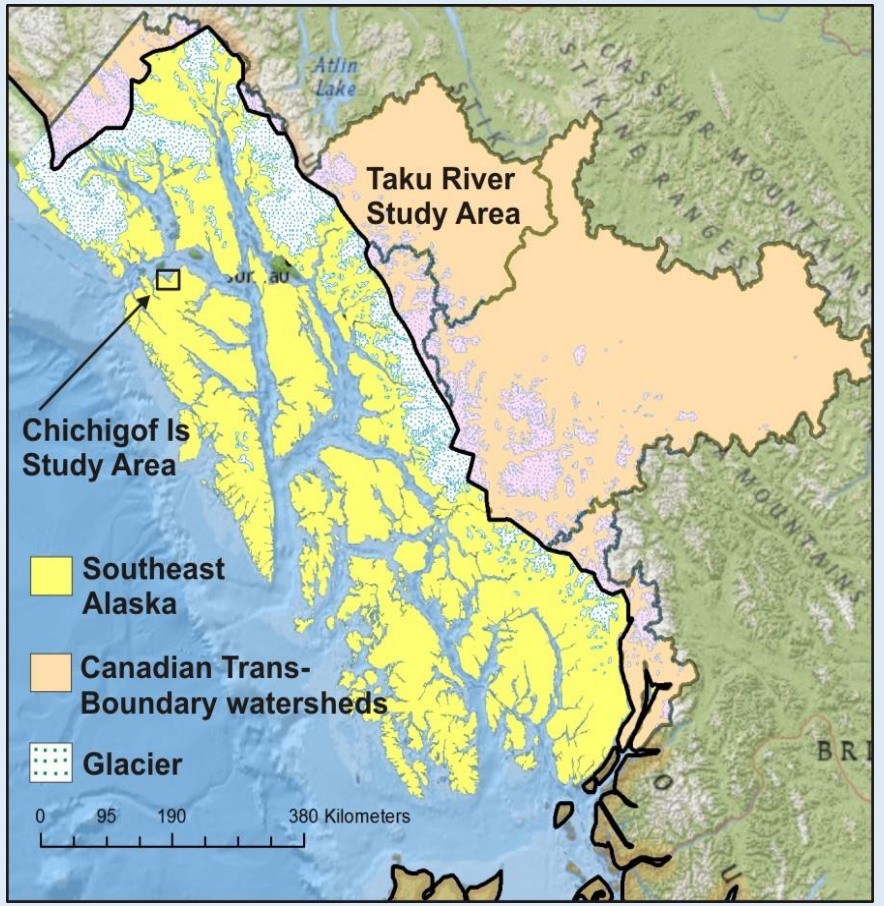
How Can We Safeguard Salmon If We Don’t Know Where They Live?

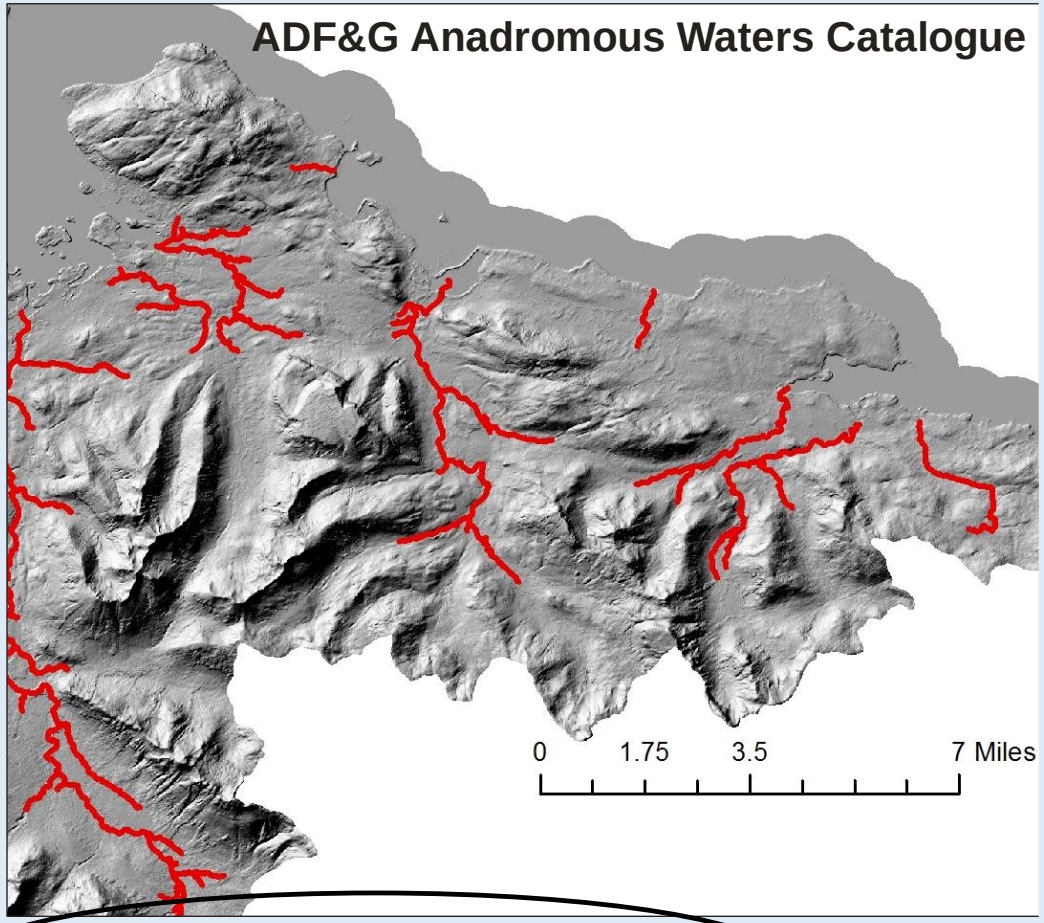
A Crowdfunding Solution to Modernize Identification and Mapping of Salmon Habitats across the Trans-Boundary region

Working Group: SEAK FHP, Trout Unlimited, Wild Salmon Center
Salmon Beyond Borders, The Salmon Project

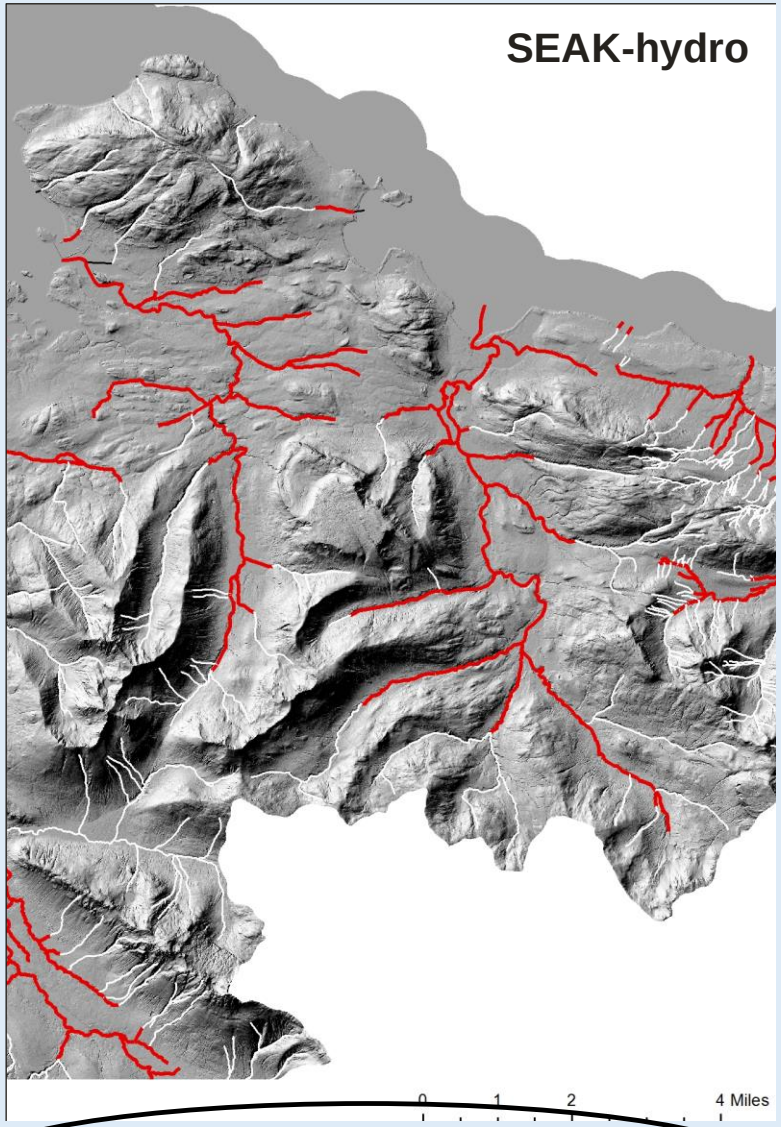
We investigated whether existing hydrographic map products and hydrography that could be developed from digital elevation models (DEM) could accurately identify locations and abundance of salmon that could be at risk in the Trans Boundary Region.



We can start with available maps that show where salmon habitats are located (using an example from northern Chichigof Island)



Salmon stream drainage density: 0.25 km km^{-2}



Salmon stream drainage density: 0.45 km km^{-2}

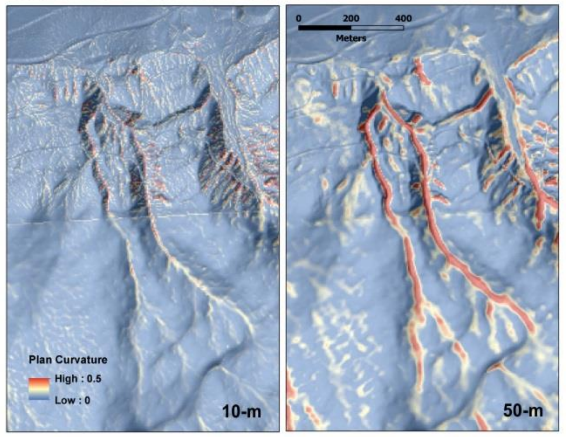
1:63,500-100,000 NHD cartographic stream layer

Note the use of densities (km km^{-2}) that allow us to compare stream networks and salmon stream length across the different data products

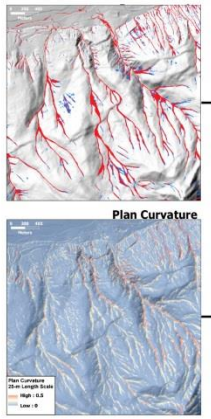
Next, we can delineate channels and salmon habitats using existing digital topographic data.

Mapping Potential Salmon Habitats using Digital Topographic Data

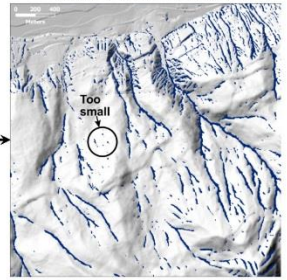
Start with Plan curvature



Add Contributing area * S^2

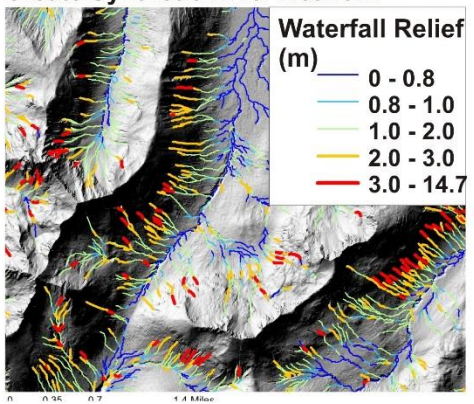


Identify Candidate Channel initiation



Areas meeting both the area-slope and plan-curvature thresholds define a set of candidate channel initiation sites. Only those persisting beyond some minimum flow distance qualify as actual channels.

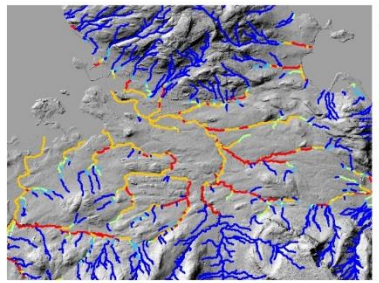
Create Synthetic River Network



Identify waterfall barriers (LiDAR)

Use Alaskan Anadromous Gradient Barriers

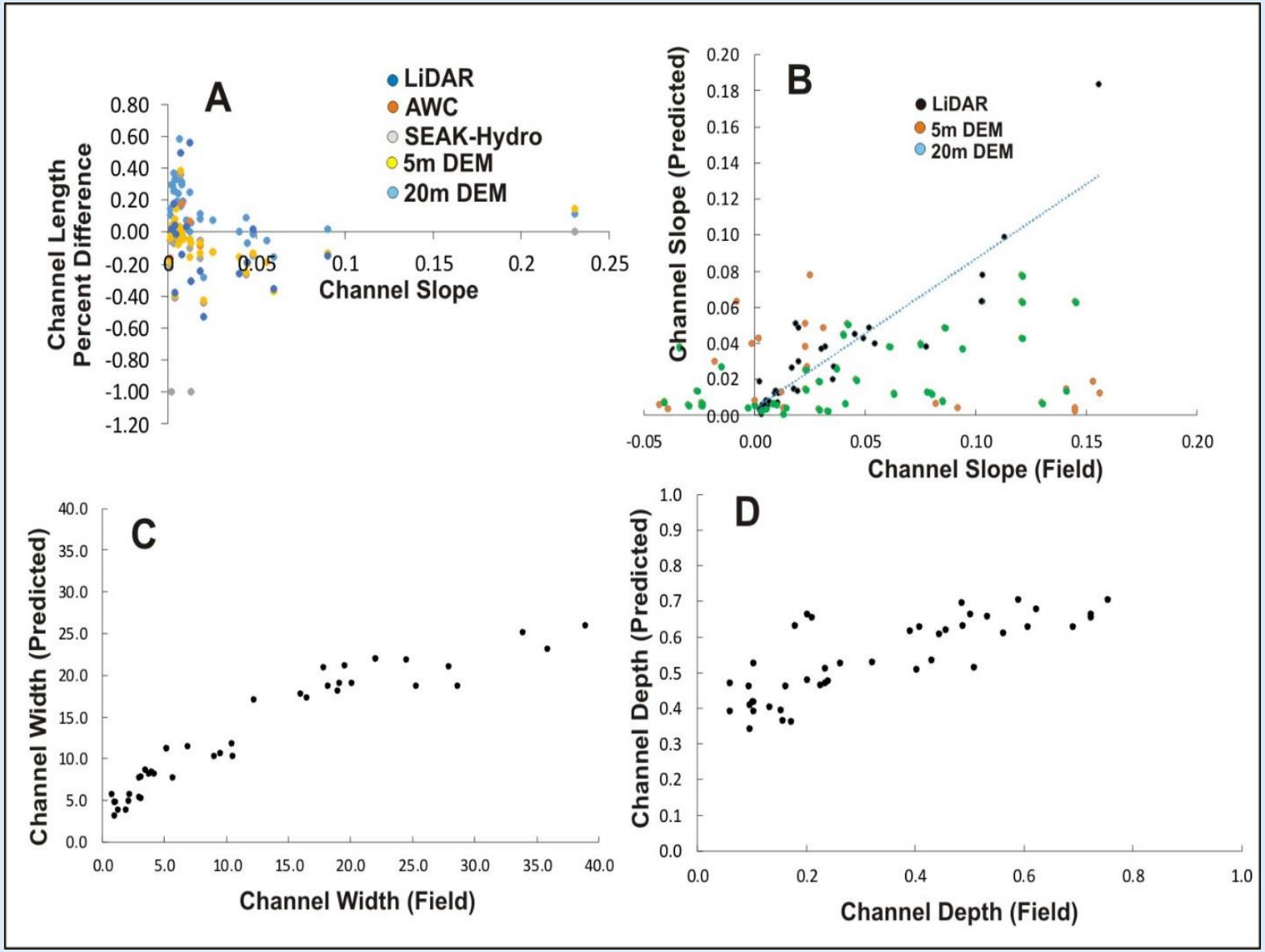
Criterion	Coho	Steelhead	Sockeye	Chinook
Steep channel	>=225 ft @ 12%	→	→	→
Fall height (m)	11 ft	13 ft	10 ft	11 ft



Apply Intrinsic Habitat Potential Models using flow, gradient and confinement thresholds (Burnett et al. 2007)

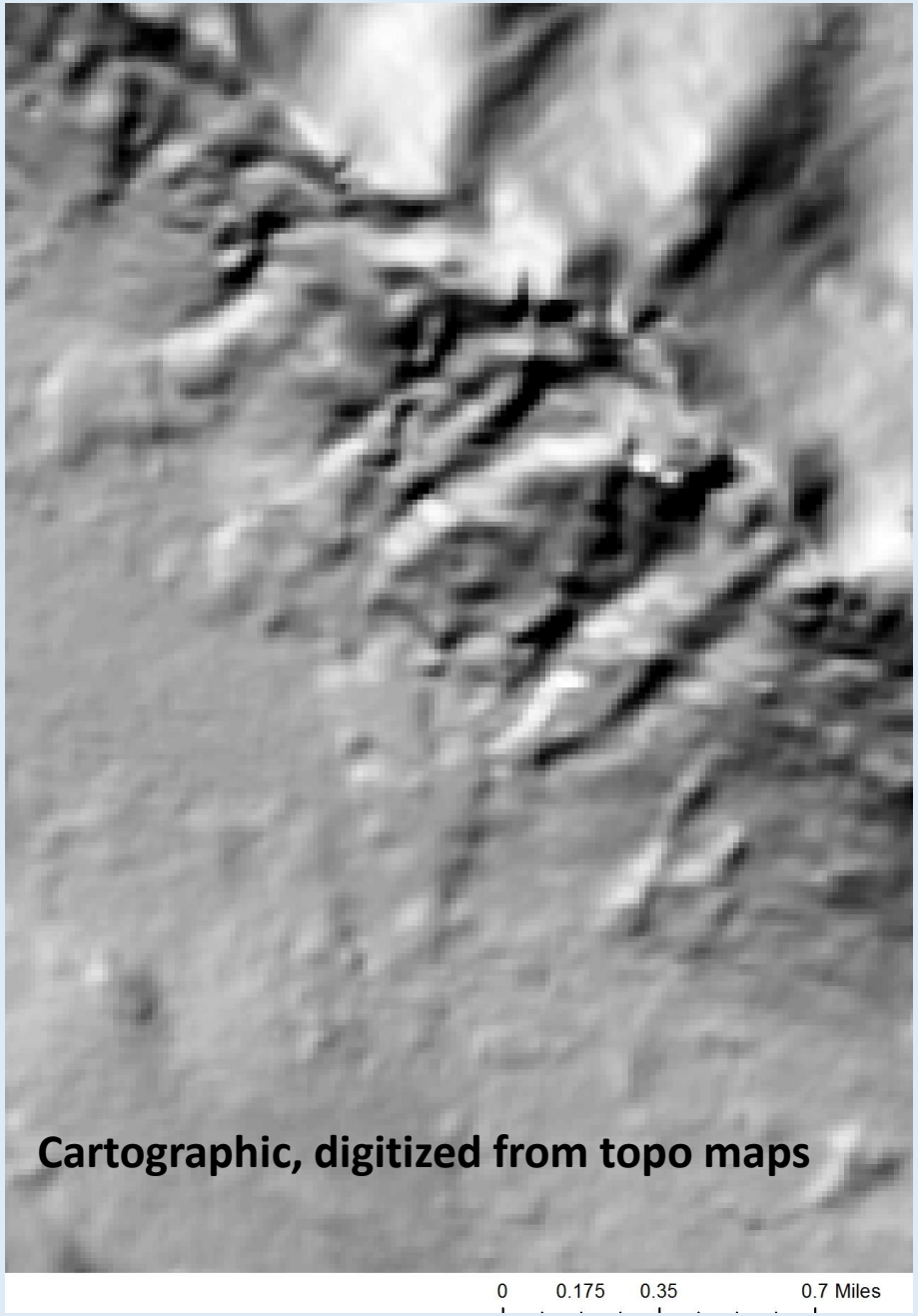
0 - 0.1
0.1 - 0.4
0.4 - 0.7
0.7 - 0.8
0.8 - 1.0

Use field measurements of channel length, slope, width and depth to validate and adjust model predictions (38 sites, 13 km of channel on northern Chichigof Is)

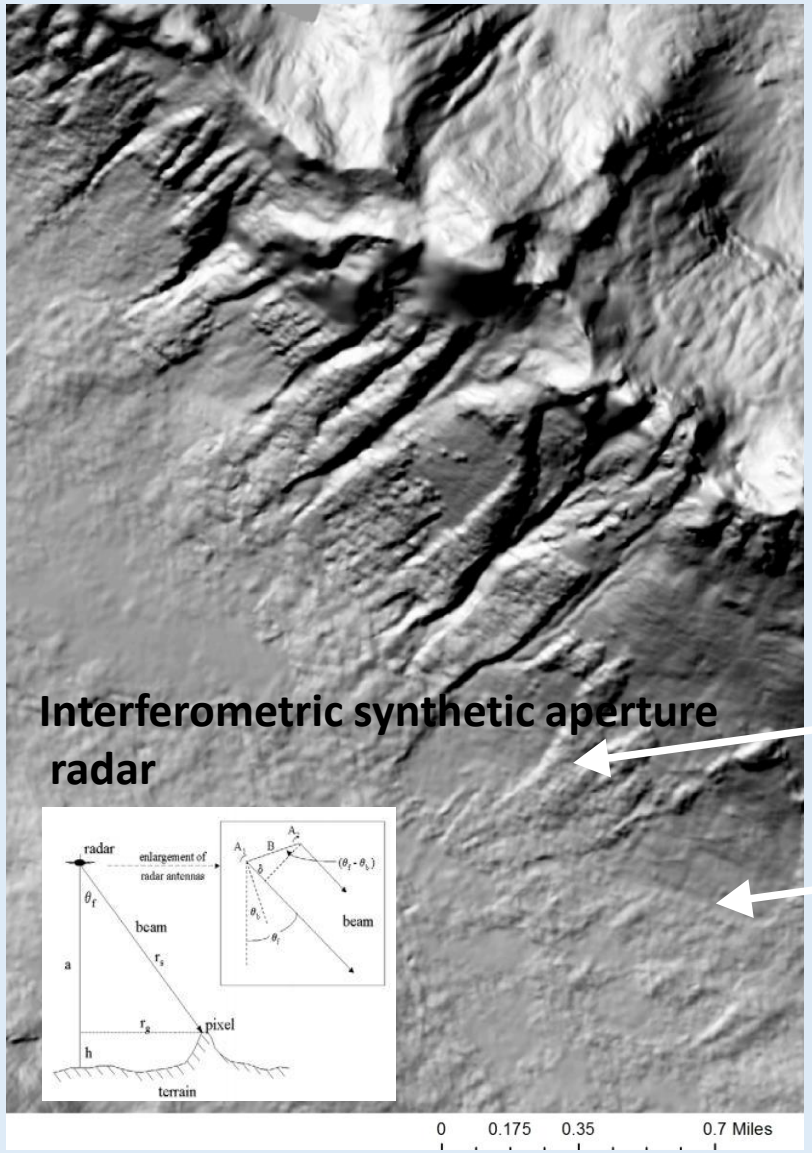


Existing topographic data in southeast Alaska

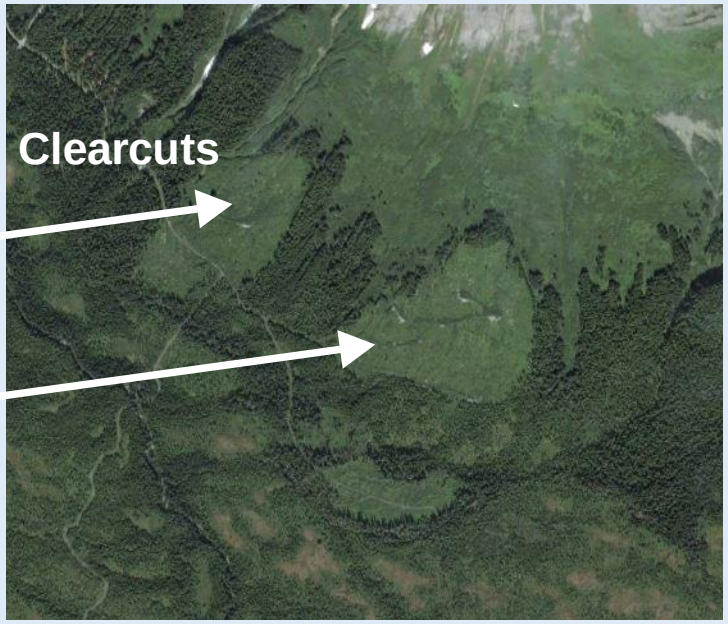
USFS 20m



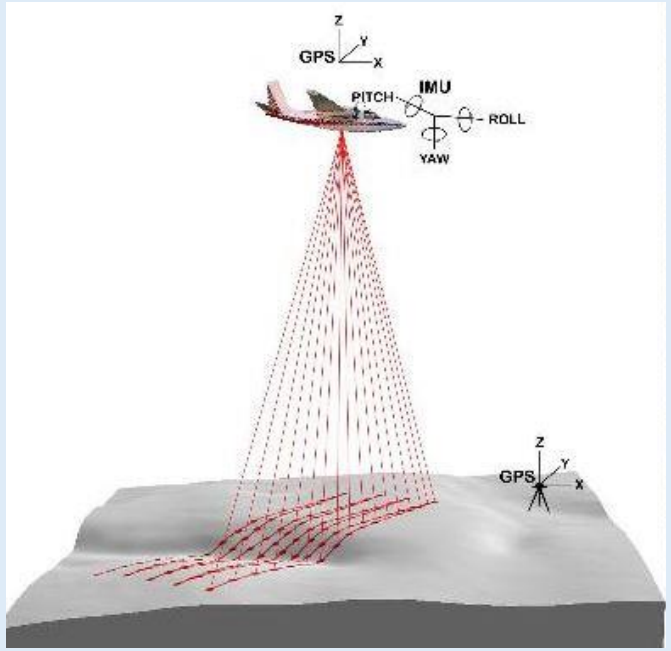
IfSAR 5m



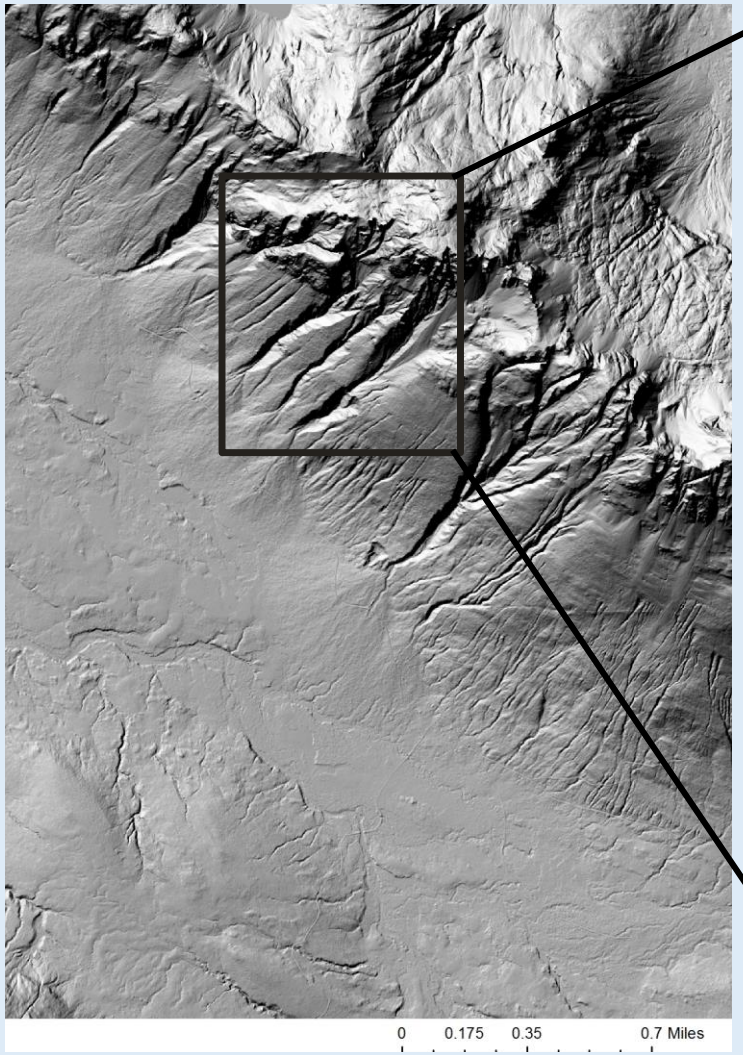
The IfSAR 5m DEM is effected by variation in vegetation heights making it unsuitable to map river networks or salmon habitats



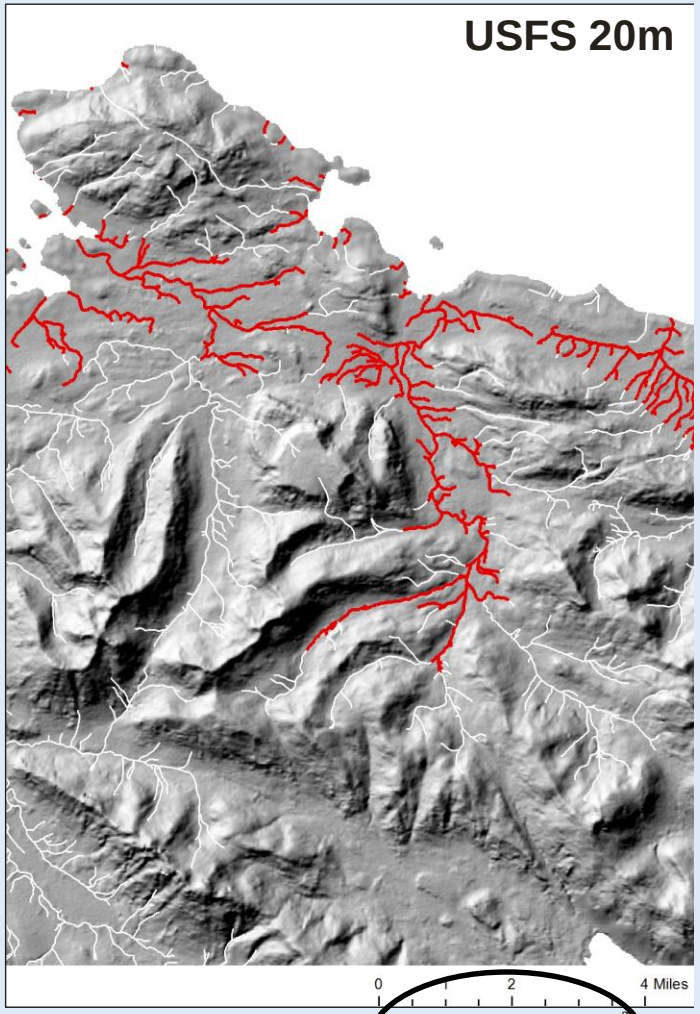
Modern airborne mapping technology (called LiDAR) can create very high resolution digital topography from which complete as possible river networks and mapping of all potential salmon habitats can be accomplished.



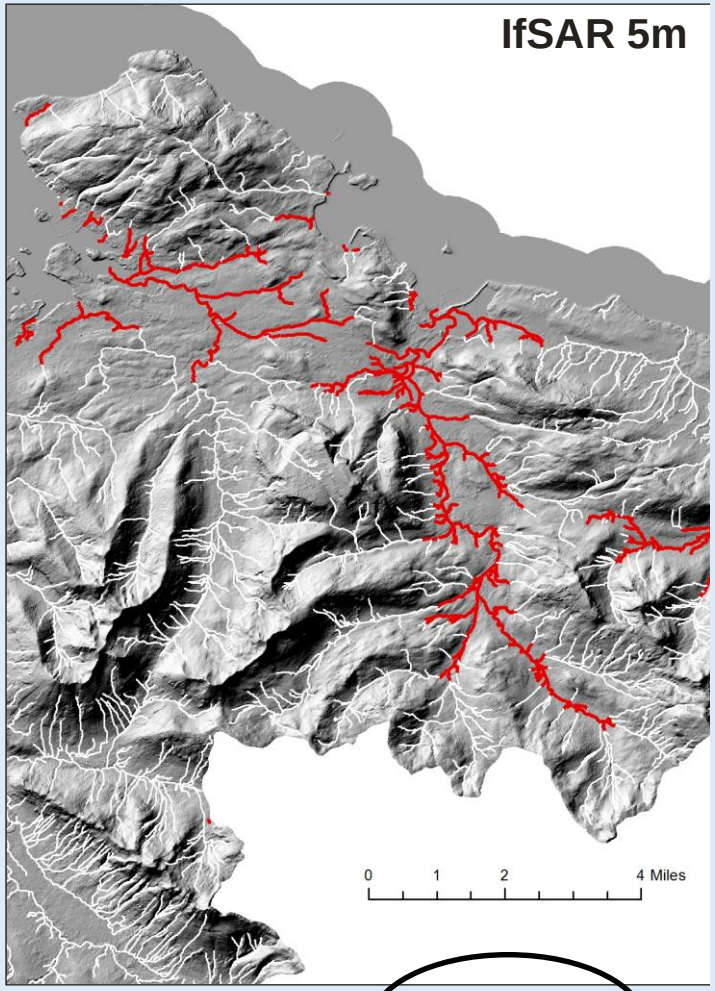
LiDAR 1-2m



North Chichigof Island
Southeast Alaska

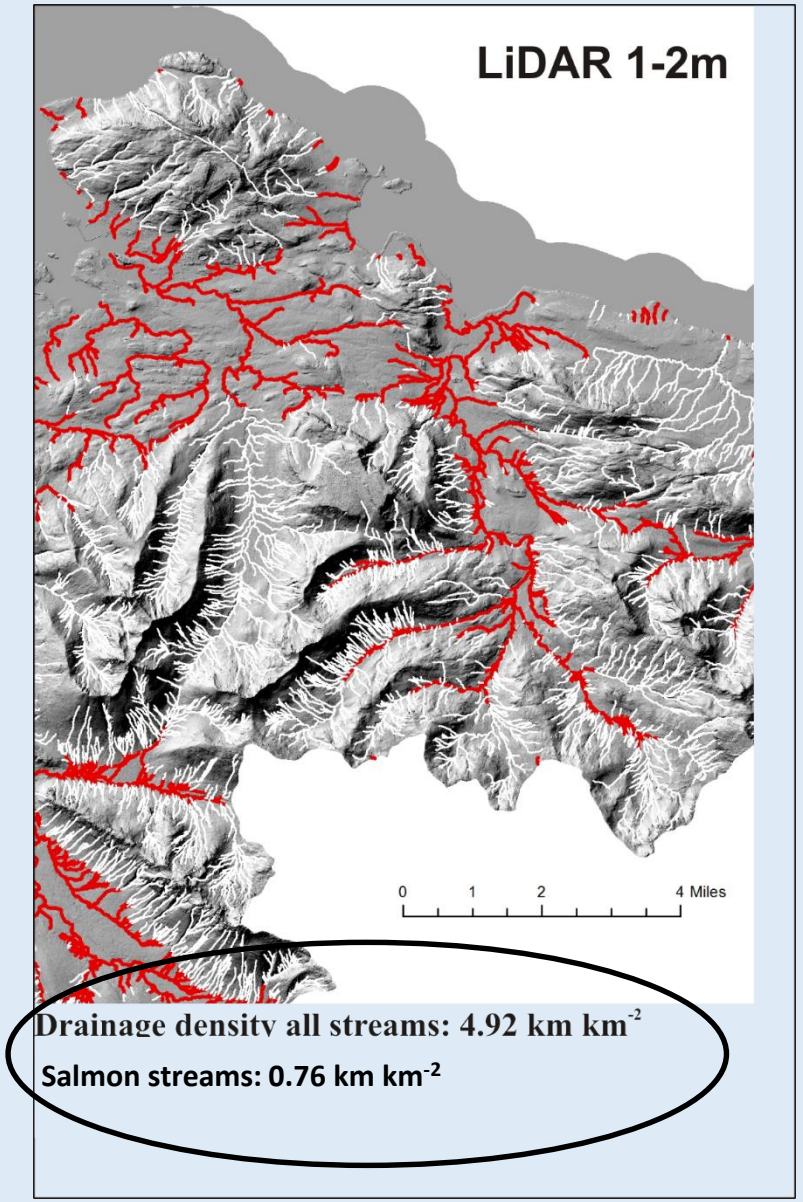


Drainage density all streams: 1.55 km km^{-2}
Salmon streams: 0.36 km km^{-2}



Drainage density all streams: 2.64km km^{-2}
Salmon streams: 0.13 km km^{-2}

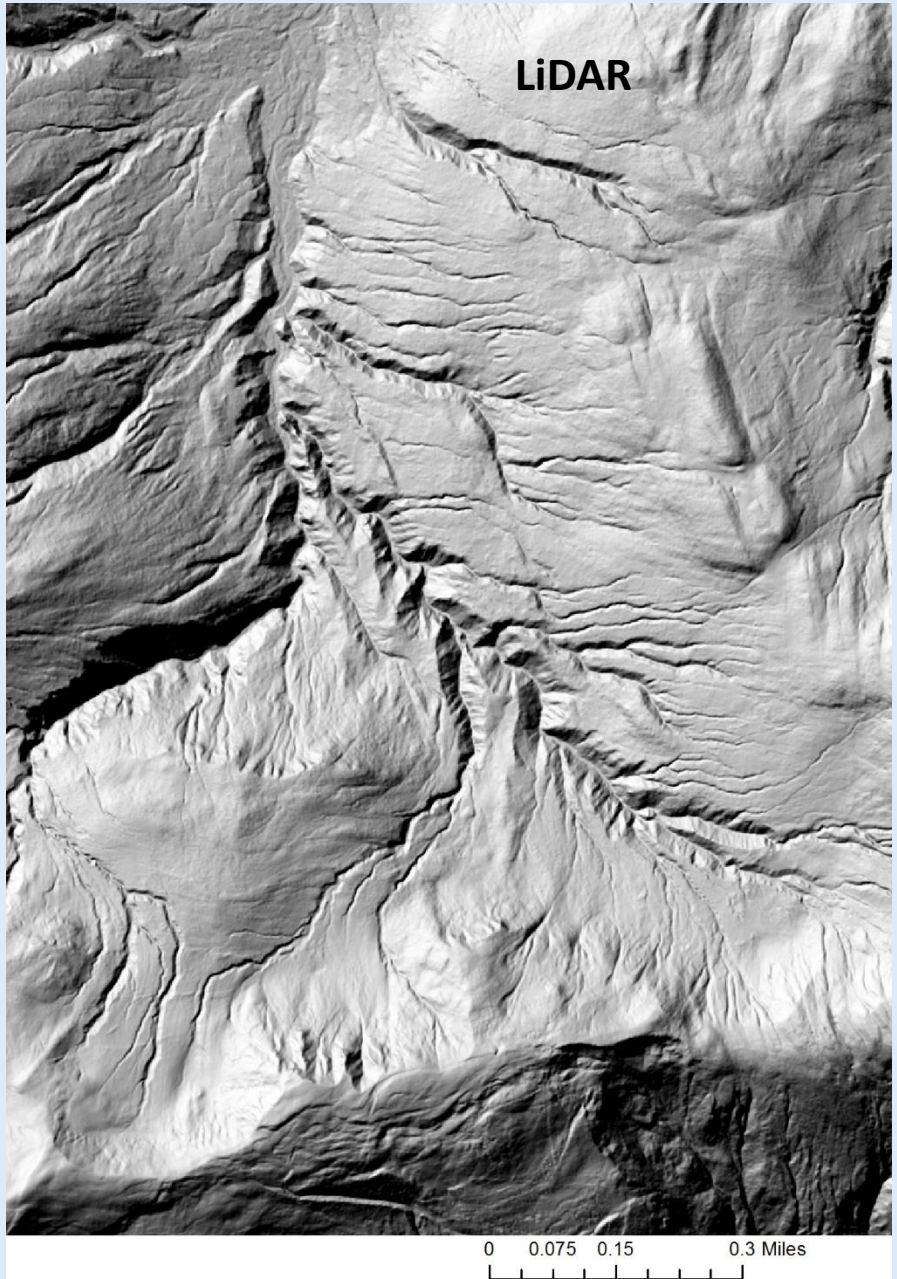
Salmon streams

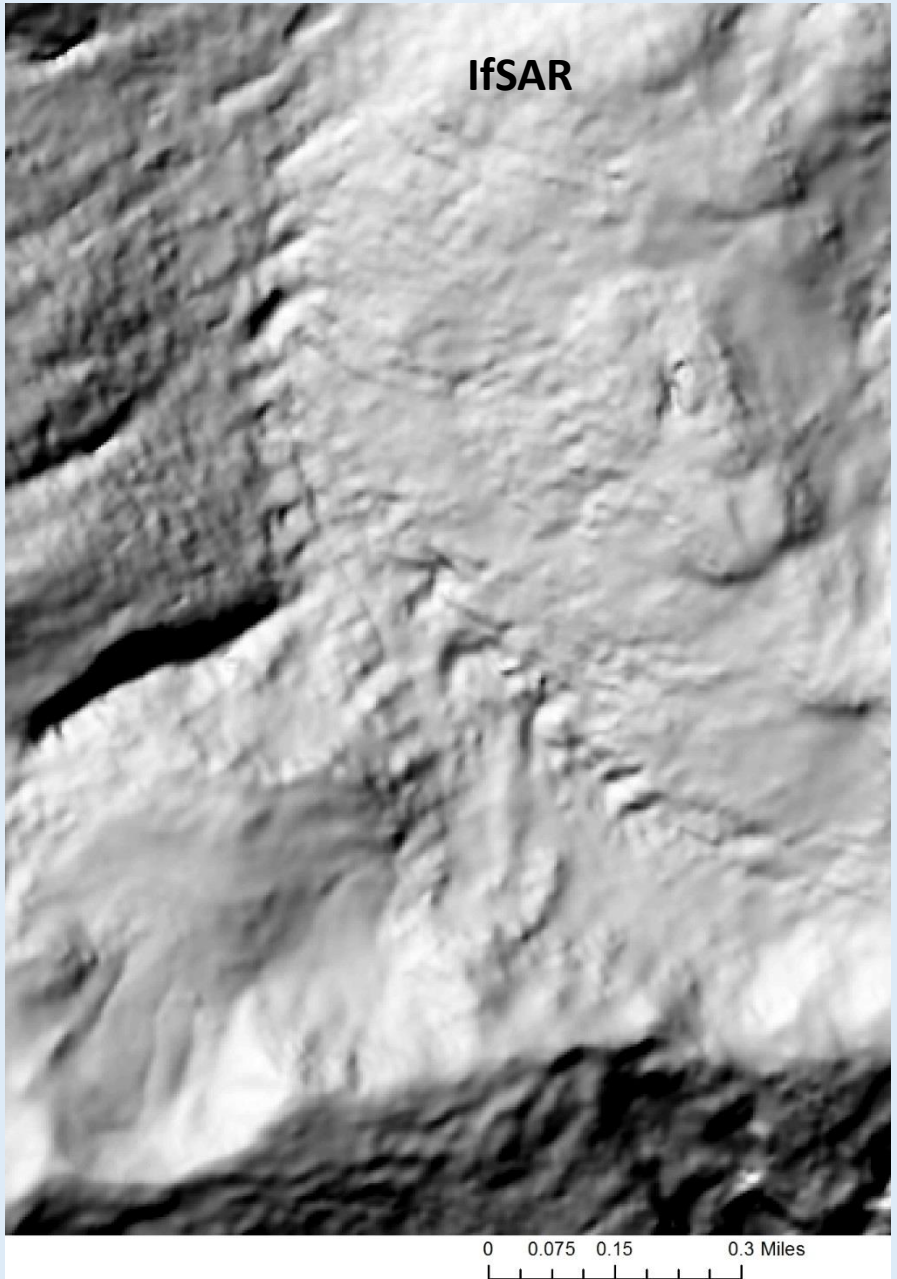


Drainage density all streams: 4.92 km km^{-2}
Salmon streams: 0.76 km km^{-2}

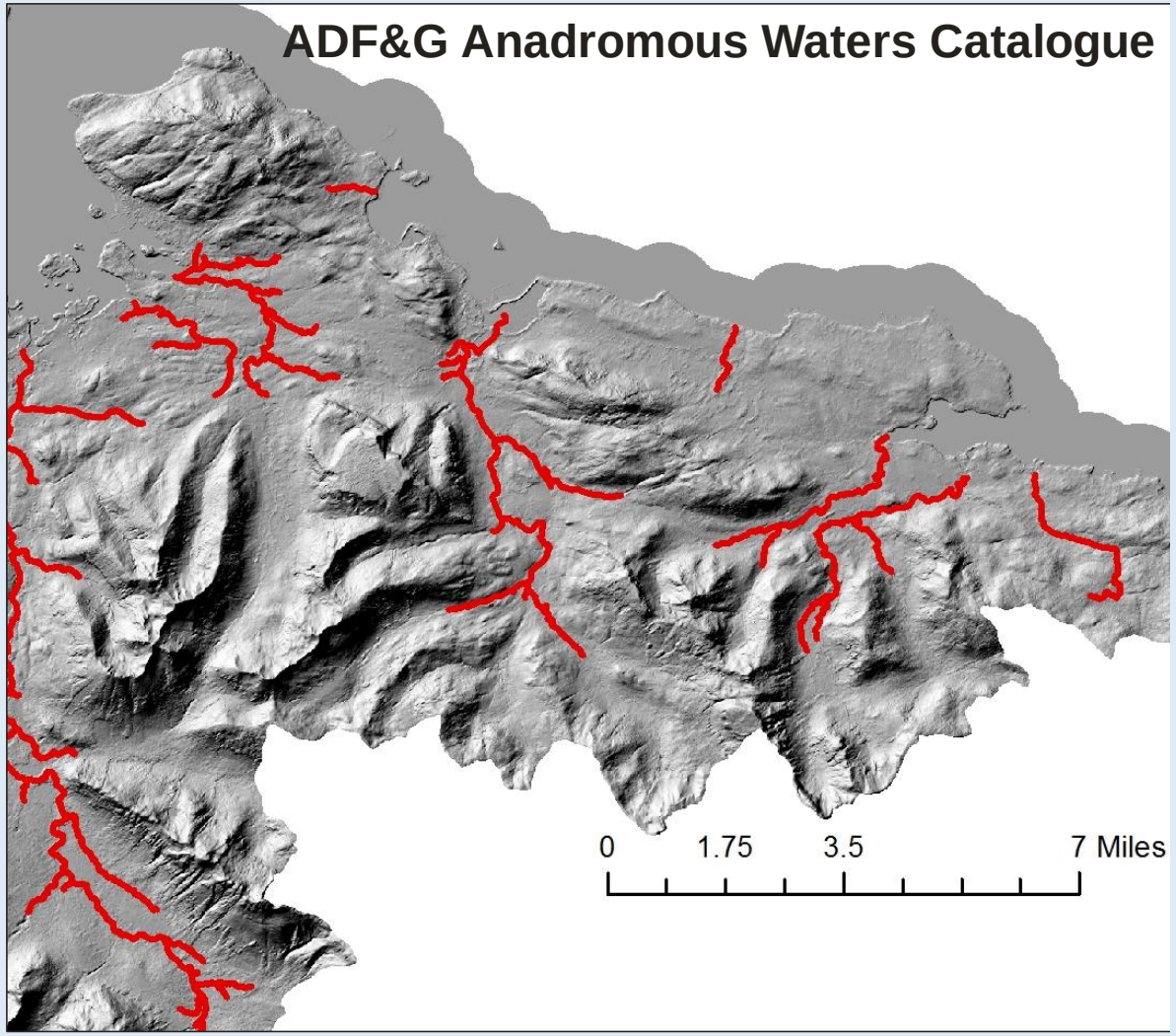
This image shows how the various DEM resolutions support, or not, the delineation of stream and river networks and salmon habitats. Note the differences in the densities of all streams and salmon streams; LiDAR produces the most complete and accurate river networks, including for potential salmon streams.

Compare topographic detail required to delineate streams (LiDAR vs IfSAR)

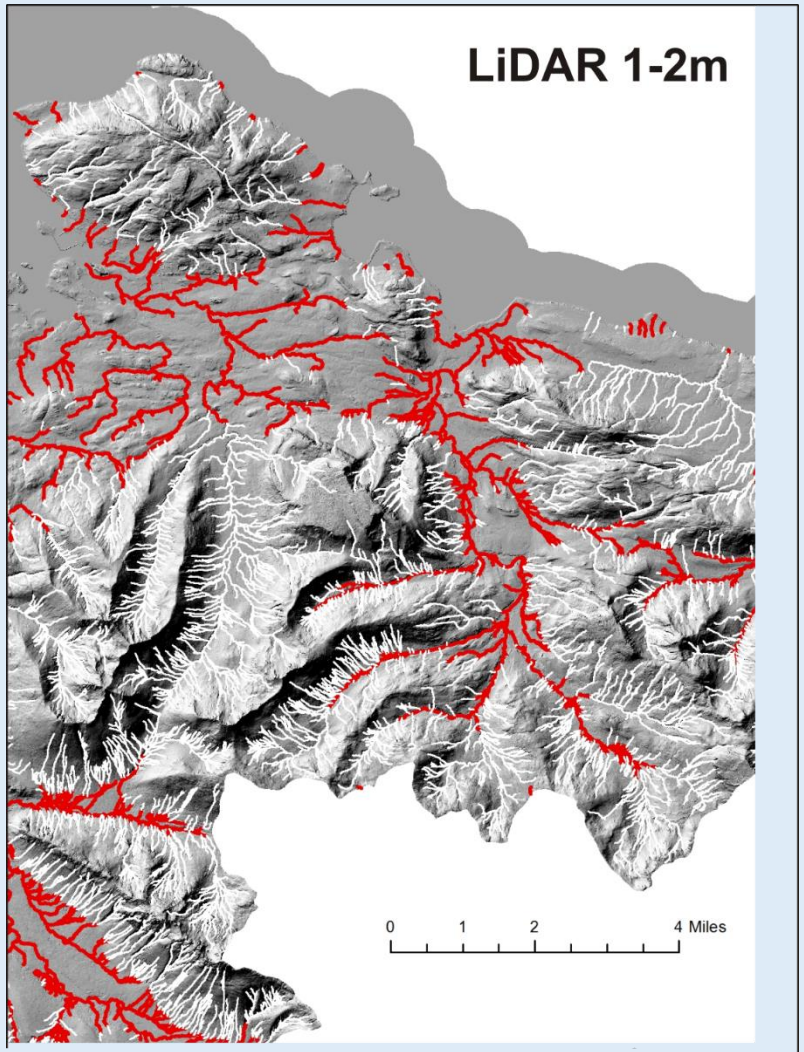




Compare the ADF&G AWC salmon extent with that predicted using the LIDAR DEM: AWC has 60% fewer potential salmon streams (based on length)



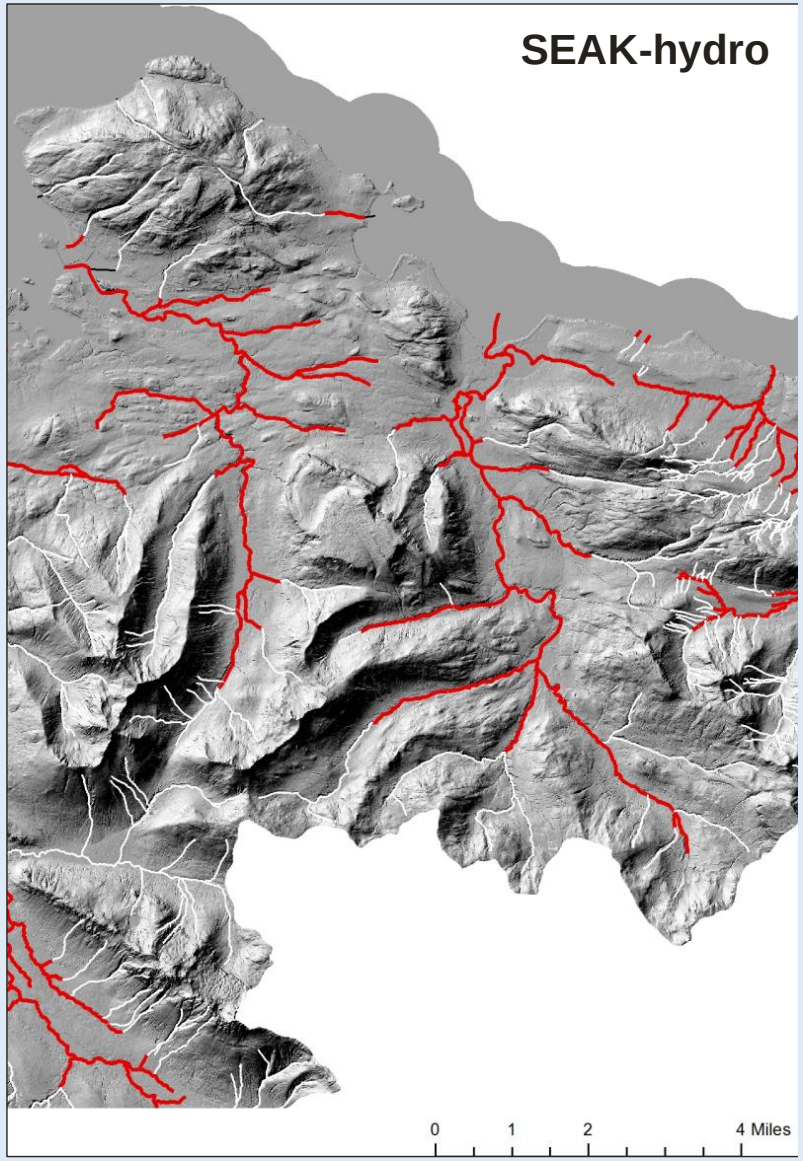
Drainage density salmon streams: 0.26 km km $^{-2}$



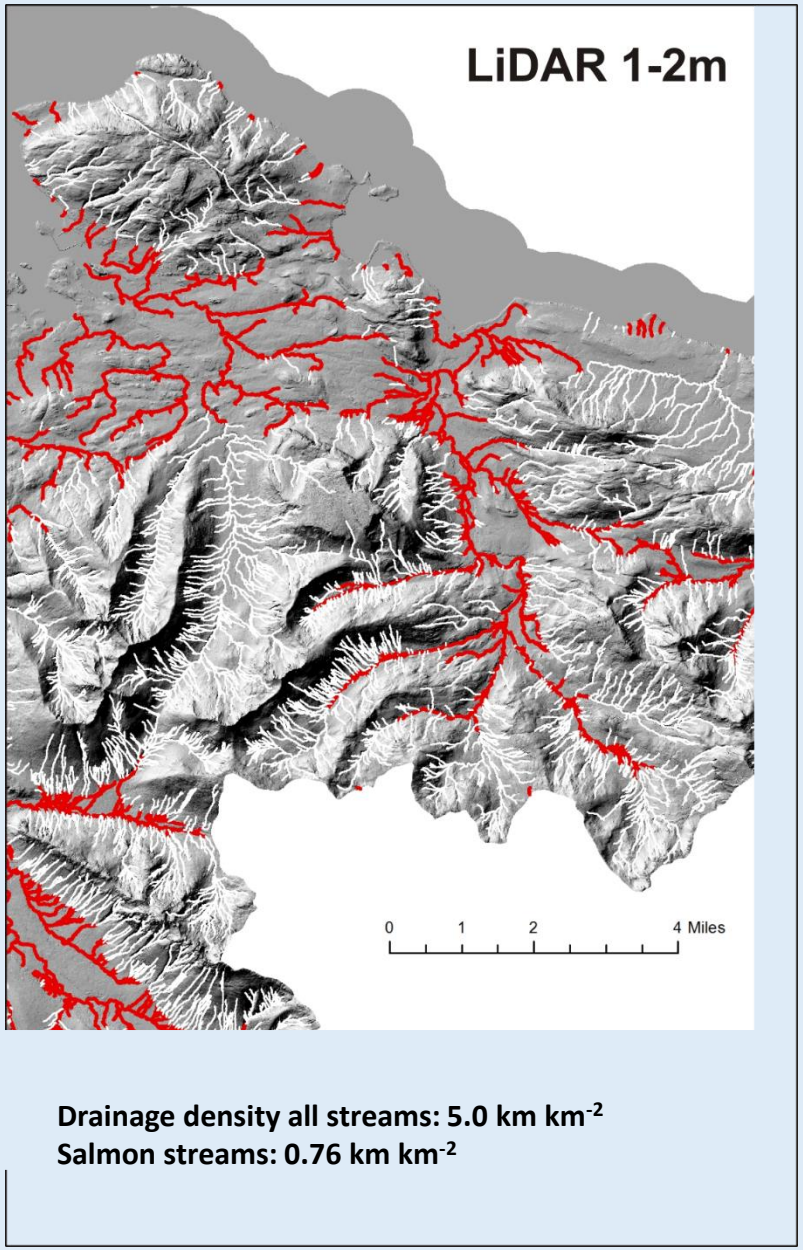
Drainage density all streams: 5.0 km km^{-2}
Salmon streams: 0.76 km km^{-2}

Salmon streams

Compare the SEAK-hydro (Tongass NF) salmon extent with that predicted using the LIDAR DEM: SEAK has about 50% fewer potential salmon streams (based on length)



Drainage density all streams: 1.6 km km^{-2}
Salmon streams: 0.36 km km^{-2}

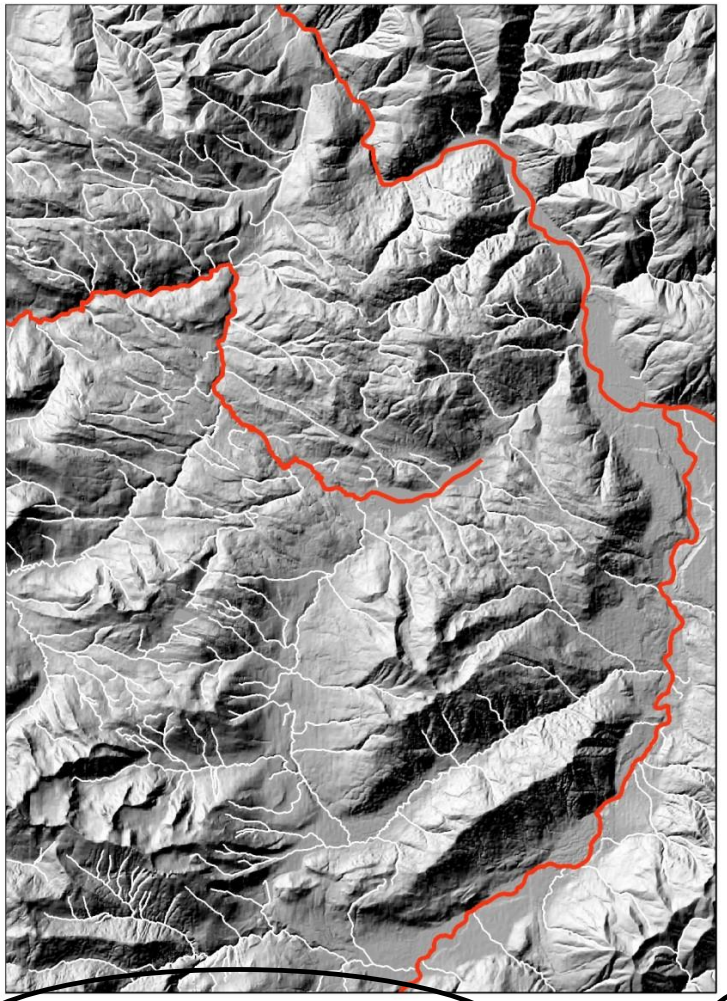


Drainage density all streams: 5.0 km km^{-2}
Salmon streams: 0.76 km km^{-2}

Salmon streams

What is available in Canadian Trans Boundary Watersheds (Taku, Iskut-Stikine, Unuk, Whiting) ?

Provincial 1:50,000 scale with historical fish distribution (cartographic)

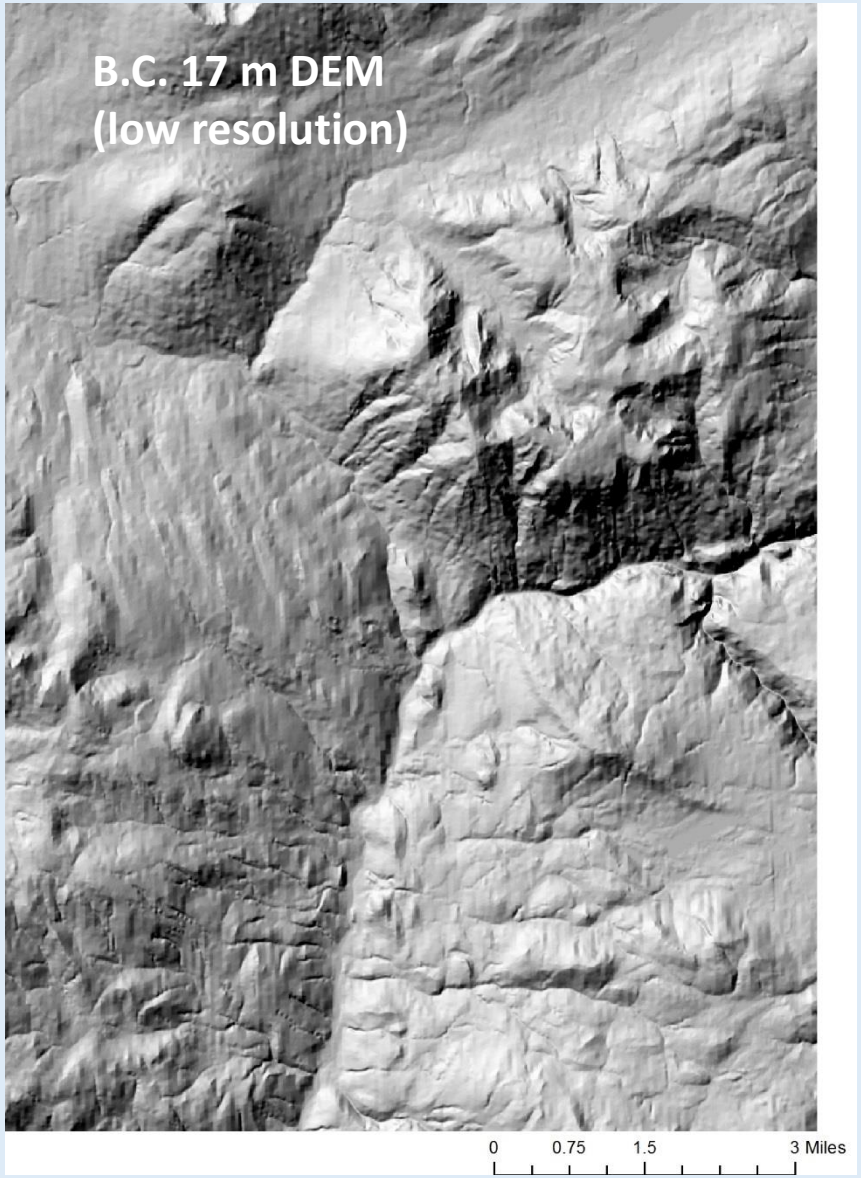


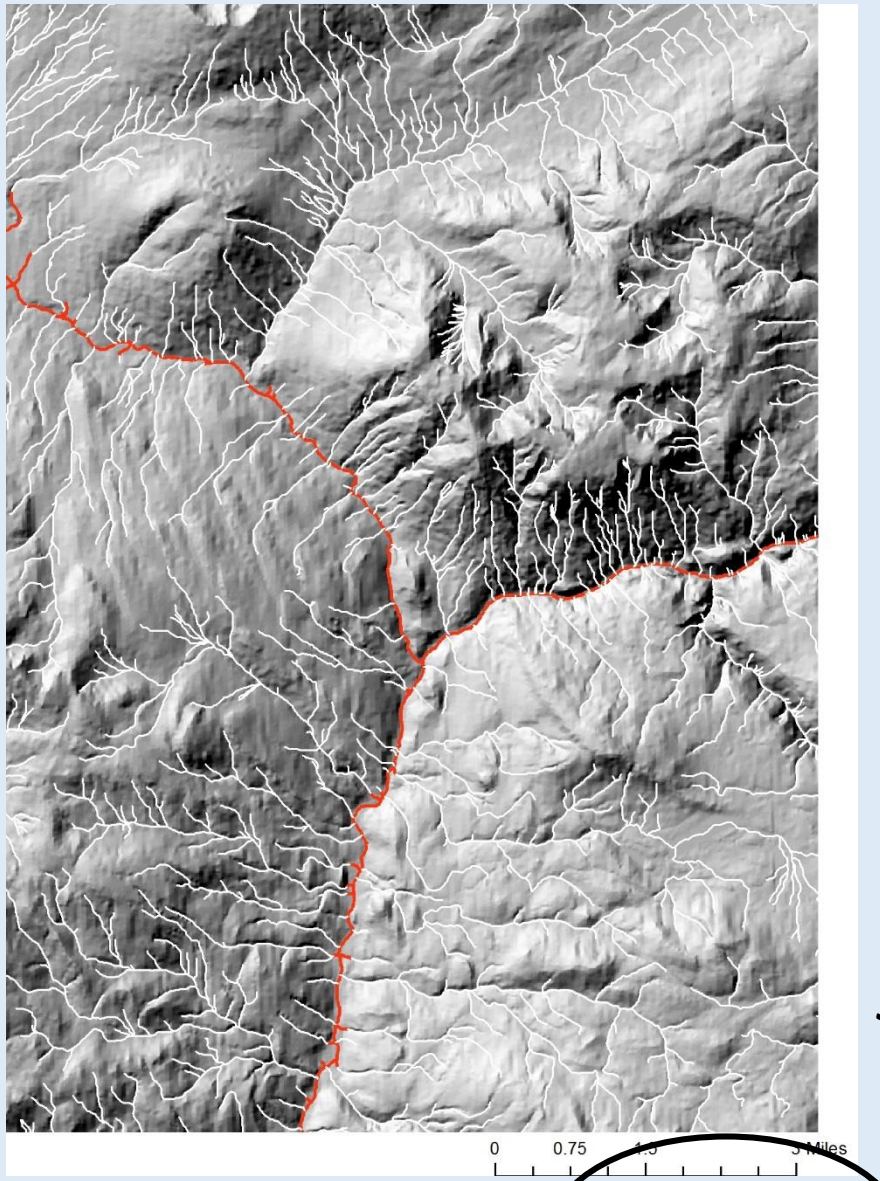
All streams: 0.95 km km^{-2}
Salmon streams: 0.03 km km^{-2}

Provincial 1:20,000 scale with no fish (cartographic)

All streams: 2.8 km km^{-2}

Can we delineate more complete stream networks and salmon habitat in B.C. using the available 17m DEM across the coastal watersheds?

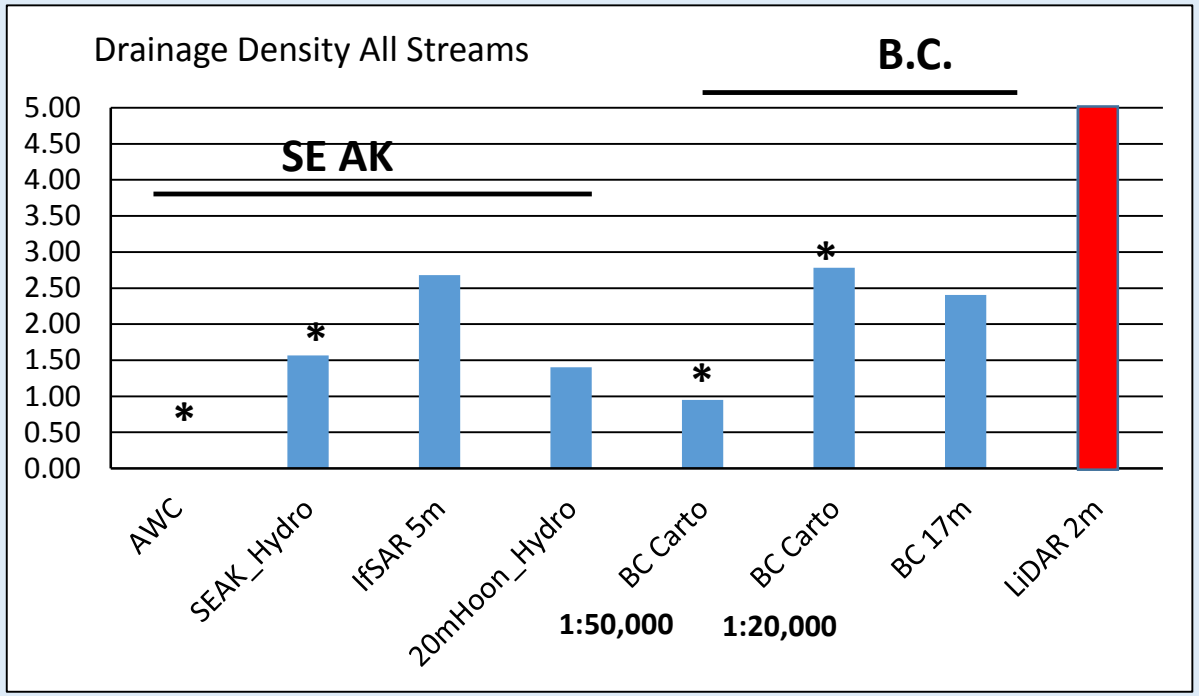




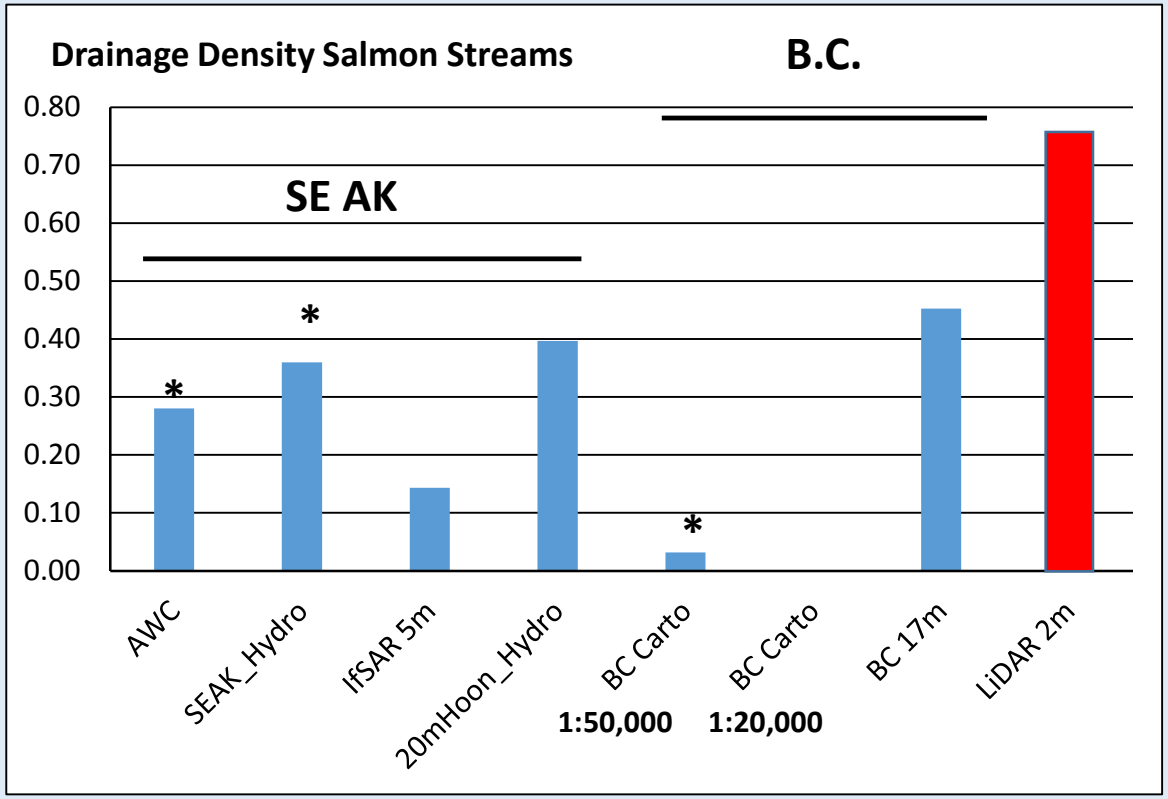
Derived stream network and salmon streams using the B.C. 17m DEM

Salmon streams

Drainage density all streams: 2.4 km km^{-2}
Salmon streams: 0.45 km km^{-2}



*** = Regionally available**



Potential Missing Salmon Streams by Percent

Locations and Data Layers	All stream difference percent from LiDAR (km km^{-2})	Salmon stream difference percent from LiDAR (km km^{-2})
Southeast Alaska		
AWC	na	63%
SEAK-Hydro	70%	53%
USFS 20m	72%[1]	48%
IfSAR 5 m	46%[1]	81%
LiDAR	--	--
B.C.		
Provincial Stream Layer	81%[1]	96%
B.C. Freshwater Atlas	44%[2]	
17m BC DEM	52%[3]	40%

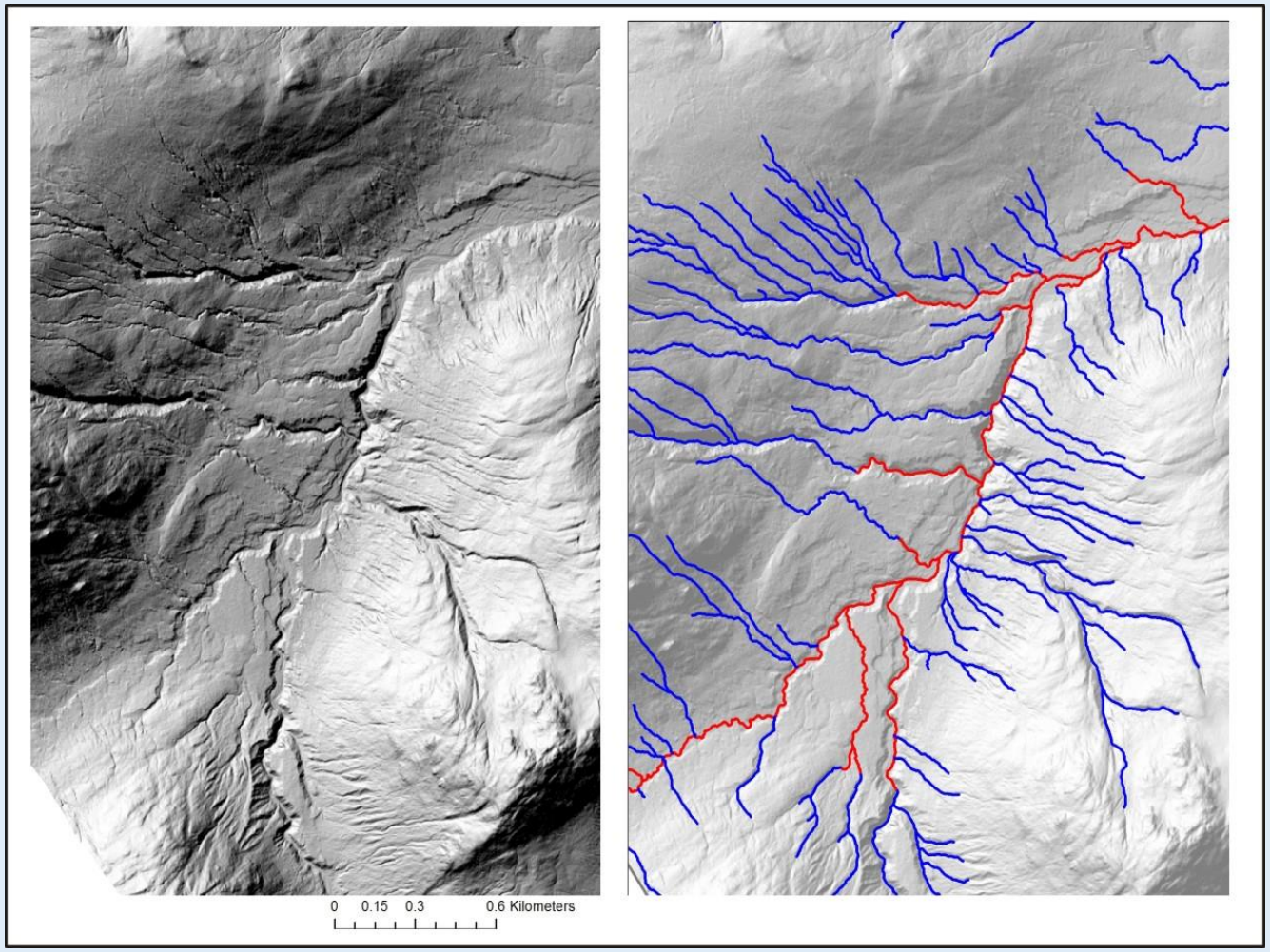
1 1:50,000
2 1:20,000

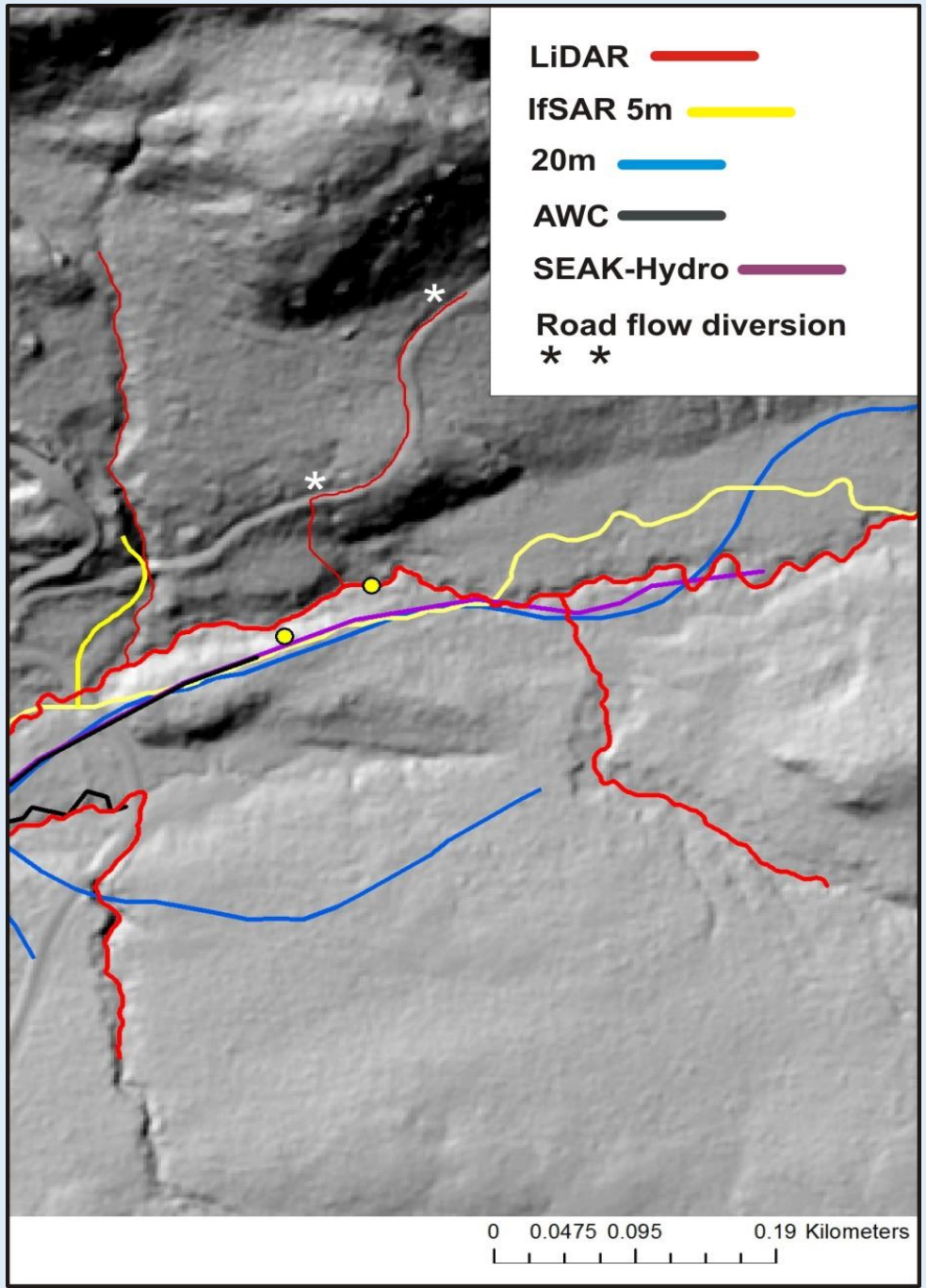
Potential Missing Salmon Streams by Length

Location	All Streams	Salmon Streams
Southeast Alaska	228,000 km[a] (142,000 miles)	27,000 to 34,000 km[b] (16,700 to 21,000 miles)
B.C.	253,000 km[c] (87,000 miles) to 155,000 km (96,300 miles)	46,600 km (29,000 miles) to 19,400 km[d] (12,050 miles)
Entire US-Canada Trans-Boundary	481,000 km (299,000 miles) to 365,000 (227,000 miles)	78,000 km (48,000 miles) to 51,500 km (32,000 miles)

[a] SEAK=Hydro.
[b] Range based on SEAK-Hydro and AWC.
[c] Range based on BC 1:50,000 and 1:20,000 hydrography
[d] 1:50,000 historical fish distribution and 1:20,000 stream layer (estimated using the BC 17m result and 0.12 gradient barrier).

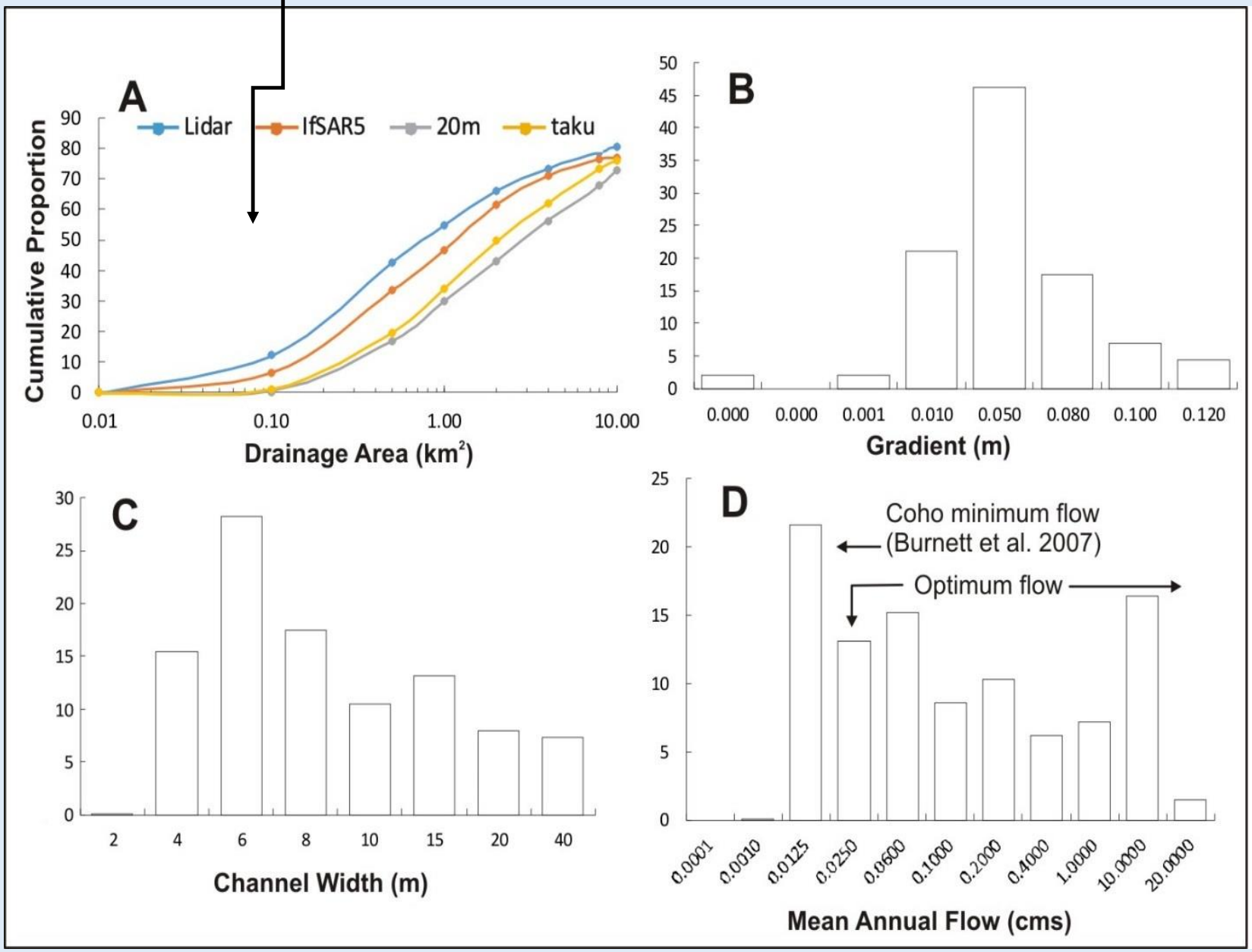
Spatial Accuracy



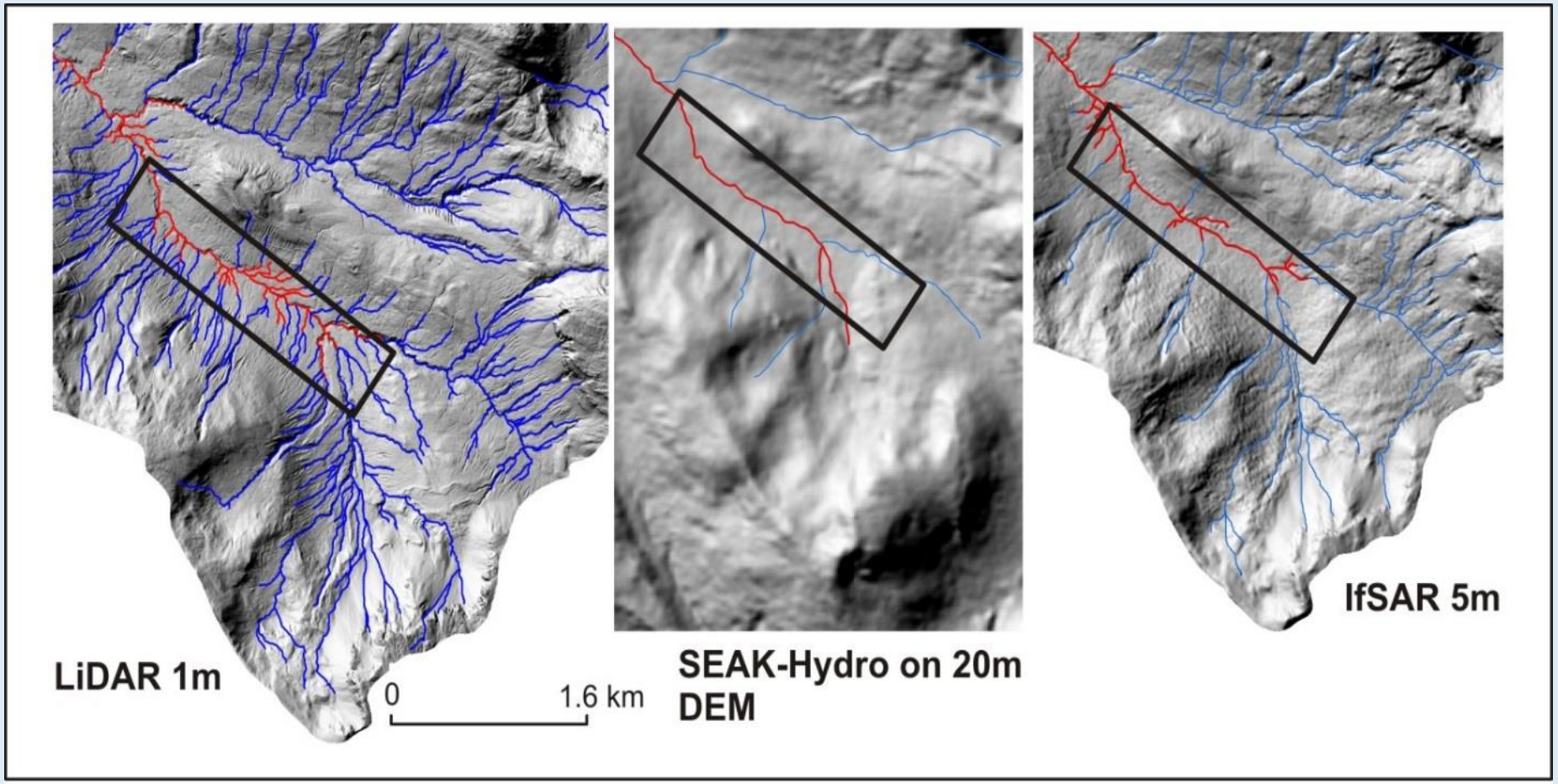


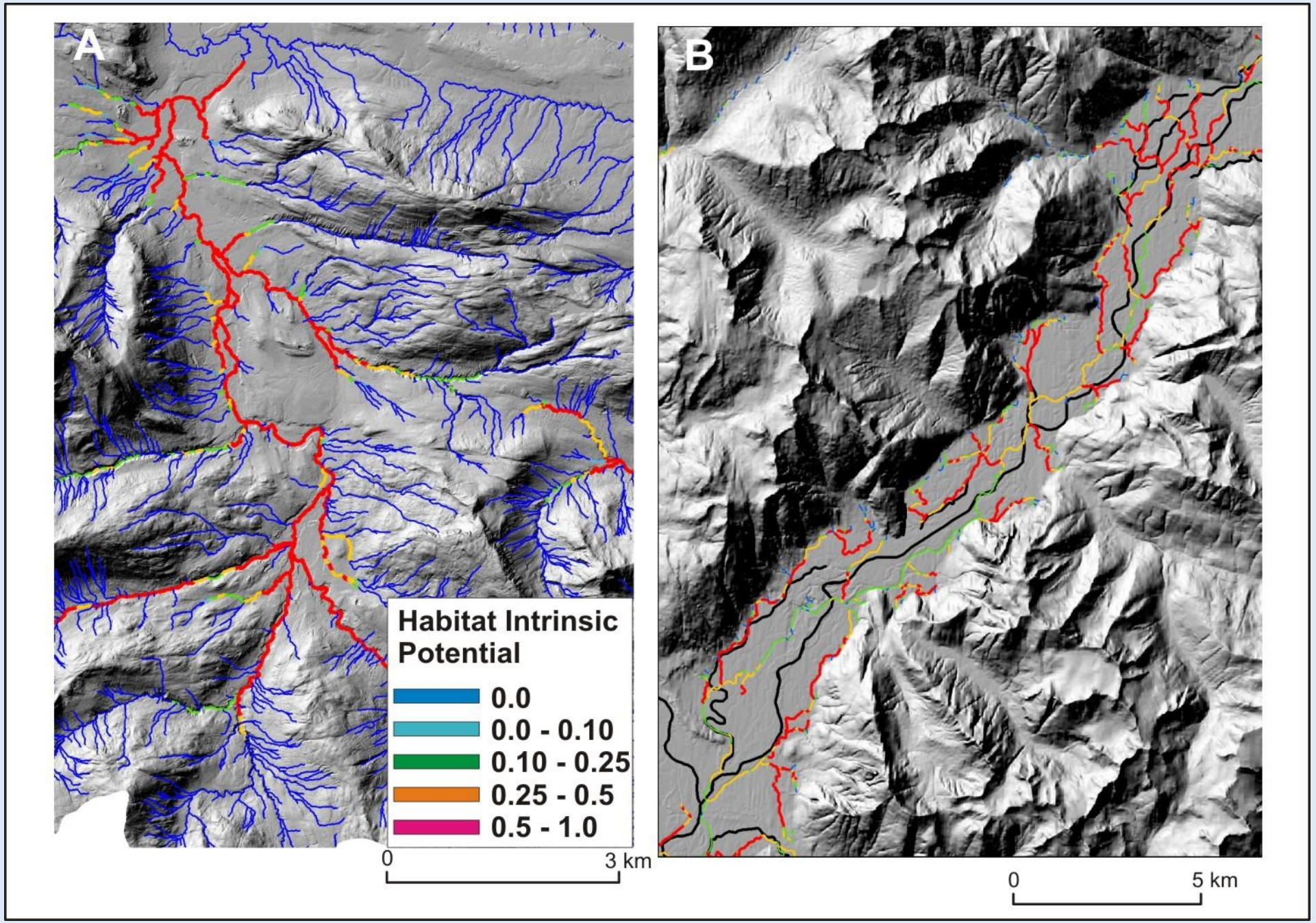
Where are the salmon streams?

Headwaters that flow onto low gradient valleys and floodplains



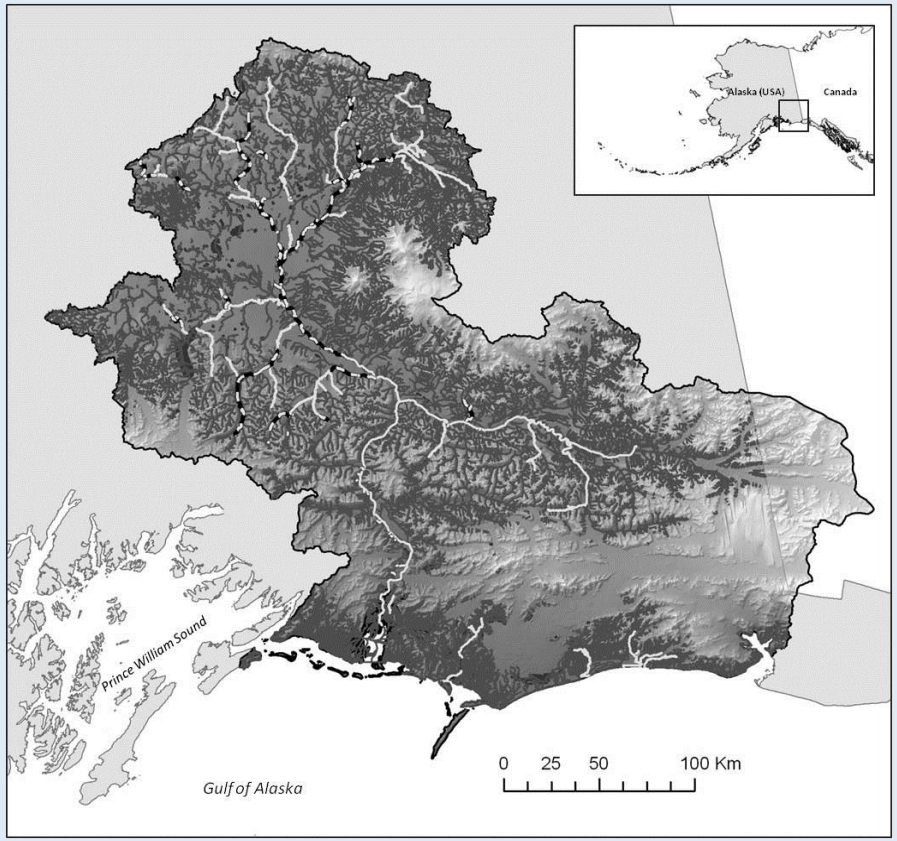
Where are the salmon streams?



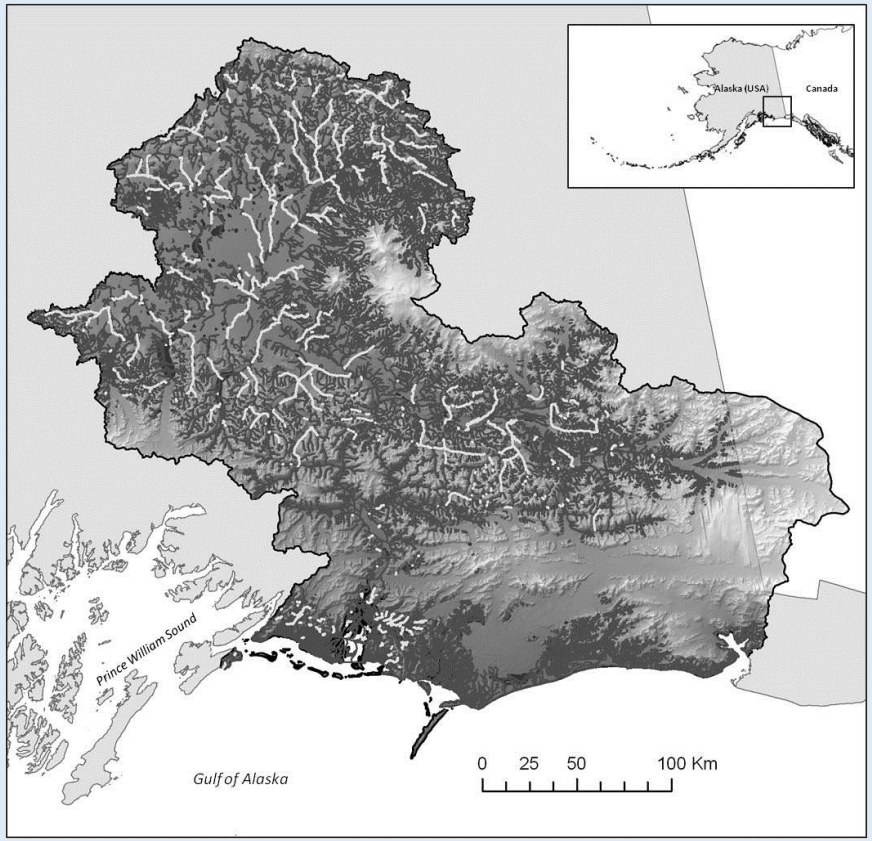

A
B
Habitat Intrinsic Potential
0.0
0.0 - 0.10
0.10 - 0.25
0.25 - 0.5
0.5 - 1.0
0
3 km
0
5 km

The issue of poor stream networks motivated the creation of a synthetic river network in the Copper River basin (TerrainWorks using 20 m DEMs) and a Chinook IP model (and based on field studies) yielding a prediction of 300% more salmon streams compared to the AWC (Bidlack et al. 2014).

AWC



Synthetic network and salmon modeling

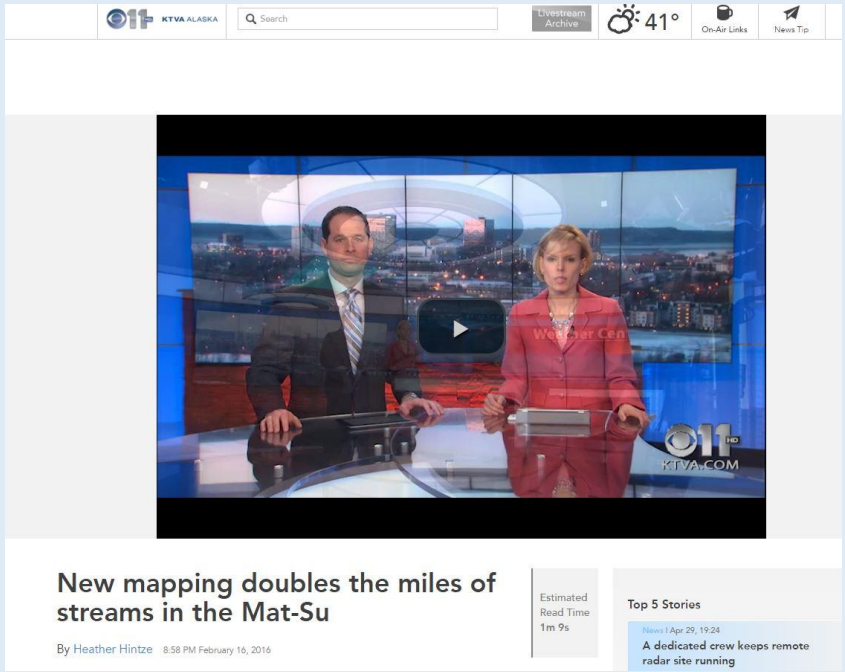


The issue of poor stream networks motivated the recent TNC effort in the Matanuska Susitna watershed (2015 -2016)

TerrainWorks developed new higher resolution synthetic stream layers using a combination of LiDAR and IfSAR (2015, finalizing currently).

Part of the TNC objective is to improve salmon habitat mapping and also to provide greater ability to guide future land developments

New stream layer will become the NHD update and likely the NHDPlus



Journal Paper in Prep.

Lack of Complete River Network and Salmon Habitat Maps in the U.S.-Trans Boundary Region Limits Science, Resource Management and Conservation

submitted mid June

Implications/challenge

1) The majority of salmon streams remain undetected, unmapped and thus unprotected in much of the Trans-Boundary area.

2) How can federal, state and provincial agencies, Alaska Natives, First Nations and fishery and conservation groups evaluate potential environmental impacts associated with mining, hydro-development, timber harvest and road building if they don't know the accurate locations and abundances of salmon habitats, or complete river networks.

3) This represents a most basic limitation on science, resource management and conservation.

4) The delineation of complete river networks and accurate salmon habitat identification will not be achieved in the U.S.-Trans Boundary region until LiDAR DEMs become available.

Opportunity

Acquisition of LiDAR is expensive, particularly given standard commercial operations (business plan) that originate outside of the Trans-Boundary area. Travel, weather logistics, multi-planes from outside the region, relatively rapid turn around time (< 1 yr) creates a cost-prohibitive scenario ($30 million).

Which is why the U.S.G.S. opted for the more economical IfSAR 5m (which did not pan out in SE AK).

However, there are DIY options that require purchase of equipment and dedicated solely to LiDAR acquisition in the Trans Boundary with a timeline of 2-3 years ($5 million). Academic advisory team (Univ. of Washington, Univ. of Montana).

Crowdfunding is a viable option to acquire LiDAR in the Trans Boundary and also to highlight the increasing development pressures on valuable and sensitive salmon habitats.

Details

-Current working group: SEAK FHP, Trout Unlimited, Wild Salmon Center, Salmon Beyond Borders, The Salmon Project

-Not in competition with current efforts to acquire federal/state funding to pursue stream monitoring (AK Trans-Boundary Working Group)

-LiDAR DEMs would be housed at the Alaska Department of Geology and Geophysics (Anchorage)

-River networks and other data layers housed in a map atlas maintained by UA SE (Juneau)

-Req. 2-3 min crowdfunding video (in progress)

-Structured fiscal plan that includes larger donors to smaller supporters (in progress)

-Reqs. “Rewards” program

-Seeking other supporters and feedback.

For additional information, contact:

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-Debbie Hart, SEAK Fish Habitat Partnership
-Mark Kaelke, Trout Unlimited