PI Name/Short Description: Muskrat (*Ondatra zibethicus*) – surviving houses (Lake St. Louis to Trois-Rivières) **[E28]**

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Credit: U. S. Fish and Wildlife Service

Performance Indicator Metric: This indicator predicts the number of dwelling houses and their loss caused by water level fluctuations after ice-cover formation. Number of muskrat houses at a particular water level in November and the loss of houses after water level increases (20, 40, 60 and 300 cm or 7.87, 15.75, 23.62 and 118.ll inches) are incurred in January and February after ice-cover formation. Water levels are those predicted at the Sorel gauge.

Ecological Importance/Niche: Muskrat are herbivorous, eating shoots, roots, bulbs, tubers, stems and leaves of various hydrophytes, especially emergent species; therefore, muskrat populations have the potential to regulate wetland habitat structure. A primary function of the muskrat is to control the expansion of cattails, which serves as the preferred food supply and building material for this species. This indicator computes the density of dwelling houses for different water level increases in January-February relative to the mean water level for the previous November.

Temporal validity: The estimate of the number of houses built and successfully maintained each year is based on November (QM 40 to 44) mean water level of the current year compared to the maximum relative increase in water level during the following January and February (QM1 to QM8).

Spatial validity: Valid for the Lower St. Lawrence between Lake St. Louis and Lake St. Pierre (except Laprairie Basin).

Hydrology Link: The muskrats build houses during the fall in areas with adequate water levels (20 to 100 cm or 7.87 to 39.37 inches, with a preferred range of 30 to 70 cm or 11.81 to 27.56 inches deep), and these houses will remain active throughout the winter season unless drastic changes in environmental conditions occur. Significant changes in water level after house construction will potentially affect the winter survival of muskrats (e.g., flooding). This species is also dependant on the type of plant cover, which is determined primarily by water depth. The muskrats begin lodge construction in the last part of October and continue through November until ice cover formation. The indicator is based on the number of houses potentially built in November, and the predicted loss of houses as function of water level increases during the winter months.

Algorithm: The algorithm is based on the mean discharge at Sorel from QM40 to QM46 for the potential house-building period and from QM1 to QM8 of the *next year* for the potential mortality period. The principal hydrologic attribute known to have linkage with the establishment of dwelling houses is water level during house construction and fluctuations during the winter months. For this PI we consider:

1) The mean water level for the four quarter months of November, including the tidal signal, to determine the potential number of houses established.

2) The maximum water level in January and February to calculate the number of houses inundated by the increase of the water level.

Because the distribution of plant species is primarily determined by hydrological attributes of the system, it was possible to include probabilities of Typha in the model. We used a probabilistic model (logistic regression) for *Typha latifolia* developed by Turgeon et al., 2004. We used *Typha* sp. because it serves as the muskrat's favourite emergent plant species for food and building material supplies, thus providing a good indicator of the potential of an area for muskrat lodge construction. The water depth and the probabilities of *Typha* sp. were integrated into a habitat suitability index (HSI). This allows the evaluation of the density of dwelling houses, which is then modified based on increases in water level after lodge establishment and the potential for the muskrat to modify his lodge by relocating the chamber for keeping the floor dry. The data used for model development are based on literature review and expert opinion.

The algorithm is: 1) $HSI_{establishment} = (HSI_{waterdepth} + HSI_{typha})^{1/2}$

2) *Potential of adaptation = Height of lodge – height of chamber dimension of chamber – minimum thickness of wall*

With this equation, we calculate the maximum value for the "potential of adaptation" of the chamber in the house. This serves to fix the upper limit (100 % of stressed houses) at 75 cm (29.53 inches) of water level increase. The lower limit (0 % of stressed houses) was fixed at 20 cm (7.87 inches) of water level increase because there are no impacts from smaller water level increases. Between the two limits, a linear interpolation is used to estimate the % of house impacted.

Based on these calculations we produced a matrix of results, which allow the calculation of the number of lodges established in November for any year and any water level and water level increase scenario. The matrix is composed of height scenarios water level (2.26 to 8.01 m) by three types of wetlands (1967, 1976 and 1984), which correspond to three different distributions of *Typha sp.* (low, medium and high). The resulting number of houses is then used to estimate the impact from relative increases in water level during the winter months:

1) If increases are under 20.0 cm (7.87 inches), there is no impact on dwellings.
2) If increases are between 20.0 cm (7.87 inches) and 74.99 cm (29.53 inches), the number of impacted houses is determined by: $y = 0.083214x - 0.083038$.
3) If increases are more than 75 cm (29.53 inches), all houses are impacted.

Calibration Data: No data available

Validation Data: Data on muskrat houses are very rare. The *Société de la Faune et des Parcs du Québec (FAPAQ)* has one recorded observations of dwelling houses in some areas of Lake St. Pierre in 1988:

Documentation and References:

Ouellet, V., J. Morin and O. Champoux. 2004. Indicator of the number of dwelling houses surviving to increases in water levels during the winter. Environment Canada, SMC-Hydrology. Saint-Foy. *In processing*.

Turgeon K., O. Champoux, S. Martin et J. Morin 2004. Modélisation des milieux humides de la plaine inondable du Saint-Laurent, du lac Saint-Pierre au lac Saint-Louis. *Rapport scientifique RS-104*. Environnement Canada, SMC-Hydrologie, Sainte-Foy, 70 pages.

Risk and uncertainty assessment: The muskrat model allowed us to predict the density of dwelling houses for the mean water level of November and which portion of these houses are affected by subsequent water level fluctuations. We have very small data to estimate the error on predicted densities, which includes an inventory of dwelling houses for 1988. From the 1988 data set, the variation on the prediction compared to the aerial survey varied from 0.5 to 2 houses per hectare on average. We have limited confidence on the accuracy of the exact number of predicted houses. The impact for water level increase during the winter months is a relatively simple estimation that has a direct impact on the use of these houses. However, the impact of the loss of houses on the muskrat population is not well known, and we do not have sufficient data to estimate the exact impact. It is clear from the literature that the loss of houses increases the stress on the muskrat population.