A Salmon-based Screening Tool to Guide Fish Protection Measures for Agricultural Waterways Summertime Maintenance Activities

By

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Summary

A salmon-based screening tool is presented to help guide fish protection efforts during maintenance of agricultural waterways in King County's agricultural production districts (APDs). This tool considers the origin and management history of the waterway as well as salmon spawning potential or connectivity with a salmon spawning system, water flow and quality factors that influence summer-time abundance and persistence of salmonids in APD waterways.

The screening tool is based on readily available data as well as observations by professional biologists of fish use and habitat conditions in King County's agricultural waterways. We recommend the continued collection and synthesis of relevant information to augment present knowledge of fish use in the APD waterways, including development of a comprehensive APD database on fish use, water flow and quality, and a set of monitoring protocols for assessing and improving the utility of this screening tool. Such information will improve our understanding of the role APD lands play in the broader context of watershed-based salmon conservation and recovery efforts.

Introduction

King County's land management jurisdiction, which exists mainly outside of urban areas, includes a variety of efforts to maintain the character, commerce, and natural resources of rural areas. Toward that end, King County has implemented policies, regulations, and programs and made significant capital investments that support both agriculture and salmon protection and recovery.

Conflicts arise between agricultural practices and salmon protection and restoration activities because the County's agricultural areas often coincide with and drain into salmon-bearing waterways. To maintain agricultural productivity, many of these waterways require periodic maintenance, including sediment and beaver dam removal, which can impact salmon and a variety of other aquatic biota and habitat. Of particular concern is potential impact to economically and culturally significant salmon species including federal Endangered Species Act (ESA)-listed Puget Sound Chinook salmon, steelhead trout and coastal bull trout as well as coho

salmon and cutthroat trout. Other fishes commonly found in agricultural waterways include native lamprey and three-spine stickleback as well as non-native species, such as bluegill.

Need and purpose

The proposed salmon-based screening tool was developed to help avoid or minimize impacts of periodic agricultural waterways maintenance activities on salmon and their habitat. This tool provides guidance for landowners and regulators in identifying potential levels of salmon use in agricultural waterways so that appropriate fish and habitat protections can be applied. This screening tool is also intended to guide funding allocations and select effective best management practices (BMPs). Figure 1 describes the management intention that, based on the proposed screening criteria, the highest effort and funding is expected for waterways in the most natural conditions and with the highest potential numbers or density of salmonids. Conversely, artificial waterways and /or those waterways with low potential for high numbers or density of salmonids would receive the least amount of effort.

Salmon are the focus of this tool because of their ecologic, economic, and legal importance. Compared to other fishes, salmonid habitat requirements and use are relatively well documented.

We propose a waterway classification system for agricultural areas that considers regulations set forth in the Washington State Hydraulic Code (RCW 77.55), and potential variations in salmonid distribution and abundance in agricultural waterways. The Hydraulic Code requires that construction activity that will use, divert, obstruct, or change the natural flow or bed of state waters must be carried out under the terms of a permit called the Hydraulic Project Approval (HPA), which is issued by the Washington Department of Fish and Wildlife. The purpose of the Hydraulic Code is to ensure that needed construction or work is done in a manner to prevent damage to the state's fish, shellfish, and their habitat. By applying for and following the provisions of the HPA maintenance activities in agricultural waterways can be allowed with little or no adverse impact on fish or shellfish.

These permits prescribe conditions with respect to the timing of work, and require adherence to approved plans and specifications for the approved project. In general, HPAs call for minimization of disturbance of streambeds and banks and associated vegetation, to that necessary to perform the project. Other typical requirements include the use of BMPs to prevent leaks and spills of petroleum-based lubricants into the water, control of erosion and sedimentation to prevent silt-laden water from entering affected waterways and other conditions deemed necessary to mitigate project impacts.

This salmon-based screening tool classifies agricultural waterways in accordance with to two basic waterway characteristics:

- waterway type, based on natural history and source of water, and
- potential degree of salmonid use, based on potential for salmon presence and flow quantity and quality.

For waterway type, we propose application of established criteria that are in use elsewhere. For potential degree of salmonid use, new criteria have been established to further refine the relative value of a given waterway to salmonids during summer or early fall when most maintenance activities are performed.

Assessing Waterway Type

In cooperation with local state and tribal fishery managers and conservation districts, the diking and drainage districts in Skagit and Whatcom counties have established individual classification systems for agriculture waterways in the lower, delta reaches of the Skagit and Nooksack rivers, respectively. The two classification systems vary somewhat, but both involve determination of waterway history, specifically whether the waterway is naturally occurring or not; i.e., is artificial, in order to determine HPA jurisdiction. For naturally occurring waterways, a distinction is made based on management history, specifically whether the waterway has been modified, e.g., ditched and/or straightened, from its natural configuration. In practice, any waterway that is not clearly natural or artificial is classified as modified or managed. The Skagit program draws further distinction based on whether a waterway has headwaters or not. An example of a non-headwater natural waterway would be an oxbow or some other relict river floodplain feature that is separated from the flow that originally created it and has no contributing surface flow.

As noted previously, the basis for waterway type criteria stems in large part from the Washington Department of Fish and Wildlife's (WDFW) Hydraulic Project Approval (HPA) authority under RCW 77.55. The HPA authority extends to all marine and fresh waters of the state except "those waterways that are entirely artificial, such as irrigation ditches, canals and stormwater runoff devices" (Boggs and Corey 2009). For the Skagit and Whatcom areas in question, state and tribal fishery managers consider historic naturally occurring waterways, whether currently in natural or modified condition or not, to largely coincide with known or likely salmonid use. Artificial waterways are identified as areas that are often either blocked from fish use, and/or so ephemeral or having such poor habitat quality that they are unlikely to contain salmon. Therefore, although no explicit salmon use criteria are used in these classification systems, these waterway type criteria in practice serve as a surrogate for salmon use. These classification systems also recognize that regardless of whether or not waterways are classified as "artificial," WDFW retains authority to reclassify them to a modified (or managed) natural waterway if fish are found in them, and will apply HPA fish protections deemed necessary to protect fish (Reinbold, WDFW, April 2010, personal communication).

A secondary distinction between the Whatcom and Skagit approach involves use of historic information. For agricultural waterways in Skagit County, historic wetlands mapped by the U.S. General Land Office (GLO, *ca* 1850) are used as an indicator of high likelihood of a waterway having been historically present. In contrast, the Whatcom County approach relies on the presence of headwaters and present-day topography (slope and aspect) and geomorphology (old stream waterways and swales) as indicators of historic waterway presence.

King County's proposed classification and criteria for waterway type adopts elements of both the Skagit and Whatcom approaches to form three basic agricultural waterway types:

- **Natural Waterways:** Natural waterways are naturally occurring water-bearing features, typically with headwaters, that have not been significantly altered from their historical flow path or floodplain in any manner.
- **Modified Waterways:** Modified waterways are historically natural waterways that have been diverted, dredged, straightened, or diked.
- **Artificial Waterways**: Artificial waterways (also known as ditches) convey water from or supply water to an individual farm property. They do not have headwaters or other natural water sources and RCW 77.55 jurisdiction does not apply to them.

Assessing potential level of salmon use

The history of a waterway, while important for determining jurisdiction and an indicator of the potential for at least some salmonid use in the past, does not by itself indicate the present potential level (i.e., abundance or density) of salmonid use. In light of financial impacts on farmers and limitations in King County's ability to provide technical and funding assistance for agricultural maintenance projects, we propose to identify, classify, and prioritize efforts to protect waterways according to their potential for high, moderate and low levels of salmonid use at the time of maintenance, typically from mid-summer to early fall.

Levels of salmon use can be described by evaluating:

- The likelihood of salmonid (specifically coho salmon) presence and abundance, based on: (1) known or likely spawning within the waterway, or (2) a fish-passable connection between the waterway in which work will occur and a known salmon spawning stream.
- Suitable summer water flow, based on known or suspected presence of a perennial water source.
- Suitable summer water quality, primarily temperature and dissolved oxygen, based on direct measurement or upstream land cover and land use indicators.

Salmonid Presence and Abundance

Agricultural waterways typically have low gradients and close proximity or a direct connection to larger salmonid-bearing waterways. Thus, they also have high inherent potential for salmon at least on a seasonal basis. However, like most animals, salmonids are not uniformly distributed throughout their environment. Instead, they concentrate in response to environmental conditions created by a range of physical, chemical, and biological factors including channel depth and gradient, water velocity, water quality, substrate, food, and habitat cover. In addition, salmonid presence or absence is strongly related to life history stage and interactions within and among salmonid populations and species, and other fish and wildlife species. These factors and their interactions are not static and can vary geographically and seasonally. Additionally, larger-scale reach, landscape and watershed contexts may affect habitat conditions and fish use at a given place and time.

Fish use and habitat data for agricultural waterways have been collected in limited portions of the County's agricultural production districts (APDs), including portions of the Lower Snoqualmie (Cherry, Tuck, and Deer creeks) and the Lower Green (Mill Creek and Mullen Slough) river basins. A complete accounting of existing fish use and associated environmental data has not been conducted, but a review of available information suggest that the data collected to date are typical of the range of agricultural waterways in King County.

By far, the most common and abundant salmonid species in agricultural waterways is coho salmon, followed by cutthroat trout, Chinook salmon and steelhead trout, all of which use these waterways less frequently than coho. The latter two species are ESA-listed listed, but have been found to occur far less frequently than coho. When found in an agricultural waterway segment, Chinook and steelhead often occur in very low (single digit) numbers, with Chinook being somewhat more likely to be present than steelhead. The status of Puget Sound coho salmon has been analyzed, but found not to warrant ESA listing. However, coho were classified as a Species of Concern in 2004 due to specific risk factors. Cutthroat trout have also been reviewed and determined not to be in danger of extinction at present, and unlikely to become so in the foreseeable future. Bull trout is another ESA-listed species that occurs in mainstem river reaches flowing through or near APDs, but rarely if ever uses smaller APD waterways based on no known observations and unsuitable habitat conditions, mainly high water temperatures.

Frequent use of APD waterways by coho salmon may be due to their affinity for low gradient, low velocity environments such as large pools and beaver ponds used by juveniles for rearing and overwintering. Like all salmonids, however, coho prefer cold water and their presence and persistence in APD waterways likely reflects the presence of perceptible flows of cool, well oxygenated water that, in varying degrees, all salmonids prefer. The low abundance of other salmonids in agricultural waterways may be due to species-specific preferences for in certain water velocities and depths, substrate conditions, and, in the case of bull trout, much colder environments. In some instances APD waterways may have flow, velocity and water quality attributes of beaver ponds, which are known to be highly productive for coho salmon, and, to a lesser degree, for cutthroat trout in the Puget Lowlands. As a result, when referring to salmonids, the conclusions contained in this paper are largely based on the habitat preferences of coho salmon.

Most proposed agricultural waterway maintenance operations are conducted in the summer or early fall when salmonid distributions are restricted due to minimum flows, relatively high water temperatures and low dissolved oxygen concentrations. In addition, many agricultural waterways lack pools and have generally poor structural habitat due to lack of overhanging cover, shade and instream habitat complexity. Many agricultural waterways have these conditions because if they aren't dry they are often shallow, un-shaded and structurally simple. Despite these generally poor conditions and even in the warmest and driest periods, salmon may occur in agricultural waterways, sometimes in surprisingly high numbers. The knowledge that their distribution is not uniform and that certain locations appear to support relatively high numbers and densities of salmon is the basis for the following additional criteria we propose for assessing potential levels of salmon use in agricultural waterways.

Criteria for Assessing Potential Levels of Salmonid During the Summer

Under summer conditions, we consider the likelihood of a waterway having relatively large numbers of salmon to be related to the presence or close proximity of salmon spawning habitat as well as sufficient flow and flow-related water quality conditions, mainly water temperature and dissolved oxygen. These criteria are described in more detail below, and depicted in a decision-tree format in Figure 2.

Likelihood of salmon use—Likelihood of salmonid presence is the first consideration in assessing potential level for actual salmon use. Presence is a defined as a function of whether a waterway (or interlinked network of waterways) supports spawning salmon, or has a juvenile fish-passable connection to salmonid spawning habitat. In the latter case, the connection should generally be downstream of a spawning environment within the other system because as salmon (especially coho) juveniles migrate from spawning areas into summer rearing locations, they tend to distribute themselves in a downstream direction presumably in response to velocity. There is, however, recent evidence that salmonid juveniles may also move upstream under certain conditions. Therefore if the waterway segment in question is upstream of a spawning area and intervening stream gradients are low, upstream movement into an agricultural waterway is possible.

Water flow—If salmonid presence is likely, then the next question is whether there is sufficient flow to support fish use. Consistent with the Skagit and Whatcom criteria, direct observations of fish behavior, and available information for King County's APD waterways, agricultural waterways with inflow either from a stream or a local spring consistently contain the highest numbers of salmonids. Conversely, waterways with no apparent inflow tend to have very few or no salmonids. Often, these waterways were artificially created. Exceptions include riverine side channels or oxbows that may have no surface connection to natural channels but are fed by shallow groundwater exchange with a nearby river. Thus, the possibility for shallow groundwater exchange should be considered where the elevation of the waterway channel bottom is at least as low as the surface elevation of the nearby river and underlying substrates are sufficiently porous to intercept shallow groundwater.

Without additional information and analysis, it is uncertain what absolute minimum flow is required to support salmonids. It appears they can detect and orient toward relatively small amounts of surface flow. Logically, water depth criteria could also help guide the screening process even in the absence of precise water depth and velocity measurements. Available data and observations are insufficient, however, to identify specific depth requirements and small variation in depth would be hard to reliably predict without direct observation. It should also be noted that salmonids can often survive in very shallow water depths (e.g., $\leq$ 2 inches), provided that the water is flowing and of adequate quality with respect to temperature and dissolved oxygen.

With respect to flow, some waterways without an incoming stream or spring may collect seepage water from landforms such as valley walls. While potentially significant seepage flows may be present, waterways fed solely by such flows are considered to support relatively few fish during the summer compared to waterways fed by known perennial surface sources.

Water Quality—If flow is known or likely to be present, the remaining factor to be considered is whether the agricultural waterway has adequate water quality, especially cool water temperature, to support salmonids. Optimal summer temperatures for coho salmon growth range from 10 to 15 ^{o} C and they can potentially withstand up to 26 ^{o} C (McPherson 2006). In assessing physical habitat limits for coho salmon, Reeves at al (1989) suggested temperatures exceeding 20 ^{o}C for two weeks as being limiting for coho salmon in western Oregon and Washington. More recently, Welsh et al (2001) found that in tributaries to the Mattole River of northwestern California, coho salmon were not likely to occur in stream reaches where the highest average of maximum daily temperatures over any 7-day period or the highest average of mean daily temperatures over any 7-day period (based on hourly measurements from throughout the summer) was 18 ^{o} C or 16.3^{o} C, respectively. We suggest either of the Welsh et al criteria as screening criteria for temperature suitability.

Water quality has been assessed in a number of APD waterways (e.g., Abella report for lower Ames Creek), so in some cases it is possible to draw conclusions about temperature and dissolved oxygen conditions. In many cases, however, there are no existing data, so conclusions about water quality must be inferred by examining upstream catchment indicators, including the extent and type of land use and riparian condition. Water sources emanating from catchments with little or no upstream riparian waterway may have elevated temperatures. Similarly, extensive urban and suburban development may contribute high nutrient and other pollution loadings that impair water quality and may lower the likelihood of salmonids occurring in a downstream agricultural waterway. Because summer flow in agricultural waterways is often derived from groundwater seepage rather than urban runoff during summer dry periods, temperature and dissolved oxygen measurements may be necessary to assess the potential of a watercourse to support fish use.

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Figure 2. Decision tree and criteria for developing a salmon-based screening tool to guide summer-time waterway maintenance activities for King County Agricultural Production Districts.

1. Likelihood of Salmon Summer Use— Is there a potential source of salmon (coho), other than fish that may be transported into theAPD waterway segment by occasional flooding?

   Q 1: Does the APD waterway segment have known or high likelihood of persistent, annual—i.e., not rare or infrequent—coho salmon spawning, assuming adequate spawning escapement?

   If yes, proceed to # 2
   If no, then…

   Q 2: Is the APD waterway segment *downstream* from an area with known or high likelihood of persistent coho salmon spawning or, prior to summer low flow conditions, is it *connected* to a waterway that either has known or high likelihood of persistent coho salmon spawning. *and* is the connection potentially passable by juvenile coho salmon under non-flooding conditions?

   If No, then presume low salmonid summer use.
   If Yes, then proceed to Step 2

2. Water Flow—Is there sufficient summer flow to potentially support salmon?

   Q 1: Is the APD waterway segment fed by a known perennial stream or spring?

   If yes, proceed to # 3
   If no, then…

   Q 2: Based on geologic or geomorphologic context, is there a high likelihood that the APD waterway segment is fed by a perennial stream, spring or is known to be deep enough to reliably intercept shallow (hyporheic) groundwater?

   If No, then presume low salmonid summer use
   If Yes, then proceed to Step 3

3. Water Quality—Prior to entry into an APD waterway segment, is the temperature of the inflowing stream or spring substantially elevated due to upstream conditions?

   Q 1: Is there direct evidence that water temperature is impaired? If yes, is impairment extreme, e.g., the maximum weekly temperature maximum exceeds 18° C. or the maximum weekly average temperature exceeds 16.8^{o} C (Welsh et al 2001)?

   If yes, then presume low salmon summer use.
   If no, then

   Q 2: Before entering the APD waterway segment, does incoming stream or spring flow drain an entirely forested catchment? If no, then…

   Q 3: Before entering the APD waterway segment, does incoming stream or spring flow drain a mostly forested catchment with rural (5-acre rural or lower density) development? If no, then…

   Q 4: Before entering the APD waterway segment, does incoming stream or spring flow drain a catchment with mixed use forest/rural development which is mostly buffered by forested streambanks?

   If yes to any of above, then presume high salmonid summer use
   If no to all, then presume moderate salmonid summer use