Supplementary Information

Text S1. A brief review of assumptions of Capture-Mark-Recapture models related to sampling of Atlantic sturgeon in the Altamaha River, GA.

Conditional likelihood capture models such as Huggins models have an advantage over full likelihood methods in certain population estimation applications. In the full likelihood framework, because covariates for uncaptured animals cannot be observed, a Maximum Likelihood Estimator for $\widehat{N}$ cannot be derived unless homogeneity of unseen individuals is assumed (Conroy & Carroll 2009; Yee et al. 2015). This assumption, however, is widely viewed as inappropriate due to its potential to produce biased estimates (Amstrup et al. 2005; Yee et al. 2015). In contrast, because Huggins models are conditioned on only the individuals observed at least once (and as a consequence, $\widehat{N}$ is no longer a parameter in the likelihood function), it is possible to formulate a conditional likelihood using the positive-Bernoulli distribution. This method allows for an assumption of heterogeneity within uncaptured individuals as follows (Patil 1962; Yee et al. 2015; all model subscripts provided in manuscript are consistent with original authors):

$$L_c \propto \prod_{i=1}^{n} \frac{\prod_{j=1}^{\tau} p_{ij}^{y_{ij}} (1 - p_{ij})^{1 - y_{ij}}}{1 - \prod_{s=1}^{\tau} (1 - p_{is}^{\dagger})} \qquad \text{Eq. S1}$$

where:

p_{ij} is the probability of capture for animal i where $1 \leq i \leq n$ during occasion j where $1 \leq j \leq \tau$,

$y_{ij} = 1$ if the i^{th} individual was caught on the j^{th} occasion and 0 otherwise, and

$p_{is}^{\dagger}$ is a subset of p_{ij} which ignores recaptures and is used to determine the probability that the i^{th} individual was captured at least once.

Like all closed population models, the ones used in this study rely on a set of assumptions which include the following:

1) the population being studied remains closed to immigration, emigration, births, and deaths (population abundance [N] remains constant between sampling occasions)
2) catchability of individuals does not change based on whether they are marked or unmarked (this assumption is relaxed in the behavior models)
3) all marked individuals retain their mark
4) following the first sampling event, the potential for random mixing of marked and unmarked individuals exists, and
5) all individuals encountered more than once are correctly identified.

These model assumptions were met in the following ways:

1) Because all members of the juvenile cohorts reside within the estuarine environment for a minimum of two years, population closure was assumed (Fox & Peterson 2019). In addition, to ensure the assumption of population closure was met, sampling was periodically conducted at sites located on the boundary of the study area as well as sites located outside of the study area. No juvenile sturgeon were captured outside of the study area.
2) No previous literature has supported the hypothesis that marking sturgeon with passive integrated transponder (PIT) tags resulted in a behavioral change or differences in gear effectiveness.
3) Although no tag retention study was conducted as part of this project, studies in the past have shown tag loss from sturgeon PIT tagged under dorsal scutes to be ~1% (Briggs et al. 2019).

4) The potential for random mixing was assured by never sampling the same location twice in the same day. This assumption does not account for the effects of site fidelity. Here, we note that site fidelity may be interpreted in two different ways. The first refers to the probability that an individual will remain in the study area, given that it is still alive. This form of site fidelity has been shown to be high in Atlantic sturgeon in this and other systems (Paradis et al. 2021). The second interpretation (which is more likely the form which would affect our model assumption) could refer to the probability that an individual will remain at a particular sampling location within the study area from one sampling occasion to the next. We are not aware of any movement studies involving Atlantic sturgeon which have addressed such a fine scale interpretation of site fidelity. We did, however, frequently observe recaptures of individuals at multiple sampling locations, suggesting that there is some degree of mixing among sampling occasions.
5) Researchers were trained to properly identify Atlantic sturgeon using the descriptions of Vladykov & Greeley (1963) and Scott & Crossman (1973) as well as to check for existing PIT tags.

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Supplementary Figures

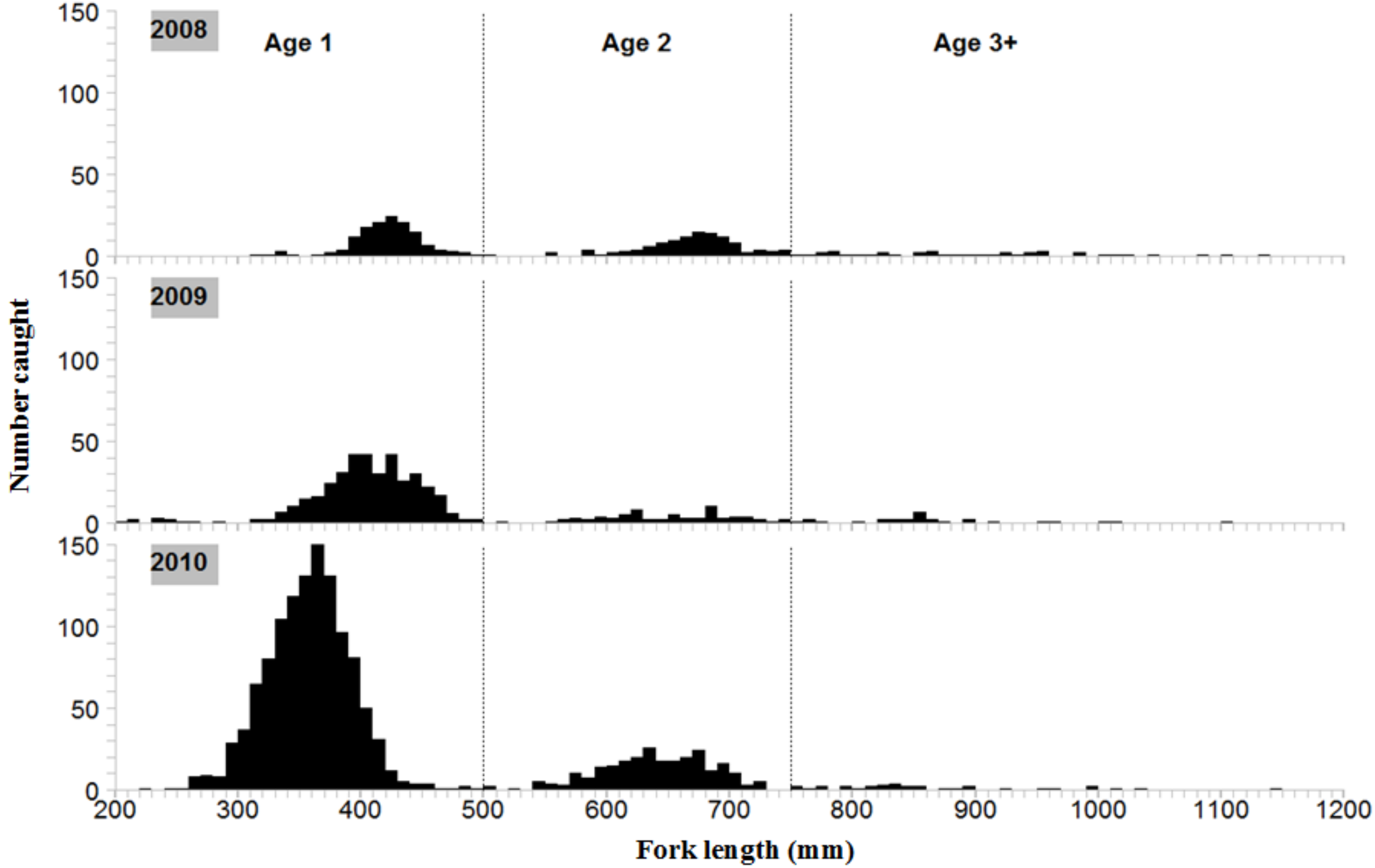

Figure S1a. Length-frequency histograms and age assignments for Atlantic sturgeon captured in the Altamaha River, 2008–2010. Ages were determined based on length distributions as described in Schueller & Peterson (2010).

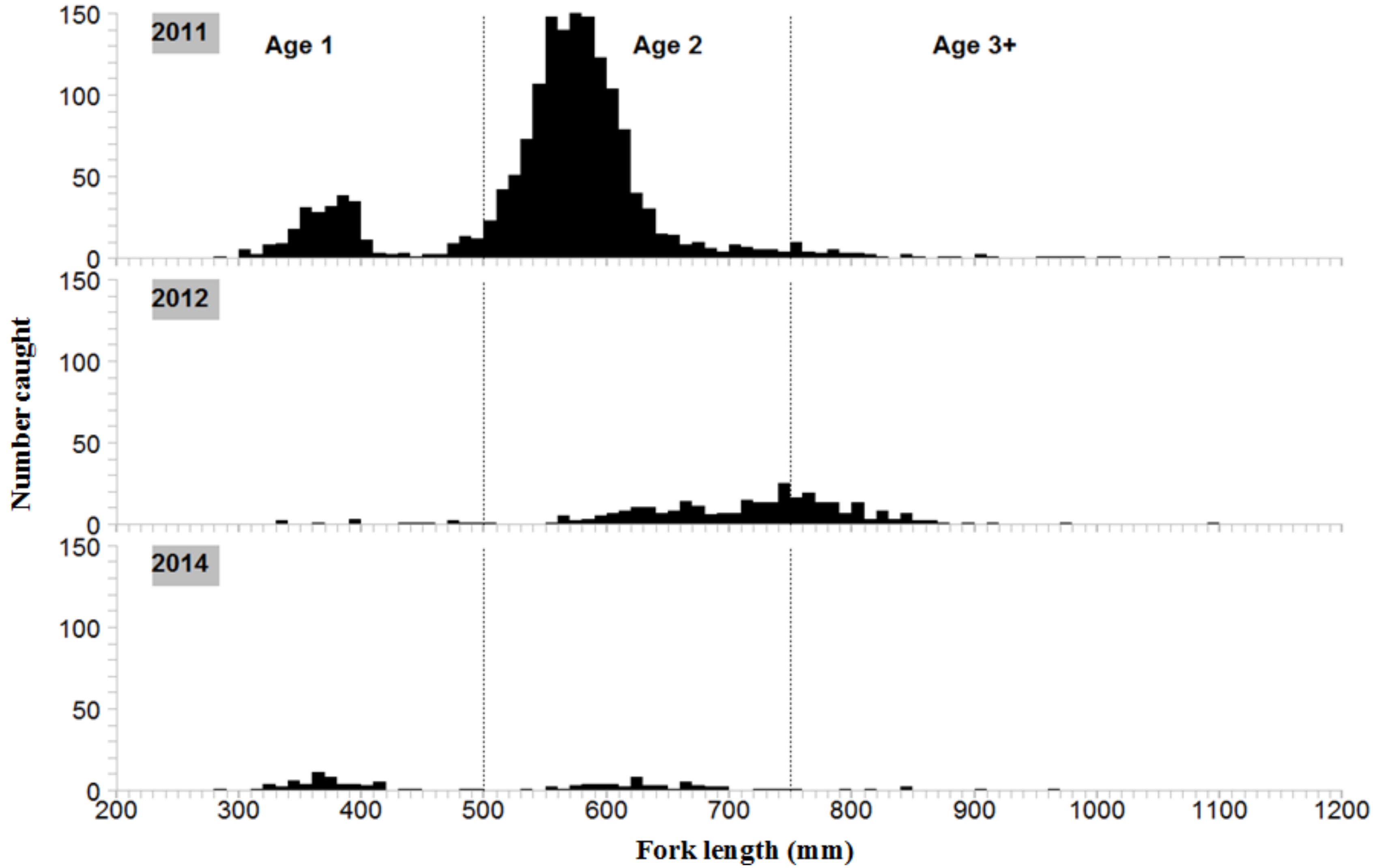

Figure S1b. Length-frequency histograms and age assignments for Atlantic sturgeon captured in the Altamaha River, 2011–2014.

Ages were determined based on length distributions as described in Schueller & Peterson (2010).

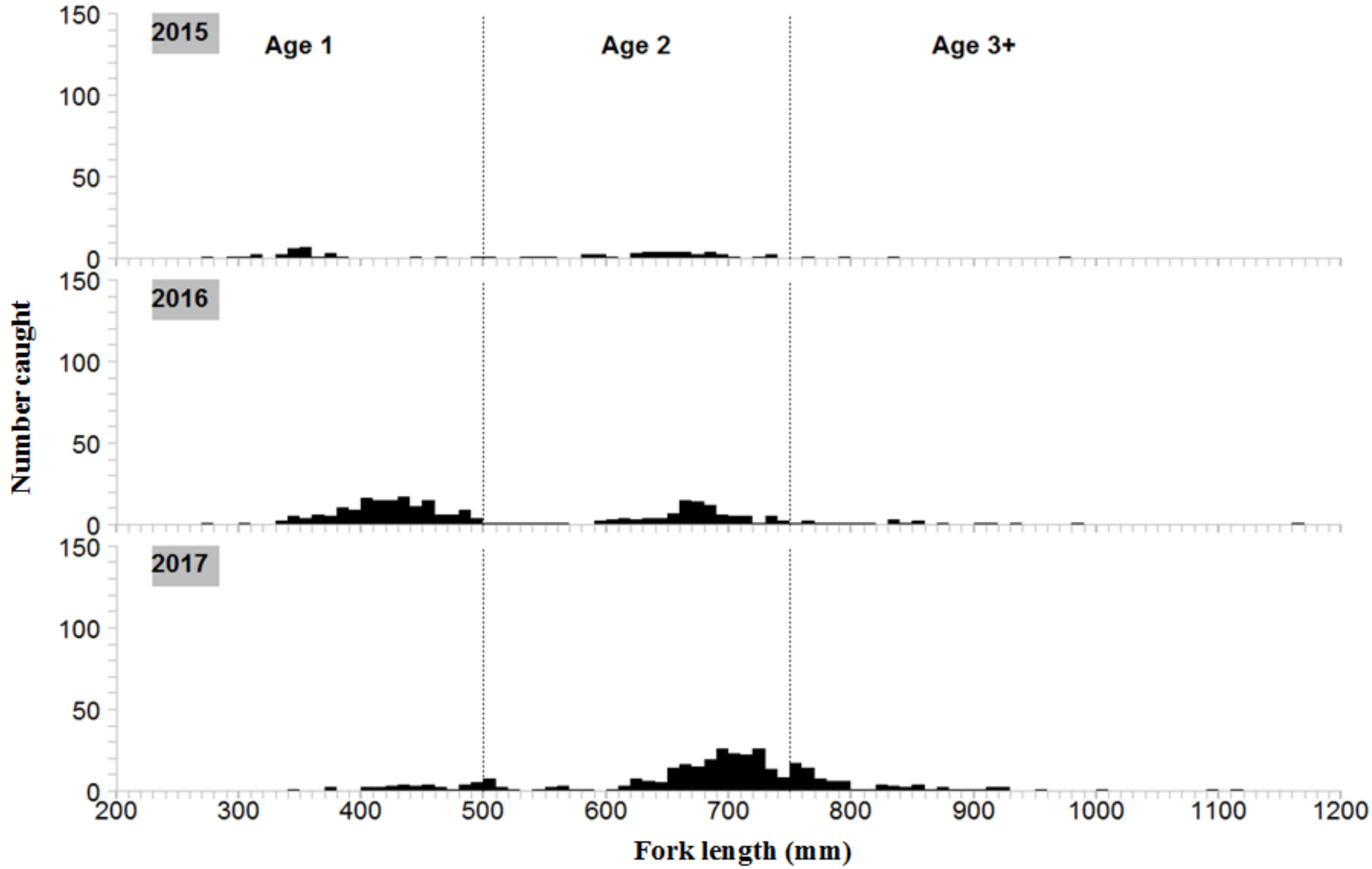

Figure S1c. Length-frequency histograms and age assignments for Atlantic sturgeon captured in the Altamaha River, 2015–2017. Ages were determined based on length distributions as described in Schueller & Peterson (2010).

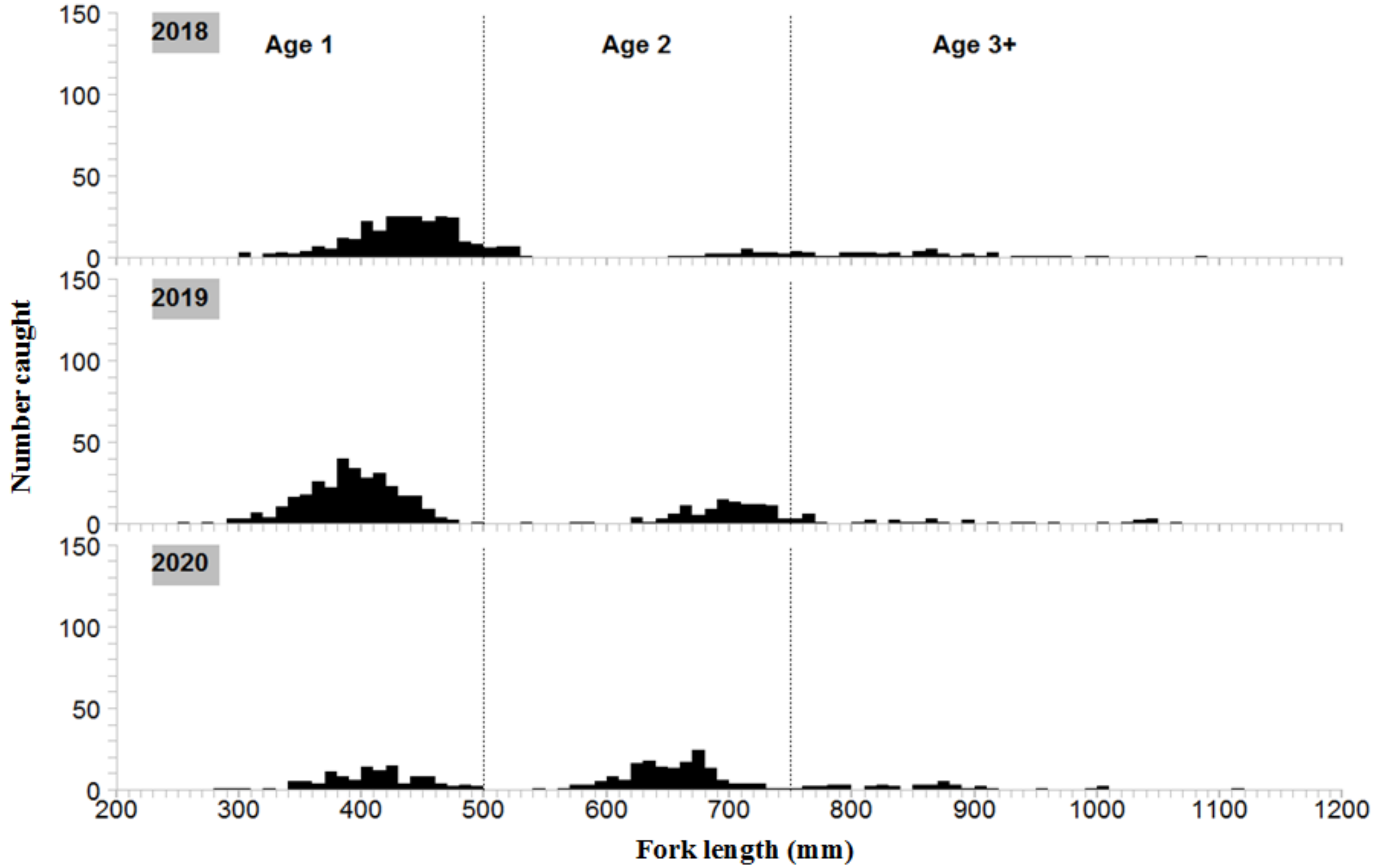

Figure S1d. Length-frequency histograms and age assignments for Atlantic sturgeon captured in the Altamaha River, 2018–2020. Ages were determined based on length distributions as described in Schueller & Peterson (2010).