Habitat Integrity Analysis for the Maine Atlantic Salmon Population

With Possible Insights into Future Fish Stock Security

Background

Historically, native Atlantic salmon stocks once occupied vast stretches of New England waters ranging all the way from Greenland to the Long Island Sound. Today, the Gulf of Maine (GOM) Atlantic salmon population remains the last historical stock in the United States not to be completely overfished by the end of the 20th century. This distinct population represents the only genetic stock left with which to replace the now extinct New England and Long Island Sound populations. Unfortunately, in 2000, the GOM salmon population was listed as endangered under the Endangered Species Act, which means that it is at risk of extinction throughout a significant portion of its' range.

Atlantic salmon are anadromous and spend the majority of their adult life at sea but migrate inshore into river basins and streams to reproduce. For one to two years, the juveniles develop through several life stages in these freshwater habitats before migrating back out to sea. While the Atlantic salmon in Maine are completely protected from both commercial and recreational fishing, various factors threaten their existence including: habitat degradation from human development, loss of habitat connectivity and changes in flow regimes from manmade barriers (dams), water quality degradation from agricultural and industrial processes, and future loss of habitat from climate change.

Figure 1. Adult Atlantic Salmon

This analysis attempts to examine the habitat integrity, or spatial extent of current suitable habitat, where salmon live in order to: 1) provide information for proper adaptive management of the species, and 2) provide insight into areas that will be most at risk in the future.

Methods

In order to determine habitat integrity, six factors were considered and analyzed using ArcMap version 10.1. These factors, including road density, distance from conservation land, dam density, distance from human development or agricultural development, density of active mining operations, and density of current habitat, were all chosen based on previous studies that aimed to determine habitat integrity of freshwater biomes in temperate regions.

The layers were projected into the same coordinate system, masked at the Maine state level, and then converted into raster format (fig. 3, distance from conservation land, dam and mining densities not shown) before being reclassified based on desirable or undesirable characteristics (ranked 1 through 5). The areas of current habitat were collected from on-ground salmon monitoring programs conducted by NOAA and the Maine Dept. of Marine Resources.

Lastly, both un-weighted (fig. 2) and weighted (not-shown) additive models were created using the ranked classes. In the weighted model, current areas of habitat were weighed twice as heavily, which effectively narrows down the important spatial areas.

The orientation analysis shown in the results was created by determining the mean linear direction of major rivers within each HUC-8 watershed boundary in Maine.

Habitat Integrity Model

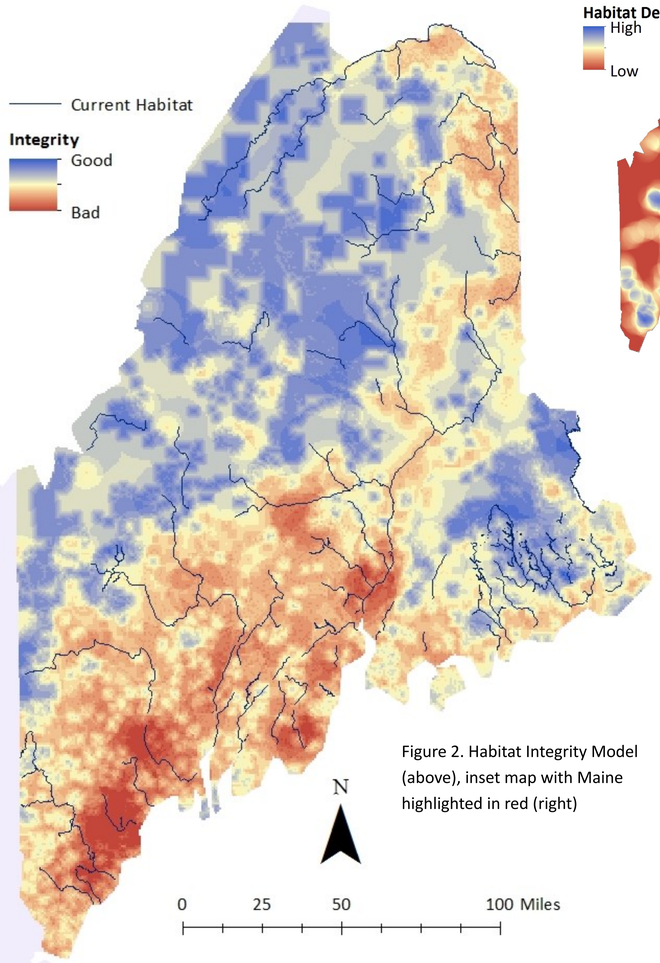

Figure 2. Habitat Integrity Model (above), inset map with Maine highlighted in red (right)

Factors

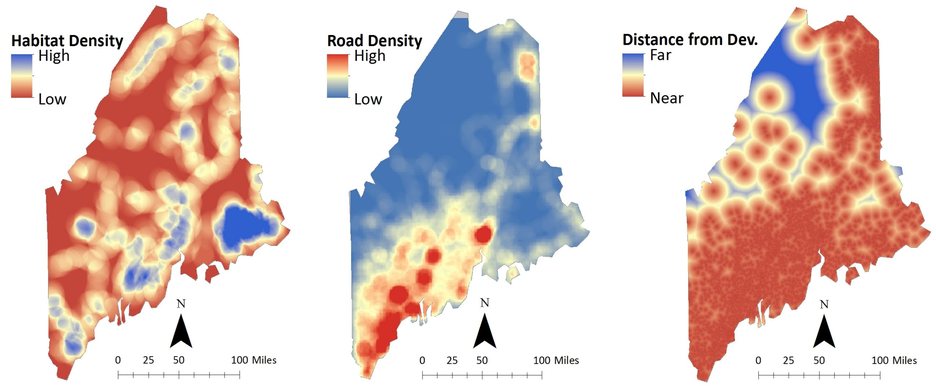

Figure 3. Three factors pre-ranked shown left to right, 1) habitat density, 2) road density, 3) distance from developed land (including agriculture) (above). Mean directional orientation of major rivers shown by arrows (right).

Results

The habitat integrity model developed in this analysis determines that suitable habitat for salmon in Maine is currently located in the Northwestern and Southeastern parts of the state. These areas have the highest density of habitable rivers, are located the furthest away from manmade development and agriculture or industry, are the closest to protected (conserved land), or are in areas with the greatest river connectivity (areas with small densities of dams). Although this is not surprising, the process of adding suitability factors to current habitat reveals the most important spatial areas for the salmons' existence.

The river orientation reveals the mean direction of major rivers within watershed. This information reveals potential for salmon migration or dispersal during period of warming climates.

Conclusions

According to this analysis, we know the current areas of suitable habitat for the GOM salmon population. This can have multiple implications for future adaptive management. If habitat restoration is the primary goal, then focusing on improving habitat connectivity and reducing habitat degradation via smarter development will be important in unsuitable areas. On the other hand, wildlife managers can use this information to focus resources on areas that will most likely be more resilient going into the future. With the inevitability of climate change, these species will experience increases in temperatures and occurrences of harmful flooding events, and will lead to decreased suitable habitat. One way for salmon to cope with these stressors is to migrate northward in order to reach more suitable climates. This may be possible for salmon inhabiting rivers with north-south orientations.

Conservation is a must in order to preserve this historic stock of fish. Looking ahead, habitat integrity is the most important issue for improving salmon resilience in the face of ever changing threats.

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Date: April 30, 2013, ENV107

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Data Sources: Maine DEP, Maine GIS, MrData.usgs

Projection: WGS_1984_UTM_Zone_19N

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