# Appendix 9

## Verification of model transferability

## Model Verification

Verification of habitat models is a complicated task that is hampered by natural variability and environmental impact. This is especially true in systems with fauna impaired by factors that were not included in the physical habitat models, such as temperature, predation and other impacts. In recent years several studies have conducted various types of model verification with varying results. The most recognized method was presented by Thomas and Bovee (1993), and suggested the use of a chi-square cross-classification for this purpose. This method is very robust as it collapses the fish density data into presence and absence categories and compares the distribution of these categories within two habitat suitability classes. It is well suited for impacted streams where one can only expect to observe basic trends (Stalnaker pers. com). In this report we analyzed the data more precisely using correlation, and also by incorporating fish density information.

To verify the transferability of the established criteria, the fish observations during the fisheries survey were compared with the habitat predictions at the same locations. We conducted chi-square classification for the predicted suitable and optimal habitat classes using every observation according to methods developed by Thomas and Bovee. Such analysis has been conducted for all species individually. The habitat conditions at sampling locations were described combining the results of all five habitat mappings at each location. The HMU mappings represented the range of flows occurring during the summer that would influence the distribution of fish in the river. This method was chosen over a more simple comparison with only one set of habitat mapping data, because it is not probable that fish distribution is determined by only one flow condition.

In August 2004 we collected fish in 182 electro-grids using methods described in Appendix 2. Presence of each species was associated with the grid as a dependent variable. The grids are associated with HMU attributes mapped at the same location at five flow conditions (approximately at 0.1, 0.3, 0.5, 0.75 and 1 cfsm). The probability of fish presence and absence was computed for every HMU using methods and data described in Appendix 3. Each HMU was classified as unsuitable, suitable, or optimal for every species. The chi-square cross-classification was applied to compare suitability classes with fish presence. The significance was investigated at the alpha level of 0.05.

## Results

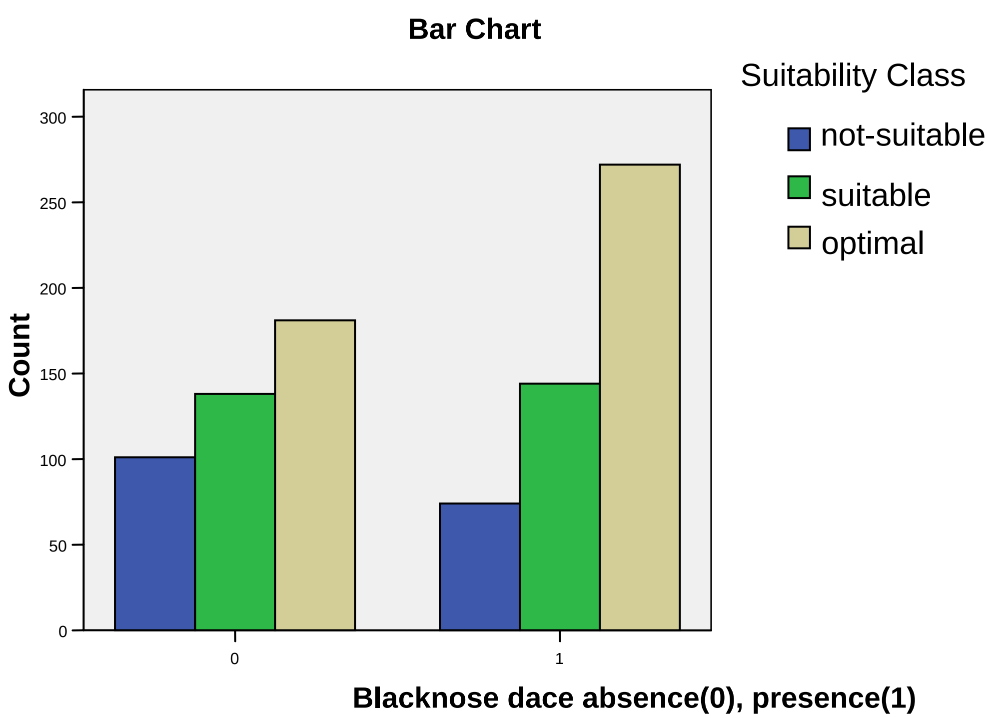
### Blacknose dace

In all compared records 98 grids were occupied by blacknose dace. The Chi-square test documents a highly significant relationship between predicted habitat suitability classes and fish presence.

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 17.291(a) | 2 | .000 |
| Likelihood Ratio | 17.325 | 2 | .000 |
| Linear-by-Linear Association | 17.272 | 1 | .000 |
| N of Valid Cases | 910 | | |

**Figure 1:** Blacknose Dace: The number of grids where fish were present (1) in three habitat suitability categories: unsuitable (0), suitable but not optimal (1), optimal (2). “0” on x-axis represents observed and “1” is predicted.



**Brook trout**

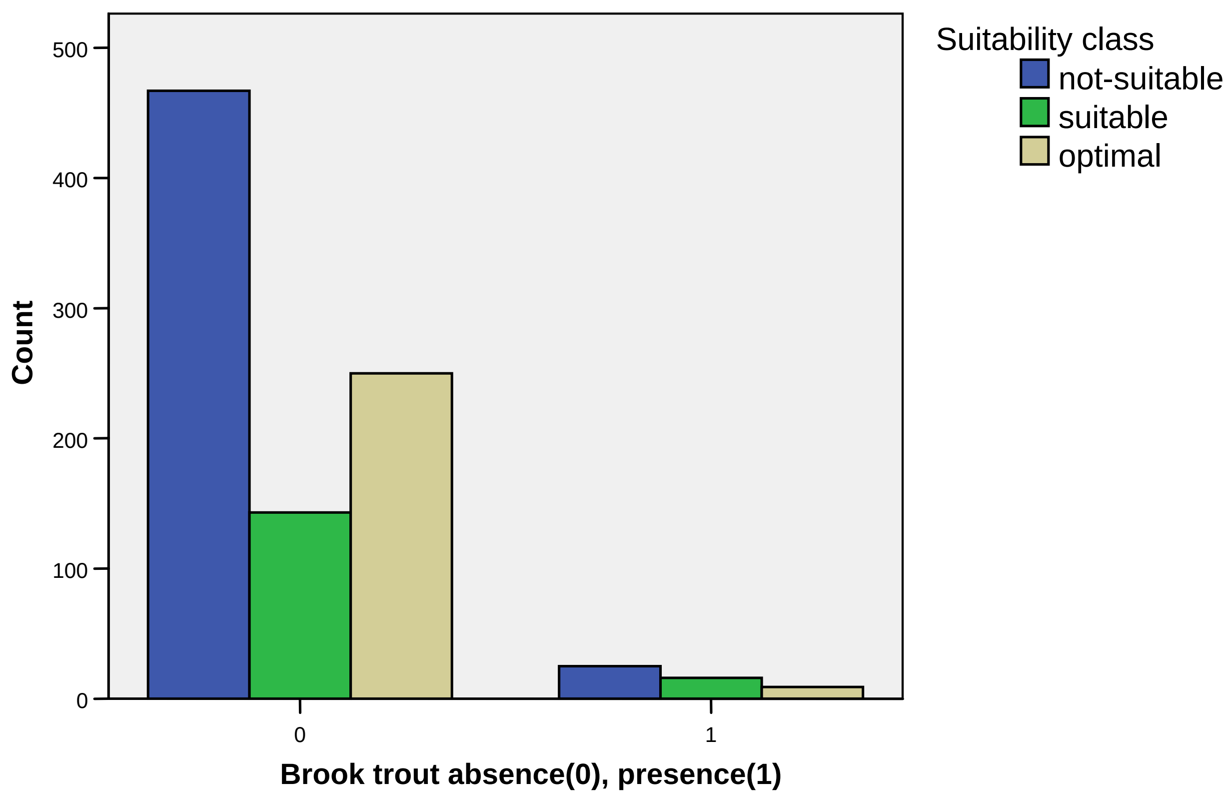
In all compared records 10 grids were occupied by brook trout. The Chi-square test documents a minimally significant relationship between predicted habitat suitability classes and fish presence.

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 8.587(a) | 2 | .014 |
| Likelihood Ratio | 7.684 | 2 | .021 |
| Linear-by-Linear Association | .285 | 1 | .594 |
| N of Valid Cases | 910 | | |

**Figure 2:** Brook Trout: The number of grids where fish were present (1) in three habitat suitability categories: unsuitable (0), suitable but not optimal (1), optimal (2). "0" on x-axis represents observed and "1" is predicted.

**Bar Chart**



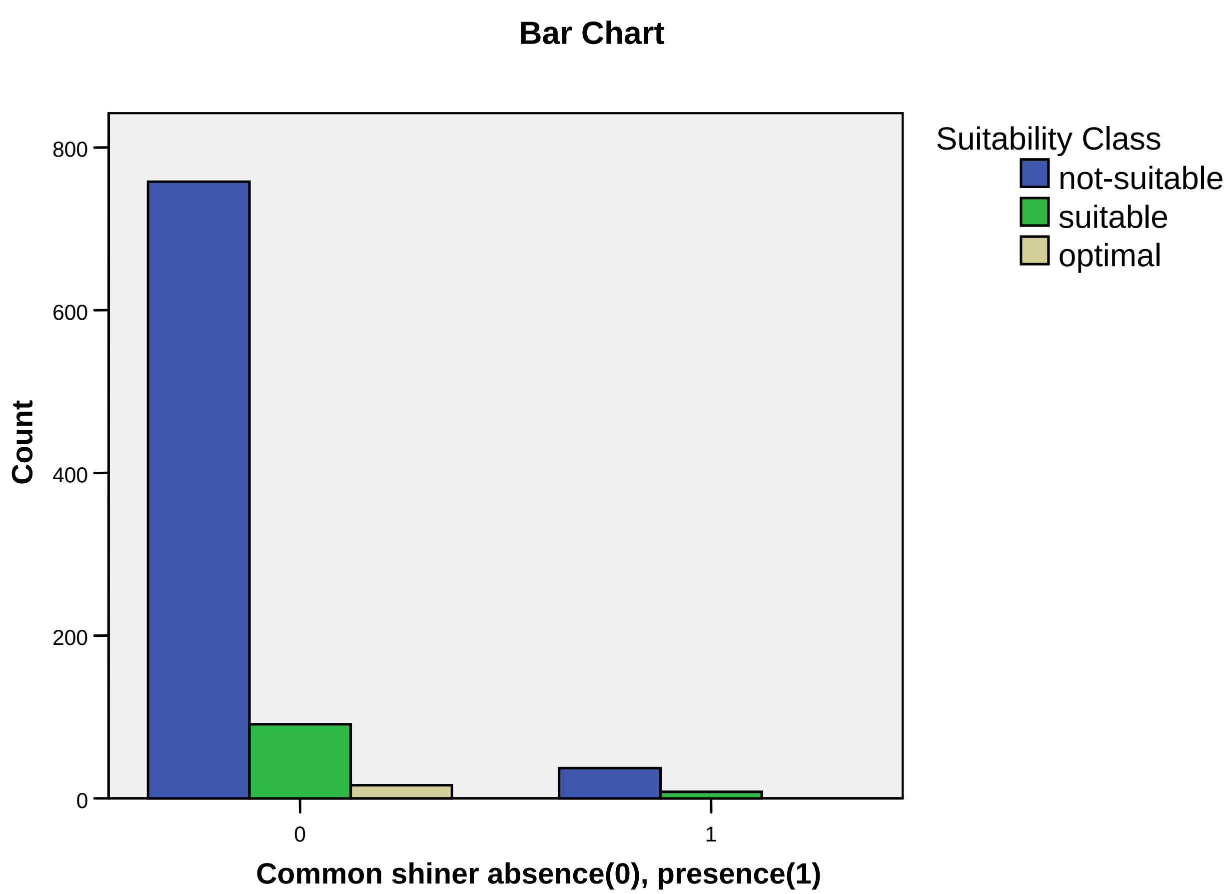
**Common shiner**

In all compared records 9 grids were occupied by common shiner. The Chi-square test documents a minimally significant relationship between predicted habitat suitability classes and fish presence.

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 3.047(a) | 2 | .218 |
| Likelihood Ratio | 3.521 | 2 | .172 |
| Linear-by-Linear Association | .342 | 1 | .559 |
| N of Valid Cases | 910 | | |

**Figure 3:** Common Shiner: The number of grids where fish were present (1) in three habitat suitability categories: unsuitable (0), suitable but not optimal (1), optimal (2). "0" on x-axis represents observed and "1" is predicted.



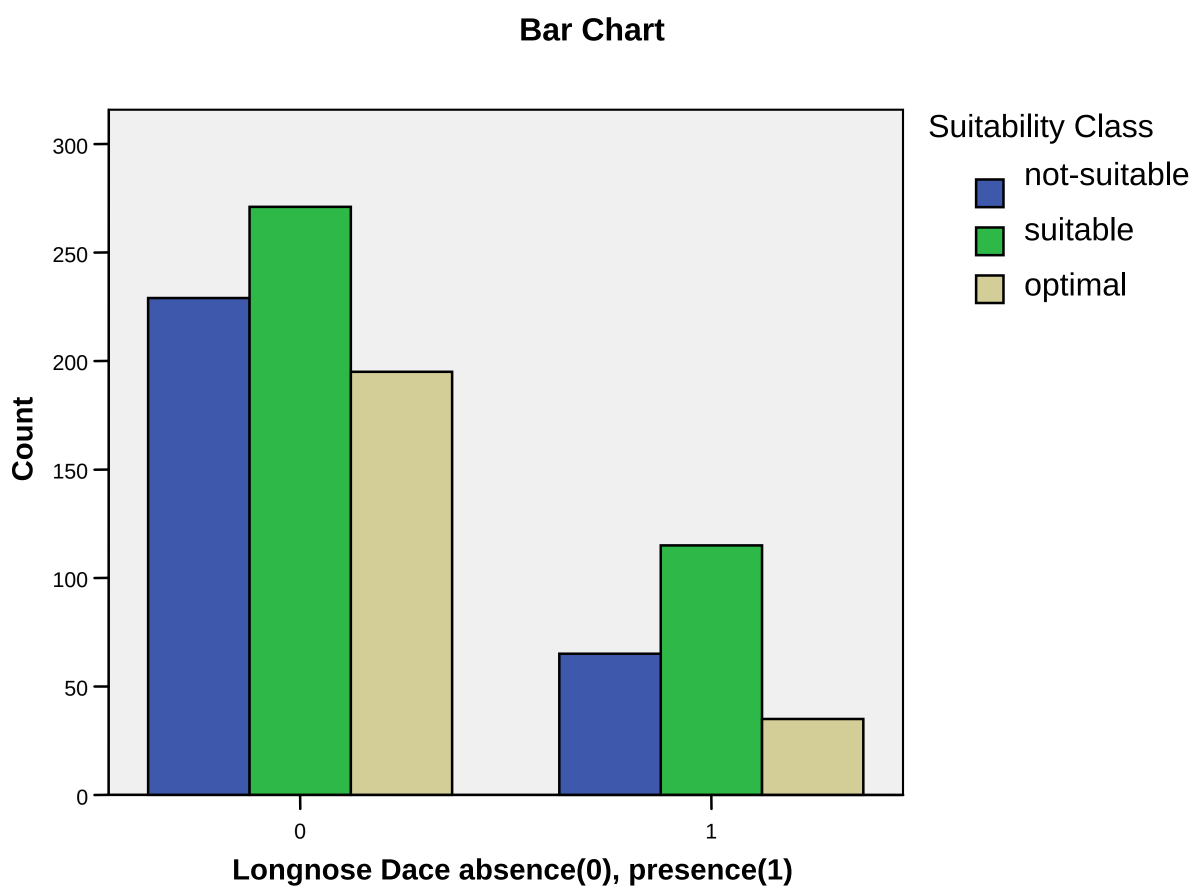
**Longnose dace**

In all compared records 43 grids were occupied by Longnose Dace. The Chi-square test documents a highly significant relationship between predicted habitat suitability classes and fish presence.

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 17.522(a) | 2 | .000 |
| Likelihood Ratio | 18.032 | 2 | .000 |
| Linear-by-Linear Association | 2.359 | 1 | .125 |
| N of Valid Cases | 910 | | |

**Figure 4:** Longnose Dace: The number of grids where fish were present (1) in three habitat suitability categories: unsuitable (0), suitable but not optimal (1), optimal (2). "0" on x-axis represents observed and "1" is predicted.



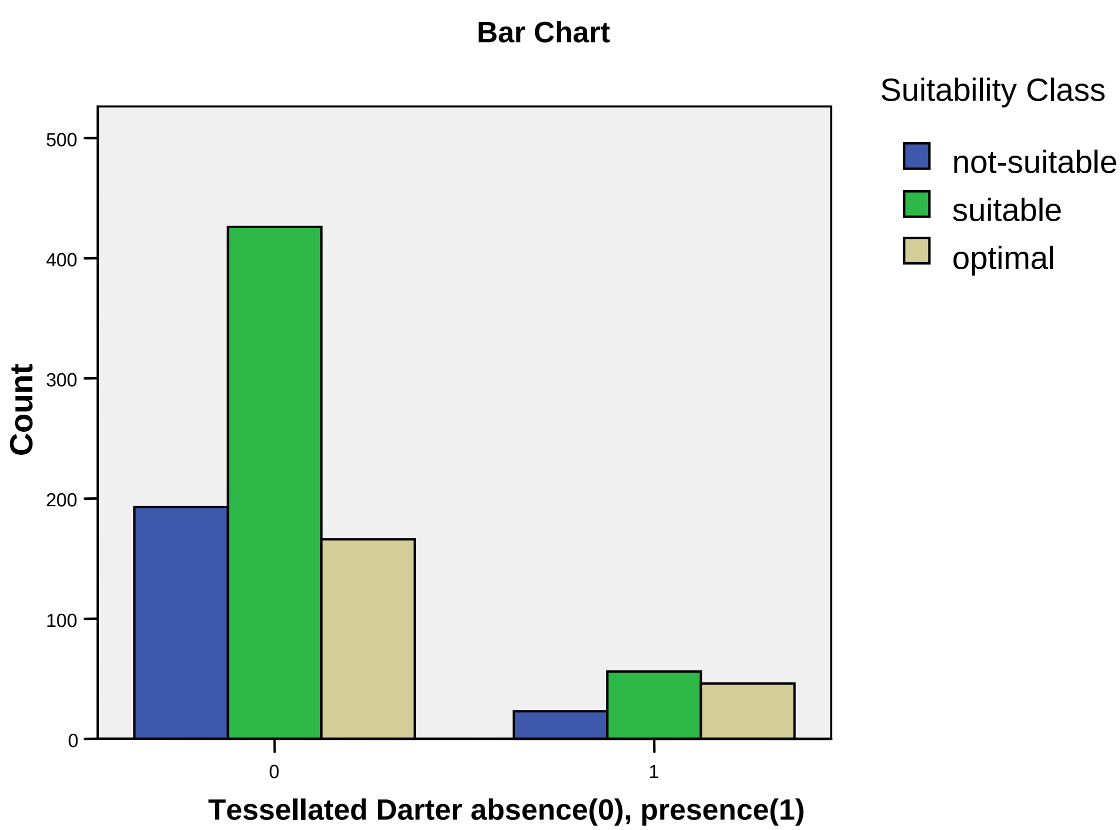
**Tessellated Darter**

In all compared records 25 grids were occupied by Tessellated Darter. The Chi-square test documents a highly significant relationship between predicted habitat suitability classes and fish presence.

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 14.905(a) | 2 | .001 |
| Likelihood Ratio | 13.684 | 2 | .001 |
| Linear-by-Linear Association | 10.923 | 1 | .001 |
| N of Valid Cases | 910 | | |

**Figure 5:** Longnose Dace: The number of grids where fish were present (1) in three habitat suitability categories: unsuitable (0), suitable but not optimal (1), optimal (2). “0” on x-axis represents observed and “1” is predicted.



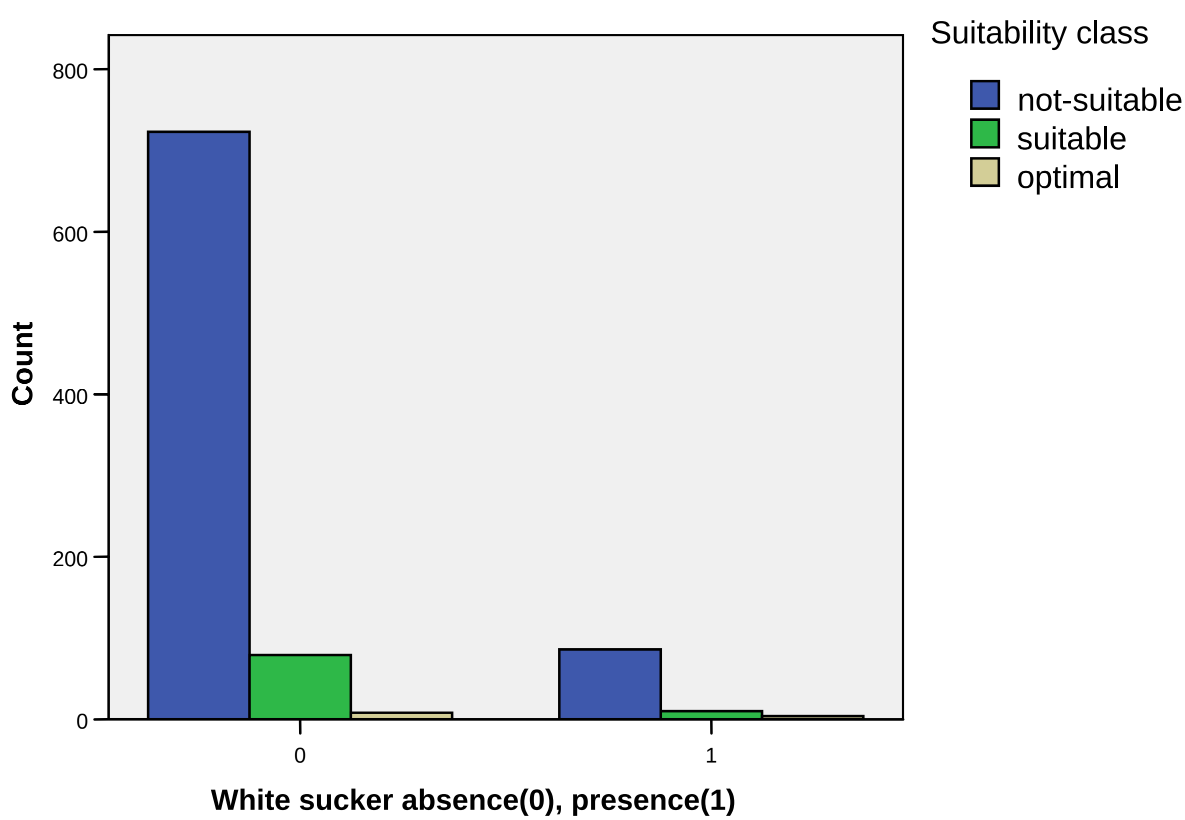
**White sucker**

In all compared records 20 grids were occupied by White Sucker. The Chi-square test documents a minimally significant relationship between predicted habitat suitability classes and fish presence.

**Chi-Square Tests**

| | Value | df | Asymp. Sig. (2-sided) |
|---|---|---|---|
| Pearson Chi-Square | 6.237(a) | 2 | .044 |
| Likelihood Ratio | 4.365 | 2 | .113 |
| Linear-by-Linear Association | 2.588 | 1 | .108 |
| N of Valid Cases | 910 | | |

**Figure 6:** White Sucker: The number of grids where fish were present (1) in three habitat suitability categories: unsuitable (0), suitable but not optimal (1), optimal (2). "0" on x-axis represents observed and "1" is predicted.



## Discussion

The model verification provides noisy but satisfying results. For five of the six species, the predicted categories significantly correspond with fish distribution. This is especially true for blacknose dace, longnose dace, and tessellated darter, where this relationship is very strong and the bar charts support this conclusion. These are also species with sufficient capture data to provide high levels of confidence. The number of grids occupied by fish for white sucker, brook trout, and common shiner is much lower. For the latter two, it comprises only 5% of the samples. Therefore, it is not surprising that the results for common shiner are insignificant, and the significance level for brook trout is also weak. The bar diagrams for these species are not very convincing either. As for white sucker, the number of occupied grids comprises 11% of the samples, which is only a small proportion of the total. Furthermore, the data serves as a base for the development of suitability models, which is also hampered by the low number of these species in the samples. Therefore, we have the least confidence in the model for white sucker. The verification of the model for common shiner suffers from both problems.

This validation has been performed at a very conservative level, by collapsing the abundance data to presence and absence observations. This method is recommended by USGS because of the large number of variables affecting fish behavior that determine fish locations. Commonly, the habitat conditions present during the time of the survey are compared with fish location. In contrast, our study compared fish observations with a number of habitat conditions occurring during the summer at the same location. This approach provides a better perspective on the spatial distribution of the fish, shaped by the range of hydraulic variability.