Receptions of JSATS tag codes within raw cabled hydrophone data files are processed to produce a dataset of accepted tag detection events. Detections from all hydrophones at a dam are combined for processing. The following three filters are employed:

1. Multipath Filter: For data from each individual cabled hydrophone, delete all tag-code receptions that occur within 0.156 seconds after an initial identical tag code reception under the assumption that closely lagging signals are multipath. Initial code receptions are retained. The delay of 0.156 seconds is the maximum acceptance window width for evaluating a pulse repetition interval (PRI) and is computed as 2(PRI_Window+12×PRI_Increment). Both PRI_Window and PRI_Increment are currently set at 0.006, which was chosen to be slightly larger than the potential rounding error in estimating PRI to two decimal places.
2. Multi-detection filter: Retain receptions only if the same tag code was received at another hydrophone in the same array within 0.3 seconds because receptions on separate hydrophones within 0.3 seconds (about 450 m of range) are likely from a single tag transmission.
3. PRI filter. Retain only those series of receptions of a tag code (or "messages") that are consistent with the pattern of transmissions from a properly functioning JSATS acoustic tag. Filtering rules are evaluated for each tag code individually, and it is assumed that only a single tag will be transmitting that code at any given time. For the cabled system, the PRI filter operates on a message, which includes all receptions of the same transmission on multiple hydrophones within 0.3 seconds. Message time is defined as the earliest reception time across all hydrophones for that message. Detection requires that at least 6 messages are received with an appropriate time interval between the leading edges of successive messages. The processing steps are as follows:

   a. For each message, select the list of messages that follow within [(Nominal_PRI×1.3×12)+1] seconds. Nominal_PRI is the nominal number of seconds between transmissions of the tag code (typically 3, 5, or 10 seconds). The list of Nominal_PRI by tag code must be available as an input and typically is obtained from the tag manufacturer.

   b. Compute a list of candidate PRIs as follows:

$$Candidate\ PRI\ list = \prod_{i=1}^{12} \frac{\left(Time_{Message} - Time_{Initial\ Message}\right)}{i}$$

   where *i* is a counter that steps through the 12 possible PRI intervals that can fit between the initial message and the end of the time window described in Step a. Round each candidate PRI to the nearest hundredth of a second and exclude candidate PRIs ≤ Nominal_PRI × 0.651 or ≥ Nominal_PRI × 1.3 from the list. These coefficients were chosen to result in a range of candidate PRIs that do not include multiples of any other candidates in the list. Avoiding exact multiples in the candidate PRI list simplifies the process of identifying a mode.

   c. Take the minimum mode of the list of candidate PRIs from Step b as the estimate of PRI to be used in building an event associated with the initial message. If no mode exists, use the minimum candidate PRI as the estimate of PRI.

d. Add messages to the accepted list if their time interval from the initial message falls within narrow bounds around even multiples of the estimated PRI from the initial message. An acceptance window for a message is defined by:

$$\text{Acceptance window} = i(Estimated\_PRI) \pm \left[PRI\_Window + i\left(PRI\_Increment\right) \right],$$

where PRI_Window = 0.006; PRI_Increment = 0.006, as described in Step 1; and *i* is the number of PRI intervals from the initial message obtained by rounding (($Time_{Message}$-$Time_{Initial\ Message}$) / Estimated PRI) to the nearest integer. The number of intervals, i, can assume any integer value from 1 to 12, inclusive.

e. Create a detection event if at least 6 messages remain (the initial message plus 5 or more accepted messages).

f. Select the first message after the initial message as the new initial message, and repeat steps a through e above until all messages have been processed.

g. Combine any two or more detection events that overlap in time into a single detection event.

h. Repeat steps a-g for each tag code

The output of this process is a dataset of events that summarize accepted tag detections for all times and locations where hydrophones were operating. Each unique event record includes a basic set of fields that indicate the ID of the fish, the first and last detection time for the event, the location of detection, and how many messages were detected within the event. This list is combined with accepted tag detections from the autonomous arrays and PIT tag detections for additional QA/QC analysis prior to survival analysis. Additional fields capture specialized information, where available. One such example is route of passage, which is assigned a value for those events that immediately precede passage at a dam based on spatial tracking of tagged fish movements to a location of last detection. Multiple receptions of messages within an event can be used to triangulate successive tag position relative to hydrophone locations.

One of the most important QC steps is to examine the chronology of detections of every tagged fish on all arrays above and below the dam-face array to identify any detection sequences that deviate from the expected upstream to downstream progression through arrays in the river. Except for possible detections on forebay entrance arrays after detection on a nearby dam-face array 1-3 km downstream, apparent upstream movements of tagged fish between arrays that are > 5 km apart or separated by one or more dams are very rare (<0.015%) and probably represent false positive detections on the upstream array. False positive detections usually will have close to the minimum number of messages and are deleted from the event dataset before survival analysis.