**METHODS**

*Study sites*.—Stonecats were collected from three Lake Champlain tributaries. The Great Chazy River which originates near Ellenburg, New York, and empties into northern Lake Champlain (44.93236N; 73.38537W) is approximately 86 km long and drains a watershed of 790 km2. Stonecats were collected in the lower 33 km of the Great Chazy River. The LaPlatte River is a 24-km long tributary that drains a watershed of 138 km2 (Pelton et al. 1998) and enters Lake Champlain in Shelburne Bay (44.39959N; 73.23385W). The Missisquoi River is 130 km long, drains a watershed of 2,200 km2 in northern Vermont and sections of Quebec, Canada and enters Lake Champlain at Missisquoi Bay (44.99630N; 73.15729W).

*Data Collection*.—Stonecats were collected from the lower 33 km of the Great Chazy River on 17-19 October 2012 as mortalities from a TFM lampricide treatment conducted on 16-18 October 2012. Additional specimens were collected from the Great Chazy River on 8-9 August 2011 and 15 November 2011, NY as part of a bioassay study (M. Calloway, U.S Fish and Wildlife Service, unpublished data). Stonecats were frozen as quickly as possible and returned to the lab where they were later thawed and measured for standard (SL) and total lengths (TL) to the nearest mm and weighed to the nearest gram before the dorsal spine was cut at the point of insertion (Buckmeier et al. 2002; Manny et al. 2014; Fischer and Koch 2017).

Spines were placed in boiling water to remove excess skin flesh and then allowed to dry before being set in epoxy. One or two 0.5-mm sections were cut from the spine using a Buehler low-speed isomet saw (Buehler, Lake Bluff, Illinois). Thin sections were glued to slides for viewing under a Olympus SZX9 dissecting microscope using fiber optic transmitted light. Of the alternating opaque and translucent zones, annuli were defined as the opaque ones. ). Using this criterion three readers blind to the size of the fish independently estimated the age for each fish. The three readers attempted to reach a consensus age if there were discrepancies among their estimated ages. If a consensus could not be reached the spine was removed from the analysis.

Stonecats were collected from the LaPlatte and Missisquoi rivers from June to October 2012, May to October 2013, and June to October 2014 using backpack electrofishing and minnow traps. DETAILS ABOUT ELECTROFISHING HERE (TYPE OF UNIT, HOW LONG, ETC). Minnow traps were 42 cm long and 23 cm diameter with 2.5 cm openings at each end and 0.6 cm square meshed walls. Minnow traps were baited and set overnight (18-24 h soak time) in gangs of three or four attached to a single weight. Sampling details are in Puchala et al. (2016).

Captured Stonecats not experiencing obvious high levels of distress were anesthetized with 100 mg/L MS-222. Each individual was measured for TL to the nearest mm and all Stonecats greater than ~90 mm TL had a passive integrated transponder (PIT) tag (Biomark, Boise, Idaho, 134-kHz, 8.4 mm x 1.44 mm) inserted into the peritoneal cavity. Individuals were examined for the presence of the PIT tag after the first sampling event.

*Data analysis.*— Growth of Stonecats collected from the Great Chazy River was summarized with the traditional von Bertalanffy growth model (Beverton and Holt 19XX):

where *Lt* is the length at time (or age) *t*, *L*∞ is the asymptotic mean total length, *K* is the Brody growth coefficient, and t0 is the theoretical time when the mean length is zero (Ogle et al. 2017). We used fractional ages in this model to adjust for our fish being collected at various times throughout the growing season (Ogle et al. 2017). We assumed that annual growth on the spine commenced on June 1st (Carlson 1966) and was completed by November 1st. Thus, the adjusted age was equal to the number of observed annuli for fish collected before June 1, was one more than the number of observed annuli for fish collected after November 1, and was the number of observed annuli plus the fraction of the growing season completed for fish captured between June 1 and November 1. We chose not to use a growth model with a seasonal component (e.g., Somers [1988]) for fish collected from the Great Chazy River because sampling dates were few and not distributed throughout the year (i.e., concentrated in the fall months).

Growth of Stonecats collected from the LaPlatte and Missisquoi rivers was summarized with the traditional von Bertalanffy growth model modified by Francis (1988) for use with mark-recapture data and including a seasonal component:

where

In this model, *Lm* is the TL at the time of marking, *L* is the change in TL between marking and recapture, *t1* and *t1* are the marking and recapture times (years), *t* is the change in time (years) between marking and recapture, *L1* and *L2* are two TL chosen by the analyst, *g1* and *g2* are parameters that represent the mean annual growth rate or increment at *L1* and *L2*, *w* is a parameter that represents the time of year where the growth rate is maximum, and *u* is a parameter that describes the extent of the seasonal variation in growth (i.e., *u*=0 represents no seasonal variability in growth). For XX fish that were recaptured multiple times, we treated each interval between recaptures as independent events (Ogle 2017). For example, if a fish was captured three times, we considered the interval from marking to the first recapture as one observation and the interval from the first to second recapture as a separate independent observation. Observations that were within 7 d of each others were excluded from further analysis under the assumption that any growth that occurred in this period was minimal and likely less than measurement error. We also combined the data from the LaPlatte and Missisquoi rivers because the small sample size (n=28) in the Mississquoi River precluded growth modeling that river alone.

Both models were fit using the “port” algorithm in the nls() function in R v3.5.1 (R Core Team 2018). All parameters in the traditional model were unconstrained, but the *g1*, *g2*, and *u* parameters in the Francis model were constrained to be positive and the *w* parameter was constrained to be between 0 and 1. At least three different starting values and at least two other algorithms (Gauss-Newton in the nls() function and the Levenburg-Marquardt in the nlsLM() function from the minpack.lm package v1.2-1 [Elzhov et al. 2016]) were used to determine robustness of the model fits (Ogle et al. 2017). Bootstrap confidence intervals for model parameters from the traditional model were estimated from 999 bootstraps using the nlsBoot() function from the nlsTools package v1.0-2 (Baty et al. 2015) as described in Ogle (2016).

Predicted annual growth increments for fish of various initial lengths were used to compare growth between fish collected from both locations (and summarized with model with different parameters) and results from the literature. Predicted annual growth increments are the *g1* and *g2* parameter from the Francis model. Annual growth increments were predicted from the traditional model by first computing the mean length at several ages and then finding the differences between these lengths. Bootstrap confidence intervals were constructed for both the predicted mean lengths and increments.

We developed a linear model from our measurements of SL and TL on fish collected from the Great Chazy River that could be used to predict TL from SL. These results were used to convert SL used in some literature reports to TL for comparison to our results.

