# Landscape-level Model for Predicting Juvenile Coho Salmon Rearing Habitat in Southeast Alaska


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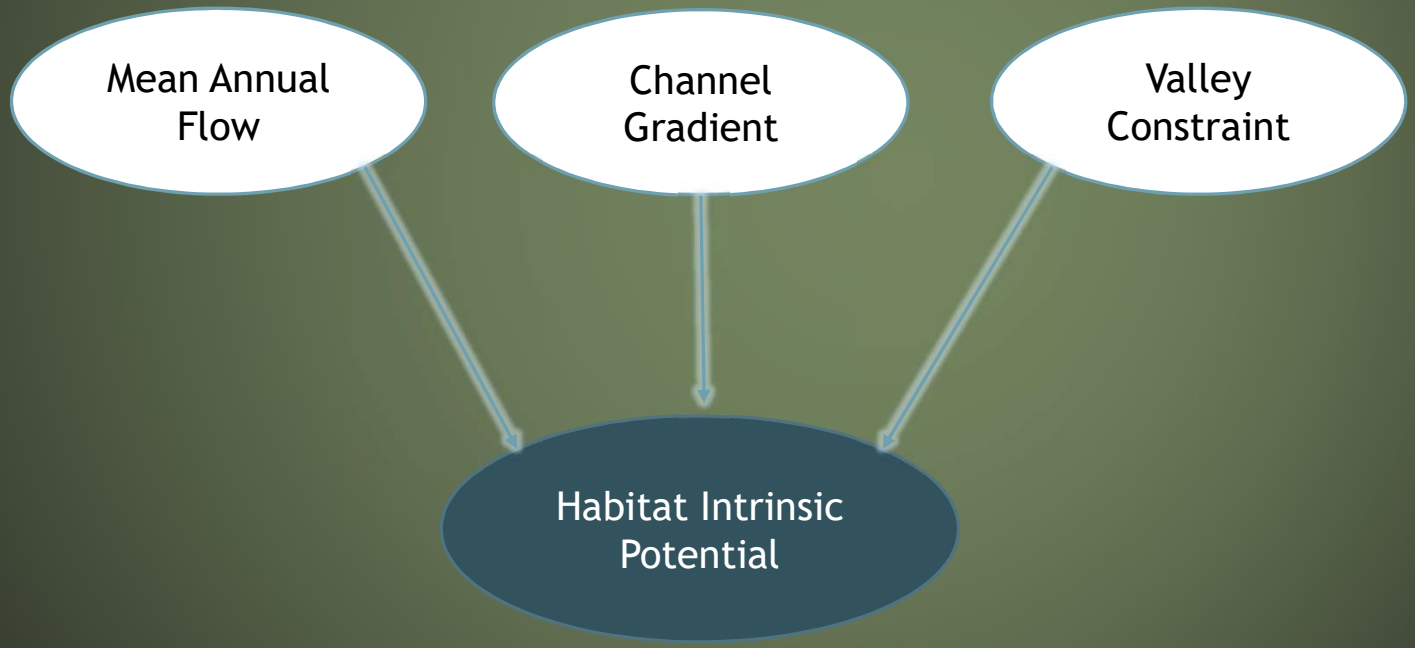
# Objectives

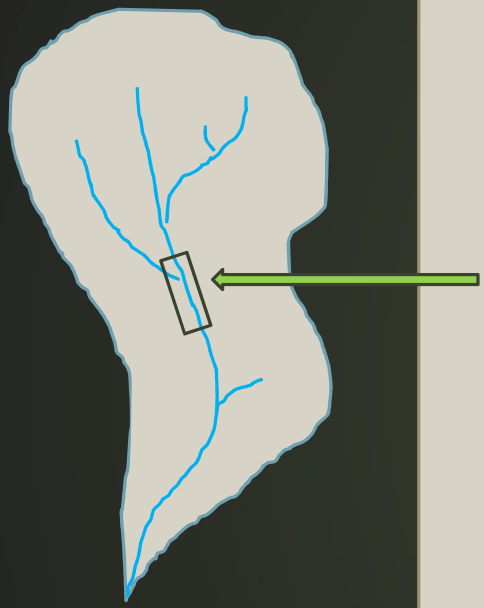
- What is habitat intrinsic potential (HIP)?
- Conceptual foundation
- Modeling, mapping, & applications

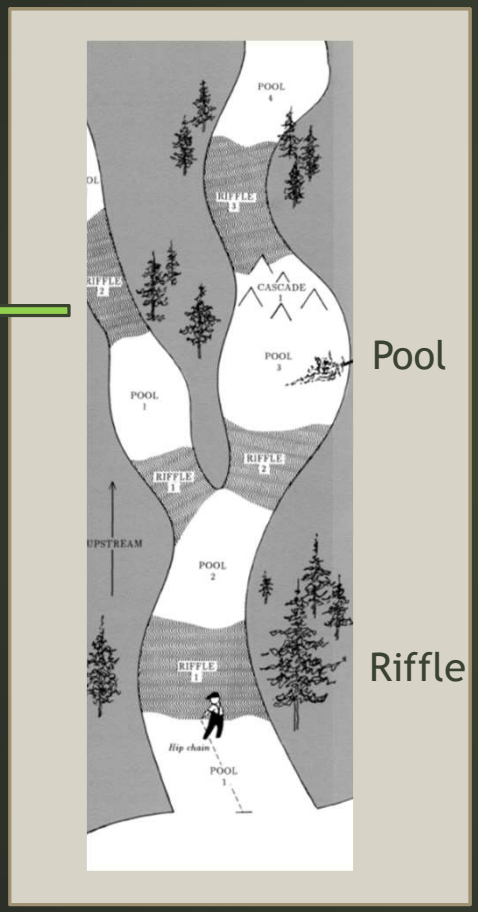
# Habitat Intrinsic Potential

Stream persistent attributes shape habitat features



# Stream System Habitat Hierarchy






Even after a stochastic event the channel will rejuvenate similar habitat - *deterministic*

Fish respond to habitat unit features formed by persistent reach hydromorphology

- Mean annual flow
- Channel constraint
- Channel gradient

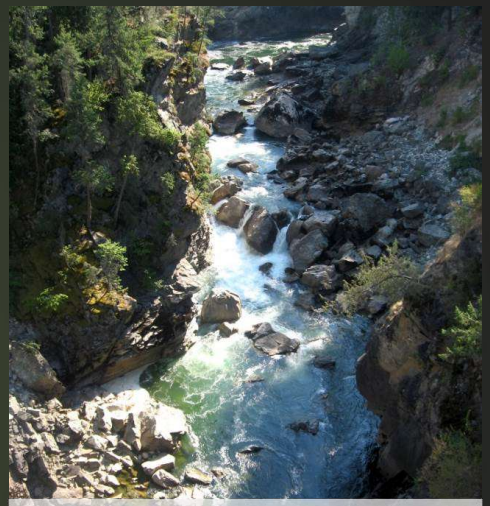
Persistent attributes -> long-term adaptation -> genetic connection

Transient attributes -> short-term response

*Frissell (1986), Dolloff (1993), Beechie (2008)*

# What is a Habitat Intrinsic Potential (HIP) model?

- HIP models predict quality & distribution of habitat based on physiographic characteristics of watersheds
  - Geology and precipitation coupled with hydrologic & geomorphic processes form the physical template
  - Fish associated with reach attributes to predict habitat quality across the landscape
  - Life history specific – limiting factor
  - Complete landscape coverage



High Gradient, Constrained

Low Gradient, Unconstrained

# The Need for HIP Models

Large Regions:

Lack accurate species-specific habitat quality and distribution information

- Important for understanding population spatial structure

Current Information (20-m DEMs):

USFS Channel type

- Channel type used to predict smolt abundance (Course)
- Good for high management areas

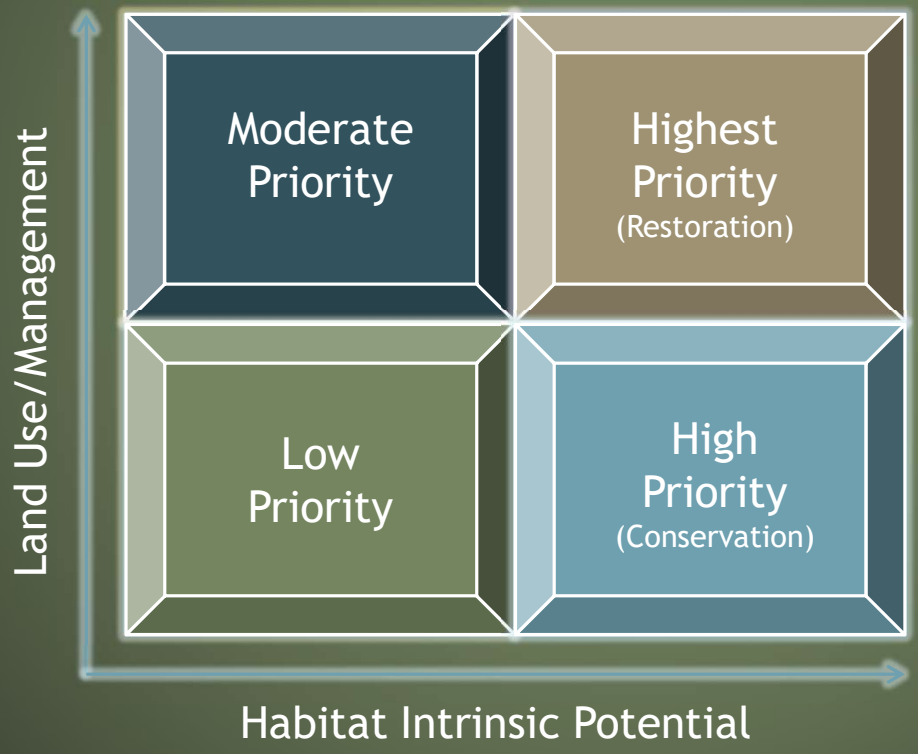
AWC: *Occupancy*

- No habitat quality & distribution, gaps >50%

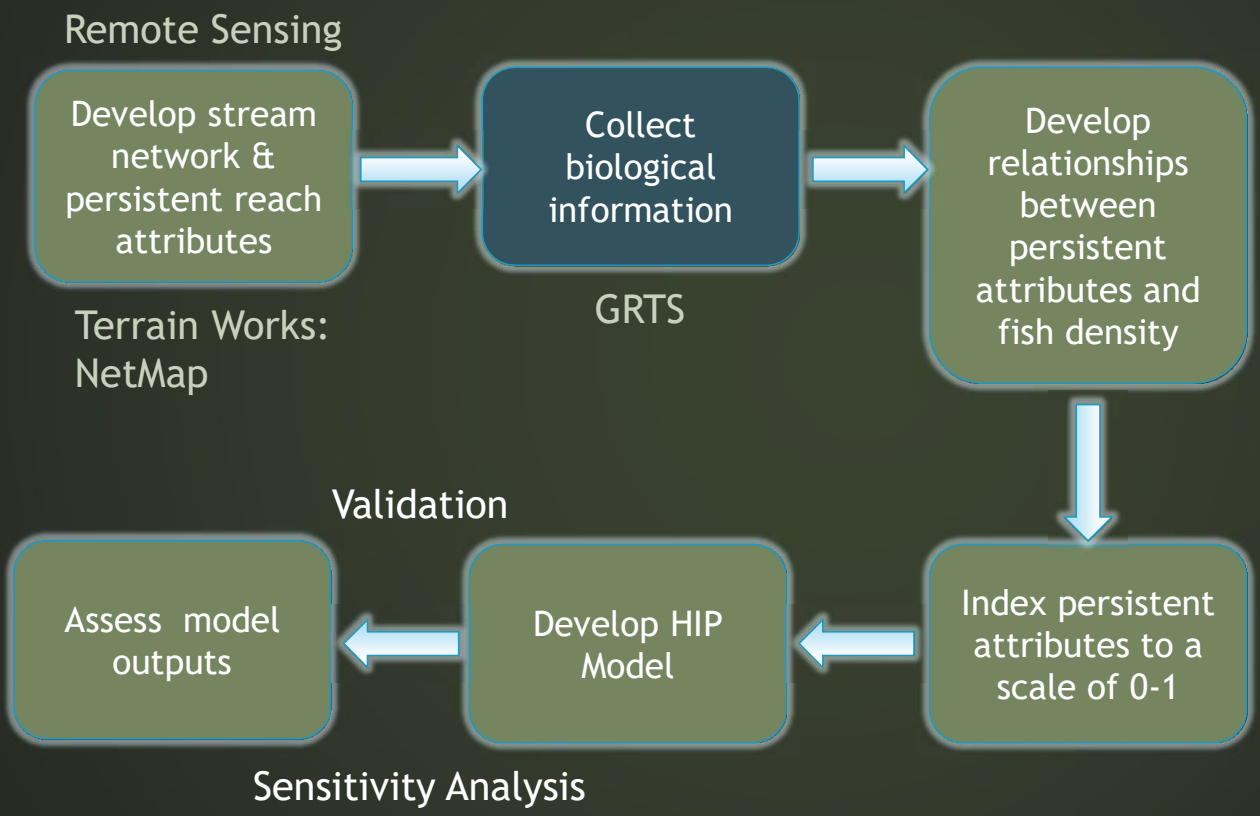
# Management Decision Matrix

## Current Habitat Conditions

= *f*(Habitat Intrinsic Potential + Management Influences)



# Modeling & Mapping HIP



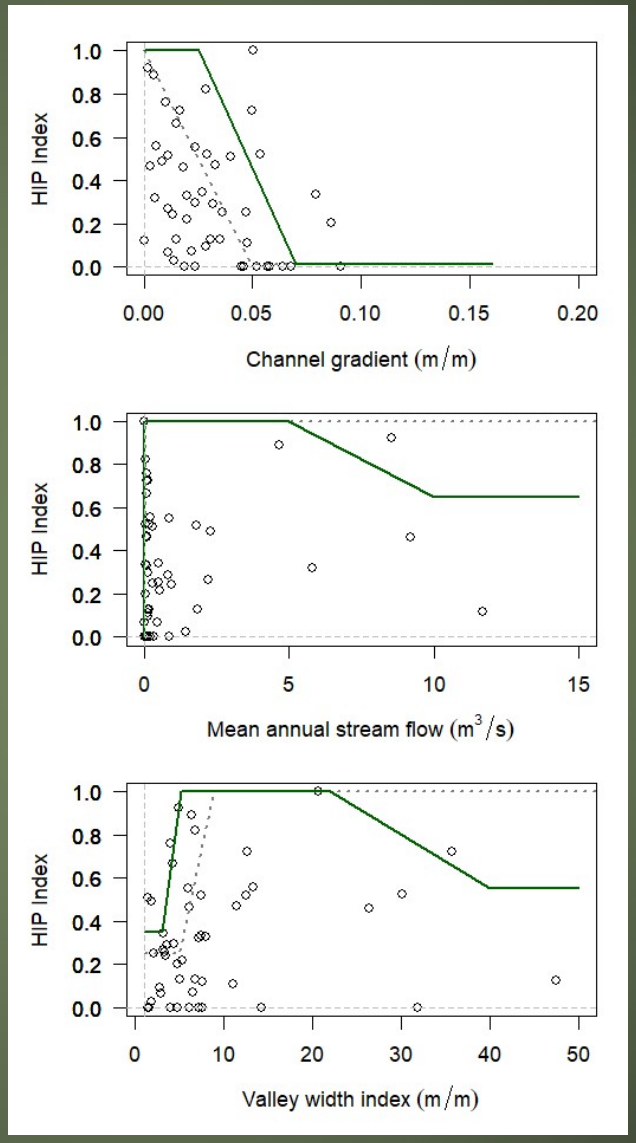
# Habitat Intrinsic Potential

AK vs OR Regional differences:

- Green line - *SE Alaska*
- Grey dotted line – Oregon
  - *Burnett IP (2007) Fig. 2*

Thresholds based on probability of fish occupancy

$$HIP = (IP_G * IP_F * IP_C)^{1/3}$$




Gradient

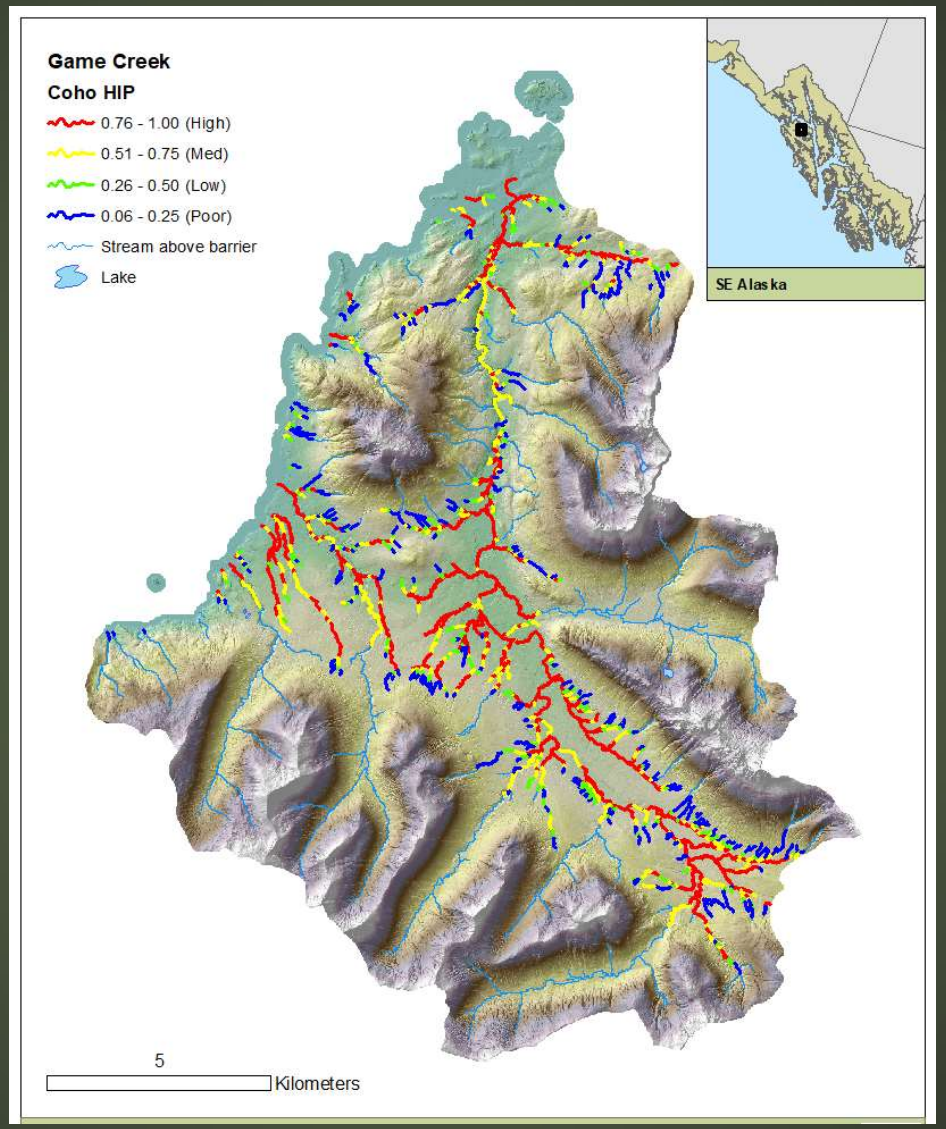
Flow

Constraint

# Coho HIP

HIP Index assigned to all reaches across the landscape

- Consistent and accurate representation of stream network and spatial extent
- Attributes derived from 1-m DEMs
- Modeled attributes evaluated against field measurements (Romey 2018)




- High quality Coho rearing habitat
- Low quality Coho rearing habitat
- Habitat mosaic required for viable population

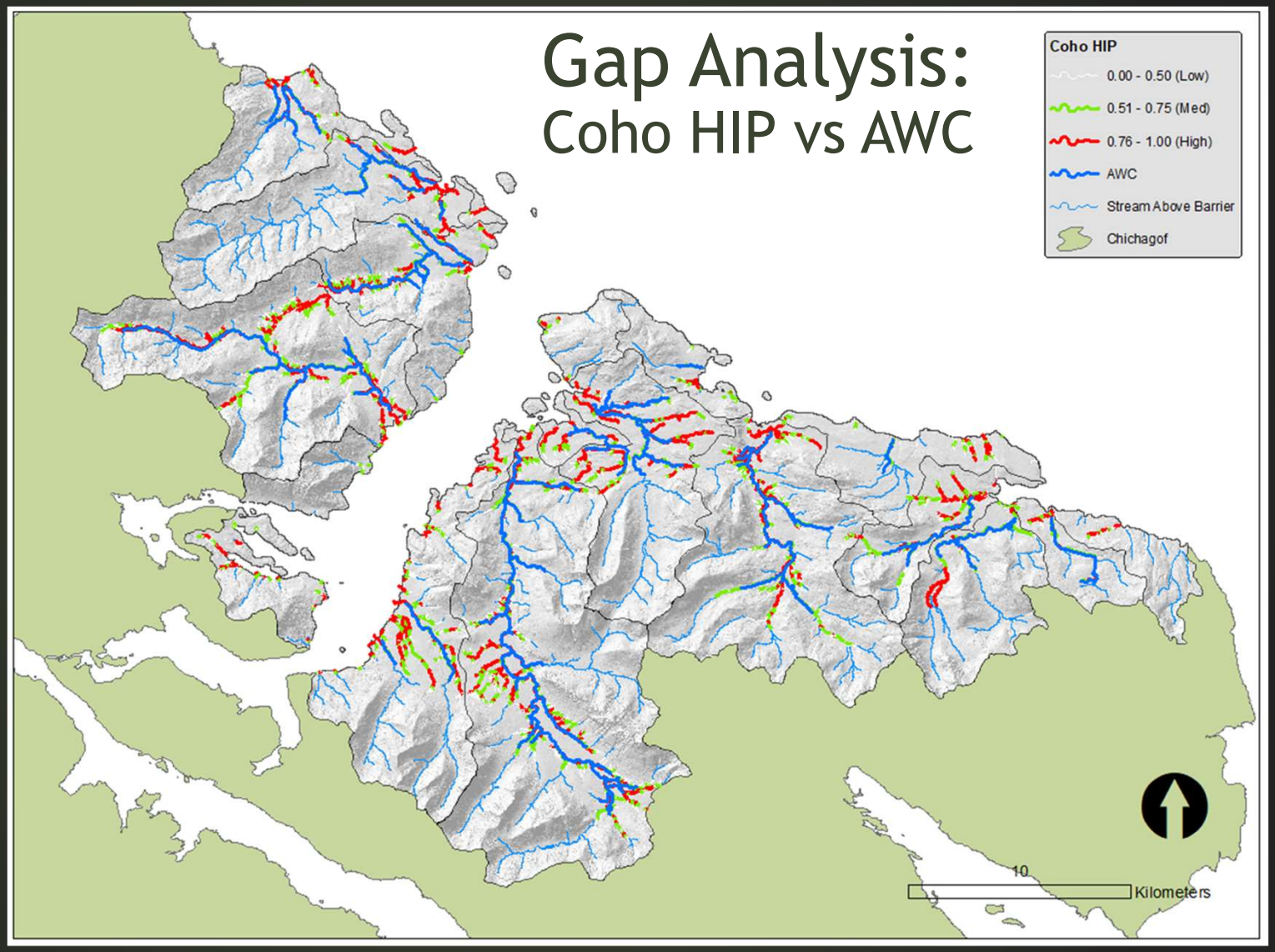
# Applications

- Improve mapping of anadromous species distribution (AWC gap analysis)
- Inform managers of habitat quality and distribution to facilitate natural resource planning at landscape scale (USFS UA- maintain habitat connectivity)
- Informing stock escapement and management at watershed scale (Natural Carrying Capacity)

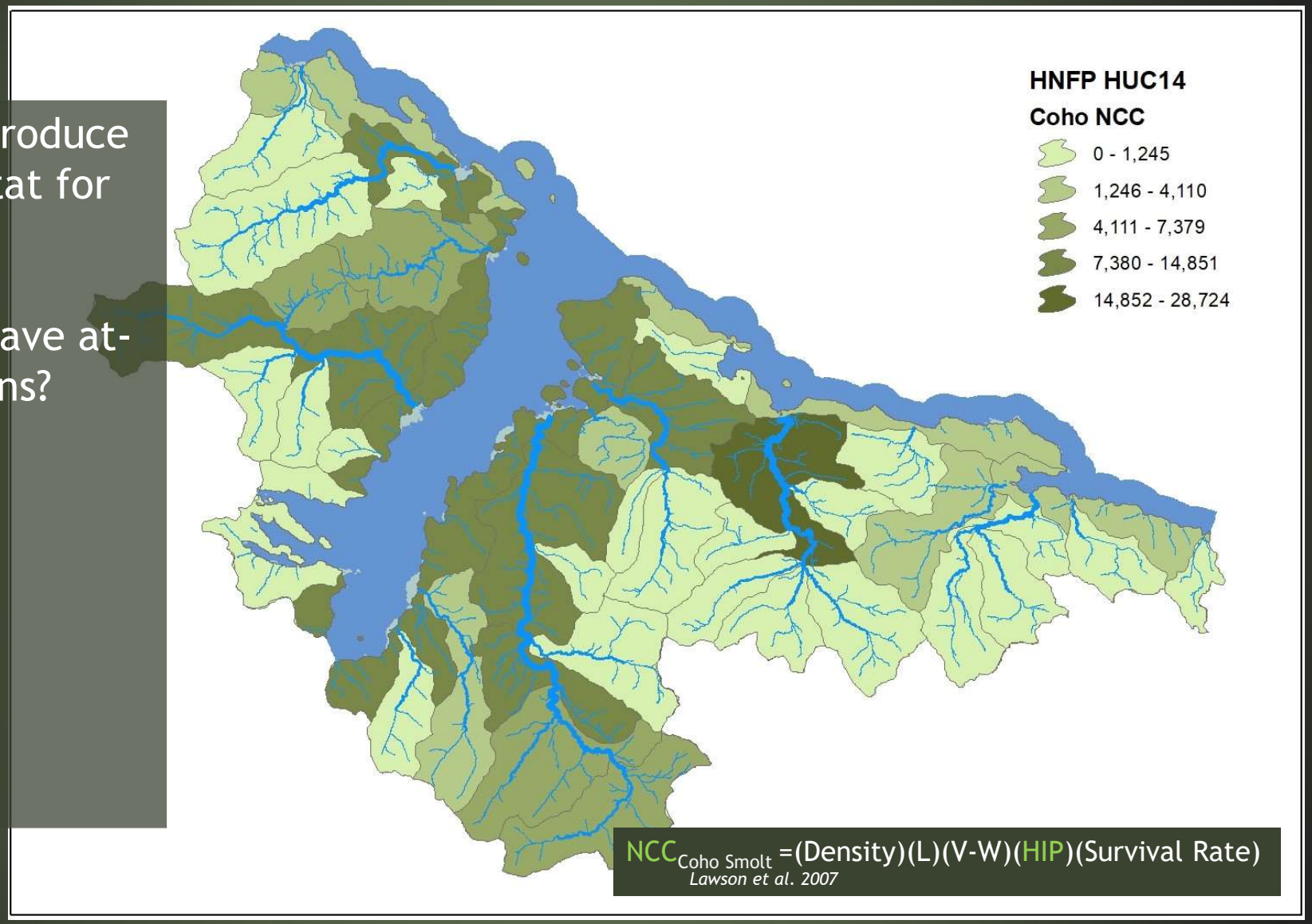
- Prioritize areas to focus limited resources (sensitive areas)
  - Core habitat areas = HIP>.80
- Identify areas with greatest potential for improvement/conservation
  - Assess if goals are being met
- Provide baseline habitat conditions for comparison with present or future land use
- Identify areas vulnerable to habitat loss from climate change
  - Transitional management strategies
- Inform species specific life history studies

180.5 km AWC
459.4 km HIP 0.5-1

60.7% more Coho HIP



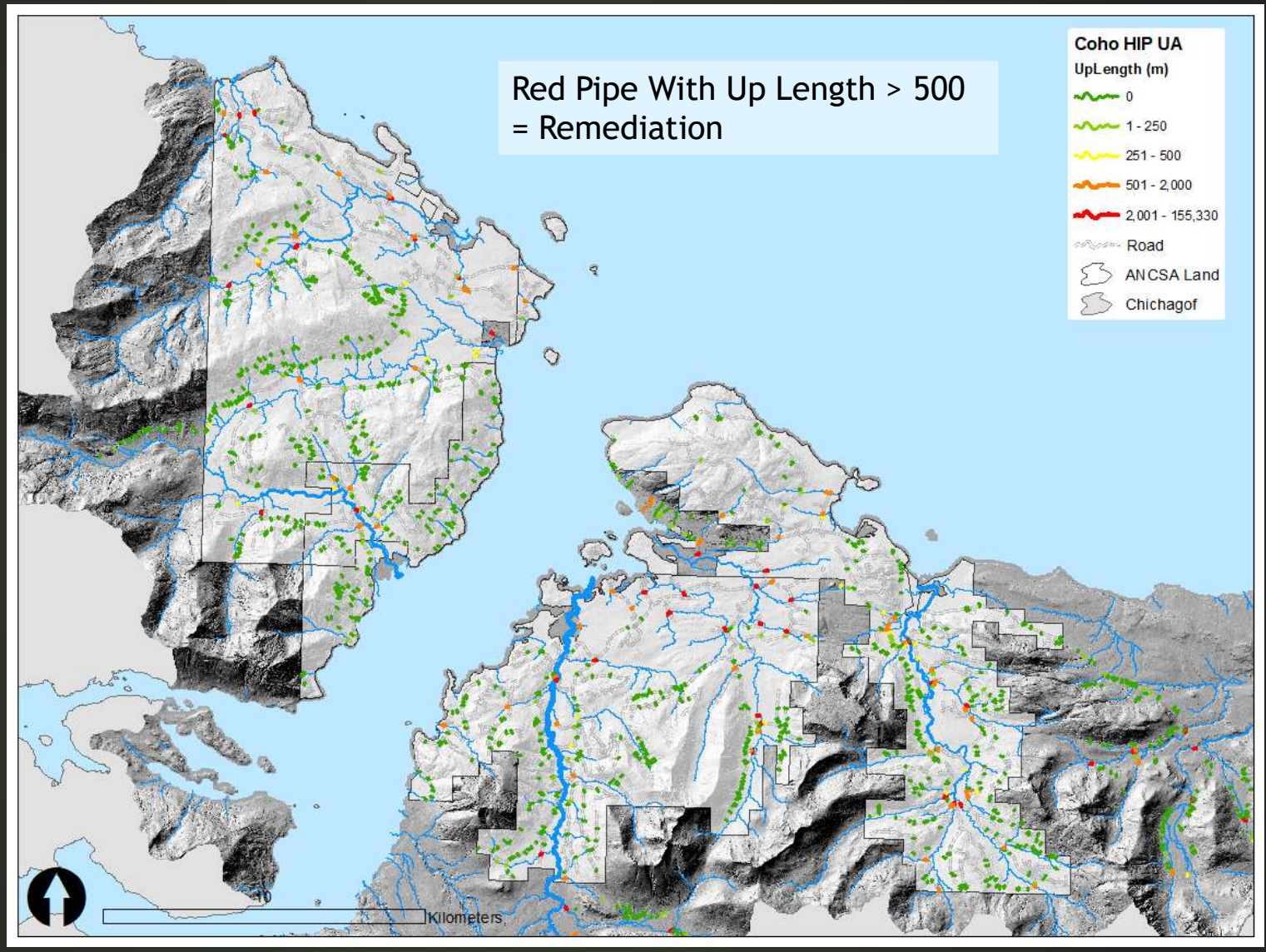
- What basins produce the best habitat for each species?
- What basins have at-risk populations?
- Inform stock management objectives
- Inform local community subsistence




$NCC_{\text{Coho Smolt}}$ =(Density)(L)(V-W)(HIP)(Survival Rate)

*Lawson et al. 2007*

- Focus field efforts
- Cost benefit for ground surveys
- Strong empirical based rational for Rd Xing project
- Natural barrier passage evaluation
- Species specific



# Summary

- Models capture features that influence fish distribution and abundance
  - Complete landscape coverage of species-specific habitat quality and distribution for viable populations
- Better informed resource management decisions
  - Compliments AWC & USFS Channel Type
- Each species reacts differently to a specific land use
  - Anadromous vs Resident
- SE Alaska HIP models for Coho, Chum & Pink salmon
  - Preliminary models for Cutthroat and Dolly Varden

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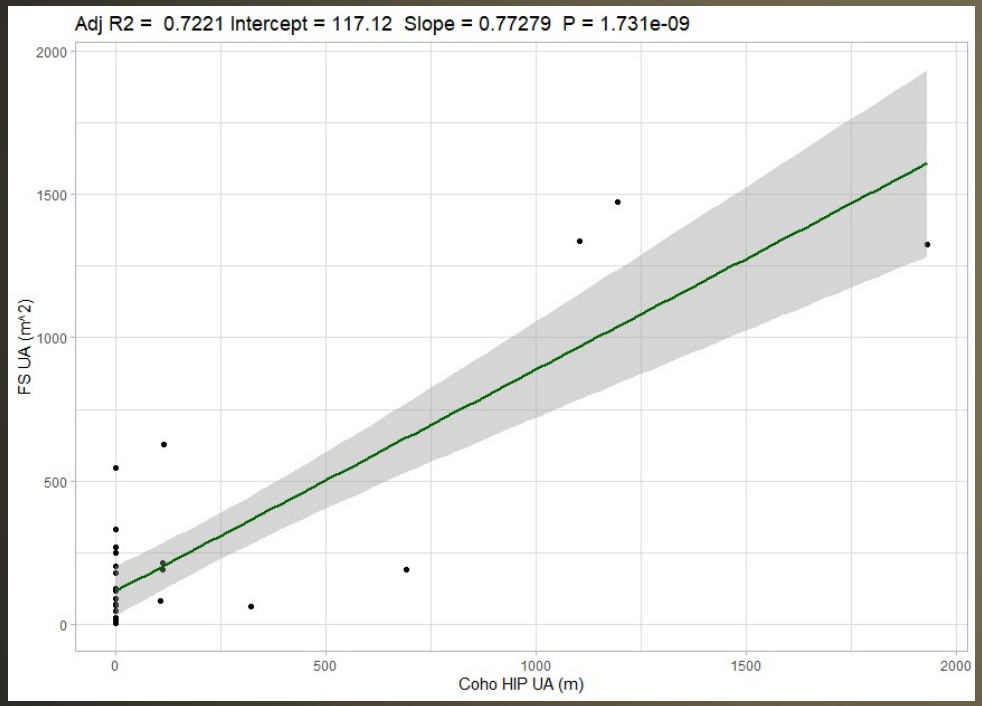
# Coho HIP UA vs FS UA Index




- HNFP Project area
- FS UA: How much critical Class I & II habitat upstream of Xing? - Course
- HIP UA: How much critical Coho habitat upstream of Xing? – High resolution
- Coho HIP UA is a significant predictor accounting for over 70% of the variability in FS UA.
- HIP UA not restricted to 1000m

# USFS Upstream Assessment (UA)

Habitat suitability index (HSI) based on fuzzy logic functions/curves (Delphi)

- BSI included in overall risk of not providing fish passage

**Fish-habitat component (habitat in $m^2$):**

- *Area* of fish habitat above crossing *(by stream class I & II)*
- *Channel gradient*
- *Pool frequency*

**Barrier index ("Barrierity")**

# USFS Channel Type

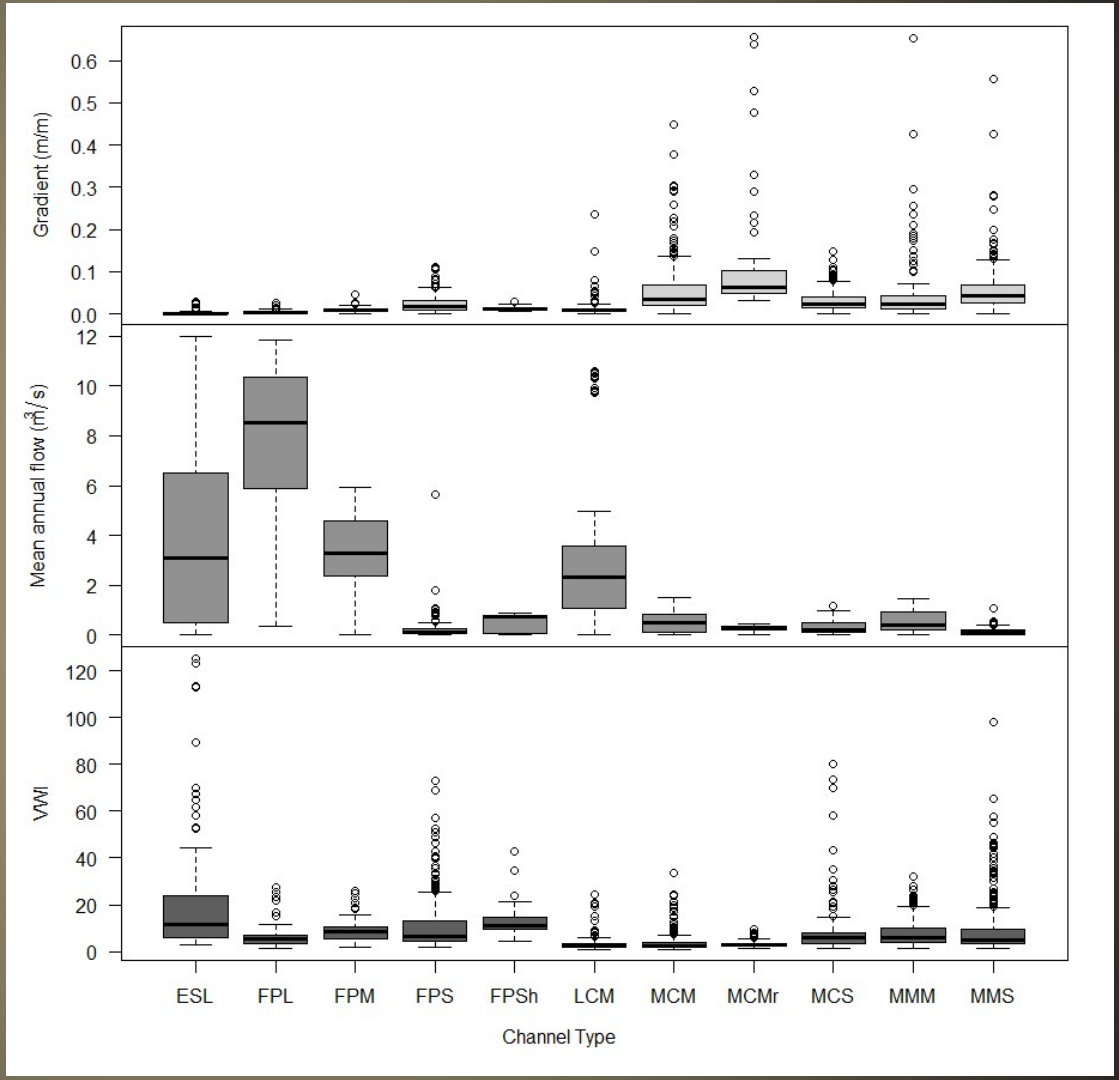
Does channel type correlate with HIP?

Poor discrimination among key predictors:

- Gradient
- Constraint
- Mean Annual Flow

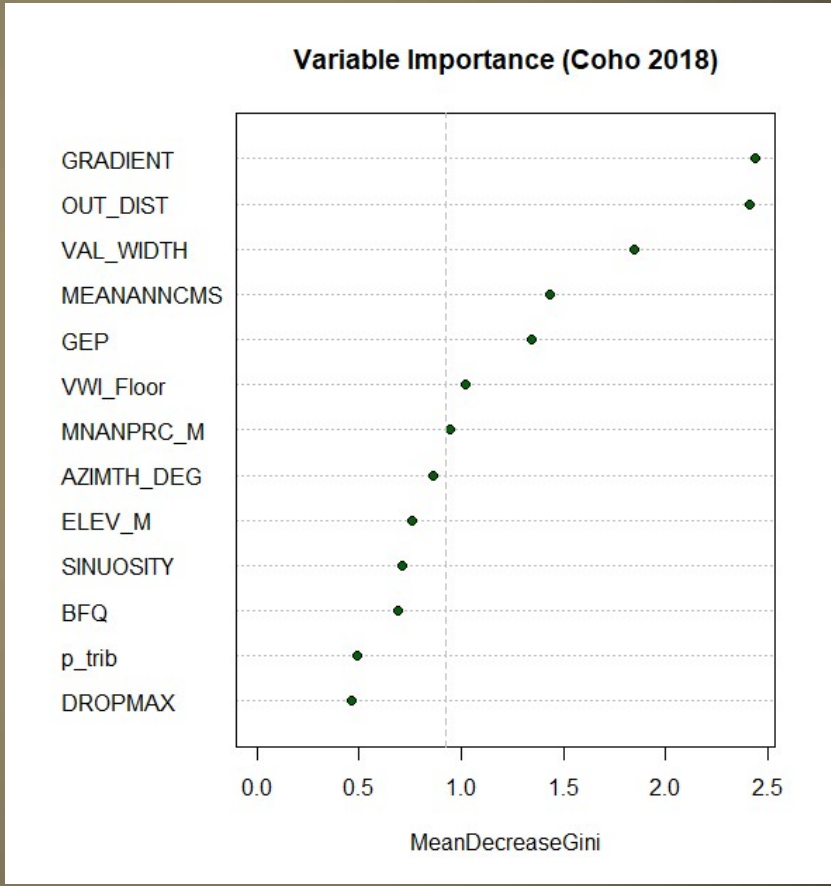
- Inaccurate representation of fish habitat distribution and quality

- Currently being updated for high management landscapes

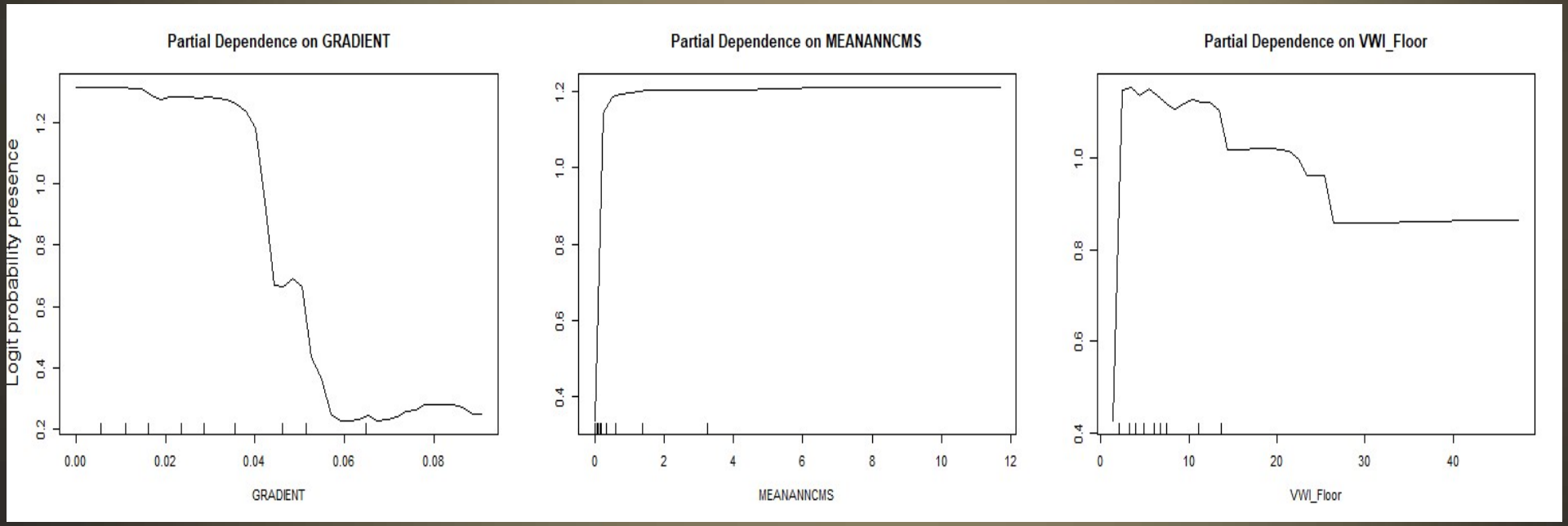


# Landscape Persistent Predictors

- RF Classification Model – Coho occupancy
- Most important persistent predictors representing channel hydromorphology



# Coho RF Model Partial Dependency



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