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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 essay in a series addressing the state of freshwater salmon habitat mapping efforts in Alaska. The first introductory article is for a more general audience and may be accessed here \_\_\_\_\_\_\_\_\_\_\_\_:, while this second article below is for a more technical audience.*

In a previous essay, I made the case for using a more systematic approach to mapping Alaska’s salmon streams. In this second article, I will begin to explore how we may do so, and how some researchers already are.

As part of efforts to institute a systematic approach for expanding the anadromous waters catalog (AWC) in the Kenai Borough region, I’ve encountered a series of technical questions on how to best proceed. Here, my intention is to outline these questions and share them with a small audience of experts to solicit ideas and feedback. There are several mapping approaches for how to predict the locations of yet-unidentified salmon streams, and I hope to learn and apply methods that will ultimately be applicable statewide.

*The need for a systematic approach*

To select field survey sites to expand the AWC, many of us rely on word of mouth, local databases, or visually searching the map for places where the existing AWC streams end while the channel continues upstream. Sometimes, we are responding to a development in progress where someone believes a stream may have salmon. The lack of a systematic approach is inefficient, as frequently we are uncertain if many miles of additional salmon habitat lay upstream from our survey location.

As an example, in summer 2022 we surveyed a small tributary of the Moose River near Sterling, AK. Figure X shows that not only was this tributary not yet included in the AWC, but the anadromous stream section continued well beyond where the currently mapped flow channel lay. Until we submitted the (pending) AWC nomination, a developer or a land manager would have little reason to think a salmon stream existed there.

FIGURE: Moose creek trib example, approach used by naïve types like me .Pic, circle fieldwork site, known stream channel, awc channel

There are certainly many additional examples like this one throughout the Alaska, not infrequently at the current margins of our development footprint. After a few too many less-than-productive fieldwork experiences, I began looking for better ways to approach the challenge of choosing where to survey for more yet-unidentified salmon streams.

*Option 1: Applying slope gradient data*

At the 2022 Mat-Su Salmon Science Symposium I met other researchers tackling the same challenges as myself. A pair of ADF&G Habitat biologists had applied the publicly available geospatial product National Hydrography Database plus (NHD+) towards the task of identifying the likely most-upstream anadromous extent. They used a gradient threshold approach, identifying stream reaches with 12% gradients and assumed these to be barriers to adult salmon migration. When superimposed with the existing AWC map, this reveals many miles of likely salmon streams and lakes not yet included in the AWC.

My reading suggests that the method has its pros and cons. On the pro side, the single threshold can be applied without complex, expensive modeling to an existing public geospatial product. Others argue that this approach may create an incomplete picture of probable salmon habitat. Attempting to infer probable upstream limit of fish occupancy from simple thresholds such as gradient, channel width, or channel type can lead to inaccurate results due to oversimplification of the many other factors that affect fish distribution (Romey and Martin 2022).

Another researcher with Alaska Center for Conservation Science shared a short introduction on new work that will apply the NHD+ in a more complex model of juvenile salmon occupancy in the Mat-Su region (Figure X). The work is part of an ongoing doctoral project with University of Alaska Fairbanks, and I am excited to see how it may apply to AWC mapping prioritization in the future.

*Option 2: Apply NetMap and other field data in a predictive model*

In Fall 2022 I stumbled across reports from a project in southeast Alaska that used more complex mapping approaches to estimate the uppermost points of anadromy within a watershed. In this project, field biologists performed hundreds of “end of anadromy surveys,” also called, “last fish observations” (LFO) in the upper reaches of a watershed. These results along with other geographic and hydrologic data fed a predictive model that generated very strong results: the map predicted *presence* of fish correctly at the most-upstream reach in 86.7% of cases, and correctly predicted *absence* in 98.7% of cases, within ± 66 m (Romey and Martin 2022). These numbers suggest enormous potential to be of help to field biologists looking to add new miles to the AWC.

Pic, link

Along with extensive fieldwork, the approach requires access to a geospatial product called NetMap, produced by the consulting group Terrainworks. (also link to slideshow from AWRA 2019). In my discussions with local colleagues experienced in GIS, some were unclear on the value of investing in NetMap when the NHD already exists, and the NHD+ likely coming in the future. NetMap is a custom GIS product that requires an annual subscription to fully apply, and may generate results slightly different than what the NHD+, a publicly-available product, would ultimately produce. Moreover, I have been told that the NHD+ may be likely slow to arrive for our region, and may not contain the data characteristics needed to generate the kind of successful predictive models discussed earlier.

As I am not an advanced GIS user, I am unable to give due justice to the debate described above. The impressions I’m left with are as follows:

* Using a threshold gradient to estimate the upper limits of salmon distribution is a better approach than other, less-systematic approaches, but is likely to still miss identifying many places where salmon habitat is found.
* A model that applies NetMap and extensive field data appears to be the “state-of-the-art” option, but is potentially expensive and potentially “data-hungry.”
* There is great value in prioritizing the locations we choose to survey for AWC nominations based on local conservation needs and interests.

*Future pursuits*

I am currently in the process of developing a grant proposal that would tackle the challenge of expanding the AWC for the Kenai Peninsula Borough region. It seems like if we have the choice (and the funding) to pursue a “state-of-the-art” option such as using NetMap, then the choice is clear. But, could this approach prove too complex to apply at a scale needed to generate AWC nominations at a broad landscape scale? It is unclear to me now, which is the reason I’ve tried to elucidate my thoughts here.

My vision for the future is something like as follows: using whatever approach we (the management and research community) settle on; we would work together to create a “treasure map” of predicted end-of-anadromy sites. Such a map might have thousands or tens of thousands of sites within the Kenai Peninsula Borough alone. Ultimately, I hope the model will prove successful enough to negate the need for Last Fish Observed ground-truth surveys in every single headwater of every single river, an unrealistic expectation. My vision is that land managers would be confident in using the more detailed predictive map to assess impacts and make decisions, and not require that every “known” anadromous water be confirmed by on-the-ground observations.

This is a ways off from current practices, but

[wrap-up sentences here] [ cite matter et al 2018 somewhere]

Romey, Bernard, and Douglas Martin. 2022. “Landscape-Level Extent of Resident Fish Occupancy in the Alexander Archipelago.” 21–03. Romey Fisheries & Aquatic Sciences.

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