Recovered Standard Rate X-Tag Data and Reports

Version 1

Part I: Understanding Data, Compressions, and Calculations

Part II: Data Reports

This document explains data and reports for Recovered Standard Rate X-Tags **only**.

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Part I: Understanding Data, Compressions, and Calculations

X-Tag States

The magnet functions as an on/off switch. When the magnet is placed over the white dot located on the X-Tag float (for at least 1 minute), the tag is powered OFF. Once that magnet is removed, the tag turns ON and progresses through the following sequence of states:

1. Constant voltage applied to release wire (1 minute)
2. Pulsing voltage applied to release wire (3 minutes)
3. Test transmissions (60 minutes)
4. Data collection
5. Pop-off release mechanism activation and data collection
6. Data transmission and data collection (until battery depleted)

The X-Tag field manual, supplied with the X-Tag order, describes the procedure for testing tags using states 1–3. This document explains data from states 4–6.

X-Tag Data

Standard Rate X-Tags collect high-resolution temperature, pressure (depth), and light-level measurements every two minutes while the tag is in data collection mode (states 4–6). The tag stores this entire time-series dataset, identified as the archived dataset, in memory. If the tag is physically recovered, the archived dataset may be extracted, providing the user with a wealth of information from the full duration of deployment. For example, a 12-month tag would provide over 750,000 combined temperature, depth, and light-level records.

When a tag is in transmission mode (state 6), it will periodically transmit real-time data messages, providing a snapshot of the tag in its current condition. Real-time measurements include information such as instantaneous battery level, temperature, depth, and light level. Additionally, the tag transmits the pop-off reason and pop-off date and time.

A Recovered Standard Rate X-Tag provides the following information:

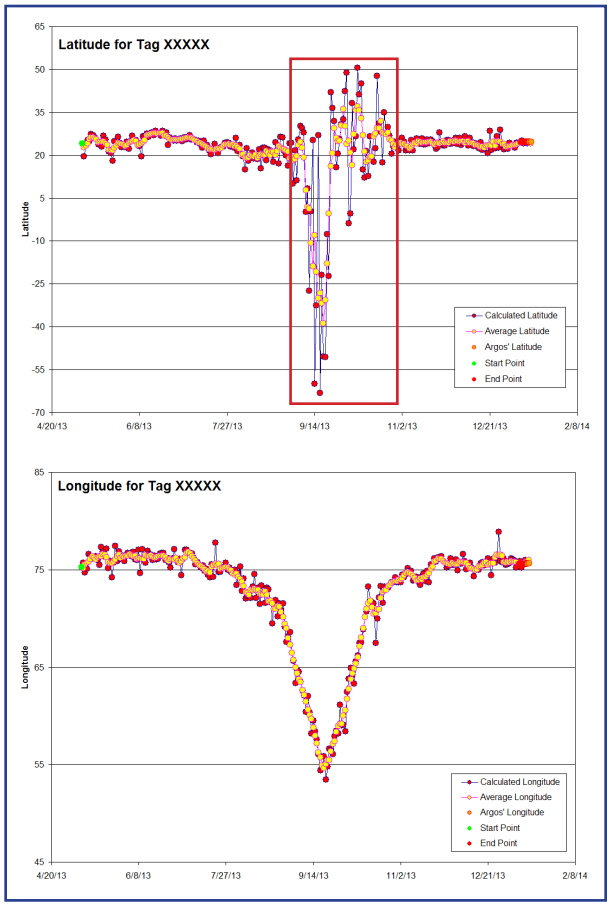
- Time-paired and time-series temperature, depth, and light-level records
- Daily sunrise and sunset times with corresponding approximate depth records*
- Daily light-based latitude and longitude estimates*
- Real-time data and Argos locations from transmission period**
- Pop-off reason and pop-off date and time

*Tag must have access to daily varying solar light levels in order to estimate sunrise/sunset times and corresponding geolocations.

**Only available if transmitted data are received from the tag

Geolocation Estimation

X-Tag Location Estimates



An X-Tag records light levels at two-minute intervals while in data collection mode. A proprietary algorithm is applied to the light-level records in order to estimate daily sunrise and sunset times; these daily sunrise and sunset estimates become part of the transmitted dataset. When a data report is created, daily geolocations are calculated from the sunrise and sunset times.

Longitude is calculated from the time of local noon, halfway between sunrise and sunset. Latitude is calculated from the length of day. Near the vernal and autumnal equinoxes, day length becomes the same at all latitudes so that day length fails to be a distinguishable characteristic between latitudes. **Consequently, light-based latitude estimates near the equinox are not reliable**. In contrast, the reliability of the longitude estimates is not impacted by the equinoxes. Unprocessed latitude and longitude estimates are displayed, illustrating error in latitude estimates approximately one month before and after the autumnal equinox (outlined in red).

Light-based location estimates are prone to error as a result of vertical behavior, time of year, water turbidity, location, etc. In general, longitude estimation is smoother and more reliable than latitude estimation. Given the X-Tag's two-minute, light-level sampling rate, the estimated latitude and longitude points are at best accurate to ±1° for latitude and ±0.5° for longitude.

Normally, latitude locations are calculated within the range of 65°S–65°N, but the bounds may be extended for tag deployments at extreme latitudes. All estimates, independent of their apparent validity, are provided in the data report. Apart from providing the five-day running average of the track, we do not process (filter) the raw light-based locations.

Argos Location Estimates

When a tag is transmitting, the Argos system estimates the tag's position using the Doppler shift of the tag's frequency. Therefore, Argos estimated positions indicate the location of the drifting transmitting tag. Argos attempts to determine the tag's location with each satellite pass, using either Kalman filtering or least-squares processing. Location class (LC) indicates the quality of the position estimate. Please refer to the Argos User's Manual or contact CLS for more information regarding Argos position estimates.

Pop-off Release Mechanism Reasons

The purpose of the release mechanism is to free the tag from the fish, enabling the tag to float to the surface where the transmitted data can reach the constellation of satellites. The release mechanism is initiated by one of four possible triggers: constant pressure, pop-off date reached, memory full, or too-deep emergency release.

Constant Pressure

A tag will release due to the constant-pressure release condition if the tag remains within a prespecified depth range for a fixed duration. Furthermore, a delay can be selected so that the tag will not consider constant pressure for a specified period of time after the removal of the magnet. If requested, the constant-pressure programming can be customized when the tags are ordered to better suit the species under study. Please contact MTI if you have questions regarding your specific constant pressure programming.

Pop-Off Date Reached

When an X-Tag is ordered, the pop-off date (day/month/year) or deployment duration (represented as integer number of months) must be specified. For example, a 9-month tag deployed on March 2, 2014 would release on December 2, 2014, provided the tag did not release prematurely due to another reason (such as constant pressure or too-deep emergency release).

Memory Full

This release mechanism typically only applies to High-Rate tags and indicates that the transmitted dataset is full. Timing of the memory full release trigger depends on the selected deployment duration and designated sampling rate.

Too-Deep Emergency Release

The tag must register depths below the emergency depth threshold (~1296 m) for approximately 15 minutes before the release mechanism is initiated. The tag will not detach instantaneously with the initiation of the release mechanism. Based on our tests, it can take approximately 15–30 minutes (given average salinity) to detach.

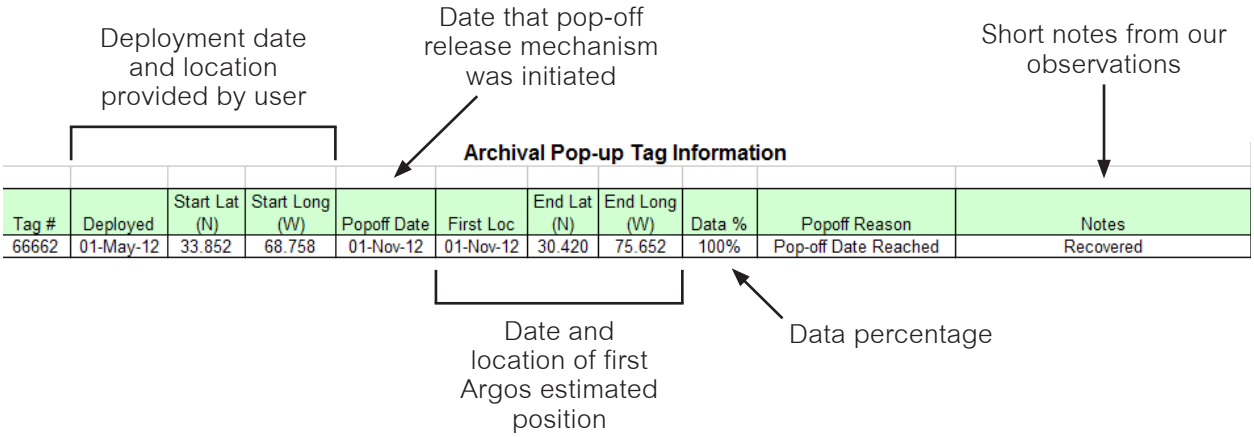
The tag can only represent depths in a range from the surface to approximately 1296 m. Therefore, if a tag descends to 2500 m, the tag would only indicate a maximum depth of approximately 1296 m.

While the crush depth of X-Tags exceeds 2500 m, please alert us prior to ordering if your study animal uses depths >1300 m.

Part II: Data Reports

Tag Information Summary

Every set of reports is accompanied by a "TagInfo" Excel file (.xls) that displays and summarizes important tag information.



Tag #	Deployed	Start Lat (N)	Start Long (W)	Popoff Date	First Loc	End Lat (N)	End Long (W)	Data %	Popoff Reason	Notes
66662	01-May-12	33.852	68.758	01-Nov-12	01-Nov-12	30.420	75.652	100%	Pop-off Date Reached	Recovered

The deployment date and location are provided by the user prior to data processing.

The pop-off date column indicates the date of the pop-off release mechanism initiation which may not necessarily match the date of the first Argos location.

When a tag is recovered, the 100% data percentage indicates that 100% of the archived dataset was extracted.

Report Components

A data report is an Excel file (.xls) containing a series of maps, datasheets, and charts that display and organize the received dataset.

Map

The map displays the tag's estimated light-based geolocations (bright blue) and a five-day running average (purple). The deployment location (green), first Argos location (red), and subsequent Argos locations (from the drifting transmitting tag; yellow) are displayed.

Sunrise and Sunset Times

This datasheet contains the tag's estimated daily sunrise and sunset times (GMT). The corresponding depths at these times (5.4 m resolution) are provided.

Longitude Plot / Latitude Plot

The tag's daily latitude and longitude estimates (red) are independently displayed versus time, and the five-day running average (yellow) is included. The deployment location (green), first Argos location (red), and subsequent Argos locations (from the drifting transmitting tag; orange) are displayed.

Lat&Long

This datasheet contains the tag's daily estimated geolocations and the five-day running average values. The estimated latitude and longitude points are at best accurate to ±1° for latitude and ±0.5° for longitude. Typically latitude locations are calculated within the range of 65°S–65°N, but the bounds may be extended for tag deployments at extreme latitudes.

Deployment information (provided by the user) and first Argos date and location are included. The pop-off release mechanism reason is indicated. The 100% data percentage indicates that 100% of the archived dataset was extracted.

Light Chart / Combined Chart / Press Chart / Temp Chart

These charts display time-series depth, temperature, and light-level data in various combinations.

Archival Data

This datasheet contains time-series depth, temperature, and light-level records. Data are sorted by date and time starting at the beginning of deployment. Depending on the deployment duration, the data may be split between multiple "Archival Data" datasheets.

Depth resolution is 0.34 m. X-Tags can represent depths in the range 0–1296 m, although this maximum depth may vary slightly between tags.

Temperature resolution varies between 0.16–0.23 °C in the standard temperature range of -4–40 °C. However, recovered X-Tags can capture temperatures between -36.09–81.02 °C with corresponding resolutions measuring up to 0.42 °C at the extreme temperatures.

Light-level records do not have units. Full light saturation corresponds to ~4091.

Recovered Standard Rate X-Tag

Column	Column Title	Description
A	Date/Time	Date and time of records (GMT)
B	Temp Val	Raw temperature value (no units)
C	Press Val	Raw pressure value (no units)
D	Light Val	Light-level value (no units)
E	Temp (°C)	Temperature in units of degrees Celsius
F	Depth (m)	Depth in units of meters

Real-Time Data

This datasheet contains real-time depth and temperature records.

Column	Column Title	Description
A	Date/Time	Date and time of records (GMT)
B	Temp Val	Raw temperature value (no units)
C	Press Val	Raw pressure value (no units)
D	Temp (°C)	Temperature in units of degrees Celsius
E	Depth (m)	Depth in units of meters

Argos Data

This datasheet contains the Argos estimated positions of the *transmitting* tag. The "LC" ("Location Class") column indicates the quality of the position estimate with 3 being the best and Z representing the lowest quality (order in decreasing quality: 3, 2, 1, 0, A, B, and Z).

When a tag is in transmission mode, Argos estimates the tag's position based on the Doppler shift of the tag's frequency during each satellite pass. Argos uses Kalman filtering or least-squares processing for estimating positions. Please refer to the Argos User's Manual or contact CLS for more information regarding Argos position estimates.

Text Files

Each report is accompanied by text files (.txt) containing the received dataset. Most information is organized in the Excel file. Shaded information is not included in the Excel file.

Recovered Data-File (xxxxx_RecoveredData.txt)

This file contains time-series pressure, temperature, and light-level records.

1	**Index**	Day of deployment (engineering)
2	**Date**	Date (GMT)
3	**Time**	Time (GMT)
4	**Bit**	Engineering value
5	**Temp Val**	Raw temperature value (no units)
6	**Pres Val**	Raw pressure value (no units)
7	**Light Val**	Light-level value (no units)

a-File (xxxxxa.txt)

This file contains the Argos locations estimated during data transmission phase.

1	**Date/Time**	Date and time (GMT)
2	**Location**	Quality of Argos location
3	**Latitude (1)**	Latitude (°N)
4	**Longitude (1)**	Longitude (°W)
5	**Latitude (2)**	Latitude (°N) (mirror image location should be disregarded)
6	**Longitude (2)**	Longitude (°W) (mirror image location should be disregarded)

e-File (xxxxxe.txt)

This file contains daily summary data including sunrise/sunset times and daily minimum/maximum temperature, pressure, and light-levels records.

1	**Date**	Date
2	**SR min**	Time (GMT) of sunrise in minutes (out of 1440 minutes in the day); 2047 indicates that no sunrise was determined
3	**SR Time**	Time (GMT) of sunrise (hours:minutes)
4	**SS min**	Time (GMT) of sunset in minutes (out of 1440 minutes in the day); 2047 indicates that no sunset was determined
5	**SS Time**	Time (GMT) of sunset (hours:minutes)

6	**Min Light**	Daily minimun light level (hexadecimal)
7	**Max Light**	Daily maximum light level (hexadecimal)
8	**Min Press**	Daily minimum pressure value (hexadecimal)
9	**Max Press**	Daily maximum pressure value (hexadecimal)
10	**Min Temp**	Daily minimum temperature value (hexadecimal)
11	**Max Temp**	Daily maximum temperature value (hexadecimal)
12	**SR Press**	Pressure value at time of sunrise (hexadecimal)
13	**SS Press**	Pressure value at time of sunset (hexadecimal)

o-file (xxxxxo.txt)

This file contains the real-time data from data transmission phase.

1	**Date/Time**	Time registered by tag at time of transmission (GMT)
2	**Real Time**	Time registered by Argos at time of transmission (GMT)
3	**Temp**	Real-time temperature records
4	**Batt.**	Real-time battery values
5	**Press**	Real-time pressure records
6	**Light**	Real-time light-level records
7	**Tx Cnt**	Transmission counter (loops 0–31)
8	**Tx Mode**	Transmission mode (0 indicates continuous transmission and 1 indicates transmission only in Satellite-in-View [SiV] windows)
9	**Midnight**	Calculated daily midnight (GMT)
10	**SR Cnt**	Number of days since tag has registered a sunrise (0–15)
11	**SS Cnt**	Number of days since tag has registered a sunset (0–15)
12	**Pop Reason**	Code for pop-off release mechanism initiation reason
13	**Pop Day**	Date of pop-off release mechanism initiation (GMT)
14	**Pop Time**	Time of pop-off release mechanism initiation (GMT)

rp-file (xxxxxrp.txt)

This file contains real-time pressure records from data transmission phase (same pressure records as o-file)

1	Date and time (GMT)
2	Real-time pressure records

rt-file (xxxxxrt.txt)

This file contains real-time temperature records from data transmission phase (same temperature records as o-file).

1	Date and time (GMT)
2	Real-time temperature records

Measurement Resolution Summary

Measurement	Resolution	Range
Time-series depth records	0.34 m	0–1296 m (approximate maximum depth)
Real-time depth records	1.34 m	Not applicable. Real-time data only received if tag is at the surface (0 m).
Time-series temperature records	*0.16–0.42 °C	-36.09–81.02 °C
Real-time temperature records	0.16–0.23 °C	-4–40 °C
Latitude estimates	±1° (at best)	65°S–65°N
Longitude estimates	±0.5° (at best)	-180°W–180°W
Sunrise/Sunset Depth	5.38 m	0–1296 m (approximate maximum depth)

* Temperature resolution varies between 0.16–0.23 °C in the standard temperature range of -4–40 °C. However, recovered X-Tags can capture temperatures between -36.09–81.02 °C with corresponding resolutions measuring up to 0.42 °C at the extreme temperatures.