NetMap: A collaborative enterprise since 2007

- US National Forests (WA, OR, NCA, AK, ID, MT)
- US Forest Service Research: PNW, PSW, RMRS
- NOAA
- BLM
- EPA
- Oregon Dept. Forestry
- State Fish and Game
- NGOs
- Watershed Councils
- First Nations
- Universities
- Foothills Research (Alberta)
- Private (West Fraser, US companies)
- International (Spain, China, Russia)

Current and Pending Coverage

2 million ha
Alberta

2013
Why? – to provide analyses and information previously unavailable to agencies and other stakeholders

Where are the best fish habitats located? Where do they overlap with land use stressors?

www.netmaptools.org

Analysis Tools
Support/maintenance
Advisory Groups

Digital Landscapes (smart stream layer)
Why? – to provide analyses and information previously unavailable to agencies and other stakeholders

Where are the best fish habitats located? Where do they overlap with land use stressors?

Which road segments pose the greatest threats to erosion, water quality and to aquatic habitats?

At what locations are energy pipelines most susceptible to erosion or flooding impacts?

Where is wildfire related erosion and flooding risk the greatest?
Components
(1) Digital Landscapes
(2) Community Tools
(3) Analyses
(4) Support & Maintenance

A digital landscape is a virtual environment where landforms and physical and biological processes are placed in context with spatial patterns of human activities and infrastructure.
Creating a synthetic river
- channel heads
- channel density
- adjustable (remove, add streams, custom segments)

**NetMap’s topographic-channel data structure**

- Uniform data structure
- Roads
- Hillslope
- Stream
Discretize
-channels
-hillsides
-roads/pipelines

Smart stream layer

- Gradient
- Floodplains
- Shear stress
- Alluvial fans
- Bed substrate
- Tributary confluences
- Channel classification
- Erosion potential
- Fish habitats
- Hillslope - slope profile (surface erosion)
- Elevations
- Valley width and transitions
- Distance to outlet
- Debris flows
- Radion loading etc.

Smart digital landscape

- Landforms
- Alluvial fans
- Erosion coefficients
- Road network and urbanization
- Hillslope - gradient and convergence (mass wasting)
- Channel network and width
- River - channel profile (surface erosion)
- Ecology
- Drainage density etc.

LI D A R issues: road – stream diversions

- Road
- Stream
- Road network
- Stream network
Correcting networks

Alberta – what else is available?

#1: stream layer (1:20,000 cartographic), drainage density (1.1 km² vs 5.0)

<table>
<thead>
<tr>
<th>Element</th>
<th>Discrepancy</th>
<th>Network Completeness</th>
<th>Consistency</th>
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Alberta cartographic

NetMap

1:20,000 cartographic

Field surveys

UNB LiDAR

Alberta – what else is available?

#2: stream layer (1m LiDAR synthetic [Univ. of New Brunswick]), drainage density (4.6 km² vs 5.0)

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UNB LiDAR

Benchmark

1:20,000 cartographic

Field surveys
NetMap’s Community Tools
(ArcMap 10/10.1)

Aquatic habitat indices
- Fish habitat (5 species)
- diversity
- biological hotspots
- classification
- floodplains
- estuaries (EPA)

Erosion
- Shallow slide/debris flow
- Surface erosion
- Sediment yield

Vegetation
- riparian
- fuels/fire risk
- post fire

Riparian Management
- habitat
- wood recruitment (USFS)
- thermal load
- erosion

Roads
- density (multi-scale)
- upstream hab. length/quality
- stability
- drainage diversion (NOAA)
- surface erosion (RMRS)

3.0 Fluvial Morphology Module
3.1 Flow Calculations (mean annual flow, Other Q [2013])
3.2 Hydraulic/Planform Geometry
- Channel width
- Channel depth
- Flow velocity
- Bed shear stress
- Substrate D50/Classes
- Channel sinuosity

3.3 Network Variables
- Channel gradient
- Maximum downstream gradient
- Drainage area
- Mean annual precipitation
- Stream order
- Stream power
- Tributary Confluence environments

3.4 Channel Classification
- Generic
- Rosgen
- Headwater (2013, funded, State of WA)
- Confinement

3.5 Drainage and Junction Density (subbasin scale)
3.6 Floodplain Mapping
3.7 Alluvial fan mapping (summer 2013)
3.8 Landslide – Channel interactions
3.9 Define Channel Heads (trim network top down)
4.0 Wood Accumulation Types

4.0 Aquatic Habitat Module
4.1 Define Fish Distribution
4.2 Create Aquatic Habitats
- Intrinsic Potential (three anadromous species)
- Cutthroat Trout (Bayesian)
- Bull Trout (Empirical)

4.3 Core Habitats
4.4 Habitat Diversity
4.5 Cumulative Habitat Length and Quality
4.6 Beaver Habitat
4.7 Channel Ephemeral Index
4.8 Piscicide Tool
4.9 Estuary mapping classification (Puget Sound)
4.10 Riparian and upland wetland screening (proposed)
6.0 Transportation/Energy Module

6.1 Import Road/pipeline Layer (discretize)

6.2 Corridor (road, pipeline) Density
   Subbasin scale
   Stream Segment/Network Scale

6.3 Road Segmentation for drain points (drainage diversion, road erosion)

6.4 Road (other corridor) Stability

6.5 Road (other corridor) in Floodplains

6.6 Habitat Upstream of Road (and other corridors)

6.7 Road (other corridor) stream overlap classification; habitat; debris flow; gully

6.8 Road Surface Erosion (GRAIP - lite, WEPP)

6.9 Toxic spill upstream tracer (proposed)

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A platform for other programs, tools, and databases

Vegetation state and transition modeling (VDDT)

Fire simulation (Flamment etc.)

Surface erosion (WEPP etc.)

Road surface erosion (GRAIP)

Burn severity (BAER)

Vegetation data (Type/age etc.)

NetMap River Network Data Structure

NetMap

NHD/NHD+ other stream layers (Data/drainage mask)

Fish data/barriers (Bayesian Cutthroat/Bull Trout models)

Information transfer between NetMap and other stream databases (including NHD)
Applications: urban and agriculture

Coho salmon habitat – where are the best habitats located? (intrinsic potential, Burnett et al. 2007)
All tools – online technical help

Landscape mapping: steelhead

WA Dept of Fish and Game

NetMap
Steelhead habitat, classify using Sort & Rank Tool

Differentiate fish habitat types (across all of Puget Sound)

Quickly search for intersections of sensitive habitats with single or multiple stressors
Road density – a stressor

Where does the highest 5% of road density (stream segment scale) intersect the top 5% of coho salmon quality?

Beaver habitat (Polluck et al. 2004)
Mapping floodplains: regulatory or part of habitat mapping/prediction

Mapping floodplains: identifying where obscured

Skokomish River

Development

Mapping floodplains: identifying where developed (restoration)
Floodplain mapping for restoration planning

Applications: the rural, upstream domain
- forestry
- roads
- erosion
- wildfire

Where are the most erosion prone areas located?
Which areas are most sensitive to land uses?
What are the best buffer designs to mitigate erosion?
NetMap shallow failure-gully potential (Miller and Burnett 2007)

Post fire gully/debris flow erosion
Debris flow potential

Red = higher risk
Blue = lower risk

Forest Roads

Map quality habitat intersections with stressors in Google Earth
Where does the top 10% of road density overlap the top 10% of erosion potential, and where does that pair overlap with the top 10% of fish habitat quality?

Pre- and post fire planning

Step 1: fuels
Step 2: fire intensity (inc. climate change)
Step 3: Erosion
Step 4: Habitat
Step 5: Overlay high fire intensity w/ high erosion risk
Step 5: Identify overlaps among high fire risk, high erosion potential & high habitat potential
Prioritize treatments
Climate change, applying downscaled GCM predictions (UW Climate Impact Group)

Increased (winter (looding (likely (Spa8ally'Explicit'Riparian'Management'))

A procedure for riparian management planning based on assessment of:
- forest growth
- riparian processes
- fish habitat

Spatially Explicit Riparian Management

Reach Scale Wood Recruitment

Mortality types include suppression, fire, insect, disease, & wind-throw.

Bells and Whistles:
- channel width,
- stand width,
- hill slope gradient,
- bank erosion,
- wood decay,
- taper equations,
- thinned trees that are tipped, and
- size of resulting wood pieces

Inputs: stand tables from forest growth models
Outputs: 10 types of plots

Kozak, 1988; Bilby et al., 1993; Benda and Gos 2003; Sobota et al., 2006; Hibbs et al., 2007; and more.
Scenarios
- Left bank is always no action scenario (70 m)
- Right bank treatment scenarios (11)
- Double entry thin, 70 TPA: 2010, 2040
- All other parameters held constant

Right bank scenarios

<table>
<thead>
<tr>
<th>Stand1</th>
<th>Stand2</th>
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<tbody>
<tr>
<td>No action (10 m)</td>
<td>No action (60 m)</td>
</tr>
<tr>
<td>No action</td>
<td>Thinned</td>
</tr>
<tr>
<td>No action</td>
<td>Thin &amp; tip 5%</td>
</tr>
<tr>
<td>No action</td>
<td>Thin &amp; tip 10%</td>
</tr>
<tr>
<td>No action</td>
<td>Thin &amp; tip 15%</td>
</tr>
<tr>
<td>No action</td>
<td>Thin &amp; tip 20%</td>
</tr>
<tr>
<td>Thinned (70 m)</td>
<td></td>
</tr>
<tr>
<td>Thin &amp; tip 5%</td>
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Cumulative wood volume using 2 bank scenarios, no buffer

Cumulative wood volume using 2 bank scenarios, 10 m buffer

The buffer reduces the effect of the thin and tip by reducing loss of wood. In the long term the volume of wood in the stream increased to near to the untreated scenario.

Total volume of cumulative wood over time
(sorted by increasing volume)

<table>
<thead>
<tr>
<th>Total cumulative wood</th>
<th>Volume (m$^3$ 100 m$^2$ reach)</th>
<th>percent change from reference</th>
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<tbody>
<tr>
<td>Untreated/Double thin</td>
<td>156 (42%)</td>
<td></td>
</tr>
<tr>
<td>Untreated/Double thin, tip 5%</td>
<td>232 (14%)</td>
<td></td>
</tr>
<tr>
<td>Untreated/Buffer10_Double thin</td>
<td>243 (10%)</td>
<td></td>
</tr>
<tr>
<td>Untreated/Untreated [reference condition]</td>
<td>371</td>
<td></td>
</tr>
<tr>
<td>Untreated/Double thin, tip 10%</td>
<td>284 (5%)</td>
<td></td>
</tr>
<tr>
<td>Untreated/Buffer10_Double thin tip 10%</td>
<td>288 (6%)</td>
<td></td>
</tr>
<tr>
<td>Untreated/Buffer10_Double thin tip 15%</td>
<td>299 (10%)</td>
<td></td>
</tr>
<tr>
<td>Untreated/Double thin tip 20%</td>
<td>305 (13%)</td>
<td></td>
</tr>
<tr>
<td>Untreated/Double thin, tip 15%</td>
<td>324 (20%)</td>
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Tree tipping from thinning operations combined with riparian buffers offer the highest volumes of wood loadings.
Assess environments: reach scale (project) and watershed scale using a mix of advanced analysis tools and field work.

Sensitivity analysis: which channels are most sensitive to changes in riparian veg?

Fully forested versus no vegetation (bare)

Radiation versus Buffer Width, Variable Densities, Height =50m, Stream Channel Width=10m
Assemble the Pieces: Design Riparian Management

- No cohuviation/habitat (no deciduous seed, dorm, - larger trees riparian avai, mammal)
- Best cohuviation/habitat (100' buffer, thin beyond - larger no stream effect of (hydrologically variable)
- Large wood to habitat (marginal effect on all wood handling - increase in large wood handling)

Delta flow delivery of
large wood to fish habitat
(excl. cohuviation/habitat)

No thin, bank erosion 1mm/yr

30' buffer, bank erosion 1mm/yr

100' buffer, bank erosion 1mm/yr

Number of pieces 100 m$^3$ >= 10 cm in diameter

- 10% reduction with 30 ft buffer

Number of pieces 100 m$^3$

Per 10 year periods

~10% reduction with
30 ft buffer

100 yrs

1995 2045 2095 2145 2195

Yrs

No thin, bank erosion 1mm/yr

30' buffer, bank erosion 1mm/yr

100' buffer, bank erosion 1mm/yr

Browser tools for data dissemination and visualization
(no ArcGIS experience needed!)
Access databases and tools, and support and maintenance