**The challenge of mapping Alaska’s salmon streams [DRAFT]**  
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*\*Note: this is the first in a series of two opinion articles addressing the state of freshwater salmon habitat mapping efforts in Alaska. This first article is for a more general audience, and the second is for a more technical audience and may be accessed here: [URL tbd]*

90% of Alaskans will tell you that wild salmon are either “important” or “very important”, according to a 2013 poll1. It’s easy to imagine this sentiment in the form of a fly fisherman casting towards a glimmering river, or a filet in our freezers, not to mention a bear swiping at their silvery prey atop a waterfall.

But wild salmon rely on more than just picturesque wilderness settings. What about a small trickle of water seeping from a bluff behind a parking lot? An impenetrable swamp? A stagnant puddle? These are all places that I have found to be teeming with salmon and other fish in my work as a biologist. It is in these corners of the watershed that many of them grow and feed, preparing for a long journey out to the ocean and back.

It can be easy to overlook the humbler places. Frequently, these smaller salmon streams do not appear on even our best maps that land managers use to understand their habitat. Our best-intended, best-designed regulations are only as good as our best information, and too often we’re using incomplete details to make irreversible decisions. As a result, Alaska has a king-sized regulatory gap that can inadvertently let even the most fish-minded among us to allow damage to salmon habitat. How can we take care of our “wild infrastructure” when we don’t yet know where exactly it exists?

The Alaska Department of Fish and Game website describes this gap in its overview of the Anadromous Waters Catalog, the map which serves as the official inventory for Alaskan salmon habitat. (“Anadromous” means any fish that is born and spawns in freshwater, but migrates to the ocean to grow into an adult, as do salmon):

“**The Catalog […]** currently lists almost 20,000 streams, rivers or lakes around the state which have been specified as being important for the spawning, rearing or migration of anadromous fish. However […] it is believed that this number represents a fraction of the streams, rivers, and lakes actually used by anadromous species. Until these habitats are inventoried, they will not be protected under State of Alaska law…”2

Put in other words: rivers and lakes in Alaska are presumed to *not* be salmon habitat unless otherwise proven. Unless someone, usually a trained biologist, has taken the time to visit a possible salmon stream in person and document the presence of juvenile or adult salmon, disturbing the waterbody does not require a fish habitat permit from the Alaska Department of Fish and Game.

As a result, if a road is to be built across an unidentified salmon stream on privately held property, it may not necessarily require that new culverts allow for fish passage. If land clearing is planned, local riparian buffer ordinances might not apply. An engineer prioritizing which road culverts should be rebuilt to fish-friendly standards by measuring the amount of upstream anadromous habitat is likely operating with a big information handicap.

Consider the case of a recently bulldozed creek tributary I encountered a few summers ago. A landowner had initiated a major construction project, excavating a stream that we later discovered was home to thousands of juvenile silver salmon and dolly varden. The stream did not appear in the anadromous waters catalog; nor was it even on the map of any streams at all. Even a conservation-minded landowner could struggle to take responsible actions around this stream if they don’t know it exists.

Identifying a salmon stream post-hoc after it has been bulldozed is a situation no one wants to see. Not landowners, not neighbors, and not the fish. Arguably not every single wild salmon stream is destined for preservation as we balance the needs of growing communities and wild fish habitat in our backyards. But we owe it to ourselves to have good information about where wild salmon live to make informed decisions.

Every summer a small but dedicated cadre of biologists from state, federal, tribal, and nonprofit groups work to expand the map of Alaska salmon streams. They are to be commended for their yeoman’s labor. But their task is gargantuan, not unlike attempting to build a towering birch tree out of twigs and twine. It can be done, slowly and with difficulty, but not soon enough.

*A way forward*

So, what are the alternatives to our current situation? There are options at all ends of the spectrum, and somewhere in the middle is the best approach to mapping Alaska’s salmon streams. The good news is that there are ways for us to work together and decide our path forward. The tools to address the challenge are ready at hand and some researchers are already changing the game as we speak.

*Option 1: Change our assumptions*

Given how widespread salmon habitat is throughout Alaska, the presumption that waters are not salmon habitat unless otherwise proven is a kind of “guilty until proven innocent approach” to habitat management. At the most progressive end of the spectrum, we could *reverse* our current assumption that waters are not salmon-bearing until proven otherwise. But this option may prove too challenging to execute.

Such a shift was proposed as part of Ballot Measure 1, also known as the “Stand for Salmon” campaign in 2018[[1]](#footnote-1). The shift could have placed the responsibility on developers to assess the status of streams, lakes, and wetlands that may be disturbed by their proposed activities, and file for the appropriate fish habitat permits based on their findings. Today, in many cases such proactive steps are voluntary for private landowners. While such a vision may be well intentioned, enforcing it could represent a sea change at a scale that Alaska may not be ready to accept, and pursuing this path could be ineffective.

*Option 2: Status quo*

At the other end of the spectrum is our current approach to documenting salmon habitat. Today, we rely on a dedicated but small array of state and federal agencies, nonprofits, tribal entities, and a few volunteer citizens to do the important work of documenting salmon habitat. Each summer, scientists pore over maps searching for rivers, streams, and lakes not yet registered the Anadromous Waters Catalog. They travel to where they estimate are the uppermost headwaters in a stream that salmon may be found, sometimes a high mountain stream or sometimes a swampy rivulet. They use tools to survey the potential fish habitat, then submit their data to be assessed by the Alaska Department of Fish and Game each fall.

Our current approach, while straightforward, is slow, labor-intensive, and will never document every salmon stream. As our communities grow, more streams and wetlands that serve as salmon habitat are likely to be inadvertently disturbed in our expanding footprint.

*Option 3: Use better maps to make better maps*

There may be more efficient ways to inventory Alaska’s salmon streams, and some researchers are already using them.

Under our current regulations, guessing the “uppermost point of anadromy” is a critical but challenging task for biologists preparing to head out to the field. Our methods for choosing where to perform fish surveys range from interviewing local people, squinting at topo lines, or checking computer databases. In my own experience, it’s usually a semi-informed shot in the dark as to whether or not many miles of additional salmon habitat lie upstream from a field survey site reached after an arduous journey.

In the last decade, scientists have begun to develop detailed watershed maps using high-resolution imagery and computer models that do a much better job of predicting where salmon habitat may lay. These maps have been applied in southeast Alaska by the U.S. Forest Service in recent fish habitat survey efforts. The results so far are promising: these models can predict with ~90% accuracy the “uppermost point of anadromy” within a stream, within ±66 meters3,4. Such efforts can result in identifying dozens or hundreds of miles of previously undocumented salmon streams.

In most of Alaska, these advanced mapping techniques have yet to be applied. But initial results from southeast Alaska are promising. This approach is still labor-intensive, but at least is informed by our best information.

A map that can so efficiently predict the extent of salmon habitat suggests that one day, we could come closer to knowing their full habitat range without having to physically set foot in every single headwater. If these predictive maps continue to prove accurate in broader regions of Alaska, one could argue that it is these new maps that land managers should use to evaluate impacts instead of the anadromous waters catalog, even if we have not set foot to gather hands-on proof at the end of every stream. Such a change would be a major shift from current policy and would require more experience and evidence to advocate for statewide changes, but could be a powerful choice in the long term.

*Ongoing efforts*

Alaskans have expressed a strong interest in helping with the work of mapping salmon streams. A hands-on experience to seek and find "baby salmon" in surprising places is an explorer’s joy. Recently, Trout Unlimited Alaska has supported these efforts both in the Juneau area, as well as on the Kenai Peninsula in partnership with Kenai Watershed Forum5,6. The “Fish Map App”7 for smartphones recently released by the nonprofit Indigenous Sentinels Network also aims to support such citizen science efforts.

It can take experience and training to know where and how to add miles to Alaska’s map of salmon streams. But the work will not wait for us. As a society where 90% of us say that we value wild salmon in our lives, doing our best to learn where wild salmon live is a start to learning how to live together.

Technical and logistical challenges lay ahead on our road towards improving anadromous waters mapping in Alaska. The second of this two-article series will outline some questions that have unfolded as I learn more about this topic.

*For ways to get involved with mapping salmon streams on the Kenai Peninsula, contact Kenai Watershed Forum (hydrology@kenaiwatershed.org).*

References

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**Using better maps to make better maps for Alaska’s salmon streams [DRAFT]**February 3, 2023  
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*This is the second in a series of two opinion articles addressing the state of freshwater salmon habitat mapping efforts in Alaska. The first article is for a more general audience and may be accessed here \_\_\_\_\_\_\_\_\_\_\_\_:, while the second below is for a more technical audience.*

In the first of this two-article series, I made the case for modernizing our approach towards mapping Alaska’s salmon streams. In this second article, I will outline the details and particular technologies that we may use to do so. My intention is to describe my unresolved questions of how to design and execute a new project to use a systematic approach for expanding the anadromous waters catalog in the Kenai Borough region, then share this article with a small audience of experts to solicit ideas and feedback.

If you’ve made it through that first paragraph, thank you for your time and assistance! Now, onwards.

A variety of state, federal, tribal, and nonprofit organizations are pursuing the work of expanding the Anadromous Waters Catalog. To select field survey sites, we may rely on word of mouth, local databases, or searching the map for places where the existing streams in the catalog end while the stream channel continues upstream. The lack of a systematic approach is by nature inefficient, as frequently field biologists are uncertain if many miles of additional salmon habitat lay upstream from their survey location.

In Spring 2022 I stumbled across reports from a project in southeast Alaska that used sophisticated mapping approaches to estimate the uppermost points of anadromy within a watershed. Field biologists traveled to a subset of these locations to perform “End of Anadromy surveys”

These data along with other geographic and hydrologic data fed a predictive model that results in ~90% (details)

\A few summers ago, a call came into our office about a just-cleared property near a local creek. Neighbors were concerned that the land-clearing had disturbed wetlands and streams that feed into a nearby anadromous stream. Land clearing and developments of this nature are not infrequent at the suburban-rural boundary of southcentral Alaska, and usually they in compliance with permitting requirements. Here, however, it was unclear what we were walking into.

We arrived to find a quarter-mile length of freshly ditched and straightened stream denuded of riparian and benthic structure. We found dozens of juvenile coho salmon and Dolly Varden residing both above and below the excavated section of stream, which we later successfully nominated to the Alaska Department of Fish and Game's (ADF&G) Anadromous Waters Catalog (AWC).

Now that this particular stream is included on the map, in the future if a developer submits plans to local permitting offices those plans would typically be reviewed for compliance with a Fish Habitat Permit from ADF&G, and reviewers will ideally make recommendations to help mitigate impacts of the planned development.

Identifying a salmon stream post-hoc after it has been bulldozed is a situation no one wants to see. Not landowners, not neighbors, not the general public, and not the fish. Arguably not every single wild salmon stream is destined for indefinite preservation as we balance the needs of growing communities and wild fish habitat in our backyards. But we owe it to ourselves to have good information about where wild salmon live to make informed decisions.

So how do we prevent this sort of uninformed travesty from repeating in more yet-unidentified salmon streams? What can we do to at least get these streams on the map?

Currently, Alaska regulations are such that we assume streams and lakes are not salmon-bearing unless otherwise proven. For our bulldozed example above, for this stream to have appeared beforehand on the Anadromous Waters Catalog map the following would have to have occurred:

* Someone would have had to known that this tiny stream existed and might have salmon
* Someone would gain permission from the landowner to visit the property
* Someone would perform a field survey to determine the presence or absence of salmon
* The data would be submitted to ADF&G review as a nomination to the Anadromous Waters Catalog

other option would be to reverse assumption of axndromy, e.g. bm1, but for now until then…

we want to encourage this behavior. how can we help create a treasure map to send out volunteers?'

'etc

use map approach . touch on netmap vs / and nhd approaches…

lots of other easons to have more complete awc: upstream distance used to prioritize culverts … read more on adfg site

one day I hope we might be able to use modeled maps as the map layer rather than solely ground-truthed streams ections. this approach has been highly successful for wetlands mapping

No one

future technique: ground-truth model, when model is good, use for permitting purposes

to do - decide on best approach/model options: a.) use ~12% gradient on NHD+ as upper estimate ( can use other features from NHD?) b.) use NetMap/statistical approach

As an initial project, Rivulet intends to tackle a challenge related to freshwater salmon habitat management in Alaska. Today, there is an enormous gap between our knowledge of salmon habitat geography and the needs of Alaska's fish habitat managers.

It is estimated that less than half of Alaska's freshwater salmon habitat is documented and mapped; and as a result these streams and lakes lack the legal protection afforded by inclusion in the Alaska Department of Fish and Game's (ADF&G) Anadromous Waters Catalog. When environmental impacts are reviewed prior to development projects, undocumented anadromous streams do not require a Fish Habitat Permit issued by ADF&G. As a result, thousands of stream miles outside of protected areas are vulnerable to development impacts such blockages from road crossings, erosion and runoff from impervious surfaces, and riparian denudement. Threats to these undocumented anadromous habitats come from both small scale developments such as driveway crossings as well as on a large scale such as a mining developments. In order to nominate salmon habitat for inclusion in the Anadromous Waters Catalog, ADF&G requires in-person visual confirmation of anadromous fish at the site location. The work requires hands-on fieldwork by fisheries technicians and volunteers, frequently via little-traveled routes crossing a complex patchwork of land ownership.

Thesis chapters Proof of concept for creating and using "treasure map" with volunteer labor

Existing municipal, state, and federal laws - how and where are there gaps, how could it change? Focus on regional examples in misc places Exploration for how to reverse assumptions on anadromy - what would it take for legal framework to change such that we assume waters "are" anadromous unless evidence suggests otherwise? Upstream: lit review of headwater contributions and their function in downstream nutrition

People to contact: Bidlack Falke Benda Romey

The NHD, AWC, IP

In working to solve local challenges, the question we should be asking is “do our environmental standards serve local needs?”

Explorers are those of us who see maps and think, "There most be more to it than what's shown here…"

1. The statewide initiative failed in the face of well-funded opposition. The “Stand for Alaska” campaign both raised valid concerns about the initiative, and was also able to outspend the Stand for Salmon campaign by a margin of 7:1. [↑](#footnote-ref-1)