Intrinsic Potential of Streams to Provide High Quality Rearing Habitat for Anadromous Salmonids: ASSESSMENT and USE in the Coastal Province of Oregon

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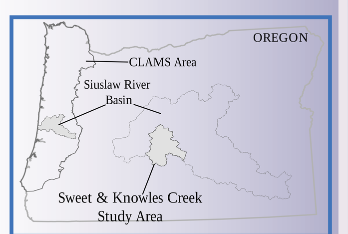
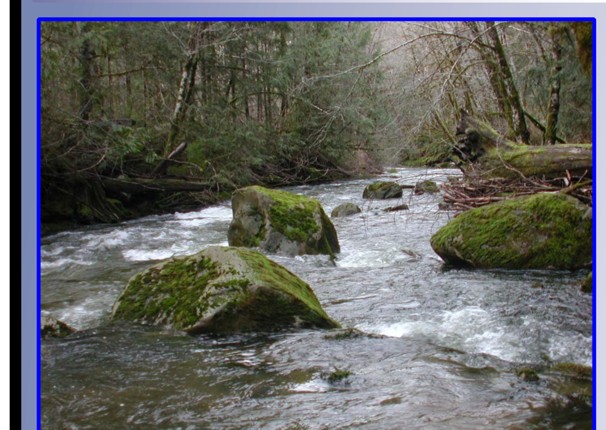
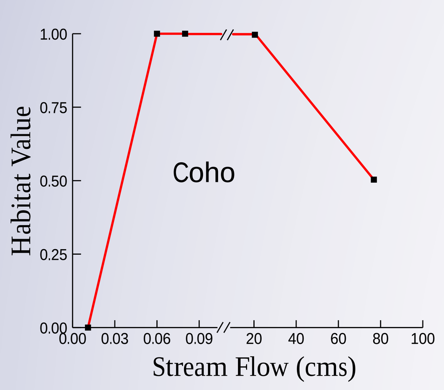
Introduction

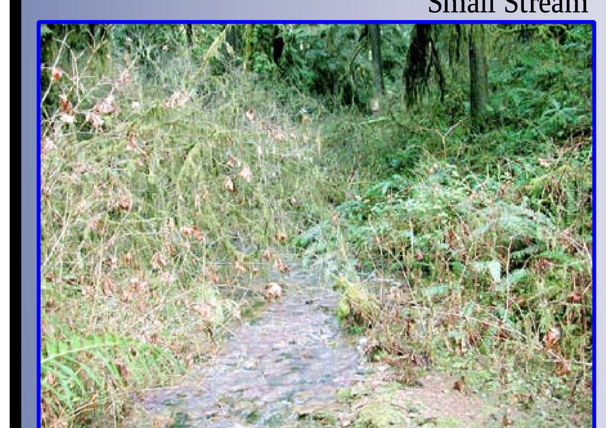
This poster illustrates a topographically-based approach to assess the intrinsic potential of streams to provide high-quality rearing habitat for salmonids. The Aquatic Component of the Coastal Landscape Analysis and Modeling Study (CLAMS) will use calculated intrinsic potentials to help managers prioritize areas throughout the Coastal Province of Oregon for restoration, protection, and low-risk, high-intensity forestry. Thus, all 7th-code Hydrologic Units (HUs) will be evaluated based upon intrinsic potential for each salmonid species and management-related watershed conditions in riparian and upland areas. Although the approach will be applied for each salmonid species in the CLAMS area, this poster addresses only coho salmon and steelhead in Sweet and Knowles Creeks.



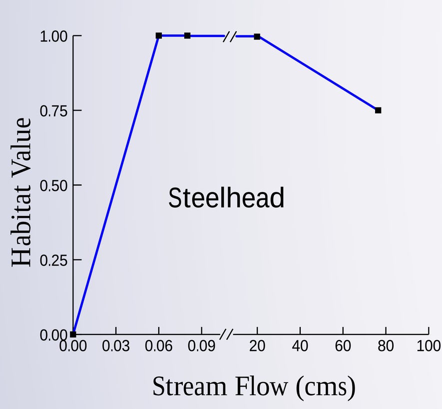


Medium Sized Stream

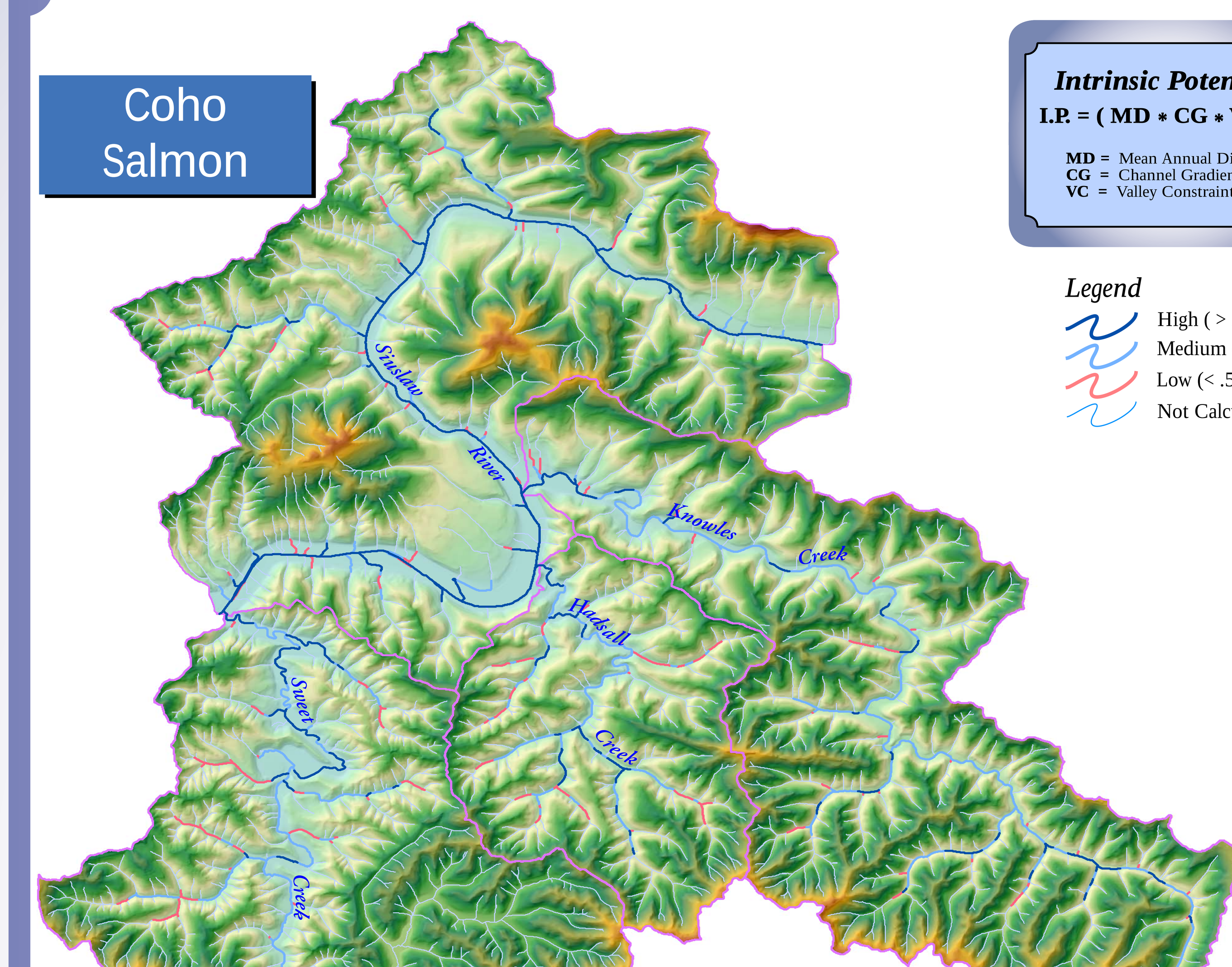




Small Stream



Coho Salmon



Intrinsic Potential

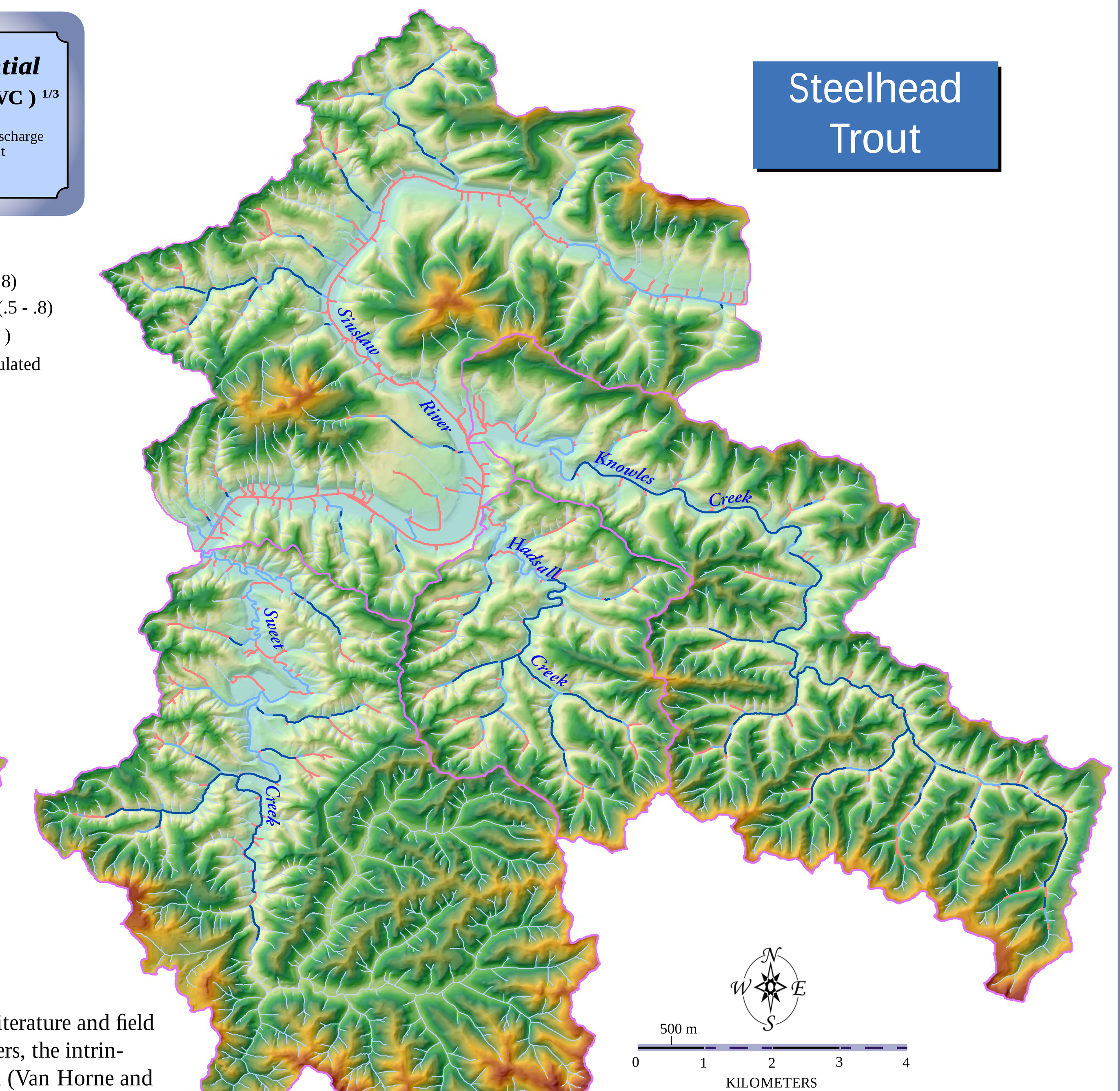
I.P. = (MD • CG • VC) $^{1/3}$

MD = Mean Annual Discharge
CG = Channel Gradient
VC = Valley Constraint

Legend

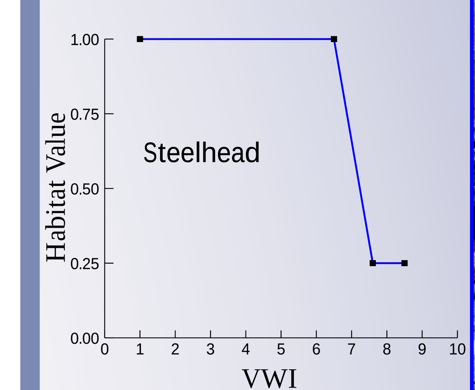
- High (> .8)
- Medium (.5 - .8)
- Low (< .5)
- Not Calculated

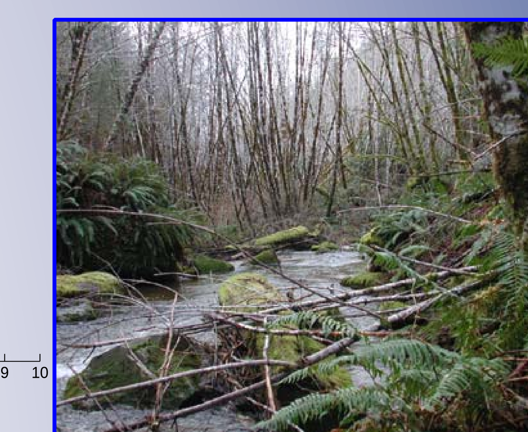
Steelhead Trout



Intrinsic potential was determined from channel gradient, valley constraint, and mean annual discharge. Presumed species-specific relationships between these attributes and value of rearing habitat were developed from available literature and field observations. For each stream reach below known barriers, the intrinsic potential score was calculated as the geometric mean (Van Horne and Wiens 1991) of the interpreted habitat value for channel gradient, valley constraint, and mean annual discharge.

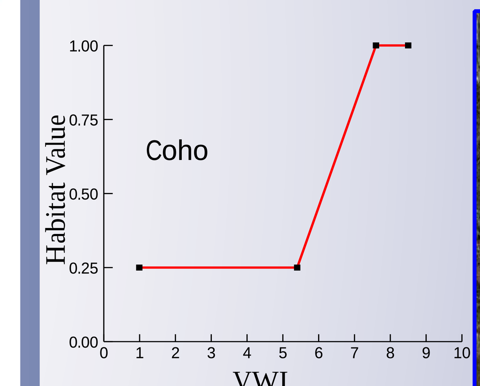
High Intrinsic Potential for Coho Salmon





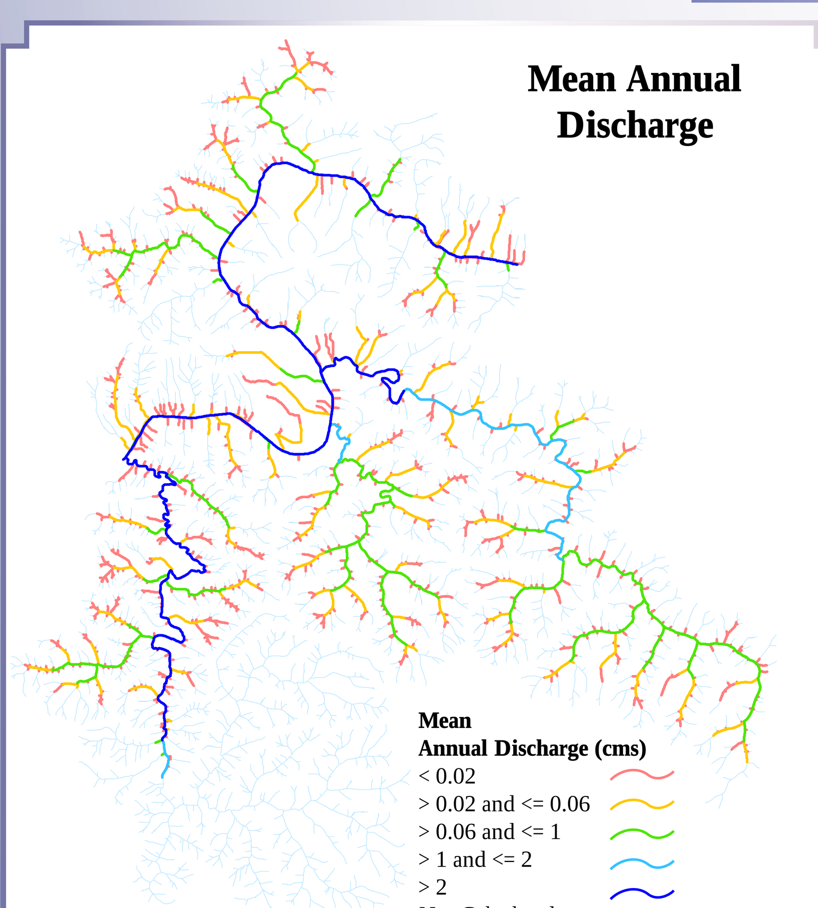
Constrained reach

Unconstrained reach

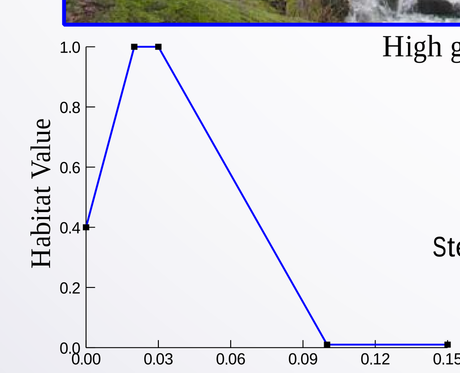


Mean annual discharge was calculated as a function of drainage area derived from 10m drainage-enforced digital elevation models (DE-DEM) and average annual precipitation from PRISM (Parameter-elevation Regressions on Independent Slopes Model) (Daly et al., 1994), using the equation developed for western Oregon (Lorensen et al. 1994). The presumed species-specific relationships between habitat value and mean annual discharge reflect that coho salmon are thought to rear primarily in small to mid-size streams (Sandercock 1991; Umpqua Land Exchange Project (ULEP 2001)) and that juvenile steelhead generally use a somewhat broader range of streams sizes (Benke 1992: ULEP 2001).

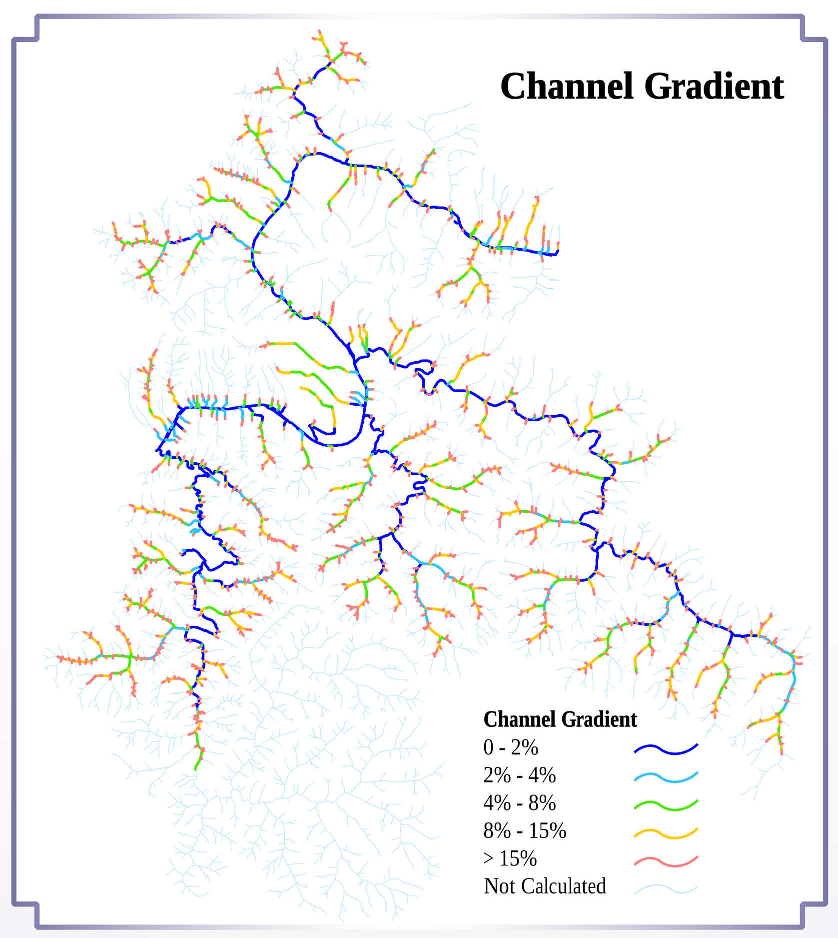
Mean Annual Discharge



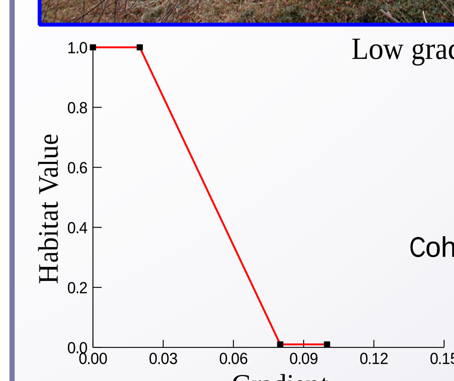
High gradient reach



Channel Gradient

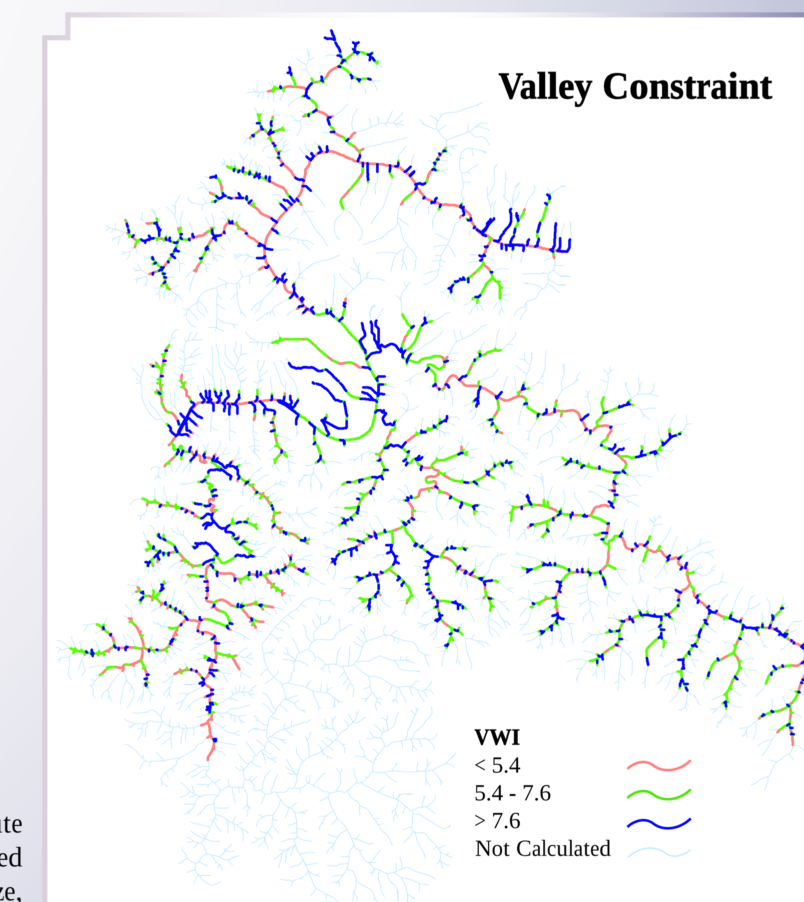


Low gradient reach



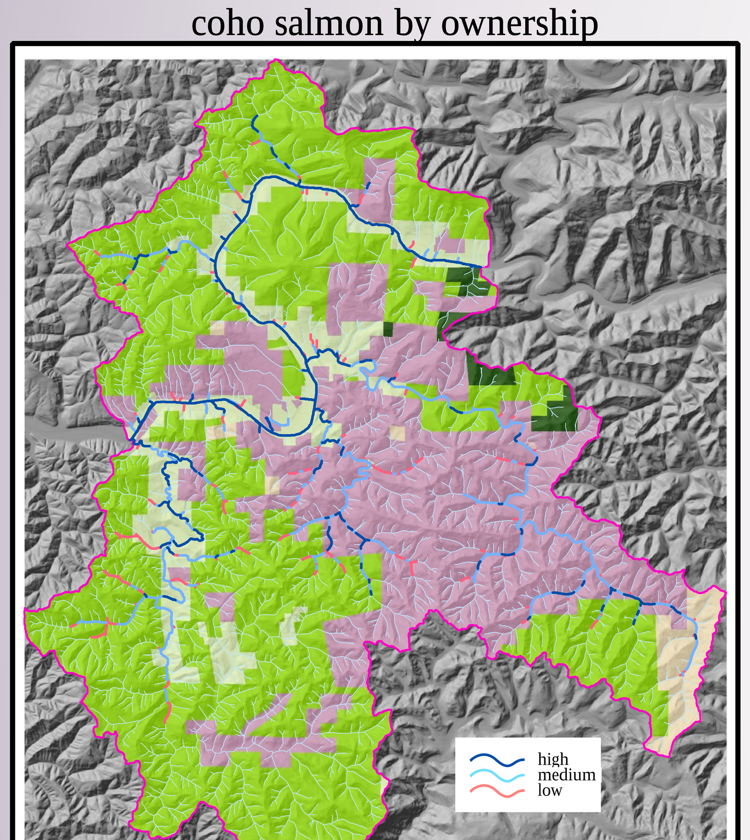
Channel gradient was determined from 10m DEMs generated by interpolation between contour lines from USGS 7.5-minute quadrangles. Mean percent reach gradient was calculated from points of known elevation wherever a contour line crossed the modeled stream and the estimated length of the channel between these points. Reach length increased with stream size, but the minimum length was 50m. Presumed species-specific relationships between value of juvenile rearing habitat and channel gradient (Hicks 1989; Schwartz 1990; Reeves et al. 1989; Nickelson 1998) reflect that: 1) coho salmon predominate in the lowest gradient reaches while steelhead predominate in reaches with gradients of 2-3%; and 2) fish density decreases with increasing channel gradient beyond the optimum up to a maximum of 8% for coho salmon and 10% for steelhead. We assumed reaches upstream of those with gradients exceeding 10% were not used by juvenile coho salmon and those with gradients exceeding 15% were not used by juvenile steelhead.

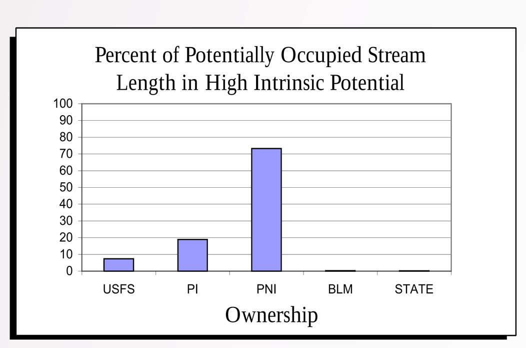
Valley Constraint

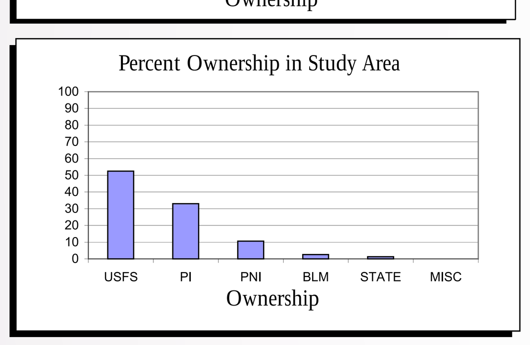


Channel constraint was derived from the relationship between channel form (Moore et al. 1997) in Oregon Department of Fish and Wildlife (ODF&W) stream surveys and modeled valley width index (VWI), a ratio of valley floor width to active channel width (ACW). Valley floor width was approximated from the 10m DE-DEM as the length of a transect intersecting valley walls above the channel at a height that varied with bankful depth. ACW was modeled from data collected by ODF&W and mean annual discharge. Presumed species-specific relationships between habitat value and channel constraint reflect that densities of juvenile coho salmon tend to be greater in unconstrained than in constrained reaches (Hicks 1989; Burnett 2001) but that juvenile steelhead may avoid unconstrained reaches (Burnett 2001).

Distribution of Intrinsic Potential for coho salmon by ownership





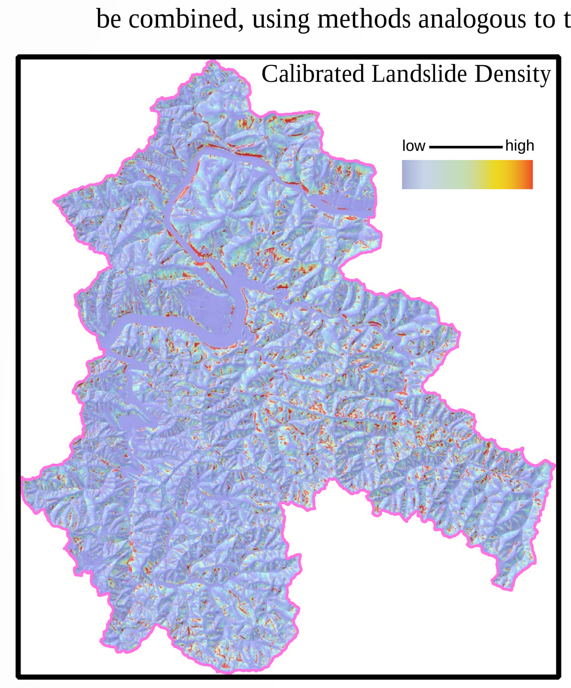


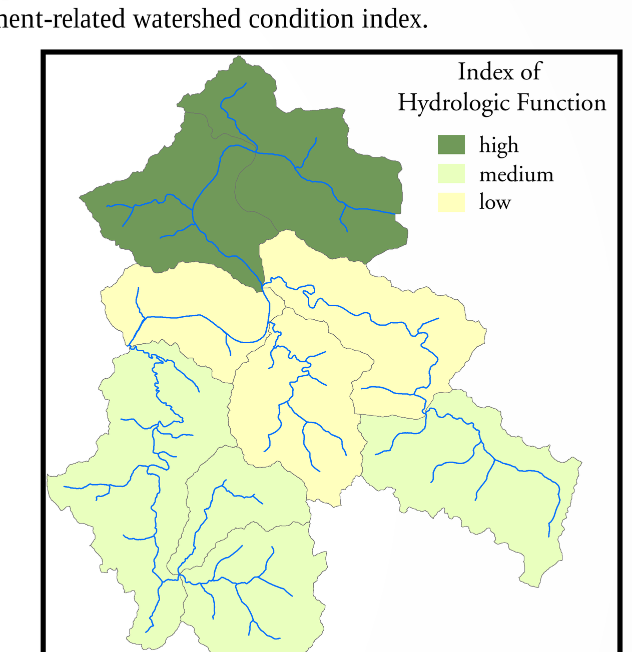
- PI - Private Industrial Forests
- PNI - Private Non-industrial Forests
- USFS - U.S. Forest Service
- STATE - Oregon State Administered
- BLM - Bureau of Land Management

Approximately 47 km of stream was estimated to have high intrinsic potential for coho salmon. The majority of this length was on private land even though most of the land in the basin was managed by the US Forest Service. Land use history and current policies vary by land ownership. Thus, opportunities to restore or protect aquatic habitat may differ by ownership.

Two example management-related watershed condition metrics

Intrinsic potential will be evaluated relative to a variety of metrics that describe land management influences in upslope and riparian areas. Metrics will be determined for each 7th-code HU based on conditions within the HU and all upstream HUs. Individual metrics will eventually be combined, using methods analogous to those for intrinsic potential, into an overall management-related watershed condition index.



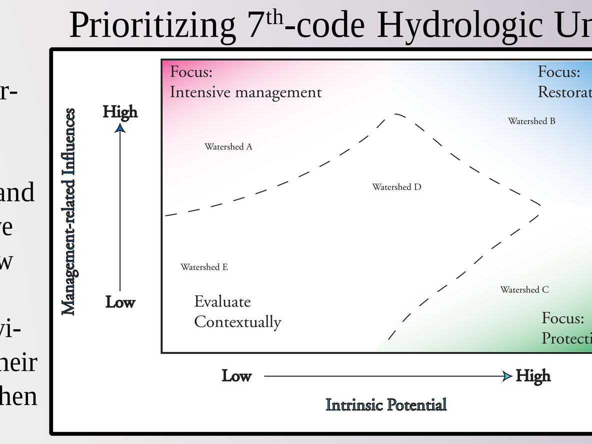


Debris flows can be important sources of episodically delivered wood and sediment for streams in montane areas (Benda et al. 1998). Probability of debris flow initiation was derived for each pixel as an estimated landslide density obtained from a topographic index and calibrated to forest cover. The topographic index is modeled with SHALSTAB (Montgomery and Dietrich 1994) as a function of slope, contributing drainage area, and local convergence and is calibrated with landslide inventories from the Siuslaw National Forest and the Oregon Department of Forestry.

Management that removes forest may alter the amount and timing of water delivered to streams from surrounding hillslopes (Ziemer and Lisle 1998). The magnitude of watershed-scale effects depends upon the area impacted and may be substantial when 15-30% of the watershed has been affected (e.g., McCammon 1993). Hydrologic functions should recover if forests reestablish and grow, returning to pre-disturbance levels within 30-40 years after timber harvest in western Oregon (Beschta et al. 1994). The index of hydrologic function (IHF), adapted from the ULEP (2001), is based on land use and stand age.

Prioritizing 7th-code Hydrologic Units

Each 7th-code HU will be plotted according to intrinsic potential and management-related watershed condition index. Those with high intrinsic potential may be good candidates for protection when relatively unaffected by past management and for restoration when management influences have been greater. Conversely, 7th-code HUs with low intrinsic potential and widespread management may be good candidates for future intensive activities. For all other 7th code HUs, evaluation of their ecological and spatial context may be essential when determining management priorities.



Conclusions

DEMs can be used to estimate the intrinsic potential of streams to provide high- quality rearing habitat for salmonids over large areas. Maps of intrinsic potential, when coupled with information on land ownership and use, can help understand the current capability of landscapes to support fish populations. These spatially-explicit data can also assist in setting priorities for future watershed restoration and protection. Although topographically-derived components (i.e., gradient, valley constraint, and mean annual discharge) have been evaluated with field data, intrinsic potential outputs have not yet been rigorously assessed. Intrinsic potential will also be predicted and evaluated for chinook salmon and cutthroat trout in all CLAMS area streams.

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www.fsl.orst.edu/clams

Cartography and Poster layout: Kelly Christiansen

Various and Sundry

Map production done using ArcGIS Software (v. 8.1). Graphics production using Adobe Illustrator software. Layout done using Adobe Indesign software.