

Jun 20th, 3:30 PM - 3:45 PM

# Landscape Approaches: Making Sense of 17,000 Structures

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# Making Sense of 17,000 Structures



Fish Passage 2016

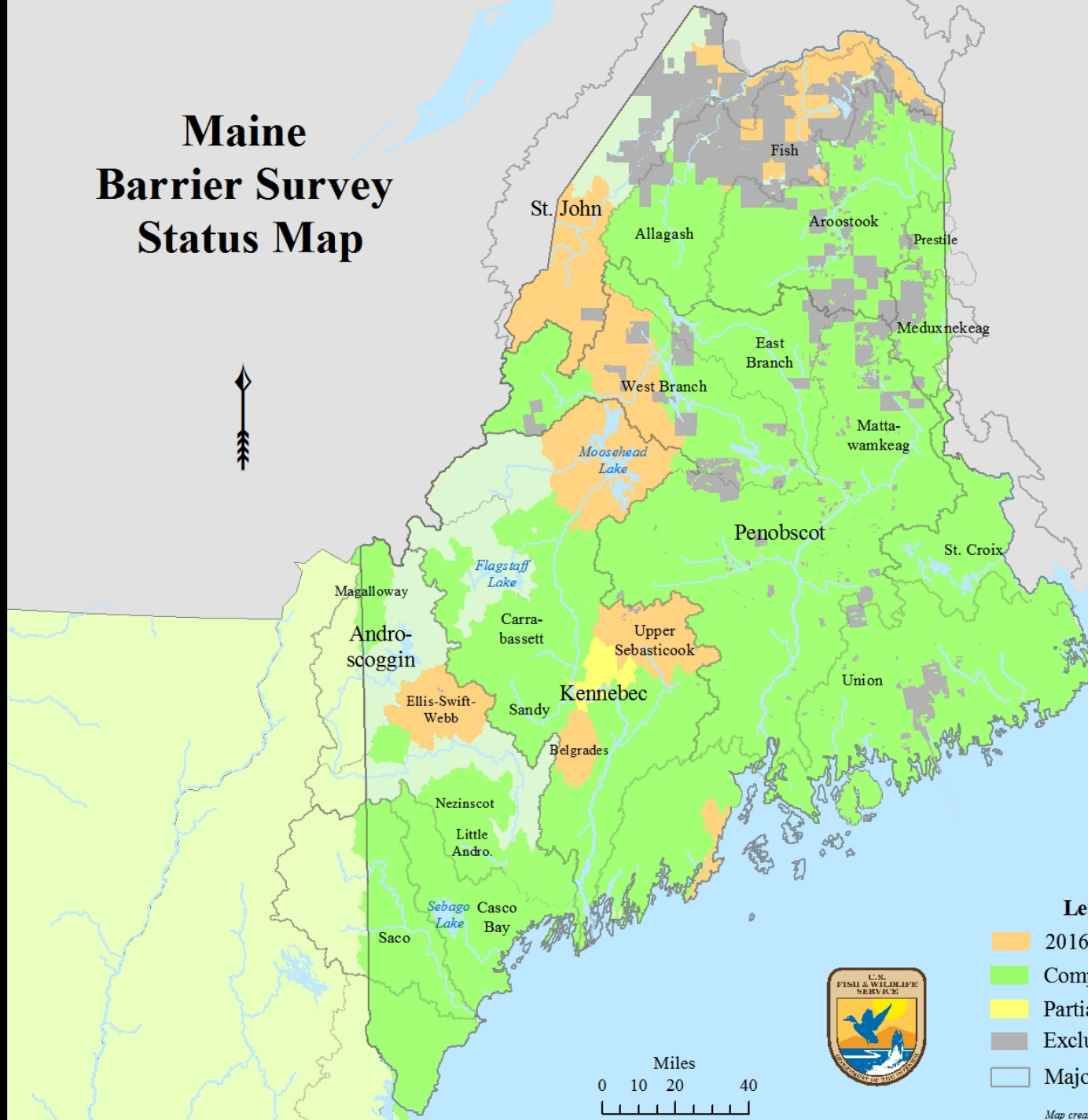
Jed Wright<sup>1</sup>, Alex Abbott<sup>1</sup>, Jesse O'Hanley<sup>2</sup>

<sup>1</sup>Gulf of Maine Coastal Program USFWS<sup>2</sup>

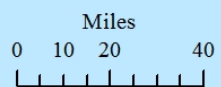
<sup>2</sup>University of Kent



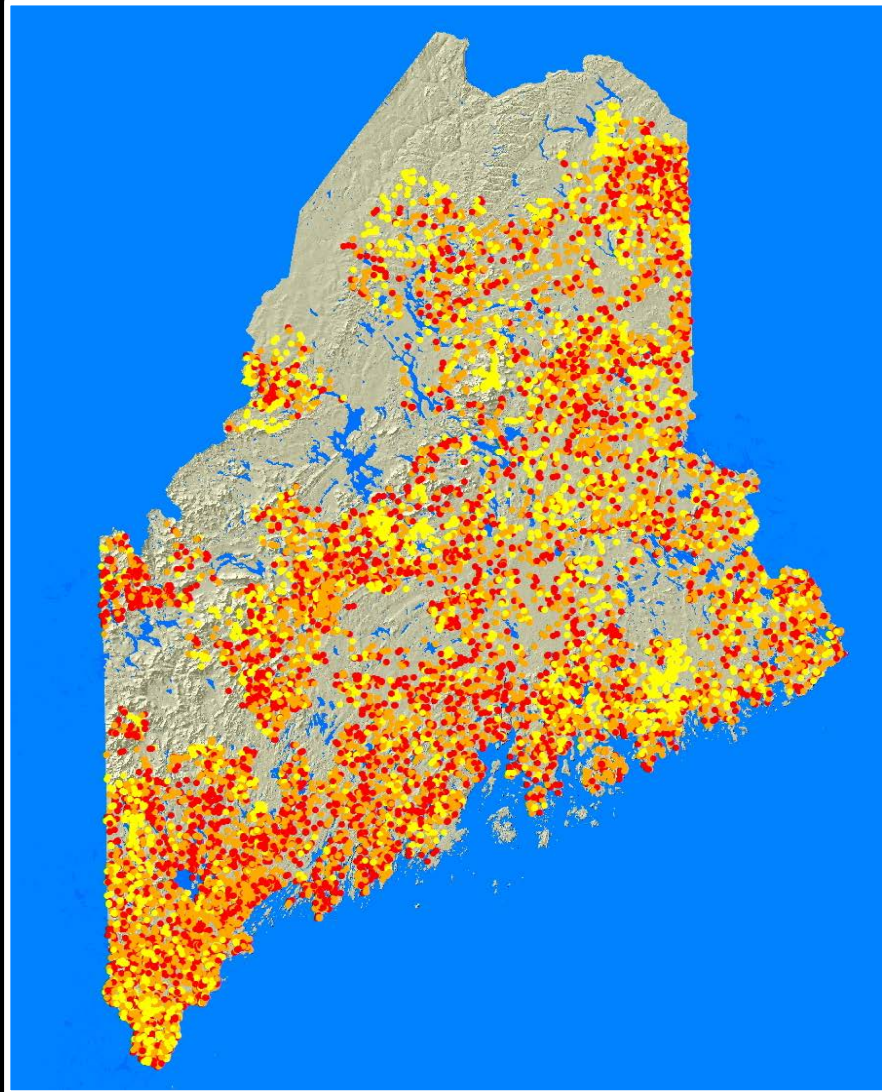
# Maine Barrier Survey Status Map



- Legend**
- 2016 Proposed Surveys
  - Completed Surveys
  - Partial Surveys
  - Excluded Lands
  - Major Watersheds



# What to do?



## Outline

Tool 1 – Habitat and barrier data sharing

Tool 2 – Scoring and ranking

Tool 3 – Optimization with OptiPass

# Tool 1

# Maine Stream Habitat Viewer

State of Maine  
Stream Habitat Viewer

Welcome Layers **Adv Search** Identify

Enter Town or Site ID of Crossing

- Crossings & Barriers**
  - Crossings
    - Barrier
    - Potential Barrier
    - No Barrier
    - Unknown
  - Dams
  - Natural Barriers
  - Impassable Waterfalls
- Priority Habitats**
  - Atlantic Salmon
  - Alewife
  - Sea-Run Rainbow Smelt
  - Wild Eastern Brook Trout
    - Heritage Ponds
    - Pond and Stream Habitat
    - Subwatershed Rankings
  - Tidal Marshes
- Other Habitats**
  - Non-Native Fish
  - Tidal Waterfowl and Wading Bird Habitat
  - Inland Waterfowl and Wading Bird Habitat
  - Beginning with Habitat Focus Areas
  - Wetlands
- Other Layers**

Hover:  
 Check this box to enable your mouse to hover over crossing locations and a small window with limited information will appear. Click on the feature to identify full information.

Esri, HERE, DeLorme, USGS, NGA, EPA, US

- Access to habitat data
- Access to crossing & dam data
- Access for the public and professionals

# The Viewer Displays Key Habitats...



# Tool 1

# ...and Known Barriers

**State of Maine**  
Stream Habitat Viewer

Welcome Layers Adv Search Identify

**Layer Details:**  
2 features currently selected

**Crossings and Barriers: Crossings**

Site ID: 4514  
Crossing Type: Culvert  
Crossing Class: Potential Barrier  
Survey Date: July 25, 2010  
Stream: Unnamed  
Town: Cushing  
County: Knox  
Road: River Rd

**Photos**  
[Downstream Inlet 1](#) [Inlet 2](#) [Outlet](#) [Upstream](#)

**Detailed Stream Crossing Information**  
Latitude: 44.00  
Longitude: -69.27  
Road Type: Paved  
Road Class: State  
Number Of Culverts: 1  
Crossing Condition: Unknown  
Structure Type: Round Culvert  
Material: Metal  
Inlet Grade: At Stream Grade  
Inlet Width (ft): 5.35  
Inlet Water Depth (ft): 0.53  
Inlet Height (ft): 3.22  
Crossing Length (ft): 68.90  
Outlet Grade: At Stream Grade  
Outlet Width (ft): 5.38  
Outlet Water Depth (ft): 1.48  
Outlet Drop (ft): 0.00  
Outlet Height (ft): 5.15  
Structure Substrate Matches Stream: None  
Physical Barriers:  
Physical Barrier Severity:  
Road Fill Height (ft): 7.00  
Total Opening Width (ft): 5.40  
Area of Opening (sq ft): 22.70  
Estimated Bankfull Width (ft): 14.10  
Upstream Blocked Miles: 5.23  
Upstream Total Miles: 5.73  
Upstream Barriers: 1  
Downstream Barriers: 0


**Habitats Related to this Crossing**  
Atlantic Salmon Modeled 100 sq m  
Habitat Units Blocked: 44.00  
Alewife Pond Acres Blocked: 19.60  
Brook Trout Miles Blocked:  
Rainbow Smelt Habitat: Yes  
Tidal Marsh: Yes

**Other Habitat Considerations**  
Beginning with Habitat Connectors: Yes  
Threatened Endangered or Rare Species:  
Non-Native Fish: Potential Downstream  
Tidal Waterfowl & Wading Bird Habitat: Yes  
Inland Waterfowl & Wading Bird Habitat: Yes  
Beginning with Habitat Focus Area:

**Watersheds**  
HUC 12 Subwatershed Name: St. George River  
HUC 10 Watershed Name: St. George River  
HUC 8 Sub-basin Name: Frontal Drainages East of Small Point-Sheepscot River  
HUC 6 Basin Name: St. Croix River

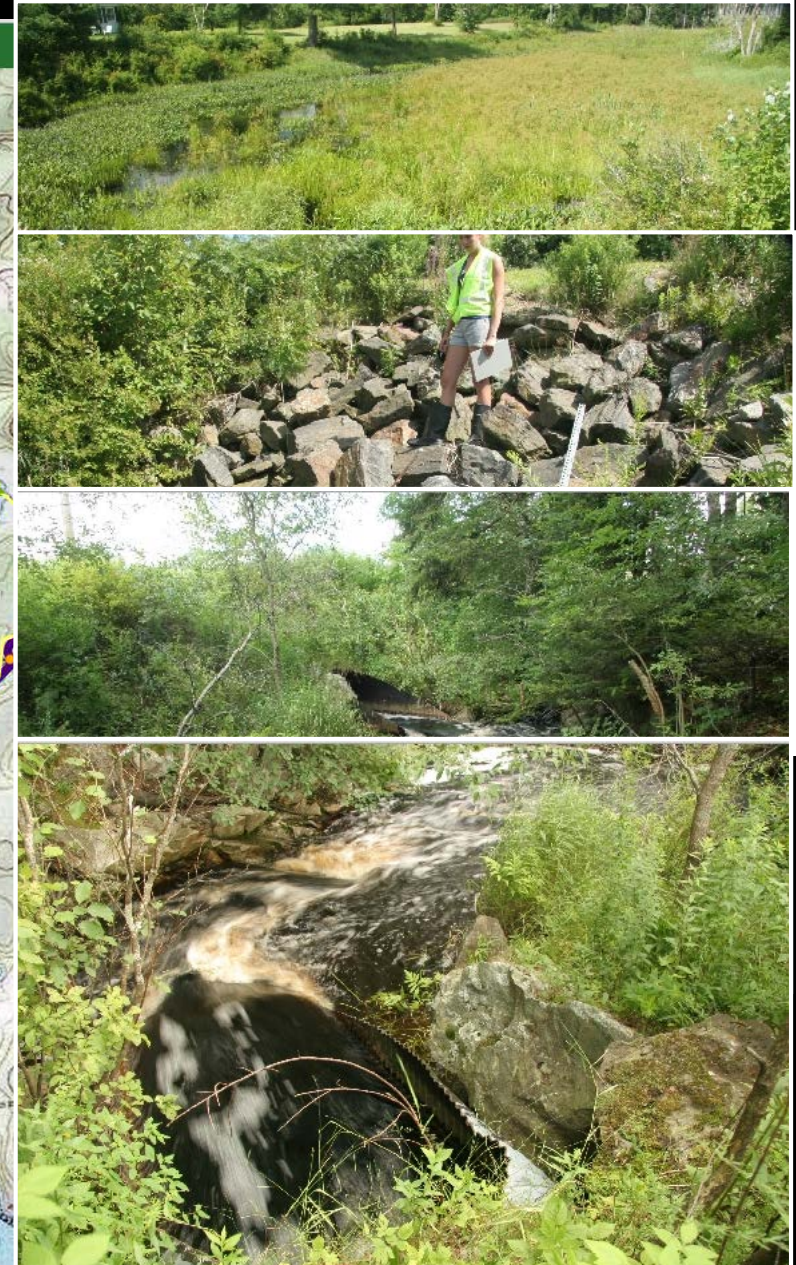
**Comments:**

**Downstream**



< Previous    Next >

0.3km  
0.2mi





## Tool 1 – Making information easily accessible

- Commonly used approach
- Biologists, restoration staff, landowners, public works staff can brainstorm approaches
- Usually easy enough to figure out the initial set of barriers to repair/remove for small number of barriers

## Informal methods:

- Static
- Lack rigour
  - Often very subjective – no framework
  - Difficult to compare options
  - Unmanageable at large spatial scales
  - Looking at multiple watersheds simultaneously is generally too difficult
- Don't get at the problem of how to allocate funds efficiently

**WATER RESOURCES MAINE** GET STARTED TOUR GO TO ▾ The Nature Conservancy Partners Legal Disclosure

Search by Address

### Aquatic Barrier Prioritization

#### Welcome to the Penobscot Habitat Blueprint Barrier Prioritization Tool

This tool can be used to help identify which barriers to aquatic connectivity would provide the greatest ecological gain if removed. Separate scenarios can be run using consensus weights developed by the Penobscot Habitat Blueprint working group for both resident and diadromous fish species. Additionally, users can define custom scenarios by applying relative weights to the metrics of their choice to reflect their objectives.

This map and prioritization tool are designed to be screening-level tools that can be used to help investigate potential fish passage projects in the context of many ecological factors. Results do not incorporate important social, economic, or feasibility factors and are not intended to be a replacement for site-specific knowledge nor a

[Get Started!](#)

#### Map Legend

**Penobscot Barriers**

- + Crossing
- Dam
- Natural Barrier

powered by **esri**  
Esri, HERE, DeLorme, NGA, USGS, NPS | The Nature Conservancy

10:49 AM 6/17/2016

# Tool 2

# Scoring and Ranking

The screenshot displays the 'Aquatic Barrier Prioritization' web application. The browser address bar shows the URL [maps.coastalresilience.org/maine/](http://maps.coastalresilience.org/maine/). The application header includes navigation links: 'GET STARTED', 'TOUR', 'GO TO', 'The Nature Conservancy', 'Partners', and 'Legal Disclosure'. A search bar is located at the top left of the map area.

The central 'Aquatic Barrier Prioritization' window is open, showing a list of input criteria for scoring. The 'Sum of Weights' is currently 0. The criteria listed are:

- Upstream functional network length
- Count of downstream barriers
- Absolute Gain (min of US & DS Func Networks)
- Count of natural barriers downstream
- One or more of the next upstream barriers is a natural barrier
- Upstream network length
- Stream size class (raise headwaters in importance)

Additional options in the window include 'Filter Barriers?', 'Diadromous', 'Resident', 'Clear All Inputs', 'Model Barrier Removal?', and 'Calculate Summary Statistics?'. A 'Submit' button is at the bottom of the window.

The map shows a large cluster of black symbols representing barriers in central Maine. A 'Map Legend' window is open in the bottom right corner, defining the symbols:

- Penobscot Barriers
  - + Crossing
  - Dam
  - Natural Barrier

The Windows taskbar at the bottom shows the system clock at 10:50 AM on 6/17/2016, and several open applications including 'sampling\_procedure.doc' and 'vc\_redist.x64.exe'.

# Tool 2

# Scoring and Ranking

The screenshot shows a web browser window displaying a map of Maine. The browser's address bar shows the URL `maps.coastalresilience.org/maine/#`. The page has a green header with the text "WATER RESOURCES MAINE" and navigation links: "GET STARTED", "TOUR", "GO TO", "The Nature Conservancy", "Partners", and "Legal Disclosure".

On the left side, there is a sidebar with a search bar "Search by Address" and several map controls: "Map Layers", "Aquatic Barrier Prioritization", "Switch To Map 2", "Split View", "Save & Share", and "Export Page".

The main map area shows the state of Maine with numerous colored dots representing different Penobscot Barriers. The dots are color-coded according to their risk tier. A legend in the bottom right corner, titled "Map Legend", provides the following information:

- Penobscot Barriers**
  - + Crossing
  - Dam
  - Natural Barrier
- Result**
  - Tier 1 - Top 5%
  - Tier 2
  - Tier 3
  - ... Tier 19
  - Tier 20 - Bottom 5%
  - [View 15 more](#)

The map also shows geographical features like the Bay of Fundy, the Canadian border, and various cities in Maine such as Bangor, Brewer, and Augusta. The bottom of the screen shows a Windows taskbar with several open applications and the system clock indicating 1:15 PM on 6/17/2016.

**Aquatic Barrier Prioritization**

Display Barriers? Inputs Results Stats Display Result?

SiteID	Name	Tier	Sequential Rank	Summed salmon parr productivity in US network	Town	County
D0060	Howland Dam	1	1	185651.395456904	Howland	Penobscot
D0108	Mattaseunk Dam	1	2	139911.800576712	Woodville	Penobscot
D0150	Ripogenus Dam	1	3	137714.557891474	T3 R11 WELS	Piscataquis
D0143	North Twin Dam	1	4	106547.305909914	T3 Indian Purchase Twp	Penobscot
D0146	Canada Falls Dam	1	5	72455.4355264364	Pittston Academy Grant	Somerset
5600	Dam 5600	1	6	89418.031316825	Seboomook	Somerset

Help Download Inputs Download Results

**SiteID: 1779**

Stream : Olamon Stream

Name : Crossing 1779

Fishway :

Drainage : Penobscot

Type : Crossing

BarrierClass : Potential Barrier

SiteStatus : Surveyed

Zoom to

**Map Legend**

Penobscot Barriers

- + Crossing
- Dam
- Natural Barrier

Result

- Tier 1 - Top 5%
- Tier 2
- Tier 3
- Tier 19
- Tier 20 - Bottom 5%

[View 15 more](#)

Esri, HERE, DeLorme, INCREMENT P, NGA, USGS | The Nature Conservancy

Show all downloads...

# Tool 2

# Scoring and Ranking

The screenshot displays a web browser window with the URL `maps.coastalresilience.org/maine/`. The browser tabs include 'Inbox (48) - jed\_wright@...', 'DEPARTMENT OF THE IN...', and 'Water Resources | Maine'. The application header features a green navigation bar with 'WATER RESOURCES' and 'MAINE' on the left, and 'GET STARTED', 'TOUR', 'GO TO', 'The Nature Conservancy', 'Partners', and 'Legal Disclosure' on the right. The main map area shows a topographic view of Dover, Foxcroft, and surrounding areas. A red line traces a path through the town, likely representing a barrier. A 'Map Legend' pop-up is open in the bottom right, listing the following results:

- Result
- Tier 1 - Top 5% (red dot)
- Tier 2 (orange dot)
- Tier 3 (yellow dot)
- ... (grey dot)
- Tier 19 (blue dot)
- Tier 20 - Bottom 5% (dark blue dot)
- [View 15 more](#)

The browser's taskbar at the bottom shows the Windows Start button and several application icons, including Internet Explorer, File Explorer, and PowerPoint. The system tray in the bottom right corner displays the time as 2:09 PM and the date as 6/17/2016.

# Scoring and Ranking

The screenshot displays a web browser window with the URL `maps.coastalresilience.org/maine/`. The page title is "WATER RESOURCES MAINE". The navigation menu includes "GET STARTED", "TOUR", "GO TO", "The Nature Conservancy", "Partners", and "Legal Disclosure".

The map shows a coastal barrier prioritization map for Dover, Foxcroft, Maine. The barrier is represented by a red line. A pop-up window for SiteID: D0084 shows a Tier 1 Sequential Result of 44 and a "Zoom to" button. A Map Legend in the bottom right corner lists results: Tier 1 - Top 5% (red dot), Tier 2 (orange dot), Tier 3 (yellow dot), Tier 19 (blue dot), and Tier 20 - Bottom 5% (light blue dot). The legend also includes a "View 15 more" link.

The browser's address bar shows the URL `maps.coastalresilience.org/maine/`. The browser's taskbar at the bottom shows the Windows Start button, several application icons, and the system tray with the time 2:10 PM and date 6/17/2016.



# Tool 2

# Scoring and Ranking

WATER RESOURCES MAINE GET STARTED TOUR GO TO The Nature Conservancy Partners Legal Disclosure

Search by Address

Map Layers

Aquatic Barrier Prioritization

SiteID: D0083

Tier: 1  
Sequential Result: 26  
[Zoom to](#)

Map Legend

Result

- Tier 1 - Top 5%
- Tier 2
- Tier 3
- ...
- Tier 19
- Tier 20 - Bottom 5%

[View 15 more](#)

Esri, HERE, DeLorme, INCREMENT P, NGA, USGS | The Nature Conservancy

Course #5 - Barrier ...pptx

2:09 PM 6/17/2016

The screenshot displays a web browser window with the URL `maps.coastalresilience.org/maine/`. The page title is "WATER RESOURCES MAINE". The interface includes a search bar, navigation tabs (GET STARTED, TOUR, GO TO), and a sidebar with "Map Layers" and "Aquatic Barrier Prioritization" options.

The main map shows a topographic view of Dover Foxcroft, Maine, with streets and a network of barriers highlighted in orange. A "Map Legend" window is open in the bottom right, showing the following results:

- Result
- Tier 1 - Top 5% (Red dot)
- Tier 2 (Orange dot)
- Tier 3 (Yellow dot)
- ...
- Tier 19 (Blue dot)
- Tier 20 - Bottom 5% (Dark blue dot)
- [View 15 more](#)

An "Aquatic Barrier Prioritization" dialog box is open in the center-left, showing the following configuration:

- Display Barriers?  Inputs  Results  Stats
- Filter Barriers?
- Network: **Salmon** (Selected from Network, Brook Trout, Sea Run, Geology, Salmon, Invasive)
- Barrier is in a Salmon Critical Habitat HUC10: 0
- DMR Salmon Priority (Tier 1, 2, 3) from HUC12: 0
- Summed salmon habitat units in US Functional network: 100
- Summed salmon parr productivity in US Functional network: 0
- Diadromous:  Resident:
- Clear All Inputs:
- Model Barrier Removal?  [D0083]
- Calculate Summary Statistics?
- Submit:
- Analysis status: Analysis complete...

The bottom of the browser window shows the Windows taskbar with various application icons and the system clock displaying 2:10 PM on 6/17/2016.

# Tool 2

# Scoring and Ranking

WATER RESOURCES MAINE GET STARTED TOUR GO TO The Nature Conservancy Partners Legal Disclosure

Search by Address

Map Layers

Aquatic Barrier Prioritization

Switch To Map 2

Split View

Save & Share

Export Page

Course #5 - Barrier ...pptx

Streets

SiteID: D0084

- Tier: 1
- Sequential Result: 21
- [Zoom to](#)

Map Legend

Result

- Tier 1 - Top 5%
- Tier 2
- Tier 3
- ...
- Tier 19
- Tier 20 - Bottom 5%
- [View 15 more](#)

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Show all downloads...

2:11 PM 6/17/2016

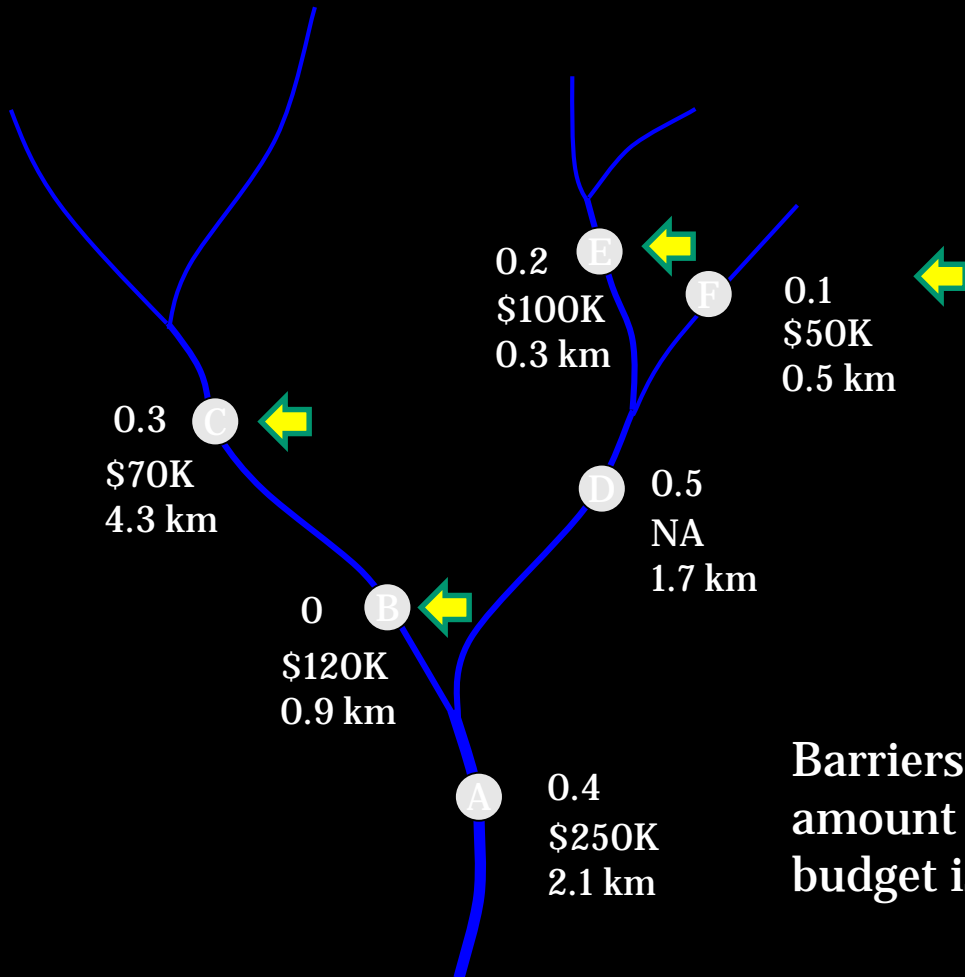
## Scoring and ranking:

- Widely accessible tools (spreadsheets, etc.)
- Output readily understandable and provides summary information for funding opportunities
- Simple scenario planning and comparisons possible

## Scoring and ranking:

- Output is a list
- Tends to focus on large-individual targets (difficult to assess cumulative impact of smaller barriers)
- Usually ignores the spatial structure of barrier networks (i.e. downstream barriers)
- Can model removal impacts on rankings across only a fairly small set of barriers

## Barrier optimization in action



Budget	Soln	Gain
\$50K	F	0.090
\$100K	E *	0.192
\$150K	B *	0.876
\$200K	B, C	2.080
\$300K	B, C, E	2.272
\$400K	A, B *	4.047

Barriers removed given a certain budget amount may not be removed when the budget is increased

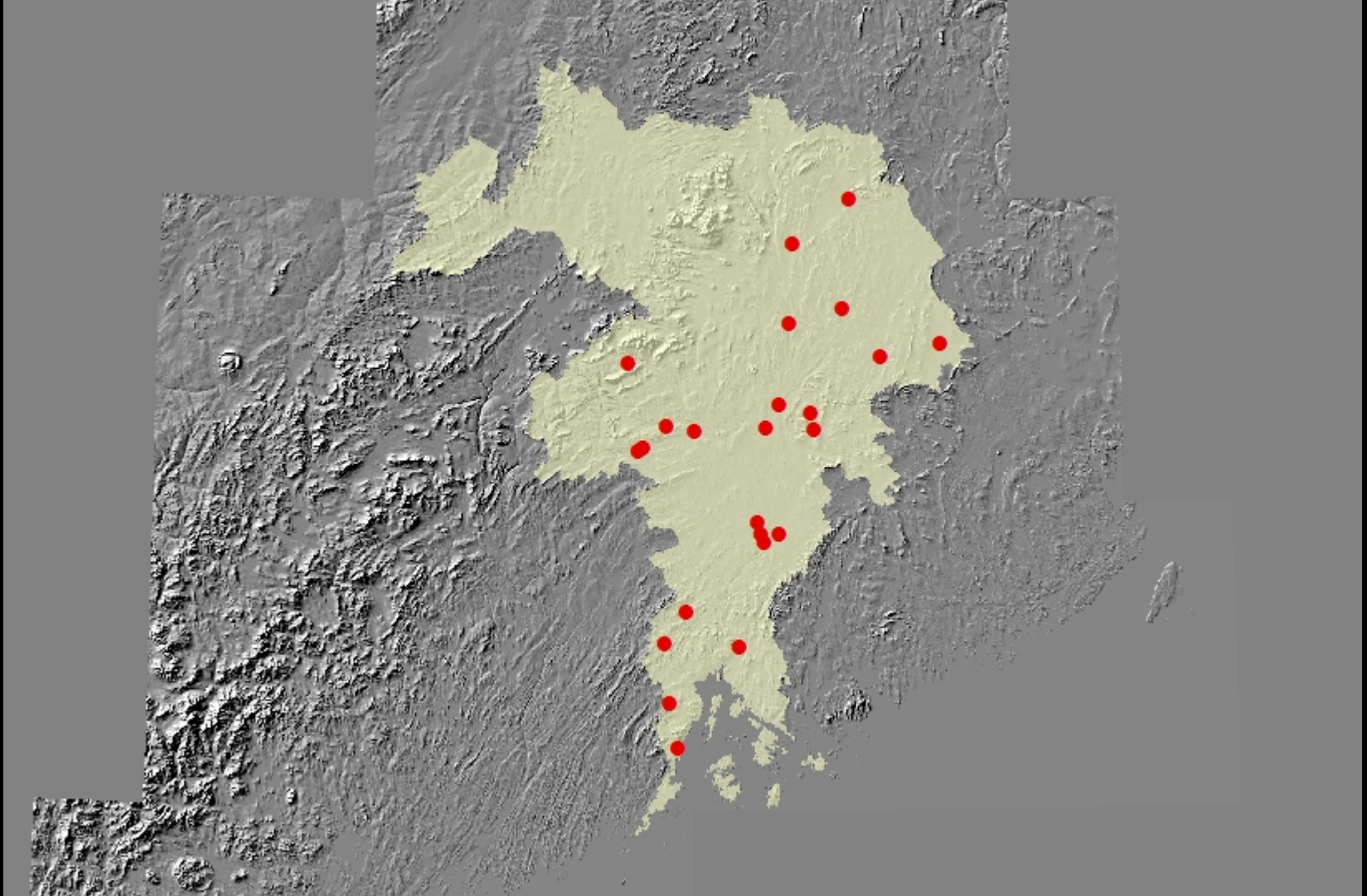
## Tool 3

### Optimization Data Inputs:

- Barrier ID
- Watershed/Area
- Immediate downstream barrier ID
- Net upstream habitat (up to the next set of barriers or the limits of river network)
- Current barrier passability
- Number of mitigation projects that can be carried out (normally 0 for natural barriers)
- Cost to repair/remove/mitigate a barrier
- Barrier passability following mitigation

## Tool 3

### Atlantic Salmon Habitat Target

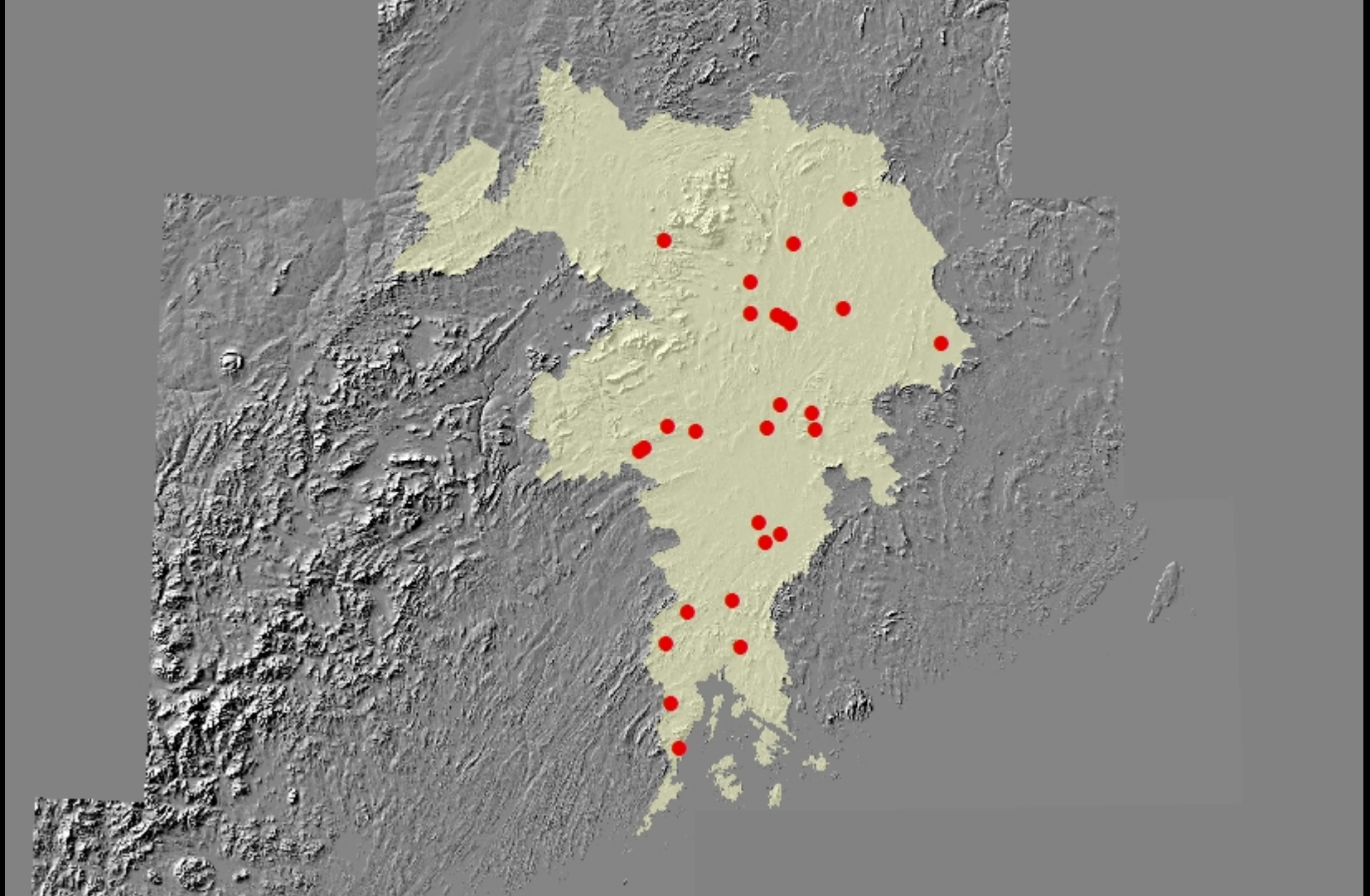


Portfolio Cost: \$2 million



## Tool 3

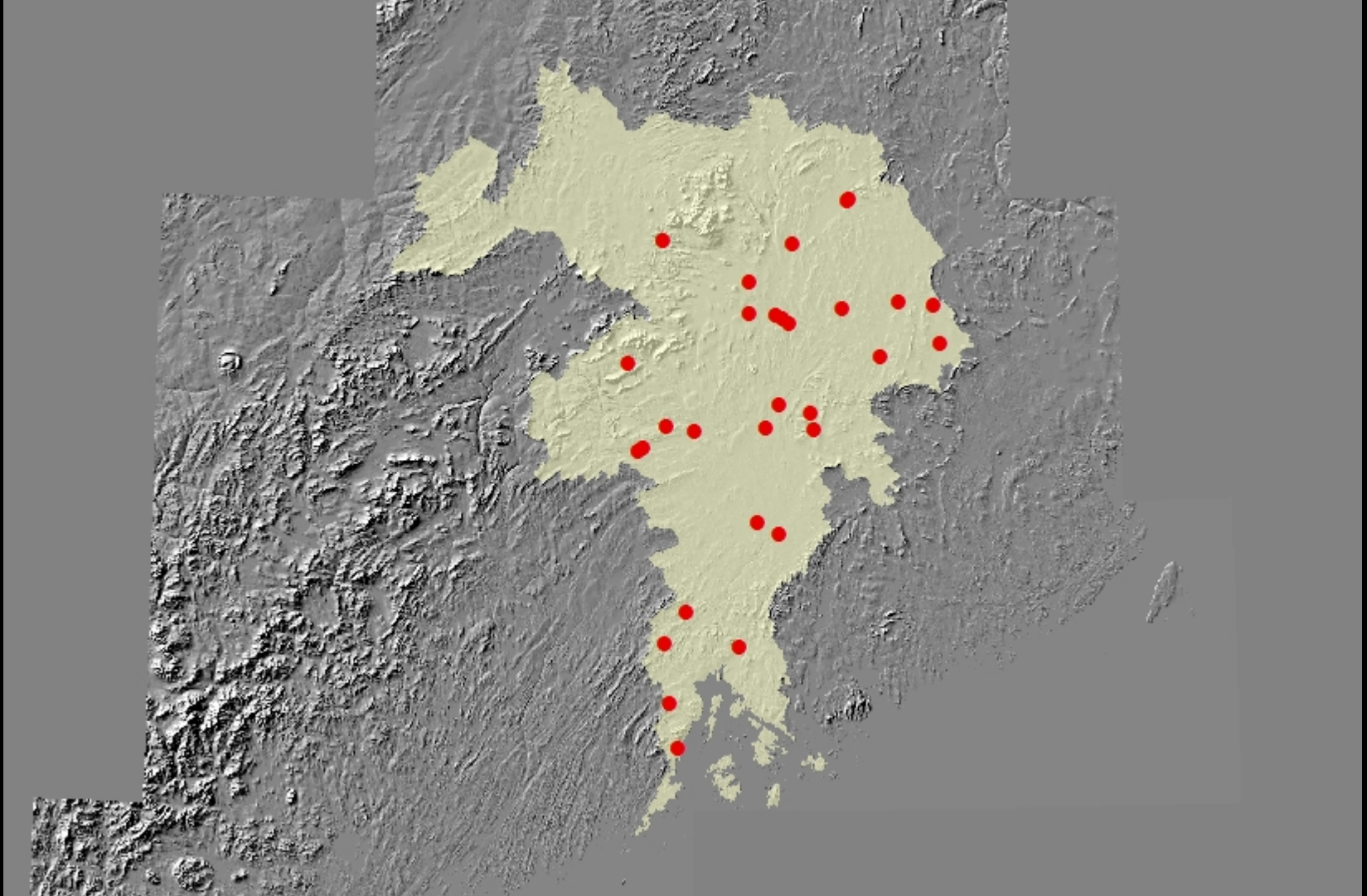
### Atlantic Salmon Habitat Target



Portfolio Cost: \$4 million

## Tool 3

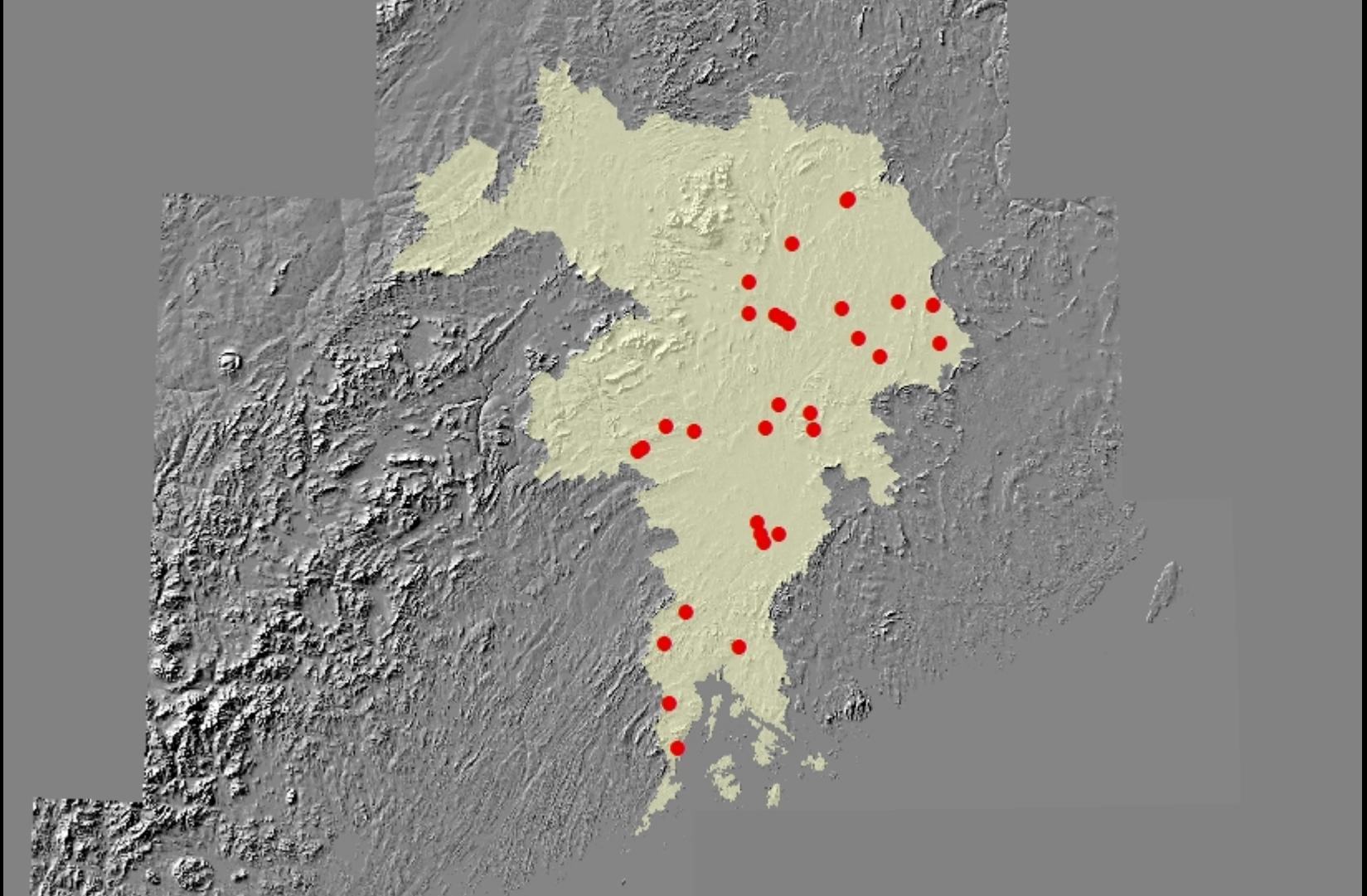
### Atlantic Salmon Habitat Target



Portfolio Cost: \$6 million

## Tool 3

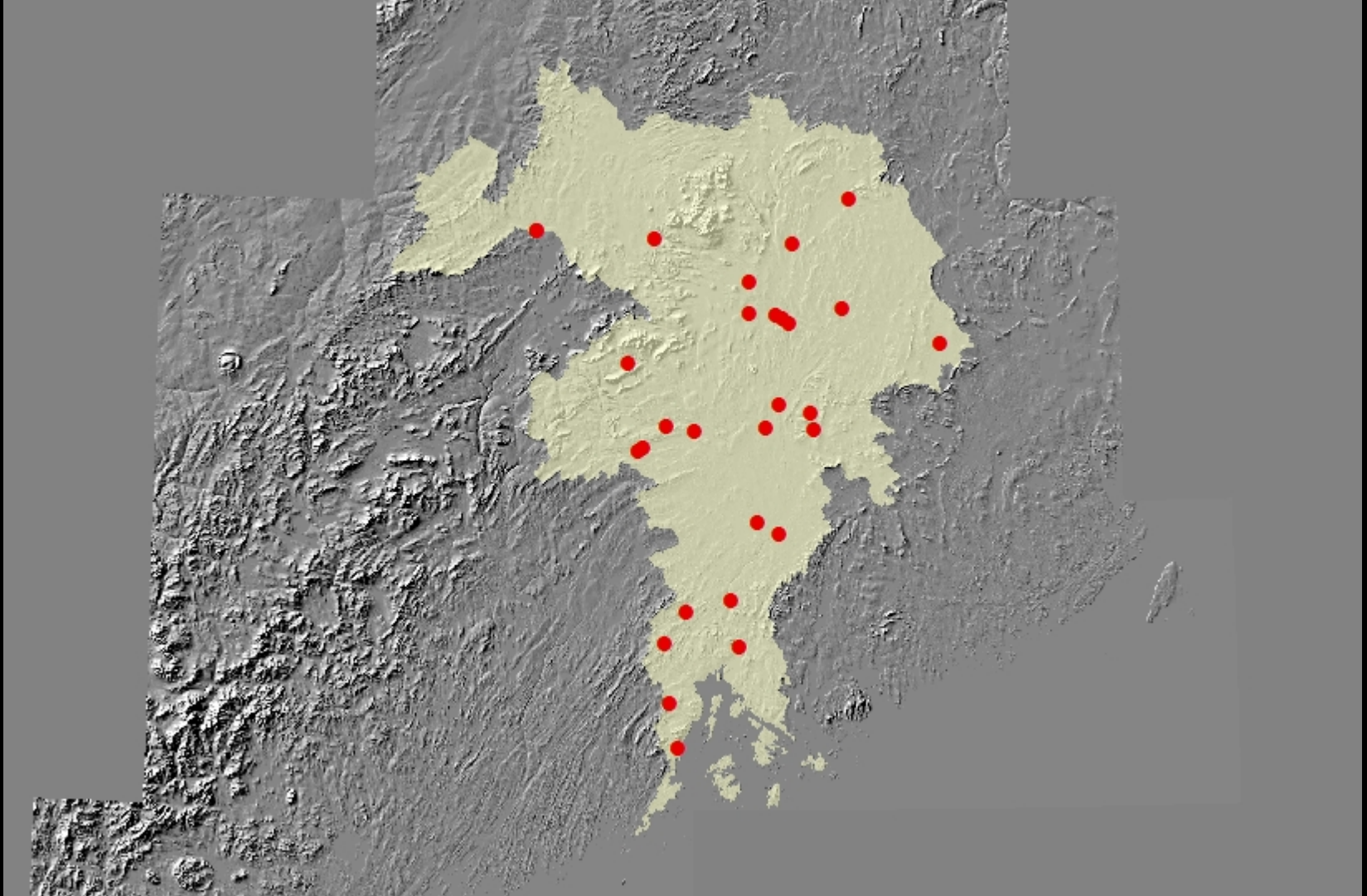
### Atlantic Salmon Habitat Target



Portfolio Cost: \$8 million

## Tool 3

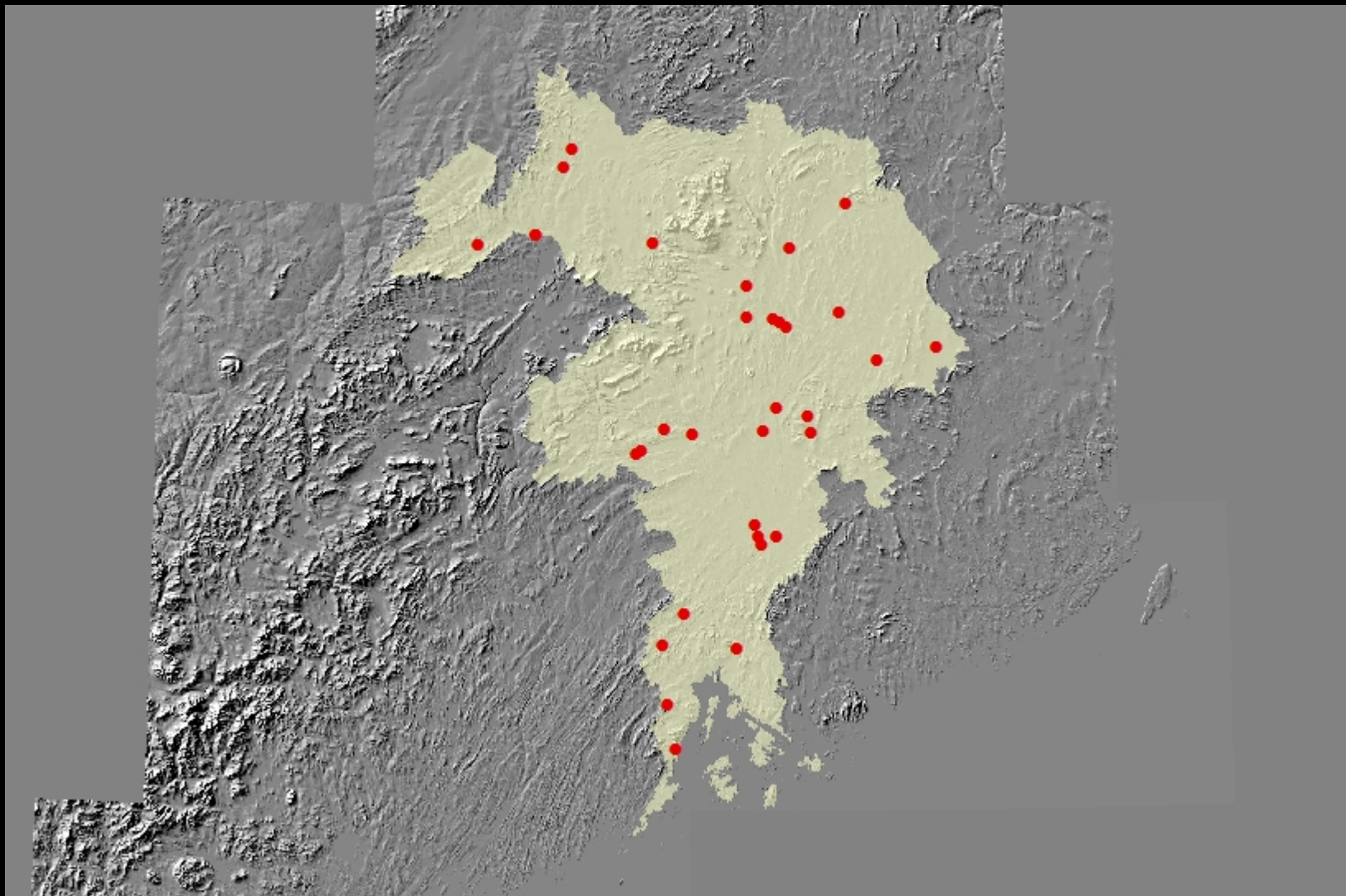
### Atlantic Salmon Habitat Target



Portfolio Cost: \$10 million

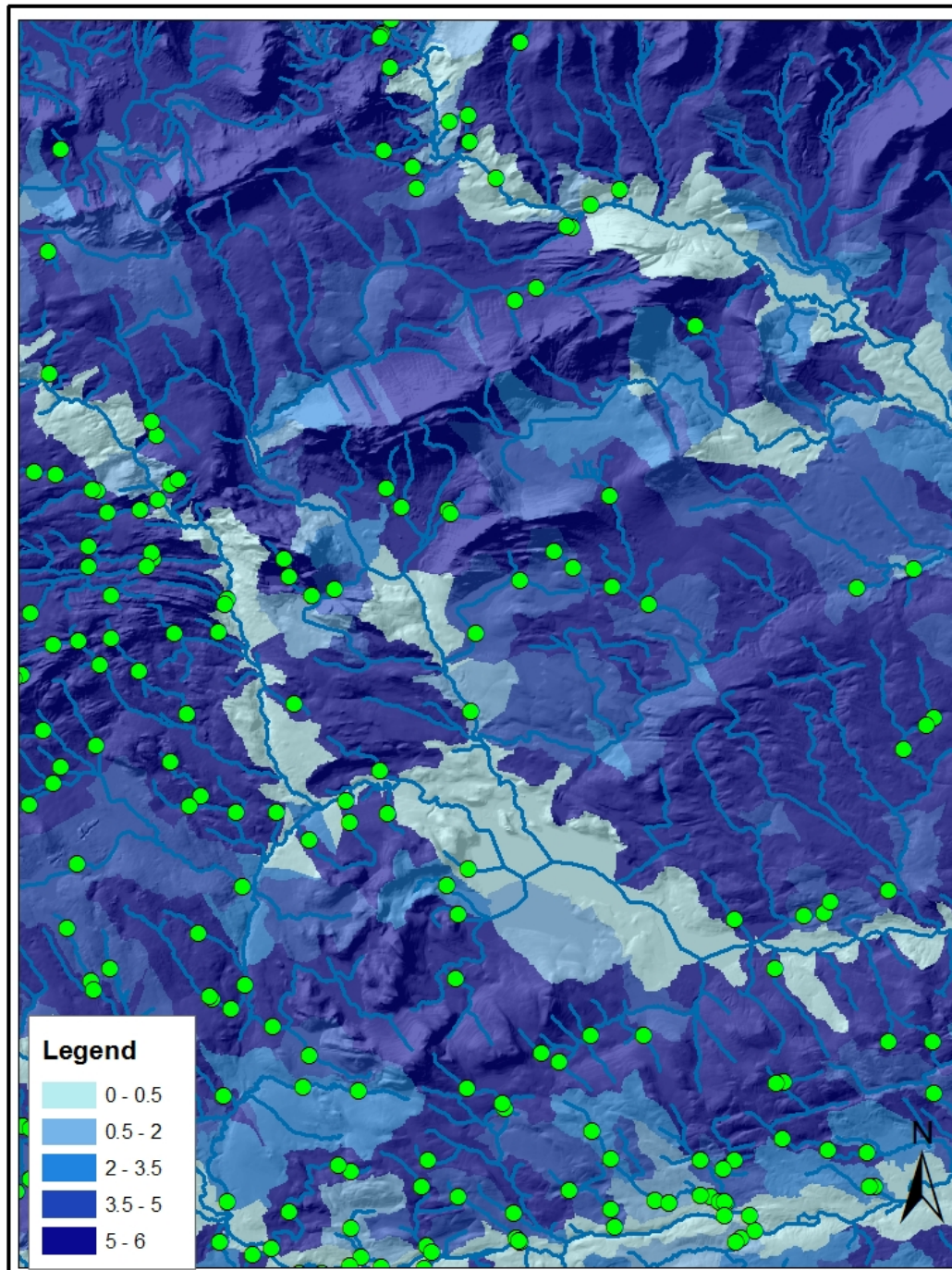
## Tool 3

Atlantic Salmon Habitat Target: 30,000 units anywhere in drainage



Portfolio Cost: \$12 million

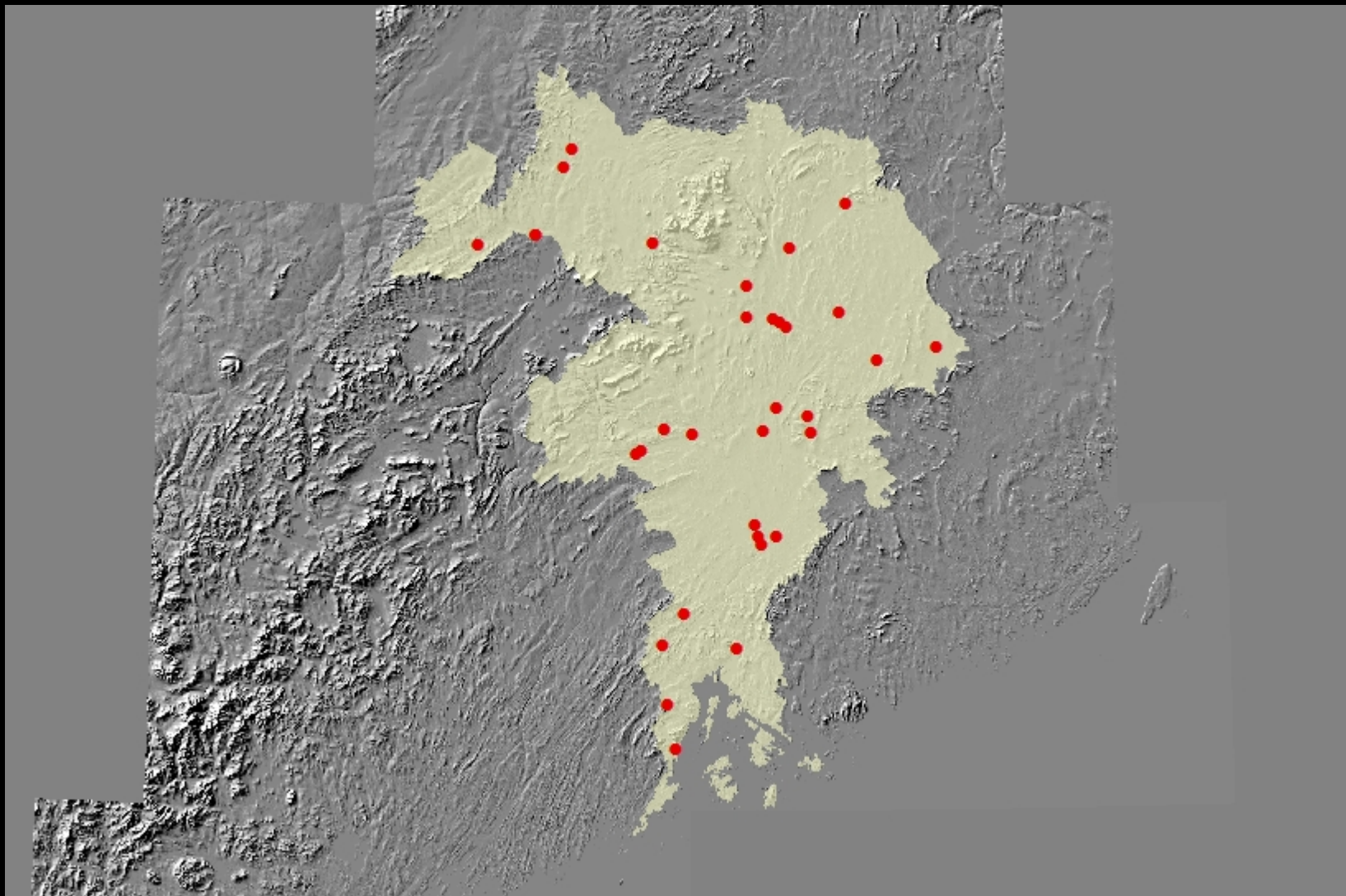
# Tool 3



Letcher (2016)

## Tool 3

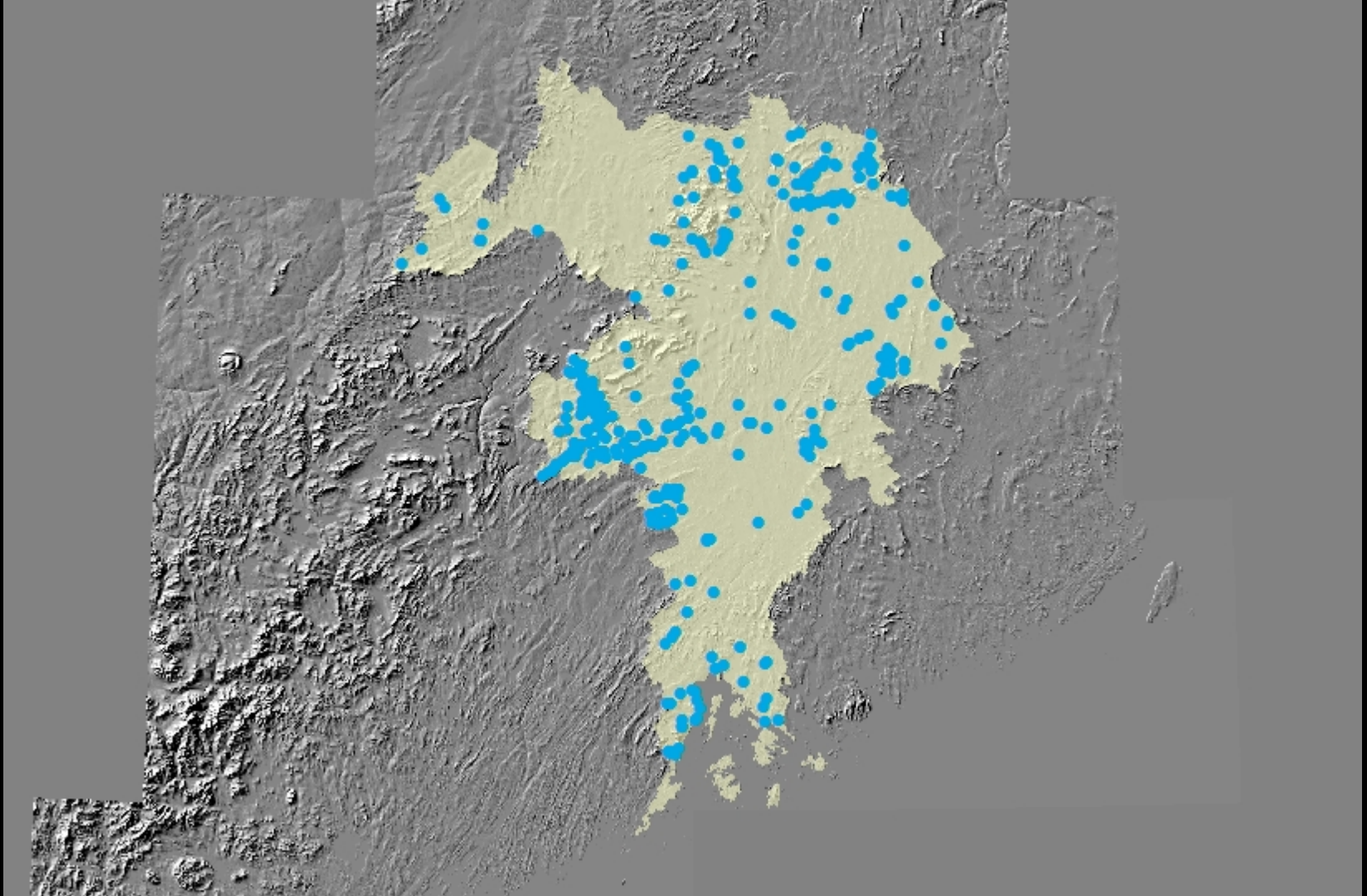
Atlantic Salmon Habitat Target: 30,000 units anywhere in drainage



Portfolio Cost: \$12 million

## Tool 3

Atlantic Salmon Habitat Target: 30,000 units with resilience

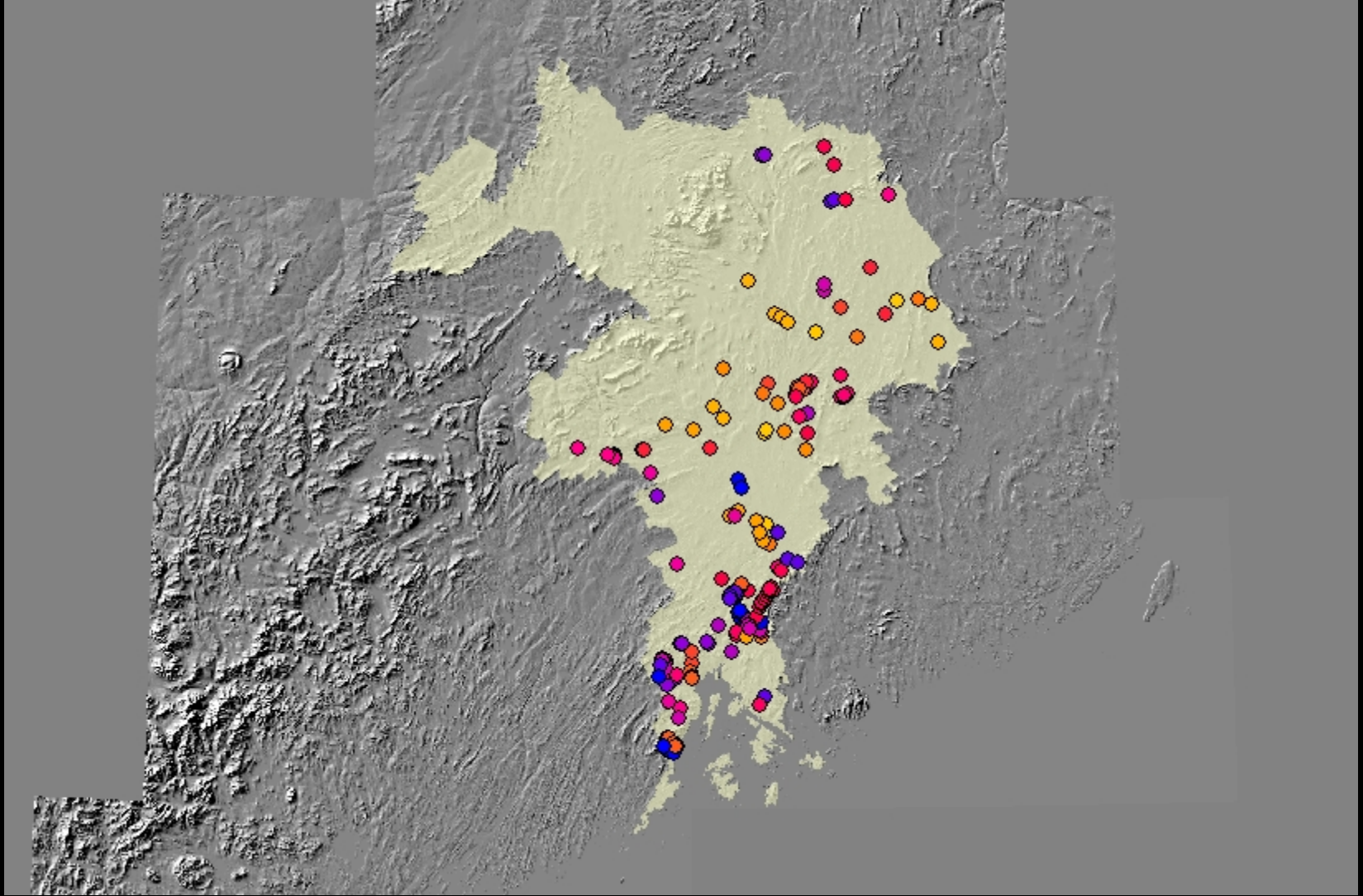


Portfolio Cost: \$66 million



## Tool 3

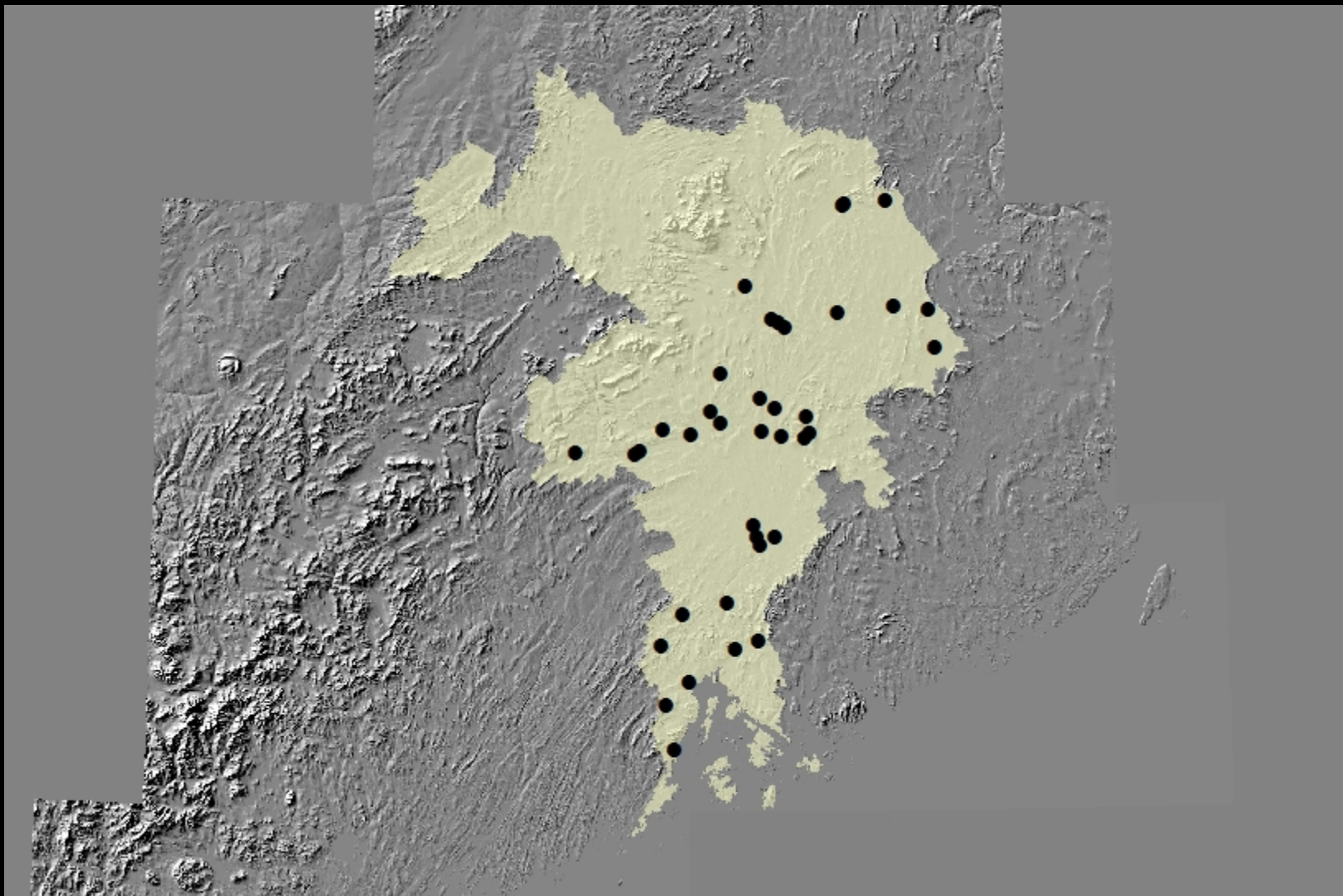
Alewife Target: Penobscot Habitat Blueprint Aquatic Barrier Prioritization Tool



Portfolio: 212 structures

## Tool 3

Alewife Optimization Target: 90% of pond habitat in drainage



Portfolio: 38 structures \$10 million

## Optimization:

- Rapidly identifies cost-efficient strategies to maximize the amount of accessible habitat above barriers
- Can use multiple targets and multiple removal/replacement/repair options
- Allows for watershed scale scenario planning

## Optimization:

- Requires expertise – limits user base for approach
- Current tools best suited to diadromous species (resident species models are computationally intensive)
- Practical applications limited
  - Cost data difficult to acquire for large number of barriers
  - Passability hard to determine for large number of barriers
  - Budget required for implementing scenarios is rarely available
- Favorable conditions determine much of what we implement (e.g. "opportunities")

# Comparison

Method	Easily accessible tool	Large number of barriers across large scales	Incorporates spatial network component	Goal setting & scenario planning	Resident fish
Data Viewer	✓	✗	✗	✗	✓
Scoring & Ranking	✓	✓	✗	✗	✓
Optimization	✗	✓ +	✓	✓	✗

All methods useful for “strategic  
opportunism”

How do we move to more well  
articulated management scenarios and  
strategies?

# Thanks to all our partners for their commitment to improving aquatic organism passage

