System for Mapping and Predicting Species of Concern

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National Petroleum Reserve - Alaska

23 million acres
1000s of miles of streams
Being rapidly developed
System for Mapping and Predicting Species of Concern

Existing Biological Data

Species Distribution Models

Predicted occurrences

eDNA

Satellite
System for Mapping and Predicting Species of Concern

Existing Biological Data

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Species Distribution Models

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Predicted occurrences
System for Mapping and Predicting Species of Concern

Application for natural resource managers to:
• Map current known and predicted occurrences
• Aquatic species of concern (T&E or invasives)
• Predict future changes in distributions
Environmental DNA:

• Detection rates 80-96%
• Faster & cheaper sampling (< 60 min, <$30/sample)
• COI assessed using qPCR
Develop & apply eDNA assays

- Burbot (
  *Lota lota*)
- N. Pike (
  *Esox lucius*)
- Arctic Grayling (Thymallus arcticus)
- Broad Whitefish (Coregonus nasus)
- Least Cisco (Coregonus sardinella)
- Humpback Whitefish (Coregonus pidschian)

[Red Crosses through Least Cisco and Humpback Whitefish]
Develop & apply eDNA assays

N. Pike  
(*Esox lucius*)
Develop & apply eDNA assays

Burbot (Lota lota)
Develop & apply eDNA assays

Arctic Grayling
(*Thymallus arcticus*)
Develop & apply eDNA assays

Arctic Char Complex
(Salvelinus alpinus, malma)
Develop & apply eDNA assays

A tail of two fish...

Broad Whitefish
(Coregonus nasus)

Least Cisco
(Coregonus sardinella)
Develop & apply eDNA assays

Currently running assays developed by USFS for:

Chinook Salmon
(*Oncorhynchus tshawytscha*)

Chum Salmon
(*Oncorhynchus keta*)
Watershed Earth Observations
Watershed Earth Observations

(1) Landscape Layers
(i.e., satellite or mapped data)

(2) Calculate zonal statistics for each catchment

(3) Accumulate all upstream catchment metrics

<table>
<thead>
<tr>
<th>ID</th>
<th>CatArea</th>
<th>CatResult</th>
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<tbody>
<tr>
<td>1</td>
<td>150</td>
<td>0.50</td>
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<td>2</td>
<td>122</td>
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<td>3</td>
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Hill et al., 2016, The Stream-Catchment (StreamCat) Dataset, JAWRA.
https://github.com/USEPA/StreamCat
Using StreamCat, we can apply models to every stream segment in National Hydrologic Dataset.
Watershed Earth Observations

Build a National Hydrologic Dataset Plus “knockoff” for North Slope
Watershed Earth Observations

Build a National Hydrologic Dataset Plus “knockoff” for North Slope 4000 river segments with associated watersheds
Watershed Earth Observations

Apply to Earth observation data using StreamCat
Example: MODIS Evapotranspiration
## Watershed Earth Observations

<table>
<thead>
<tr>
<th>Static Predictors</th>
<th>Dynamic Predictors</th>
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<tr>
<td>Percent Lakes Unfrozen (SAR)</td>
<td>Active Layer Thickness (SAR)</td>
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<tr>
<td>Drainage Area</td>
<td>Evapotranspiration (MODIS)</td>
</tr>
<tr>
<td>Stream Slope</td>
<td>Land Surface Temperature (MODIS)</td>
</tr>
<tr>
<td>Soil Characteristics</td>
<td>EVI/NDVI/LAI/GPP (MODIS)</td>
</tr>
<tr>
<td>Vegetation Type (Landsat)</td>
<td>Fire Activity (MODIS)</td>
</tr>
<tr>
<td>Thermokarst Activity</td>
<td>Oil &amp; Gas Development</td>
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<td>Snow cover (MODIS)</td>
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Watershed Earth Observations

Apply to temporal Earth observation data using StreamCat
Example: MODIS Land Surface Temperature
Watershed Earth Observations

Characterize the connectivity of rivers to lakes that remain partly unfrozen in winter using cost-distance rasters.
Watershed Earth Observations

Characterize the connectivity of rivers to lakes that remain partly unfrozen in winter using cost-distance rasters
Connecting Earth Observation to Biodiversity and Ecosystems, Bush et al., *in press*, Nature Ecology & Evolution
Next Steps

1. Complete species distribution models
2. Develop & test user interface
3. Expand to other parts of Alaska
Questions