Salmonid Rivers Observatory Network (SaRON): Integrating Science and Freshwater Conservation at Multiple Scales

By

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http://www.umt.edu/flbs/Research/SaRON.htm

Objective 1: To use SaRON empirical field data and remote sensing classification of freshwater habitats at multiple scales to determine intrinsic capacity of production of Pacific Rim Rivers and to assess whether river production has declined in relation to harvest levels and a subsequent decrease in Marine Derived Nutrients brought in by spawners.

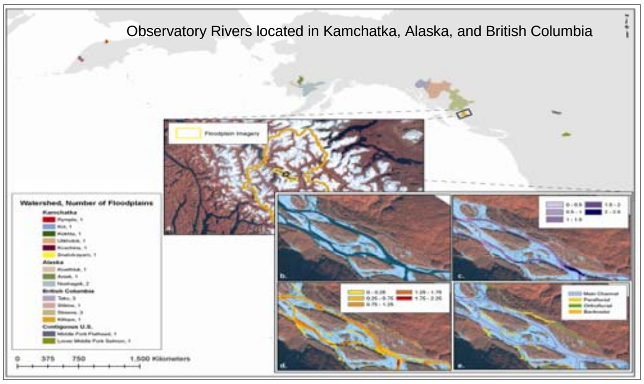

Figure 1. SaRON Rivers in which field research and fine scale habitat classification has been conducted. Inset a) shows the Kitlope basin and location of study flood plain. Inset b) shows Quickbird multi-spectral satellite imagery for a portion of the study flood plain. Inset c) shows water depth (m) extrapolated from Acoustic Doppler Profile (ADP) field data. Inset d) shows water velocity (m/s) extrapolated from ADP field data. Inset e) shows imagery classified to habitat type based on physical characteristics.

Supervised imagery classification

Basic metrics	Length (km)
Main Channel	22.5
Seconday Channel (connected)	29
Backwater/springbrooks	14.4
Complexity	**#**
Separation nodes	183
Return nodes	180
Average separation per river km	12.71
Channel Types	**Area (ha)**
Main channel	218.61
Islands	235.08
Isolated water bodies	7.01
Disconnected Springbrooks	12.33
Connected backwater/springbrooks	27.51

Habitat Type	% of Total Water
Shallow Shore	11.55
Shallow Run	14.35
Deep Runs	46.63
Pools	2.04
Rapids	3.79
Riffles	10.49
Shallow Off Channel	10.41
Deep Off Channel	0.74
Floodplain Cover	**% Cover**
Water	15.10
Bare	12.50
Vegetation	72.40

Table 1. Example of fine scale classification of floodplain features. Results for Kitlope observatory using Quickbird satellite imagery. Metrics in bold are scalable to the catchment level using Typology data base.

Scale up to entire catchment

	Kitlope	Skeena	Kwethluk	Kol	Utkholok
Basin Area km²	3,206	51,383	3,787	1,502	1,371
# of floodplains	43	222	30	4	11
Floodplain Area Km²	94	892	223	115	52
Ratio of Area Floodplain/Basin	2.95%	1.66%	5.8%	7.7%	3.8%
Main Channel Length km	102	648	241	110	106
Average # of nodes per river km	3.14	1.24	0.75	2.15	1.63

Table 2. Subset of key physical metrics from Typology data base for SaRON sentinel rivers (after scaling up from floodplain analysis).

Use Physical Complexity Metrics to rank catchments

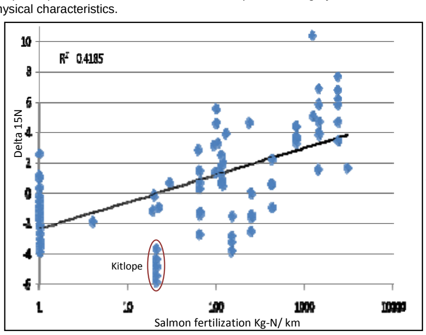

Figure 2. An example empirical product of SaRON field data: Regression of Marine Derived Nutrients (delta 15N) in riparian leaves versus the amount of salmon Nitrogen brought in by spawning salmon.

Output

Field data: Biological Production Proxies

- **Physical-chemical characteristics of Water**: Flow, Nutrient and Temperature patterns
- **Benthic Invertebrates**: Quantitative analysis (biomass/area and density), species composition and diversity, and Marine Derived Nutrient content (N, C)
- **Aufwuchs** (algae, fungi & bacteria): Quantitative analysis (biomass/area, C/N) and Marine Derived Nutrient content (N, C)
- **Riparian Vegetation**: Foliar analysis for Marine Derived Nutrient content (N, C)
- **Juvenile Fishes**: Electrofishing for species composition, salmonid density, Marine Derived Nutrient content (N, C), growth rates, lipid content, genetics

Table 3. SaRON Field Measures/Biological Production Proxies

Pacific Rim Typology Database

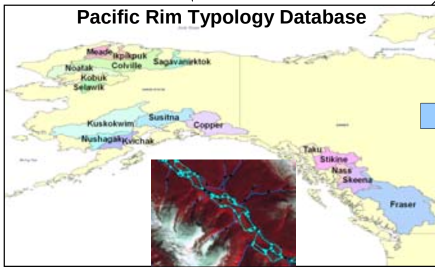

Figure 3. Pacific Rim Typology Database. A geospatial database describing physical structure of 1200 rivers using remote sensing (reprocessed Landsat image) for north Pacific Rim. Figure shows major North American catchments. Inset shows an example of metrics extraction (e.g., a flow network and nodes of separation/return) for a floodplain reach of an observatory river, Kitlope, B.C).

Output

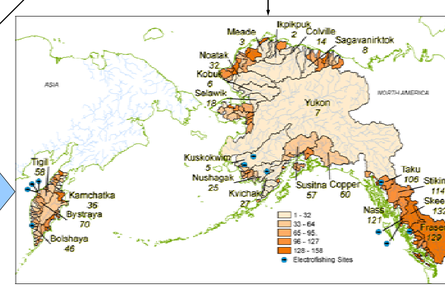

Figure 4. Physical Complexity Ranking of Large Catchments around Pacific Rim using metrics from Typology Database (Matt Luck, N. Maumanee, J. Kimball, J. Stanford, M. Lorang, D. Whited. In press.)

	Average # of juvenile salmonids / km² of flood plain	Intrinsic Productivity Potential of juvenile salmonids for entire watershed	Intrinsic Productivity Potential / km²
Kitlope	587	1,883,237	Low
Skeena	332	17,058,287	Low
Kwethluk	6,640	25,148,588	High
Kol	9,514	13,750,463	High
Utkholok	2,786	3,819,652	Medium

Table 3. Interim Biophysical Production Metrics. Freshwater habitat based estimates of intrinsic productivity capacity from Typology classification scaled to SaRON field data.

Objective 2: To determine how salmon and salmon habitat will respond to climate change, using models at different scales for a variety of climate and hydrologic scenarios.

Global Scale Climate Model (VIC)
Hydrology, temperature

Global Scale Remote Sensing Geospatial Data (DEMs, Landsat, Modus)

Catchment Scale Flux Model (BIOME/BGC):
Flow, Temperature, nutrients

Scenarios: a...n

Scenarios: a...n

Floodplain scale model (WREN):
a. Mass balance: water, heat, nutrients
b. Fish production, marine derived nutrients

rescaling

Ocean models (non SaRON activities)

Catchment level analysis of model output

Other Salmon databases at catchment scale from Agencies and other sources (e.g., Dorner et. al., 2008. CJFAS)

Biophysical Rankings from Modeling

Testing climate scenarios on freshwater productivity as influenced by Marine Derived Nutrient import

compare

Biophysical Rankings from Empirical Data

Primary Outcomes:

- Defines relationship of Typology metrics to total and species specific production potentials for rivers of different geomorphic types
- Quantifies the relationship of physical Typology metrics to total and species specific production potentials using other biological data sets
- Examines Marine Derived Nutrient limitations in freshwater
- Integrates climate change and hydrological models at fine and coarse scales to predict changes in salmon habitat under various climate scenarios
- Provides approach to assess impacted basins and guide restoration efforts

Implications for Strategic Salmon Conservation

- Provides two un-biased approaches (empirical and modeled) to rank Pacific Rim rivers for conservation actions.
- Allows assessment of Marine Derived Nutrient feedback on freshwater productivity (e.g. overharvest reduces MDN feedback in some rivers).
- Provides a template of observatories for monitoring effectiveness of conservation strategies long term.
- Provides a protocol for unbiased comparison of monitored and unmonitored salmon rivers around the Pacific Rim under current and modeled climate scenarios.