ENVIRONMENTAL
Fact Sheet

NEW HAMPSHIRE DEPARTMENT OF Environmental Services

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Predicted Coldwater Fish Indicator Species Presence in NH Wadeable Streams

Introduction

Coldwater fish species are a valuable natural resource of many New Hampshire aquatic communities. Generally defined as species requiring water temperatures below 70 degrees Fahrenheit and inhabiting well-oxygenated waters, the occurrence of coldwater fish species is also an important indicator of aquatic community condition. Just like the changes, we observed in our natural vegetative communities across the New Hampshire landscape, fish communities also vary with respect to a variety of environmental factors. One of the primary factors controlling fish community type is water temperature. The statewide natural occurrence of coldwater fish species in rivers and streams is restricted to where conditions are favorable for their survival, growth, and reproduction.

While the state of New Hampshire maintains historical records of the locations of coldwater fish species occurrences, a comprehensive catalog based on field investigations (i.e. data obtained from actual sample site visits) of over 15,000 miles of streams and rivers is impossible. In response, the NHDES biomonitoring unit completed an analysis of 163 minimally-disturbed stream segments from which fish data were collected from 1997-2006 in an effort to determine the current natural distribution of coldwater fish species in wadeable streams. The objective of the analysis was to develop a predictive model based on the use of simple, static (non-changing) landscape factors. The factors tested included longitude, latitude, drainage area, elevation and gradient. The goal was the development of a statewide map of the areas expected to support coldwater fish species year-round.

Results

A coldwater fish indicator species predictive model was developed based on the presence or absence of either brook trout (*Salvelinus fontinalis*) or slimy sculpin (*Cottus cognatus.*) These two species were selected because they are known as strict coldwater specialists, can occur statewide where conditions are favorable, and are native to the state.

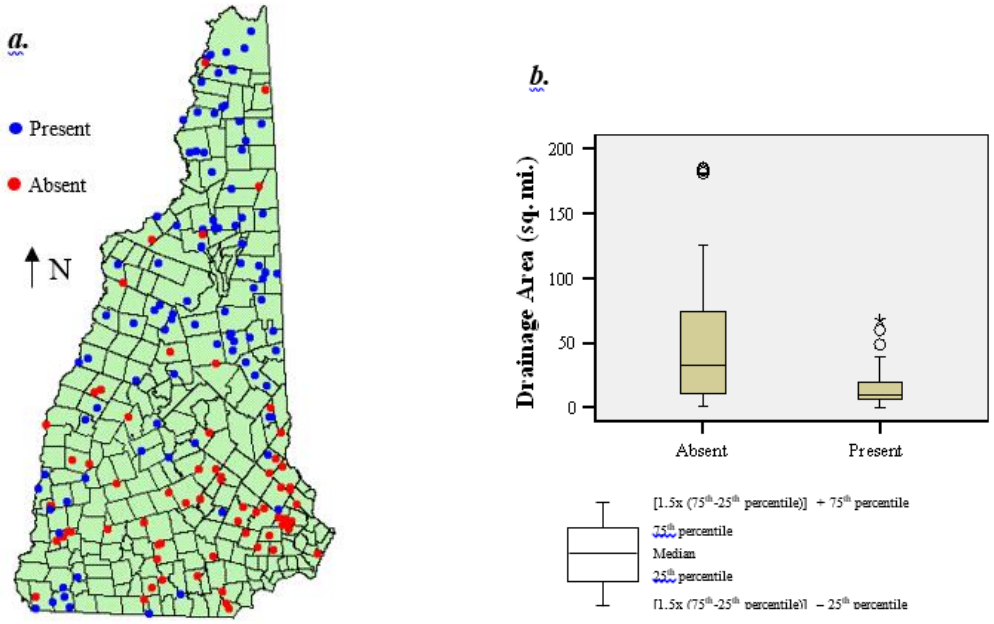
Brook Trout (*Salvelinus fontinalis)*

Slimy Sculpin (*Cottus cognatus)*

Of the 163 minimally impacted sites, 95 (58%) had either naturally occurring brook trout and/or slimy sculpin. The remaining 68 sites (42%) were considered to be located in rivers and streams that did not support naturally occurring populations of brook trout or slimy sculpin.

Latitude and longitude, when considered collectively, proved to be two of the three most important factors in predicting the presence or absence of the coldwater indicator species from minimally impacted sites. In general, brook trout or slimy sculpin were found in rivers and streams with more northern latitudes and western longitudes, and absent from the southeastern portion of the state (Figure 1a.) The inclusion of drainage area into the model completed the suite of most important factors tested. Sites where the indicator species were present tended to have smaller drainage areas than sites where the indicators species where absent (Figure 1b.)

Figure 1. Geographic location ***(a)*** and drainage area ***(b)*** of sites where indicator species were found (present) or not found (absent) in field collections.



Next, a predictive equation based on logistic regression was developed using latitude, longitude, and drainage area. The outcome of the equation predicted the probability of occurrence of the indicator species. Probabilities of occurrence for the indictor species ranged from zero (0% chance indicator species present) to one (100% chance indicator species present.) Streams or rivers in areas with a probability of occurrence greater than or equal to 0.50 (50%) are expected to contain indicator species. Locations of streams or rivers with a probability of occurrence less than 50% are not expected to contain an indicator species. The predictive equation was applied across the state and allowed for the establishment of boundaries for expected indicator species presence in streams with drainage areas ranging from 5-100 square miles.

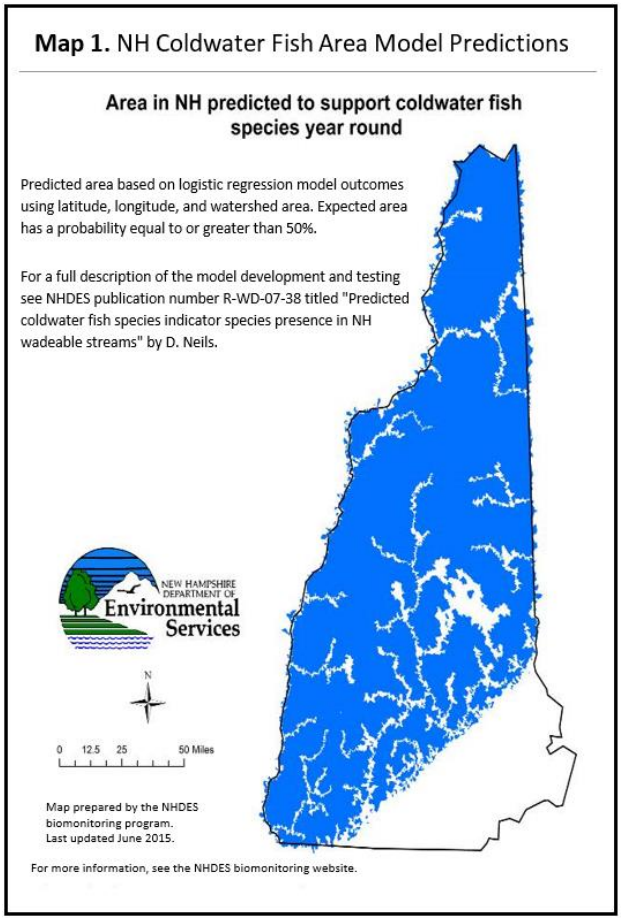
Predicted natural occurrences of the indicator species extended farthest south and east for streams with small drainages. Streams with predicted resident populations of the indicator species having larger drainage areas were restricted to northern and western portions of New Hampshire. Map 1 shows the statewide area expected to support coldwater fish species year round.

Table 1. Observed and predicted presence and absence of indicator fish species for data used to develop (calibration) and test (validation) the logistic model based on latitude, longitude and drainage area.

	Observed	Predicted	Absent	Present	Percent Correct
Calibration	Absent		38	6	86.4
	Present		5	60	92.3
	Overall				89.9
Validation	Absent		14	5	73.7
	Present		3	26	89.7
	Overall				83.3

Comparisons of predicted (model) and observed (field) occurrences of

Map 1. NH Coldwater Fish Area Model Predictions



coldwater fish indicator species from the dataset used to develop the model showed an overall accuracy rate of 89.9% (Table 1.) A similar comparison of independent data not used in model development had an overall accuracy rate or 83.3% (Table 1.) Additional field data collected in summer 2007 provided further verification with the presence or absence of indicator species matching model predictions at 19 of 21 (90%) sites sampled. When these results were combined with the calibration and validation data, an overall accuracy rate of 88% (157 out of 178 sites) was achieved. In other words, out of 178 sites where field data were available, the model correctly predicted the presence or absence of the indicator species at 157 sites.

Model Limitations

Model outcomes should be limited to streams with drainage areas between 5 and 100 square miles and based on the summer distribution of the indicator species. Limited results also indicate that for streams with small drainage areas (less than five square miles); coldwater species may occur throughout New Hampshire and should be determined through field verification for southeast portions of the state (see Map 1.) The indicator species were observed to be absent at 68% of the rivers and streams with low gradients (<1% slope) regardless of latitude, longitude, or watershed size. Therefore, caution should be observed when applying model predictions to low gradient rivers and streams.

Finally, the results indicated a strong positive relationship between latitude and elevation for all sites sampled (Figure 2.) Limited results indicated that in certain circumstances, the cooler climate experienced at higher elevations can offset the effect of southern latitudinal warming and create instream water temperatures cool enough to support coldwater fish species. As a result, for streams where the elevational effect on water temperatures is substantial, observed results may differ from model predictions. In particular, streams with small drainages (i.e. <15 square miles) at elevations greater than 500 feet but south of 43.5 degrees latitude should be field verified.

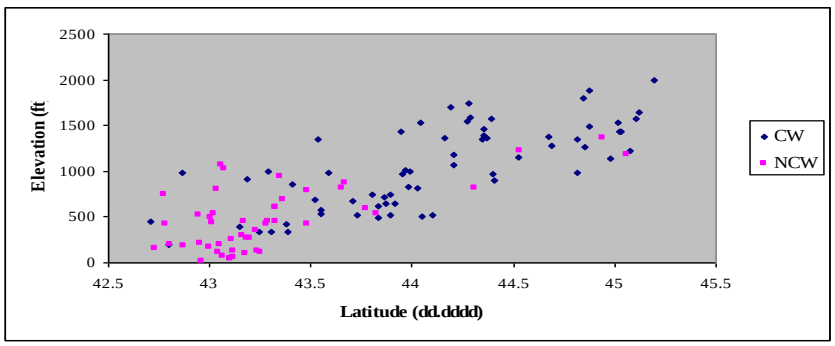


Figure 2. Relationship of latitude and elevation for sites with observed coldwater fish indicator species presence (CW) and absent (NCW) from the calibration dataset. Pearson correlation coefficient 0.81, p<0.01.

Application and Summary

Ultimately, the predictive model based on readily available, easily obtained desktop variables was an accurate predictor of the presence or absence of brook trout and slimy sculpin. Latitude, longitude, and drainage area were determined to be the most important variables in explaining their natural distribution in undisturbed streams and rivers in New Hampshire. If applied as suggested, stream segments for nearly 80%

of the state could be designated as either expecting to contain or not contain the indicator species. The benefit of the resulting distributional map would allow for more complete implementation of water quality standards, such as dissolved oxygen and instream water temperature criteria. Additionally, the development of biological criteria can be more appropriately tailored to different types of fish assemblages. Also, since the model was developed based on undisturbed streams, its predictions can be utilized to determine if streams or rivers should or should not support coldwater fish species in the absence of human disturbance.

More Information

For questions, contact the NHDES Biomonitoring program coordinator at (603) 271-5334. The complete Coldwater Indicator Fish Species report is available on the NHDES Biomonitoring program website under publications.