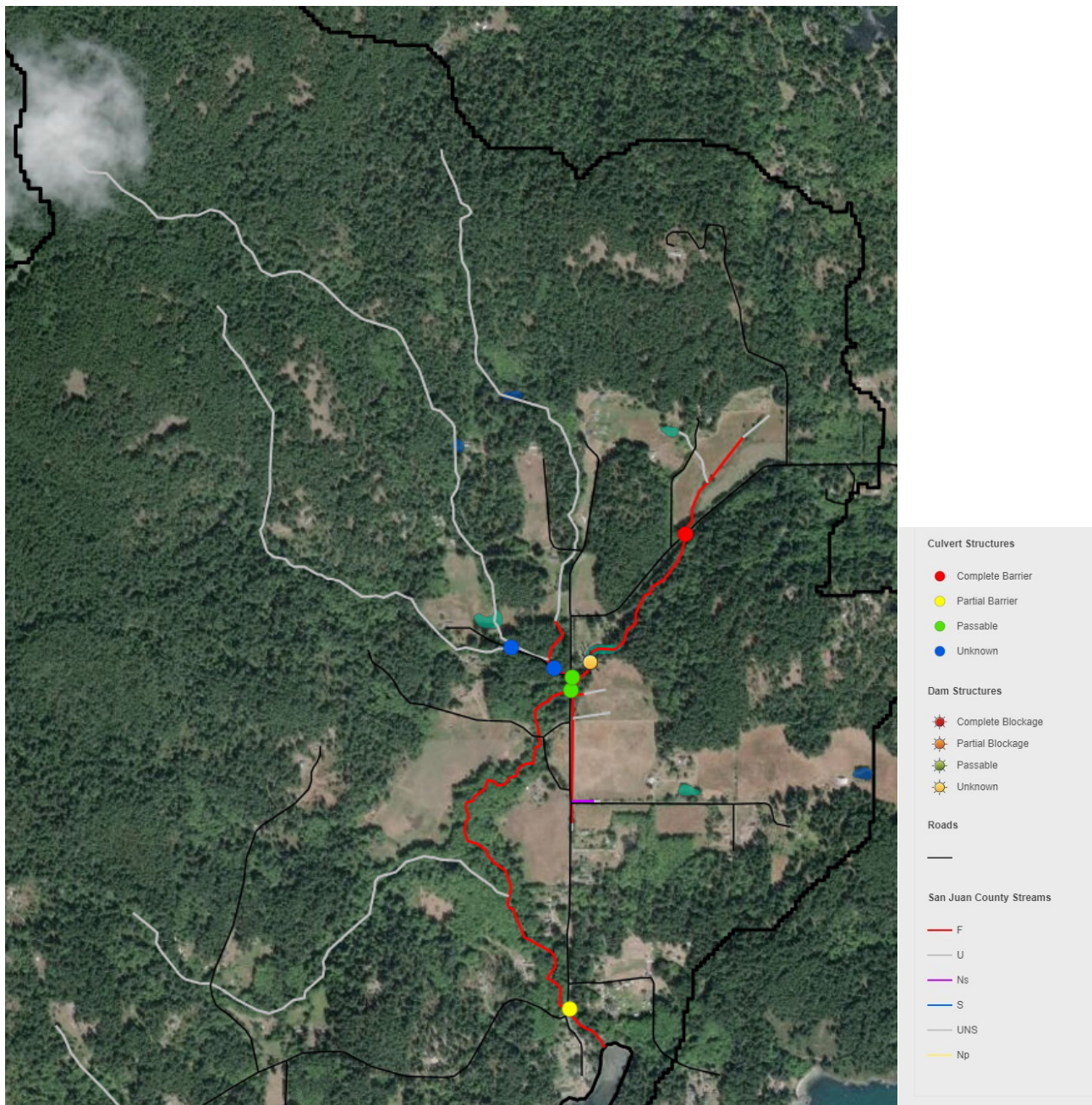


Figure 12. Doe Bay Creek watershed with mapped culverts and ponds. “F” San Juan County Streams are fish-bearing or have fish-bearing potential. Culvert and channel typing assessment WFC (2004).

Doe Bay Creek hosts one of two genetically distinct CCT stocks in the San Juan Islands, the other being Garrison Creek on San Juan Island (Glasgow et al. 2016). Doe Bay Creek cutthroats are *Resident* to the watershed; anadromous fish passage is prevented by falls at the mouth of the creek.

Limiting Factors to salmonid recovery (data gaps underlined):

1. Hydrology:

In 2017, a continuous monitoring gauge was installed at RM 0.14; it is upstream of the lowest Pt. Lawrence Rd. culvert. The 1974 data was collected on Doe Bay resort property. Doe Bay Creek is a seasonal creek, with watered pools and dry reaches from June-October (Table 12). It is unknown whether historically Doe Bay Creek was seasonal or perennial. There are three constructed in-channel ponds, which is much fewer than other San Juan watersheds. In-channel ponds increase evaporation during low flows, reduce flow contribution from wetlands (often under ponds), and delay initiation of stream flow in the fall until the ponds fill.

Table 12. Doe Bay Creek discharge 2017-2018 (STC 2018), and 1974 (Russell 1975).

Date	2017-2018 discharge (cfs)	1974 discharge (cfs)
November	0.05	NM
December	4.94	NM
January	NM	12.67
February	13.72	3.45
March	2.31, 1.03	1.98
April	4.13, 0.91	0.98
May	NM	NM
June	0.03	0.48, 0.09
July	NM	0.02
August	0	trace
September	0	trace
October	0.05	trace
November	0.77	0.28
December	2.19	0.25

2. Water quality –

Doe Bay Creek from 2003-2005 was measured at Doe Bay Resort. The creek met Class AA standards for temperature, pH, and turbidity. Low DO (<9.5 mg/L) occurred in 60% of samples, and very high to extreme fecal coliform counts in >50% of samples (SJICD 2005)

Doe Bay Creek had two surface water-quality samples collected February 20, 2018 and April 26, 2018 (Stillwater 2018). Fecal coliform for two non-rain flow events were low, below 1 CFU/100mL. Metals (copper, lead, zinc) were not sampled. Nutrients (total phosphorous, total nitrogen, nitrate+nitrite) were low relative to other basins with results inconclusive at year one data (Stillwater 2018).

Pt Lawrence Rd cuts the basin in half from north to south, runoff from the road drains into ditches directly connected to the stream. There is potential for road-related toxics, although traffic is light. There is minimal Agriculture in the basin.

3. *Salmonid Distribution and Habitat Connectivity* - About 50 ft. upstream of the mouth, there is a 12 ft. waterfall that is a complete block to anadromous passage. Another 100 ft. upstream of the first barrier, is a second 8 ft. falls (Table 14). Distribution and densities of the resident cutthroat stock watershed-wide are unknown, with County road crossings as the primary exception (Table 13).

Table 13. Doe Bay Creek cutthroat capture locations and sizes (WFC 2004 and 2007; and 2014 survey year in Glasgow et al. 2016).

Cutthroat captured	Location RM (river mile)	Status
2 separate falls, 12 ft. and 8 ft., anadromous barrier.	50 and 100 ft. from mouth.	Two cutthroat observed in a pool between the two barriers (2004).
Pt Lawrence Rd, 1 st crossing	0.1	22 fish captured (2014). Four age classes, many young of the year. Combined data with next site.
Upstream 1 st Pt Lawrence Rd culvert, county owned property.	0.25	28 fish captured (2014).
Pt Lawrence Rd., 3 rd crossing	0.82	One 7" cutthroat captured (2007).

Known fish passage barriers (Figure 12, Table 14).

Table 14. Doe Bay Creek fish passage barriers.

Fish Passage barriers and culverts	RM (river mile)	Status
2 separate falls, 12 ft. and 8 ft., anadromous barrier. This is a resident CCT watershed	50 and 100 ft. from mouth.	Natural falls
Pt Lawrence Rd, 1 st crossing	0.1	Partial block, pool high quality cutthroat summer refugia. Doe Bay Resort.
Constructed Pond	0.82	Stocked with non-native trout with no fish screen.
Pt Lawrence Rd, 4 th crossing	1.01	Blocking 2.5 ft. culvert perched 1.6 ft.

4. *Salmonid habitat*

Most of the watershed habitat is not surveyed and in unknown condition. The condition of likely prime salmonid habitat between the lowest Pt Lawrence Rd crossing (RM 0.1) and the 2nd Pt Lawrence Rd crossing (near RM 0.75) is unknown. The riparian zone in this reach is mostly continuous deciduous red alder (GIS maps, vegetation layer). The pool downstream of the 1st Pt Lawrence Rd crossing is cutthroat summer refugia (Barsh 2010). Whether other cutthroat summer refugia exists is unknown.

A private constructed pond at RM 0.82 was stocked in 2018 with fertile, non-native trout, which endangers this resident and genetically unique cutthroat stock (Eleazer 2018, personal communication). The landowner and fish purveyor did not file for permits with WDFW (Eleazer 2018). WDFW will reach out to the landowner to assess whether they can remove the fish and/or install a temporary screen if needed. The landowner has subsequently stated the pond has a fish screen, and the pond is not fish accessible.

Recommended restoration or protection actions (priority actions bolded, data gaps underlined).

1. *Hydrology:* Develop an instream flow study. Are a portion of the Doe Bay water right from Cascade Creek useable in Doe Bay to enhance summer flows for cutthroat?
2. *Water quality:* A county road, Pt Lawrence Rd-ditch drains about 0.25 miles of Bond Mill Rd, and Pt Lawrence Rd (Figure 12). This ditch exits directly into Doe Bay Creek at Pt Lawrence Rd culvert #2, about RM 0.75. Recommend sampling this ditch for stormwater quality. Water quality sampling for fecal coliform should also occur at Doe Bay resort (SJICD 2005).
3. *Salmonid Distribution and Habitat Connectivity:* An assessment of cutthroat condition, numbers, and location within the watershed will resolve a major data gap for Doe Bay cutthroat. A second assessment is the potential impact of stocked non-native trout from a private pond on this native cutthroat stock.
 - a. **Stocked ponds needs fish screening.** We ask the pond landowner to consider re-fitting their pond as summer refugia habitat for native cutthroat and remove the non-native trout. Measure summer temperatures in this pond to see if it is satisfactory summer refugia.
 - b. **We ask for a moratorium on stocking ponds in this watershed and Garrison Creek watershed as well,** to protect the genetic integrity of the cutthroat stocks.
4. *Salmonid habitat:*
 - a. Survey in-stream habitat between Pt Lawrence Rd culvert #1 and #2 immediately (Figure 12).
 - i. Similar to other watersheds, we expect summer refugia to be a limiting factor. **If pool habitat is limited in this reach, install PALS, hand-installed logjams throughout this reach.**
 - b. Two culverts (Pt Lawrence Rd. #3 and #4) are perched and may limit cutthroat migration. Consider them for replacement.
 - c. Investigate Pt Lawrence #1 culvert to see if replacement is advisable and warranted, with retaining or expanding the downstream rearing pool as a design feature.
 - d. **Protect headwater wetlands on private property, for the three tributary channels flowing off Mt. Pickett.**
 - e. Protect through easement the riparian corridor upstream of the first Pt Lawrence Rd culvert.

Bayhead/Victorian Creek

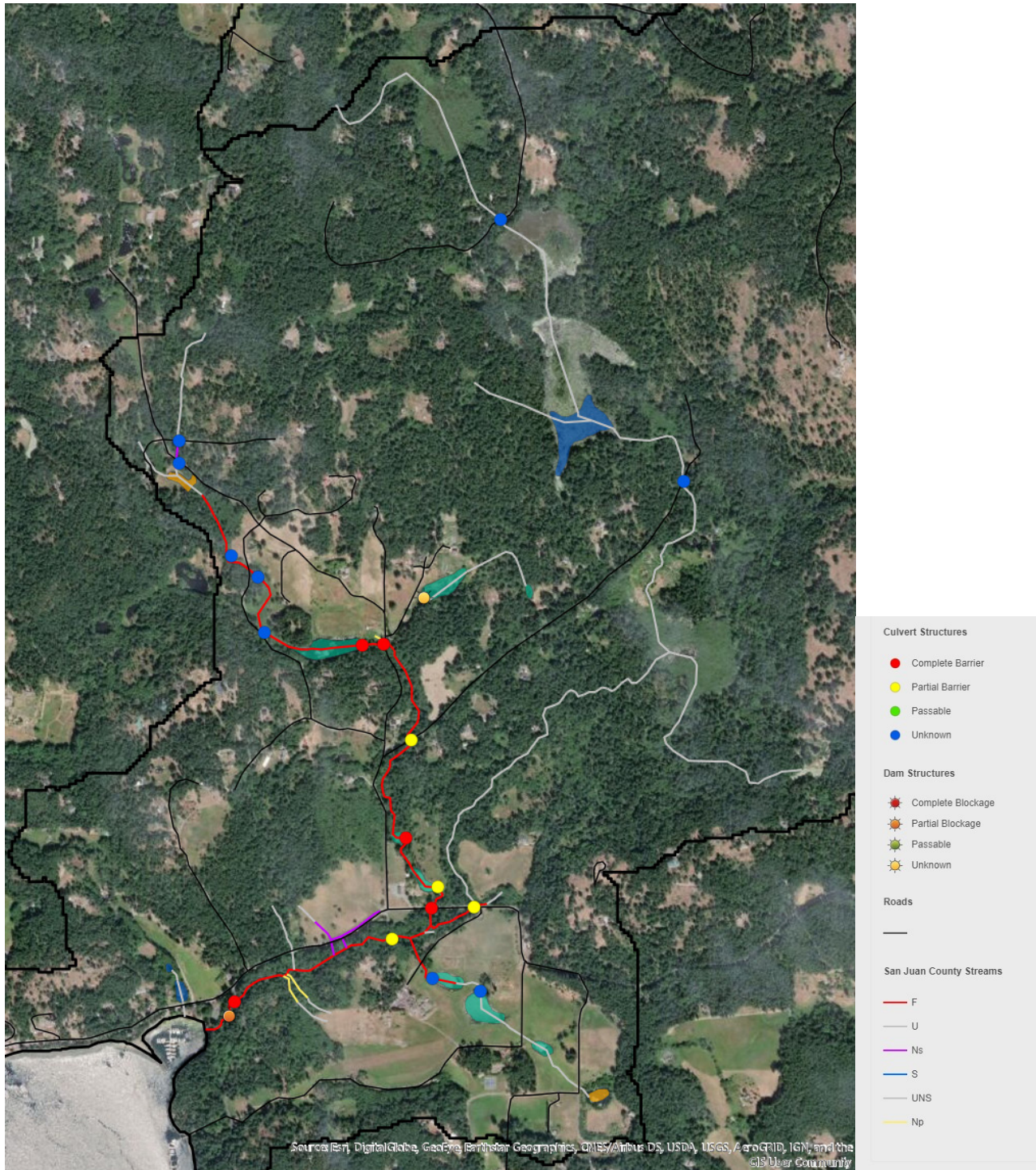


Figure 13. Bayhead-Victorian Creek watershed with mapped culverts and ponds. “F” San Juan County Streams are fish-bearing or have fish-bearing potential. Culvert and channel typing assessment WFC (2004).

The main channel upstream of Killebrew Lake Rd appears from aerial photos to be relatively unimpacted by development, and the channel flows through three large ponded wetlands. This section of watershed is unsurveyed for fish presence and habitat condition. The Victorian Valley tributary entering Bayhead Creek adjacent to LaPorte Rd is substantially impacted and in poor condition. A second tributary, Willow Creek, enters from the south. There are nine described blocking culverts/ponds in the surveyed portion of the watershed. The small watershed size, significant blocks to salmon passage, unknown salmonid presence, and declining flows due to existing ponds make this a low priority for restoration, relative to other watersheds in this report.

Limiting Factors to salmonid recovery (data gaps underlined):

1. *Hydrology:*

No stream gage was installed on Bayhead Creek for this study. Spot data was collected in 1974 (Table 15). From an earlier study, the channel fully wetted beginning December 5, 2007. Maximum spot discharge was 4-5 cfs around January 1, 2008, with the flow reduced to under 1 cfs early March 2008. In December 2007-April 2008, Willow Creek tributary from the south had substantially more flow than the Victorian Valley tributary from the north, despite it being a much smaller portion of the watershed (Barsh 2010).

Table 15. Bayhead Creek 1974 spot discharge measurements at RM 0.25 (Russel 1975).

Month	1974 discharge (cfs)
January	8.03
February	3.07
March	2.25
April	0.62
May	0.08
June	0.01
July	0.003
August	trace
September	trace
October	0.002
November	0.03
December	0.03

Barsh (2010) also observed in 2007, a landowner substantially enlarged the pond just north of Killebrew Ln, and they observed significant subsequent flow reduction from the Victorian Valley tributary of Bayhead Creek.

There are eight known or suspected constructed ponds in this watershed. The impacts of these constructed ponds is similar to other watersheds, potential block to fish passage, potential planting of non-native or invasive fish, streamflow is delayed until pond is full, and reduces summer low flows by evaporating water from the creek.

2. *Water quality*: data was collected about 1000 ft. upstream from the mouth in a forested ravine. Class AA standards were met for temperature. Low DO (< 9.5 mg/L) were found in 40% of the samples, pH and turbidity were slightly elevated over standards in 10-15% of the samples, and fecal coliform exceeded standards (> 50 CFU/100 mL) in 25% of the samples (SJICD 2005).

3. *Salmonid Distribution and Habitat Connectivity*:

In 2004, WFC surveyors captured cutthroat below the lowest blocking culvert at Meadowbrook Lane, near the creek mouth (WFC 2004). In 2008 and 2009, no cutthroat were found at the same location despite numerous surveys (Barsh 2010).

The main channel upstream of Killebrew Lake Rd is unsurveyed. This section of the watersheds is untyped, and fish presence and habitat condition is unknown. In this reach are three large wetland complexes, a primarily forested riparian corridor, and little development. Several of the properties are under conservation easements. It is possible habitat here is in good condition.

There are 20 culverts, ponds, or other structures that may be blocking (WWU GIS). Table 16 is a summary of the main fish passage barriers in Bayhead Creek watershed.

Table 16. Bayhead Creek fish passage barriers (WFC 2004). This is the minimum list; there are other ponds and culverts unsurveyed on Willow Creek and Bayhead Creek upstream of Killibrew Lake Rd due to lack of access.

Fish Passage barriers and culverts	RM (river mile)	Status
Concrete dam 1.5 to 4 ft. tall, ownership unknown.	0.07 (360 ft.)	Drop to bedrock with no plunge pool. High flow passable.
5 ft. diameter CMP culvert under Meadowbrook Ln., private drive. 100 ft. long, 1.05 ft. drop to riprap.	0.07 (390 ft.)	4% grade, complete barrier
Natural bedrock cascade	0.27 (1450 ft.)	27% grade, 50 ft. long, likely a low-flow barrier
3 ft. CMP under Willow Creek Ln. Private drive. 60 ft. long, 0.7 ft. perched.	0.38 (2000 ft.)	Partial barrier
Willow Creek four in-channel ponds., the lower two appear to have culverts		Unknown
<i>Below are barriers in Victorian Valley tributary along LaPorte Rd.</i>		
Killibrew Lake Rd., County Rd., 2 ft. diam. CMP, 120 ft. long, outlet drop 2.8 ft. onto rocks.	0.49 (2591 ft.)	Full barrier
1 st pond outlet, pond 0.52 ac	0.52 (2733 ft.)	Likely not fish passable
2 nd Pond outlet, 2.5 ft. x 4 ft. culvert, pond 0.25 ac	0.66 (3488 ft.)	Not fish passable
La Porte Rd culvert, County Rd., 2 ft. round concrete, 60 ft. long, 0.75 ft. perched	No data	Partial barrier
6.5 ft. tall constructed waterfall, outfall from 253 ft. concrete flume. For pond below.	1.06 (5581 ft.)	Full barrier. Outfall from waterfall is onto rocks
Pond control structure, 2.5 ft. high	1.10 (5834 ft.)	Full barrier

4. *Salmonid habitat*

The main limiting factor is the substantial water impoundment and blocking culverts that reduce flows in an already small system. Spawning gravels were found periodically in the lower mainstem and Victorian Valley tributary in the WFC survey (WFC 2004), however habitat condition is unknown in Willow Creek and the main channel upstream of Killebrew Lake Rd. Pools may be limiting in this watershed as they are in other watersheds.

The main channel upstream of Killebrew Lake Rd has several bogs and wetland ponds, potentially serving as salmonid refugia.

Recommended restoration or protection actions (priority actions bolded, data gaps underlined).

1. *Hydrology*: Assess landowner willingness to reconfigure how their ponds release water to the stream.
2. *Water quality*: **With willing landowners, plant trees and shrubs alongside the stream in unvegetated parts of Willow Creek and Victorian Valley Creek.**
3. *Salmonid Distribution and Habitat Connectivity*: **Reconfigure ponds to allow fish passage. This will have the added benefit to providing summer refugia habitat as well.** The four Willow Creek ponds and the three lowest Victorian Creek ponds are the priority.
 - a. Assess salmonid extent and densities in Bayhead Creek watershed.
 - b. Assess presence of warm water fish in ponds and non-native trout in watershed.
 - c. Assess ponds for likelihood as summer refugia. Is this pond potentially accessible, and if so can it serve as summer refugia? If yes and non-native fish are present in the pond, consider their removal.
 - d. **Remove concrete dam in lower 360 ft of creek.**
 - e. **Replace blocking culverts.** Prioritize Meadowbrook Ln culvert.
4. *Salmonid habitat*: Assess salmonid habitat in main channel upstream of Killibrew Lake Rd.
 - a. Locate areas with salmonid access where installation of PALS will create limiting pool habitat.

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Appendices

Appendix A.

Summary of Data gaps and **Priority Restoration and Protection Strategies**

San Juan Island

False Bay Creek

Data gaps

1. Install a stream gauge on False Bay Creek.
2. Survey entire watershed for salmonids.
3. Survey 64 watershed ponds and lakes for warm-water fish and non-native salmonids.
4. Survey ponds for summer-rearing habitat potential.
5. WA State Dept of Ecology enforce water quality regulations for all landowners and managers out of compliance.
6. Monitor water quality for False Bay Creek and San Juan Valley Creek on False Bay Preserve.

Priority Restoration and Protection Strategies

1. Design salmon flows as part of water storage package for an increased Trout Lake dam height.
2. Manage Upper and Lower Zylstra Lakes for fall salmon-spawning flows and for spring salmon-outmigration.
3. Remove two flow diversions for stock-watering ponds, and replace with fencing, planting, and off-channel watering facilities.
4. Provide resident salmon passage at Wold Rd Aug 2 re-regulation facility
5. Remove bass and other warm water fish from Upper and lower Zylstra Lakes
6. Consider chum reintroduction in lower False Bay Creek following implementation of above actions.
7. Fence livestock out of lower False Bay Creek and San Juan Valley Creek, plant with trees and shrubs, and provide cattle off-channel watering facilities.
8. Consider beaver reintroduction or beaver analog log structure to riverine-wetlands portions of the channel network.

Garrison Creek

Data gaps

1. Collect additional nutrient and temperature water quality data.
2. Install a stream gauge on Garrison Creek
3. Landowner survey of the 13 ponds for non-native fish presence.
4. Survey ponds for summer-rearing habitat potential.
5. Survey upper watershed for potential to enhance floodplain storage/retention of water for summer release.

6. Monitor water quality near creek mouth.

Priority Restoration and Protection Strategies

1. Revegetate the ditched wetland portion of Garrison Creek with appropriate native trees and shrubs.
2. Remove the unused diversion dam upstream of West Valley Rd.
3. Replace the three partially blocking culverts sites (6 culverts total) on The Clearing property. Two are at the downstream property boundary; the other four culverts are under the driveway.
4. Replace the undersized and partially collapsed West Valley Rd culvert.
5. Screen Trout Lake to prevent escapement of planted bass and rainbow trout. Alternatively, remove fish.
6. Reintroduce beaver or install beaver analog structures.

Orcas Island

West Beach Creek

Data gaps

1. Continue to monitor flow, create discharge ratings curve.
2. Monitor water quality.
3. Survey watershed for salmonids.
4. Survey watershed/ponds for introduced salmonids/warm water fish.

Priority Restoration and Protection Strategies

1. Install beaver-dam analog structures on Land Bank Turtleback Mtn property and if feasible, adjacent private property to increase water storage and low flow release.
2. Reconfigure in-channel ponds to release fall rainwater prior to pond completely filling.
3. Plant trees and shrubs in areas around WBC mainstem and tributary upstream of 4th West Beach Rd culvert
 - a. Fence cattle out of the creek and tributary.
4. On lowest tributary, improve fish passage on lower tributary and directly upstream driveway
5. Create low-flow, summer refugia pools forced by debris jams at replaced culvert on Pottery Rd.
6. Create low-flow, summer-refugia pool habitat as part of the West Beach Rd culvert replacement.
7. Install Post-Assisted Log Structures (PALS) through channel network, but especially in forested lower 1 mile of stream channel.
8. Conservation easement for both properties directly upstream and downstream of first West Beach Rd. culvert.

Fish Trap Creek

Data gaps

1. Continue to monitor flow, create discharge ratings curve.
2. Monitor water quality.
3. Survey watershed for salmonids.
4. Survey Helsell and Treacy ponds and two in-channel ponds for introduced salmonids/warm water fish.

5. Investigate whether watershed ponds (Treacy, two in-channel ponds) can serve as summer refugia for salmonids.
6. Monitor culverts as flow is released from Helsell pond.

Priority Restoration and Protection Strategies

1. Release flow from headwater pond into Fish Trap Creek per water right agreement with Ecology.
2. Create full fish-passage at lowest pond below Cormorant Rd.
3. Replace significantly undersized Cormorant Rd culvert with larger fish-passable culvert.
 - a. Find funding to replace two other undersized private culverts in watershed.
4. Excavate buried channel blocking Treacy Pond tributary.
5. Secure riparian conservation easements from interested landowners.
 - a. Locate funding or partners to fund easements.
6. Install PALS log structures throughout channel network, focusing on lower 720m of channel.
7. Plant conifers and shrubs downstream of Cormorant Rd.
8. Plant salt-tolerant shrubs and trees around Cayou Lagoon.

Crow Valley (West Sound) Creek

Data gaps

1. Continue to monitor flow, create discharge ratings curve.
2. Survey watershed for salmonids.
3. Survey four major ponds (Hungar, Elliott, Old Trout, and Shaeffer) for introduced salmonids/warm water fish.
4. Investigate whether Hungar and Shaeffer ponds can serve as summer refugia for salmonids and if landowners are interested.
 - a. If feasible, modify pond outlets to allow fish passage.
 - b. Are any ponds available for fall release flow for spawning salmon?
5. Observe natural cascade in winter flows at RM 0.5 to see if fish passable.
6. Survey habitat in lower 1 mile.
7. Monitor water quality at gauge site.

Priority Restoration and Protection Strategies

1. Plant at least a 50 ft. riparian buffer in as much of the bare stream network as possible, prioritizing properties in the Crow Valley tributary.
2. Install PALS or beaver dam analogs where it makes sense based on salmonid presence and patterns.

Cascade Creek

Data gaps

1. Continue to monitor flow at Coho Preserve, create discharge ratings curve.
2. Study the impacts of manmade fish passage barriers (e.g. water diversion structures) on resident cutthroat.
3. Study the impacts of brook trout on resident and anadromous cutthroat trout.

Priority Restoration and Protection Strategies

1. Number one restoration priority is sufficient flow for salmon and cutthroat from May-December. Ask Water Users to sell or lease total minimum 1 cfs year around to the Washington Water Trust.
 - a. Alternative is to find funding to replace Rosario hydropower with solar or some other green power.
2. Install PALS in anadromous portion of Cascade Creek to create summer low-flow pool habitat and refugia from predators.
3. Remove the defunct 7 ft. tall Old Olga diversion dam (RM 0.57).
4. Protect through acquisition or easement the eastern property at the mouth, across from the Land Bank Coho Preserve.

Doe Bay Creek

Data gaps

1. Continue to monitor flow, create discharge ratings curve.
2. Monitor water quality at gauge site.
 - a. Survey stormwater ditch that drains Bond Mill Rd. and Pt. Lawrence Rd.
3. Survey watershed for cutthroat, their distribution, age classes, and density.
4. Complete a salmon habitat survey; focus efforts on reach between 1st and 2nd Pt. Lawrence Rd. crossing.
5. Investigate Pt. Lawrence Rd. blocking culverts #1 and #4 to see if an upgrade will maintain existing pool refugia habitat.

Priority Restoration and Protection Strategies

1. Screen ponds stocked with non-native fish.
2. Following the habitat survey, install PALS in appropriate reaches to increase pool habitat and cover.
3. Protect headwater wetlands on private property for the three tributary channels flowing off Mt. Pickett.

Bayhead (Victorian Valley) Creek

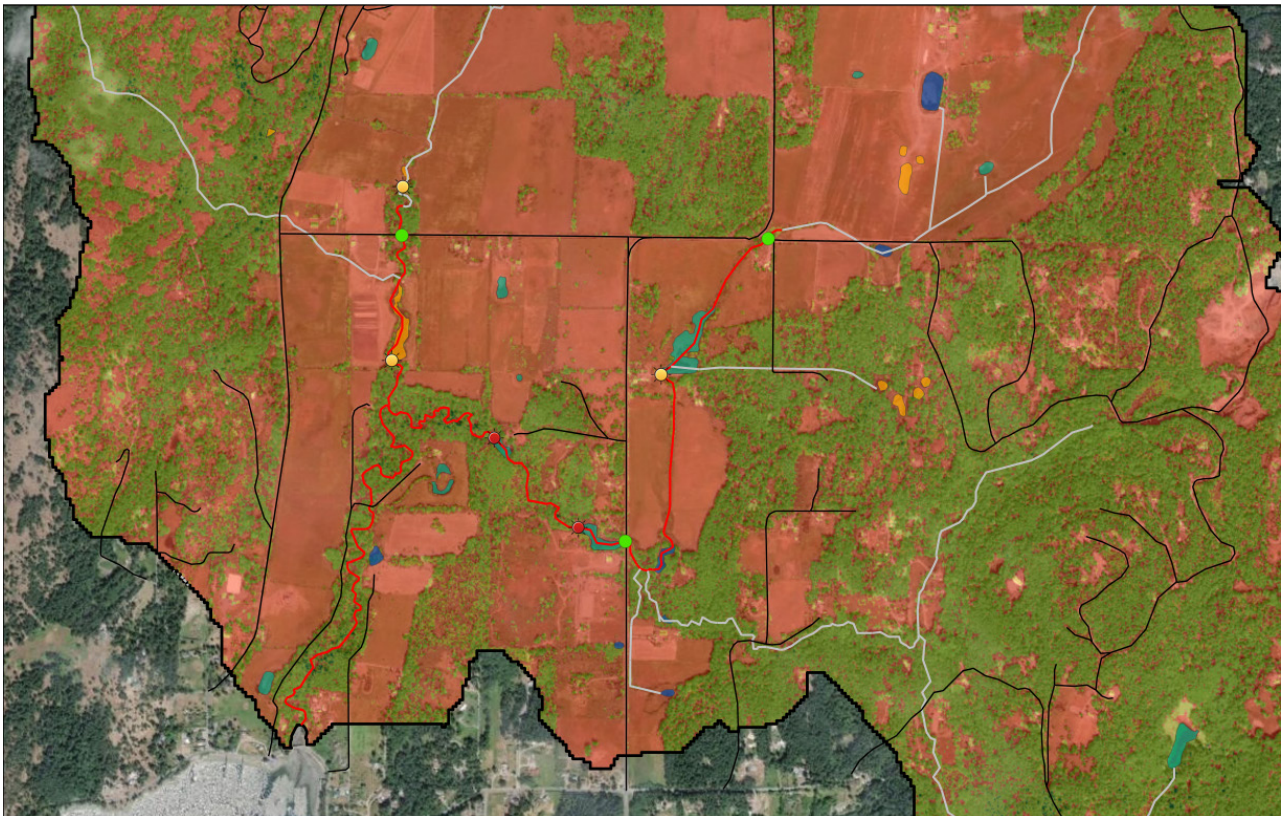
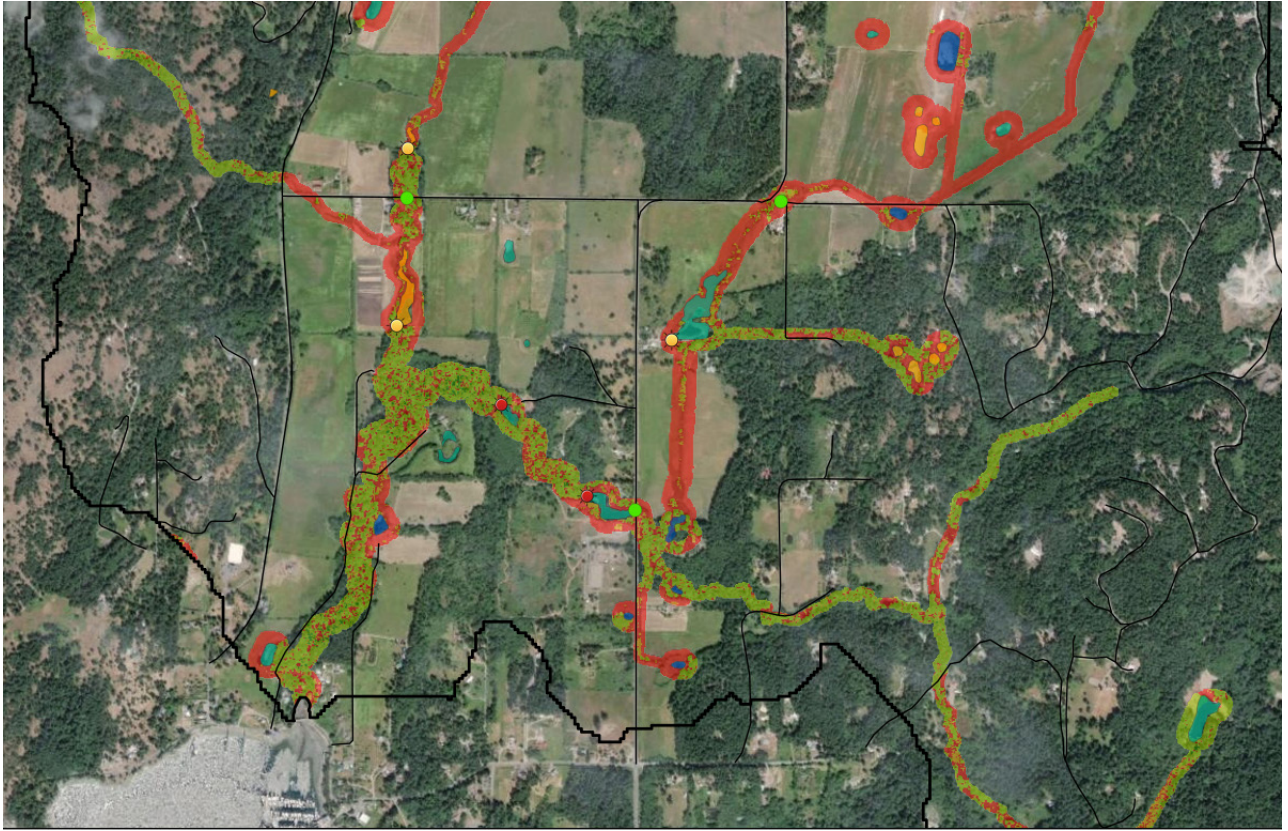
Data gaps

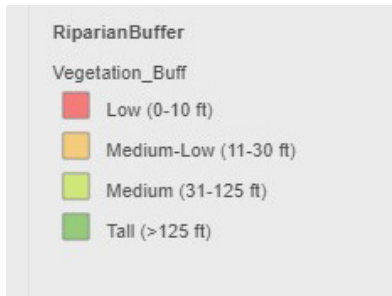
1. Find location in lower watershed to install a stream gauge.
2. Monitor water quality.
3. Survey watershed for cutthroat, their distribution, age classes, and density; especially in ponds and the main channel upstream of Killibrew Lake Rd.
4. Assess the presence of warm-water fish and non-native trout.
5. Assess ponds for likelihood as summer refugia (accessibility, temperature, location).
6. Complete a habitat survey on the mainstem upstream of Killibrew Lake Rd.

Priority Restoration and Protection Strategies

1. Plant trees and shrubs in unvegetated parts of Willow Creek and Victorian Valley Creek.
2. Remove the concrete dam in lower 360 ft. of creek.
3. Replace the blocking Meadowbrook Creek culvert. Prioritize other blocking culverts or ponds.

Appendix B





Riparian GIS summary and future work

Top map, Crow Valley Creek riparian vegetation corridor. The riparian analysis used County LiDAR, and instead of returns to the ground, analyzed returns at different vegetation heights (Bauder 2016). The regulatory San Juan County Critical Area Ordinance was used to define the riparian buffer widths. Using this data, a more in-depth study of riparian condition and restoration potential by watershed is possible. The LiDAR results are divided into four vegetation bins (Bauder 2016).

Bins are grouped by vegetation height:

1. Low (0-10 ft) generally represents agricultural pasture.
2. Medium-Low (11-30 ft) are usually degraded riparian areas, often dominated by the invasive English Hawthorne tree/shrub (*Crataegus monogyna*), which is ubiquitous in San Juan County.
3. Medium (31-125 ft.) forested areas, both hardwood and conifer. This bin can represent a range of age classes and stream riparian habitat value.
4. Tall (126 and higher ft.) this height class is rare in San Juan County, and mostly confined to upland areas in Moran State Park. Our oldest forests were cleared long ago during the late 1800's to early 1900's to feed the lime kilns and also for settlement.

Lower map, Lower Crow Valley Creek watershed. A watershed scale assessment, similar to the assessment for the riparian corridor. This provides information on the extent of disturbed land across the watershed.