

# WGFP\_Enc\_Summaries\_RShinyApp How-To

Location:

U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detectors\CodingDetectors\WGFP\_Enc\_Summaries\_RShinyApp

## Table of Contents

Uses.....	3
General Notes.....	3
How to Open .....	4
Navigating the App .....	5
About/How to Use Tab.....	5
Individual Datasets Tab.....	5
Encounter Histories Tab .....	5
Encounter Release History Summary Wide .....	5
All Encounter Histories.....	8
Sequences.....	14
Examples .....	15
Weekly States Tab.....	21
States Dataframe.....	21
States and Days Wide .....	22
Unknown States .....	22
Daily Movements Map, Plots, and Data .....	22
“Movements” Defined .....	22
Map and Table .....	23
Plots .....	24
Pressure Transducer, USGS and Detection Distance.....	26
Time Series.....	26
Movements Overlay.....	27
Variable Correlations .....	27
Detection Distance .....	28
QAQC Tab.....	28
Marker Tags .....	28
Release and Recap Lengths/Weights, Growth Rates.....	30
Unknown Tags.....	30
Ghost Tag Movements.....	31
Crosstalk QAQC .....	31
Detection Distance/Water Level.....	32

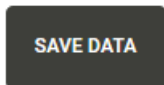
Adding/Removing Dummy rows in the data.....	32
Data Used in the App .....	33
Tabular data: WGFP_dataclean_vis2.0\data.....	33
Spatial Data: WGFP_dataclean_vis2.0\gis.....	36
Updating the App.....	36
File Readins.....	37
Updating file names .....	37
Other Data Updates .....	37
Creating New Flat Files/Running the Script.....	37
Common errors.....	38
Modifying, Updating, Adding New Antenna/Stations.....	39
Updating the code and data that wrangles the tabular data.....	39
Adding or updating layers on the map .....	43
Functions.....	45
All_Combined_events_function.....	45
Spatial_join_function .....	48
PrepareforStatesMovementsandSummary_function.R.....	49
Get_movements_function.....	54
Get_States_function.....	55
Shapefile/Polygon Readins.....	57
.Rds files .....	57
Advantages of .rds files in this app .....	58
Shiny Modules.....	58
Site, Movement and Species Colors.....	59
Known Bugs .....	59
Sequences.....	59
Movements .....	59
Crosstalk QAQC.....	59

## Uses

- Combines, cleans, and displays data from Stationary OregonRFID readers, Biomark antennas, mobile runs, Recaptures, release data, pressure transducers, site visits, and USGS in one location.
- Shows fish movement by day in map, table, plot, and custom animation
- Shows dataset of physical “states”
- QAQC of marker tags, lengths and weights, unknown tags, crosstalk, ghost tag movements

## General Notes

- All plots are interactive. Hover over plot for more info and toggle what is displayed by clicking and double clicking items in the legend. Zoom in by clicking and dragging within the plot.
- Datatables are also interactive. Click the column titles of any column to sort in ascending/descending order. You can use the Search bar on the right to search/filter for any specific values. Most of the individual filters work, some don't, depending on column type I believe.
- It's important when adding a new updated file to the app that it had the exact same column names and order as the older file
- Data displayed in tables is often downloadable
  - When the table is accompanied by this download button, all data within the table will be downloaded



- When the table is accompanied by this download button, only the data that is displayed on the screen will be downloaded. Display all rows of the table to download all data in this table.

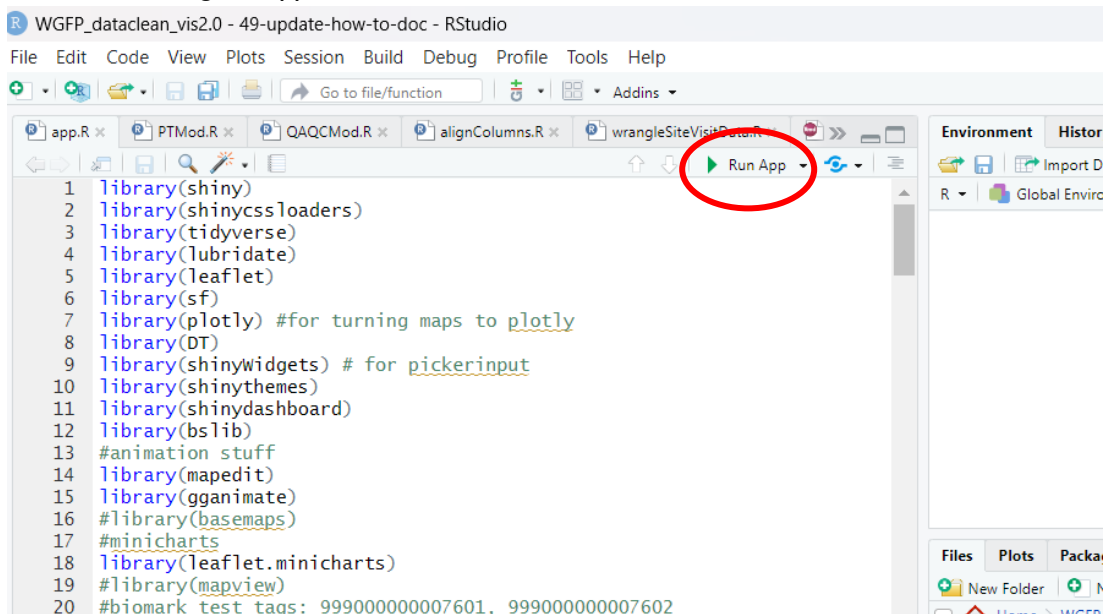


- UTM's for stationary and biomark stations are assigned in the metadata file
- DTY field for Stationary Antenna data refers to Detection Type in the raw .txt files but refers to date in the app

## How to Open

### OPENING FROM U: DRIVE

1. Navigate to  
U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detectors\CodingDetectors\WGFP\_Enc\_Summaries\_RShinyApp and open the WGFP\_dataclean\_vis “R Project” file. Rstudio will open
2. If the “app.R” file isn’t already open in the top left panel: in the bottom right panel, navigate to the “files” tab and open the app.R file.
3. Click “Run App” in the top right of the screen. You may be required to download some packages if this is the first time running the app.



Note: It typically takes 20-40 seconds to read in all files from the app. If you are frequently opening and closing the app in one session, you can speed this process up by reading in the files to your local environment. These files are located in the “data read ins” section of the app.r file. To read them in, select all the code in this section, then use cntrl+enter to run this code. It takes 20-40 seconds to read in the files but once you do this, when you run the app each subsequent time, it will boot right up in a couple seconds.

```
# Data Read Ins -----
start_time <- Sys.time()
print("Reading in Static Files for app....")
if(!exists("combinedData_df_list")){
  combinedData_df_list <- readRDS("data/flatFilesforApp/combinedData_df_list.rds")
}
if(!exists("indiv_datasets_list")){
  indiv_datasets_list <- readRDS("data/flatFilesforApp/indiv_datasets_list.rds")
}
if(!exists("Enc_release_data")){
  Enc_release_data <- readRDS("data/flatFilesforApp/Enc_release_data.rds")
}
if(!exists("states_data_list")){
  states_data_list <- readRDS("data/flatFilesforApp/states_data_list.rds")
}
if(!exists("movements_list")){
  movements_list <- readRDS("data/flatFilesforApp/movements_list.rds")
}
if(!exists("Marker_tags")){
  Marker_tags <- readRDS("data/flatFilesforApp/Marker_tags.rds")
}
if(!exists("unknown_tags")){
  unknown_tags <- readRDS("data/flatFilesforApp/unknown_tags.rds")
}
```

## Navigating the App

### About/How to Use Tab

This tab is a concise version of this document. It doesn't have much there now but can be modified to include the most relevant pieces of the how-to doc.

### Individual Datasets Tab

This Tab shows data incorporated into the app from different sources.

- Stationary Clean: A clean dataset of all Stationary antenna data with added UTM's, no marker tags, or duplicate rows. All timestamps and dates are in the same format. 900\_ is taken off of the tags. See cleanStationary function in update data app for more info on cleaning.
- Biomark: All Biomark combined detections from Kaibab Park/Granby Diversion and both Windy Gap Sites including Marker Tags
- Mobile: All Detections from all Mobile Runs
- Recaptures: All Recaptured fish
- Release: All release data along with frequency plots for length and weight. Note: entries with no L/W listed won't show up in the plot
- Ghost Data: a list of ghost tags that also have a "ghost date" associated with them, or the date they turned into a ghost tag
- Aviation predation: list of tags with a "predation date" associated with them when they turned into a predated tag
- Pressure Transducers: a combined dataframe of all pressure transducer data in the app
- USGS 15 Minute Data: USGS Data from their website from the stream gauge at Hitching Post. As of 5/22/2024, only water temp and discharge are read in
- Site Visit Data: Combined site visit data from all stationary and biomark sites.

### Encounter Histories Tab

**Encounter Release History Summary Wide:** shows ENC\_Release\_wide\_summary Dataframe from enc\_hist\_summary\_wide\_function.

- This tab is meant to be a summary file for all fish in "wide" data format. Each tag will have just one entry, along with release info and information about what sort of Events it has experienced over its life.
- Filters are pretty self-explanatory. Click Render Table/Data to display new tables with filters.
- **Should be same amount of entries as release file**
- Columns and filters to note:
  - SiteCode\_n is the raw number of detections at one antenna, or recaptured, etc.
  - SiteCode/Recapture binary columns are just whether or not a fish was detected or captured by that method
  - TotalEncounters adds the number of unique Events (a recapture, stationary detection, mobile detection, etc). There is a filter for this column in the sidebar.
  - Through\_dam tells whether a fish has gone through the dam or through the connectivity channel in its history, based on release info, recaps, and detections. It does NOT tell if a fish went upstream or downstream through the dam. There is also a filter for this in the sidebar
  - CondensedAllStates is a quick history of the "states" dataframe (see Weekly States Tab) for each fish. Consecutive, identical letters are removed, leaving only the concise history. There is a filter for this in the sidebar.
  - ChannelSummary: tells if a fish has had ANY detection on any CRCC channel
  - Went\_above\_dam\_no\_channel and subsequent columns are derived from the States function, which tells if a fish went below/above the dam using the channel or not from upstream or downstream,

compared to `through_dam` which simply says if a fish has gone through the connectivity channel or dam or not. These columns give more specific info than `through_dam`, telling *how* the fish got above/below the dam: whether through the connectivity channel or not, and whether they started upstream or downstream. For example, a “TRUE” value in `went_above_dam_no_channel` would mean that the fish started below the dam, made it above the dam, but didn’t use the connectivity channel. Get-`states_function` section for more details

- `Sum_dist` is the total number of meters travelled by a fish in its history. There’s a filter for this in the sidebar.
- This is a good tab to see how many fish have swam through CRCC, fish that have swam a long way, or find fish with extensive encounter histories while being able to filter on tag number, species, length/weight, Release Site.

### Examples

- Finding fish that have swam through the CRCC, specifically down through, that were less than 350mm.

*Strategy 1: Using Above/Below/Through\_dam*

- Adjust the filters pictured to desired categories and render table

Filter by Tag

Select Fish Species:

LOC, MTS, NO INFO, RBT, RXN, TGM

Fish Length (mm)

0 350 663

Fish Weight (grams)

0 3,383

Select Release Site:

BELOW CONFLUENCE ANTENNA, BELOW RED BARN DIVERSION #1, BELOW RED BARN C

Total Number of Unique Events/Encounters:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Total distance travelled (m)

0 148,430

Above/Below/Through the Dam:

WENT THROUGH DAM OR CONNECTIVITY CHANNEL

RENDER TABLE/DATA

- Scroll to the column `went_below_dam_throughChannel` and select “true” from the filters here

went\_below\_dam\_throughChannel

["true"]

true

- c. Scroll back to the beginning of the table and view the row numbers. There have been 6 fish of length 350 or below that have swam through the connectivity channel from upstream to downstream (as of 5/14/2024).

	River	Run
230000143924	Colorado River	Lower Ri Run
230000143976	Colorado River	Lower Ri Run

Showing 1 to 6 of 6 entries (filtered from 127 total entries)

- i. Note that the A fish registers TRUE in went\_below\_dam\_throughChannel not solely if it is detected in the CRCC (see All Events and plot for that example), but only if the fish was actually detected in CRCC then subsequently detected (whether at RB, HP, Biomark, recapture, or mobile run) downstream of CD or CS.

### Strategy 2: Using Condensed States

- A fish will have the history "BCA" at some point (See "Weekly States tab") if they have been recorded above the CRCC (whether by mobile detection, recapture, biomark or stationary antenna), then detected by any of the CRCC antennas, then was recorded downstream of the channel (whether by mobile detection, recapture, biomark or stationary antenna). In the sidebar filter, find and select those instances, in addition to changing the "Fish length" filter

SELECT ALL	DESELECT ALL
ABABAB	
ABABCA	✓
ABC	
ABCA	✓
ABCB	
AC	
ACA	
ACB	
ACBCB	
ACBCBCA	✓
AG	
AP	
B	
BA	
BABA	
BABG	
BAC	
BACA	
BAP	
BC	
BCA	✓
BG	

ABABCA, ABCA, ACBCBCA, BCA

- Render this table, and here you can see again the 6 fish we found in strategy 1

State Summary

ABABCA, ABCA, ACBCBCA, BCA

RENDER TABLE/DATA

230000143924	4	Colorac River
230000143976	4	Colorac River

Showing 1 to 6 of 6 entries

- This differs from finding “Sequences” in the CRCC (see “Sequences”) because the states include recaptures, release, and mobile detections. However, you can’t see timeframe with this data; use the Sequences tab or plug the tag into “ALL Encounter Histories” for that

- Identify Fish to explore as potentially avian predated
  - Fish that have swam abnormally long distances may have been avian predated. Adjust the distance moved filter and render table

Total Number of Unique Events/Encounters:

0, 1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 11, 12, 13

Total distance travelled (m)

0

10,628

148,430

Above/Below/Through the Dam:

STAYED ABOVE THE DAM, STAYED BELOW THE DAM, WENT THROUGH DAM OR CONNEI

RENDER TABLE/DATA

- Scroll to the “sum\_dist” column and click it to sort by ascending

US

sum\_dist

148430

65130

- Scroll back to the beginning of the table to view the tag names, then manually view the encounter history of each tag in the movements tab or “All Encounter Histories” to see if their encounter history makes spatial and chronological sense. Lots of these tags may already be in the avian predation file, so check that file in the “individual datasets” tab to see if that tag has already been accounted for.

**All Encounter Histories:** Shows and plots All\_Events Dataframe from All\_combined\_events\_function. These are all detections/events combined, including Statoinary, Biomark, and mobile antennas; recaptures and releases. 230000142723 has over 120k detections on its own at Hitching Post.



- Most filters are self-explanatory, but a the checkboxes are important to note:
  - Display USGS Discharge Filter allows you to filter data based off USGS discharge reading at Hitching Post within 13 hours of the detection (in winter, they record the data every 8-12 hours, 15 minutes in the summer). However, not every detection has an associated discharge reading because of this, so those rows get filtered out of the dataset immediately if you use this filter
  - Display Environmental Data Filter allows you to filter data based off Pressure Transducer readings at specific sites within one hour of the detection. However, only sites that have a transducer at them will get this data associated with their detections and only within one hour, so using this filter will automatically filter out rows of data that do not have any of these readings associated with the detections.
  - Remove Duplicate Days, TAGs, Events and UTM's condenses detections into the first and last detections of the day as well as any other antenna detections with unique UTM's. In this way, it filters out most of the redundant detections across days. For example, using this filter condenses TAG 230000142723 down to 996 entries. This equates to about 259 days of detections from May 6, 2021 to Feb 3, 2022. All at Hitching Post.
    - The df that results of this filter used on all detections is downloaded, brought into GIS, and used to make stations with, which is then subsequently used to make the "movements" df with.
    - This is one of the most "useful" files you can get from this app because of how it shaves off the dataset to the most relevant detections.
  - Remove Duplicate Tags Filter will remove instances where there are multiple detections of the same tag. This is helpful in answering questions involving "How many unique fish?". Example: on this tab you could answer the question "How many unique rainbow trout over 250 mm hit Windy Gap Biomark and Hitching Post antennas during the day in spring 2021?"
- The plot will plot anything made with the filtered data and the frequency table will display the raw number of detections from that filtered data for each antenna

### Examples

- How many fish released in 2023 were detected in the CRCC in Fall 2023?
  - In the filters tab, change the following filters:

**Filter by Tag**

**Select a Date Range:**

2023-10-01 to 2023-12-31

**Hour of Day**

0 23

**Select Event**

CD1, CD2, CS1, CS2, CU1, CU2

**Select Fish Species:**

LOC, MTS, NO INFO, RBT, RXN

**Fish Release Length (mm)**

63 663

**Fish Release Weight (grams)**

2 3,383

**Release Date Range:**

2023-01-01 to 2023-12-31

**Select Release Site:**

BELOW CONFLUENCE ANTEN

And make sure the “Remove Duplicate Tags” filter is checked before clicking “render table”

☐ Display USGS Discharge Filter

☐ Display Environmental Data Filters

☐ Remove Duplicate Days, TAGs, Events and UTMs

☒ Remove Duplicate TAGs: doesn't work with TAG filter

**RESET FILTERS**

Note: If there are any NA entries in any of the applicable filters (especially the numeric ones), those rows are excluded from the table.

**RENDER TABLE**

- The code filters the data based on the date range and events selected, then removes instances where the same tag shows up multiple times under these filters. The result is a df of unique tags that qualify for those filters. Find the number of fish by viewing the row number: 21

023-12-31

NTEN

Charge

ntal Data

Days, UTM's

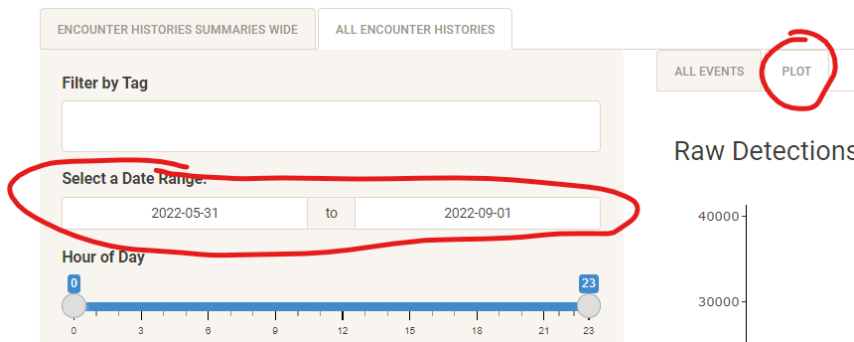
230000144338 2023-10-27

230000144373 2023-10-28

230000144331 2023-11-01

Showing 1 to 10 of 21 entries

- Which antenna had the most raw detections in summer 2022?
  - Select a date range, render the table, and navigate to the "Plot and Table" tab



- Scroll to the "Raw Detection Frequencies by Event" table to see the distribution of events during that time frame: Looks like HP3 had the most raw detections.

Raw Detection Frequencies by Event

Copy CSV Print Show 10 entries Search:

Event	Raw Detections
All	All
HP3	840487
WG1	606174
CF6	399632
HP4	300309
GD1	168594
WG2	98010
RB1	97001
RB2	72061
CF5	19243
Release	4837

Showing 1 to 10 of 22 entries Previous 1 2 3 Next

- These numbers can shoot up if a fish is sitting on an antenna for a long amount of time. If we want to get a better picture of how much activity actually occurred on a daily level between antennas, we can use the "Remove duplicate days, tags, events and UTM's" filter described above.

☐ Display USGS Discharge Filter

☐ Display Environmental Data Filters

☒ Remove Duplicate Days, TAGs, Events and UTM's

☐ Remove Duplicate TAGs: doesn't work with TAG filter

- The result shows a much better representation of what is going on at the sites across this timeframe, showing instances where fish had their first and last detections of the day and all detections in between. Hitching Post saw a lot of action.

Event	Raw Detections
All	All
HP3	1398
HP4	1139
RB2	402
RB1	337
CF6	246
Release	218
GD1	132
Recapture	65
WG1	52
CF5	49
Recapture and Release	10

Showing 1 to 11 of 11 entries

Previous 1 Next

- Why might CF5 have so much less action than CF6? To answer this, there's a few things to check. My first thought would be that there's a sculpin hanging out on just CF. We can go back to the "All Events" tab, select just those antennas in the "Event" filter, and scroll through the data so see if this is true

- We see that there are a lot of different tags on CF6 during this timeframe, so that theory doesn't work. Next thought is if the detection distance was very low, or the antenna was just off during this time. To check that data, we go to the QAQC tab.

- Under "Marker Tags", can check if the antenna was running. Select CF5 and CF6 from the options, select all marker tags, change the timeframe to what we were looking at before, and render the data. Then toggle the plot displays by clicking in the legend.



- What we learn is that CF5 actually didn't seem to be working for much of this time period. If you were to turn on CF6 on the map, you'd see marker tag detections pretty consistently across the same timeframe. This explains the discrepancy between CF5 and CF6 during this timeframe.
- Seeing a Fish's Full Encounter History/Investigate Individual Tag for Avian Predation
  - Using one of the tags found (could be from by sorting on distance moved on the Encounter Histories Summaries Wide tab, seeing something in the states tab, seeing quick movement in the movements tab), we copy and paste that tag into the "All Encounter Histories" Tab. For example, I found 230000143683 (a big rainbow trout) by filtering for fish on Encounter Histories Summaries Wide tab that had 11 or more "events".
  - Once the table is rendered, you can scroll to look at the fish's history (it default sorts by datetime). This fish has 630 encounters.

Showing 1 to 200 of 630 entries

Scrolling through this data, you find yourself seeing a lot of detections on the same antenna across a bunch of days that doesn't tell you much. However, using the "Remove duplicate days, tags, events and UTM's" filter here is helpful again, preserving useful detections and removing ones that are unnecessary. In this case, it takes the total encounters down to 104.

230000143683	2022-10-15	18
--------------	------------	----

230000143683	2022-10-15	18
--------------	------------	----

Showing 1 to 10 of 104 entries

- Now this is easier to view. The Encounter history of the fish started with its release 2022-10-5, hit WGI until the antenna was taken out of the river 2022-11-02. It hit hitching post and red barn next spring intermittently, including missing hp3 in late May, a time when the marker tag on HP3 wasn't being registered consistently (seen from the Marker tag QAQC tab). It was recaptured in June at lower Red Barn Fry Site and was registered as having grown 9mm in length. In December 2023, it made its way up the CRCC, hitting CD in December then resuming its journey in March, hitting CU March 12, then hit CF a week later where its more or less stayed since then (as of 5/14/2024). Based on this encounter history, I'd say the fish is not a tag succumbed to avian predation, just well-travelled.

## Sequences

This is where you can pick a first antenna (or multiple), a last antenna (or multiple), and antennas in between then find instances where a fish have hit that sequence, and how long it has taken. This is an attempt to be able to easily answer questions like "How many times have fish used the connectivity channel?" or "are there any fish that have gone from Red Barn to the Granby Diversion Antenna?"

To use, select a downstream site (or more) and then select an upstream site (or more). Select Date range if desired. The table will then show instances where a fish has started at the first site(s) then was detected at the last site(s) with instances of middle detections in between. In the above example, this is helpful in showing instances where fish have moved through the CRCC (with CD, CS as first sites and CU as the last site).

Select First Antenna(s) in Sequence:  
CD, CS

Select Last Antenna(s) in Sequence:  
CU

ADD SITE DROP SITE

Date  
31 Aug 20 17 May 24  
31 Aug 20 26 Feb 22 24 Aug 23

RENDER

SAVE DATA

Instances of Detections Between CD, CS and CU with middle antennas

Show 10 entries Search:

TAG	DatetimeDetectedAtFirstAntennas	DatetimeDetectedAtLastAntennas	Time Between First/Last Detections (User Friendly)	Time Between First/Last Detections (For Sorting)
All	All	All	/	/
230000143234	2024-01-09T12:50:26Z	2024-05-05T15:04:08Z	117.09 days	-10116822
230000143620	2023-10-26T16:47:39Z	2024-04-12T02:40:36Z	168.41 days	-14550777
230000143637	2024-04-21T20:25:27Z	2024-04-22T02:15:51Z	5.84 hours	-21024

- fish that have traveled multiple times in the sequence will have multiple rows
- Ghost tags recorded in the ghost tags csv are included,
- I added a user-optional filter to include avian predation tags in results. Not all screenshots have this included because I added it later.
- Mobile detections, recaptures, and release data are NOT included
- A fish starts the sequence when it last hits the first site antenna and ends it when it first hits a site antenna from the last antenna
- For example, a fish could hit CD1 at 2023-11-03 12:04:15, hit CD2 on 2023-11-04 19:03:54, hit CS2 on 2023-11-06 03:34:41, hit CUI on 2023-12-01 11:04:05, and CU2 on 2023-12-02 4:55:02. The Date/time sequence for this instance would be "2023-11-03 12:04:15" for the "DatetimeFirstDetectedatFirstAntennas" column, and 2023-12-01 11:04:05 for the "DatetimeFirstDetectedatLastAntennas" column. The time between US/DS detections would register as 28 days.
- When multiple antennas are selected for first and/or last, the sequence begins on the last instance of one of the first antennas. For example, if you have "CD, CS" selected for the Downstream antennas and a fish has hit CD2 on 2023-11-04 19:03:54, hit CUI on 2023-12-01 11:04:05, and CU2 on 2023-12-02 4:55:02, the sequence will show up with 2023-11-04 19:03:54 in the "DatetimeFirstDetectedatFirstAntennas" column and 2023-12-01 11:04:05 in the DatetimeFirstDetectedatLastAntennas column.
- If there are other antennas that were hit in between the selected upstream sites and selected downstream sites, it breaks the sequence. So if you selected "HP" for first and "CF" for last, the results would not include fish that used the CRCC or hit WGI/2 along the way to get there. If you wanted to find these results, click "add site" and select all those antennas as the middle antennas.

- You cannot use a first/last antenna as one of the middle antennas, so sequences like “RB -> HP ->RB -> HP” aren’t possible
- However, you CAN use the same antenna for first/last, so sequences like “RB -> HP -> RB” are possible to find.
- Use “All Encounter Histories” tab to plug in individual tags and investigate results you feel don’t line up with what you’d expect to see in the results
- There’s currently a bug that I’m not really able to replicate where sometimes you click “add site” and multiple inputs pop up off of that one click, instead of just one. If this happens, restart the app.

## Examples

- How many time have fish have swam up the connectivity channel?
  - Selecting CD, CS as downstream antennas and CU as upstream antennas can tell you how many times fish have used the channel.

The screenshot shows a mobile app interface with the following elements:

- Select First Antenna(s) in Sequence:** A dropdown menu with the text "CD, CS" and a downward arrow.
- Select Last Antenna(s) in Sequence:** A dropdown menu with the text "CU" and a downward arrow.
- Buttons:** Two buttons labeled "ADD SITE" and "DROP SITE" are positioned below the dropdowns.
- Date:** A date range selector with a timeline. The start date is "31 Aug 20" and the end date is "17 May 24". The timeline has markers for "31 Aug 20", "26 Feb 22", and "24 Aug 23".
- RENDER:** A button at the bottom of the form.

- Check the number of rows in the dataframe to get the answer: 20 times (as of May 27, 2024). A couple fish have made this journey multiple times.

Showing 1 to 10 of 20 entries

- How many times have fish swam from Confluence to Hitching Post through the channel in 2024?
  - Select the appropriate filters, using “Add Site” to include CRCC antennas in the desired sequence.
    - Note: There’s a difference in selecting this sequence vs just selecting “CU, CD, CS” in just one middle antenna input. Selecting all the CRCC antennas in the same “middle antennas” input would allow for the fish to have a history like “2024-01-02 13:00:00 CF, 2024-01-03 15:00:00 CU, 2024-01-04 13:00:00 HP” and get included in the results dataframe when it misses CD/CS detections. The current inputs state that the fish have to first hit CF, then CU, then CD or CS before hitting Hitching Post. Another example: in a hypothetical scenario a fish could have this history: “2024-01-02 13:00:00 CF, 2024-01-03 15:00:00 CU, 2024-01-04 13:00:00 CS, 2024-01-08 13:00:00 CU, 2024-01-08 13:00:00 HP”. With the current inputs, this instance would not be included in the results data, but if the inputs were instead changed to “CF”, then “CS/CD/CU”, then “HP”, then this instance would be included since the fish just needs to have hit *any* of the selected middle antenna, not in a specific order.

Select First Antenna(s) in Sequence:

CF

Select Next Antenna(s) in Sequence:

CU

Select Next Antenna(s) in Sequence:

CD, CS

Select Last Antenna(s) in Sequence:

HP

ADD SITE

DROP SITE

Date

31 Aug 20

27 Dec 23 — 17 May 24

31 Aug 2028 Feb 2224 Aug 23

RENDER

- In this case, there has been one fish (as of May 27 2024).

SAVE DATA

Instances of Detections Between CF and HP with middle antennas CU, c("CD", "CS")

Show10entries

Search:

TAG	DatetimeDetectedAtFirstAntennas	DatetimeDetectedAtLastAntennas	Time Between US/DS Detections (User Friendly)	Time Between US/DS Detections (For Sorting)
All	All	All	/	/
230000143888	2024-04-15T21:49:42Z	2024-04-16T02:36:37Z	4.78 hours	-17215

Showing 1 to 1 of 1 entries

Previous1Next

- We can plug this tag number into the “All Encounter Histories” tab or Movements tab to get more details about that instance.



Filter by Tag  
230000143888

Select a Date Range:  
2020-08-01 to 2024-05-17

Hour of Day  
0 to 23

Select Event  
CD1, CD2, CF5, CF6, CS1, CS2, CU1, CU2, G1, GD1, HP3, HP4, M1, M2, RB1, RB2, RECAPT

Select Fish Species:  
LOC, MTS, NO INFO, RBT, RXN, TGM

Fish Release Length (mm)  
63 to 663

Fish Release Weight (grams)  
2 to 3,383

Release Date Range:  
2020-08-31 to 2024-05-17

Select Release Site:  
BELOW CONFLUENCE ANTENNA, BELOW RED BARN DIVERSION #1, BELOW RED BARN

Display USGS Discharge Filter

ALL EVENTS PLOT

SAVE DATA

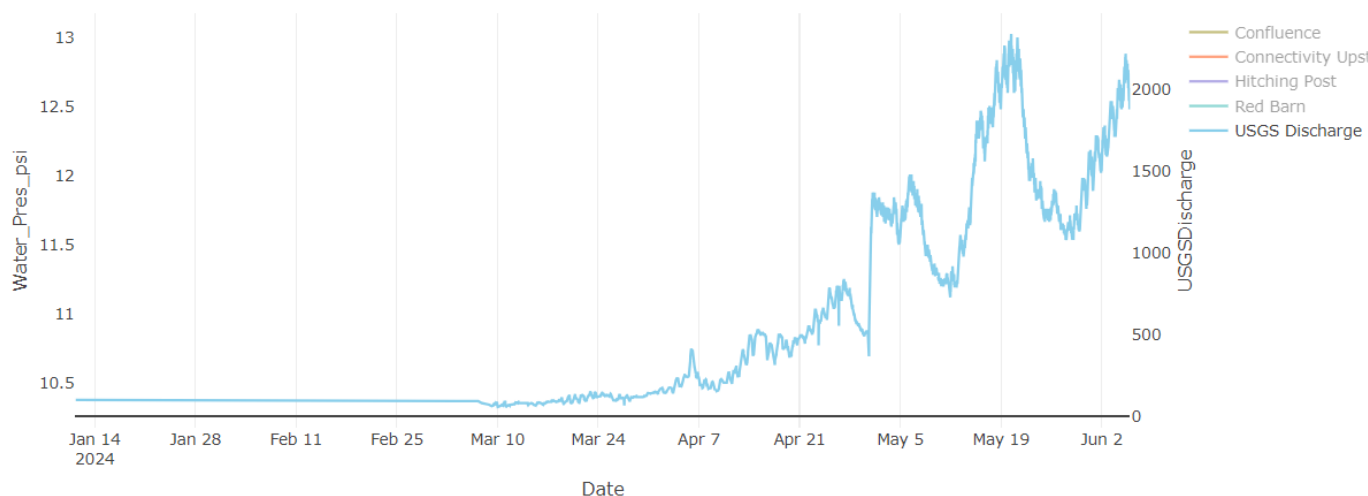
Show 10 entries Search:

TAG	Date	Time	Datetime	Event	Species	Release_Length	Release_Weight	ReleaseSite	Release_Date
All			A			All	All	All	All
230000143888	2023-09-06	13:00:00	2023-09-06T13:00:00Z	Release	RBT	187	66	Kalbab Park	2023-09-06
230000143888	2024-04-15	21:49:42	2024-04-15T21:49:42Z	CF5	RBT	187	66	Kalbab Park	2023-09-06
230000143888	2024-04-15	22:48:25	2024-04-15T22:48:25Z	CU2	RBT	187	66	Kalbab Park	2023-09-06
230000143888	2024-04-15	22:48:32	2024-04-15T22:48:32Z	CU1	RBT	187	66	Kalbab Park	2023-09-06
230000143888	2024-04-16	00:57:17	2024-04-16T00:57:17Z	CD2	RBT	187	66	Kalbab Park	2023-09-06
230000143888	2024-04-16	00:57:18	2024-04-16T00:57:18Z	CD1	RBT	187	66	Kalbab Park	2023-09-06
230000143888	2024-04-16	00:57:20	2024-04-16T00:57:20Z	CD1	RBT	187	66	Kalbab Park	2023-09-06
230000143888	2024-04-16	02:36:37	2024-04-16T02:36:37Z	HP4	RBT	187	66	Kalbab Park	2023-09-06

Showing 1 to 8 of 8 entries Previous 1 Next

- One interesting takeaway is that the fish missed detection on CF6 and HP3 in its journey. A quick look at the marker tags data (see QAQC-Marker tags) shows us that the antennas were functioning well during that time. If you look at the time between the detections though, you'll see it took only 4.78 hours late at night for the fish to travel that far; it was moving super fast. Looking at the movements data –map and table tab in the “MPerSecond” column, we can see specifically that between CF and CU, the fish moved an average of 0.01 m/s, between CU and CD it moved .18 m/s, and between CD and HP it moved .34 m/s.
  - Note: on this fish since this movement spanned across multiple days, it has this more detailed speed travelled, but if the fish had just moved from CF to HP in one day (whether or not it hit CD, CU or CS in between), you would only see an average speed for that movement
- A quick look at the discharge data (see “Pressure Transducer, USGS and Detection distance” tab) shows that flows measured at HP really started to rise around then, so it had some good momentum.

## Environmental Time Series Data



- What is the quickest time it's taken a fish to swim from RB to Hitching Post?
  - Select “RB” as the first antenna and “HP” as the last one. Render the data then click “Time Between First/Last Detections (for sorting)” to sort the results in either ascending or descending order.

## Instances of Detections Between RB and HP with middle antennas

Show  entries Search:

TAG	DatetimeDetectedAtFirstAntennas	DatetimeDetectedAtLastAntennas	Time Between First/Last Detections (User Friendly)	Time Between First/Last Detections (For Sorting)
<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="/"/>	<input type="text" value="/"/>
230000228275	2021-04-29T10:46:53Z	2021-04-29T11:25:03Z	38.17 minutes	-2290
230000228275	2021-04-27T07:29:57Z	2021-04-27T08:10:32Z	40.58 minutes	-2435
230000228275	2021-04-21T17:52:03Z	2021-04-21T18:35:20Z	43.28 minutes	-2597
230000228314	2021-05-03T11:19:50Z	2021-05-03T12:21:01Z	1.02 hours	-3671

There was a fish that has gone multiple times in under an hour upstream from RB to HP. This is a bit of a red flag! Input the tag number into the “All Encounter Histories” tab to investigate further and record this in the avianpredation.csv if judged to be predation.

- How many fish have gone through the dam to go upstream since the connectivity channel was built vs before?
  - Set filters to below dam antennas for the first antennas, then the upstream of dam filters for the last antennas. Set the date range to “pre CRCC antenna construction” and filter out instances of avian predation

**Select First Antenna(s) in Sequence:**

**Select Last Antenna(s) in Sequence:**

**Date**

☐ ☒ Exclude Avian Predation Tags

- Here we get 44 instances where non-avian predated fish\* have gone upstream through the dam
  - \*based on what is in the avian predation file. This tab could be used as another check to add tags to that file, especially using these filters
- Change the filters to post-CRCC construction

Select First Antenna(s) in Sequence:

HP, RB, WG1, WG2

Select Last Antenna(s) in Sequence:

CF, GD1

ADD SITE DROP SITE

Date

31 Aug 20 06 Oct 23 — 17 May 24

31 Aug 20 26 Feb 22 24 Aug 23

☒ Exclude Avian Predation Tags

RENDER

- Here we see only 3 instances of that sequence since CRCC was built
- To compare, add a Site and adjust the filters as you wish

Select First Antenna(s) in Sequence:

HP, RB, WG1, WG2

Select Next Antenna(s) in Sequence:

CD, CS, CU

Select Last Antenna(s) in Sequence:

CF, GD1

ADD SITE DROP SITE

Date

31 Aug 20 06 Oct 23 — 17 May 24

31 Aug 20 26 Feb 22 24 Aug 23

☒ Exclude Avian Predation Tags

RENDER

- In this instance, there's one instance of a tag recording this sequence. Since the CRCC hasn't been built long, a better measure might just be to exclude the below dam antennas.

Select First Antenna(s) in Sequence:

CD, CS, CU

Select Last Antenna(s) in Sequence:

CF, GD1

ADD SITE DROP SITE

Date

31 Aug 20 06 Oct 23 — 17 May 24

31 Aug 20 28 Feb 22 24 Aug 23

☒ Exclude Avian Predation Tags

RENDER

- These filters yield 24 instances. However, it should be noted that this would include fish that might have swam down from CF, hit CU, then headed back to confluence. To get the more-desired sequence, the following filters might be most helpful.

Select First Antenna(s) in Sequence:

CD, CS

Select Next Antenna(s) in Sequence:

CU

Select Last Antenna(s) in Sequence:

CF, GD1

ADD SITE DROP SITE

Date

31 Aug 20 06 Oct 23 — 17 May 24

31 Aug 20 28 Feb 22 24 Aug 23

☒ Exclude Avian Predation Tags

RENDER

- This yields 17 instances of fish who have used this sequence.
- Interpret the data how you feel especially given how you can change the filters, but it's important to know what they are showing about the data. This would definitely suggest that fish are travelling upstream more now that the CRCC is built (17 instances vs 3 instances) but it's not exactly a straightforward comparison. When the Windy Gap Biomark antenna is consistently deployed, that may be a good way to level the comparison because then maybe we can see more clearly when fish come up to the dam, then decide which way of passage to use.

## Weekly States Tab

This is where “States” are displayed. The states are defined on a weekly basis as A (below the dam), B (above the Dam), C (in the Connectivity channel), G (ghost tag detection), or P (predated by bird). A weekly “Unique event” is a filter in the sidebar, and is defined as a detection on a new antenna for that week, recapture, or release. A fish could have 6 different events in a week, but if they are all below the dam, it will just get assigned state “A” for that week.

## States Dataframe

- The States filter in the sidebar can help determine “magic” fish that may have succumbed to avian predation, since they hit multiple weird states in a week. For example, 230000228444 has one week where it transitions at confluence, then red barn, then confluence again.
- Det\_type column is useful when there is only 1 state of the week, but doesn’t accurately capture everything if there are multiple states on a week
- Date is the day that the week starts, not when the actual detection(s) happened.
- C\_number\_of\_detections is the total number of raw detections for the week. Might be 22k, might be 1.
- Weekly\_unique\_events is the total number of events that happened in a week. This can also be helpful in finding “magic” fish.
- These states are used to determine the columns “went\_below\_dam\_throughChannel” etc in “All Encounter Histories Summary Wide” tab, because if a fish started upstream then used the channel, it will have B then a C somewhere in its history

## Examples

- Here is the fish 230000228709, a sizable brown trout.

Show  entries

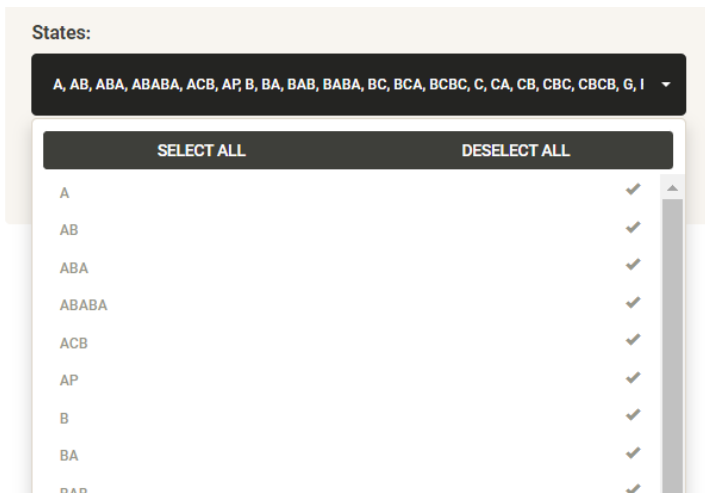
Search:

Date	weeks_since	TAG	State	det_type	ReleaseSite	Species	Release_Length	Release_Weight	c_number_of_detections	weekly_unique_events
<input type="text"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text"/>	<input type="text"/>	<input type="text" value="All"/>	<input type="text"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>	<input type="text" value="All"/>
2020-10-06	5	230000228709	A	Release	Hitching Post	LOC	360	505	1	3
2020-10-13	6	230000228709	A	Hitching Post Stationary Antenna	Hitching Post	LOC	360	505	4	2
2020-10-21	7	230000228709	A	Mobile Run	Hitching Post	LOC	360	505	1	1
2021-01-27	21	230000228709	A	Hitching Post Stationary Antenna	Hitching Post	LOC	360	505	4	2
2021-02-24	25	230000228709	A	Hitching Post Stationary Antenna	Hitching Post	LOC	360	505	4	2

Showing 1 to 5 of 5 entries

Previous  Next

- Finding Avian Predated Fish to Investigate
  - Use the “States” filter to view all the different states that fish have been in in a week. Select the most dubious like ABABA, BAB, etc.



- Copy Tag number and investigate in the “All Encounters” or “Movements” tab

Showing 1 to 1 of 1 entries

Date	weeks_since	TAG	State	det_type	ReleaseSite	Species
2021-05-14	36	230000272182	ABABA	Hitching Post Stationary Antenna	Chimney Rock Below Island	LOC

## States and Days Wide

This is the same data displayed in `States_dataframe`, but in wide format where each unique tag gets a row and each column is a day since the beginning of the study. This may have a bit more rows than the release file because there are some fish in there without release info, but should typically have the same

## Unknown States

This is where events that were unable to be captured by states are displayed. This hopefully should be pretty small...it's filled with tags with detections before official 'Release' such as in May 2021 and tags without release info. Mainly tags without an idea where they came from. But if a Tag shows up where release info is known, might have to go into the `get_states_function.R` code to make another case\_when entry to account for the new state. All in all, this is a check to see how well the `get_states_function` is working, and also to see if fish without release info have gotten by the other filters.

## Daily Movements Map, Plots, and Data

Displays data of “movements” (Movement\_table\_no\_transitions from `Get_movements_function`), where a fish has changed position along the river.

## “Movements” Defined

Movements are inferred by encounters of the same tag on different antennas (including mobile runs) or recaptures throughout the river. Each detection along the river is assigned a “station”, breaking up the centerline of the stream into 10 m increments. The stations start at 0 m, starting about 150 m below the Sheriff Ranch Fry Site. They extend to 13480 m on the Upper Colorado River, where the mobile run begins, and to 22850 m (10120 m at confluence + 12730 m from confluence to Fraser River canyon) on the Fraser River (5/23/2024).

These stations, which are made in GIS from stream centerlines, are joined by coordinates to a dataset of all relevant detections for each unique UTM, using the `Spatial_Join_function`. The resulting dataset is passed back to a larger dataset of all detections to assign stations to all UTMs. From there, the data is condensed down to a dataset of daily fish detections, keeping the first and last detections of the day and one detection in between. Wacko fish/avian predation that hit multiple different antenna in between the first and last detection of the day won't display all of these detections. Example: tag 230000272182. These CAN be seen in the states and All Events dataframes though.

Once there is a dataset of daily movements, the distance moved between days is calculated for each fish when a new detection is recorded, calculated by taking the difference between stations.

### Types of Movement

- Upstream movement: positive difference between stations (IE new detection station = 8000, previous detection station 6000, so  $8000 - 6000 > 0$ ; upstream movement).
- Downstream movement: negative difference between current station and previous station (new station = 6000 m, old station is 8000 m,  $-2000 < 0$ ; negative movement).
- No movement: the previous station and current station are the same (IE new station = 8000, previous station = 8000. Difference = 0, no movement). Consecutive detections at the same stationary antennas spanning more than one day are registered as no movement.
- Changed Rivers: Where a fish has moved from the Fraser River to the Upper Colorado (above the confluence) or vice versa. (IE a fish was detected on a mobile run on the upper Colorado but its release site was Fraser River Ranch. Although this is no upstream/downstream movement, the total distance moved in one example is 1910 meters, since that is the summed distances of Fraser River Ranch to the confluence + confluence to gps coordinates where the fish was detected on the Upper Colorado mobile run).
- Initial Release: Event when the fish was released. Used to establish the first station on the river that a fish was seen.

The absolute value of total distance moved is summed for each fish and displayed in the movements tab under "sum\_dist". It also seen in the Encounter Histories created in the `Ind_tag_enc_hist_summary_wide` function.

- Filters in the sidebar control what is displayed on the map or plot
  - USGS Data is combined with movements on a *daily* level, contrasted with events in All Encounter Histories where PTdata and USGS data is associated with an event within 13 hours for USGS data and 1 hour for PTdata
  - Like the Environmental Filters and USGS data filters in Encounter Histories Tab, using the filters for Release length, USGS WaterTemp, and USGS Discharge will automatically filter out rows that don't have that data associated with the movements. All the Tiger Musky in the release file for example don't have release length/weight data so they don't show up on the map/table/plots if the release length filter is on

### Map and Table

- This tab can be used to answer questions like "what time of year are fish moving?" and is the easiest/funniest way to examine individual tag histories. A method I frequently use is to find fish that have moved a long distance or have weird daily states recorded, copy and paste the tag, and plug it into this tab. Or find an event on the map, click on it, copy the tag number, and plug that in.
- Map is interactive, where you can click and hover to get more info about a movement. Clicking on an event in the map will navigate to the event column in the table, and vice versa.
- Can be used to help find suspect avian predation tags by clicking/sorting on the `dist_moved` and `MetersPerSecondBetweenDetections` columns
- Note: if there aren't any data to display after the filters are applied (ie no data fit that criteria), then the app will crash and the following error message appears in the console:

```
Warning: Error in $<-.data.frame: replacement has 2 rows, data has 0
```

You can restart the app and everything works fine, just know that those filters meant there were no data to show.

MAP AND TABLE MINICHARTS MAP MOVEMENT GRAPHS			
	dist_moved	MPerSecondBetweenDetections	sum_dist
	A	All	
Antenna	-1030	-0.006507126250884464	1030
Antenna	0	0	1030
ry Antenna	-4790	-0.02201701607380067	4790

- Layer control is available in top right, controlling detections, antennas, Release Sites, Stream centerlines, Stations that were used to make these movements, and mobile reaches. Note that loading the Stations takes about 10 seconds and can also slow map performance.

Show 25 entries

Search:

Date

Datetime

TAG

movement\_only

det\_ty

All

All

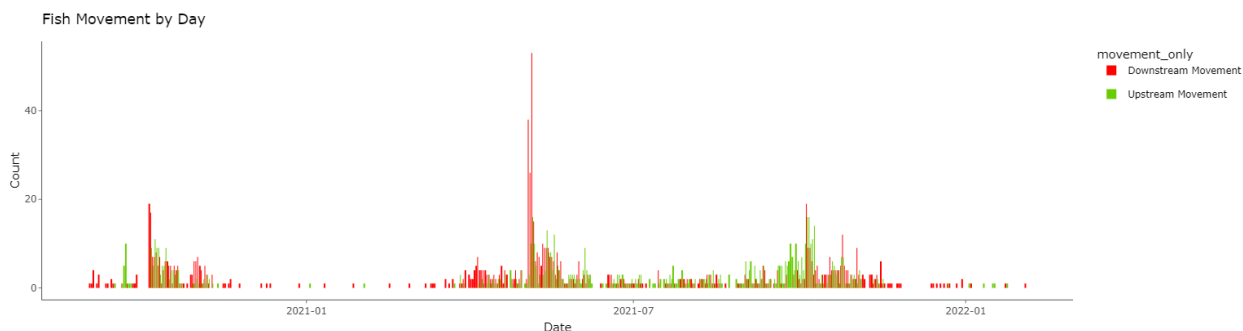
All

2020-10-05	2020-10-05T11:20:00Z	230000228444	Initial Release	Release
2020-10-19	2020-10-19T16:20:00Z	230000228444	Upstream Movement	Mobile
2021-04-12	2021-04-12T13:15:00Z	230000228444	Downstream Movement	Mobile
2021-06-03	2021-06-03T15:40:18Z	230000228444	Downstream Movement	Confluent
2021-06-03	2021-06-03T15:40:31Z	230000228444	No Movement	Confluent
2021-06-04	2021-06-04T07:07:39Z	230000228444	No Movement	Confluent
2021-06-04	2021-06-04T08:42:44Z	230000228444	Downstream Movement	Red Bank
2021-06-04	2021-06-04T11:19:35Z	230000228444	No Movement	Red Bank
2021-06-04	2021-06-04T12:14:38Z	230000228444	Upstream Movement	Confluent
2021-06-07	2021-06-07T05:39:56Z	230000228444	No Movement	Confluent
2021-06-08	2021-06-08T06:40:35Z	230000228444	No Movement	Confluent
2021-07-26	2021-07-26T12:05:05Z	230000228444	Upstream Movement	Mobile
2021-07-26	2021-07-26T14:40:00Z	230000228444	No Movement	Mobile

Leaflet | Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, Aerogrid, IGN, IGP, UPR-EGP, and the GIS User Community

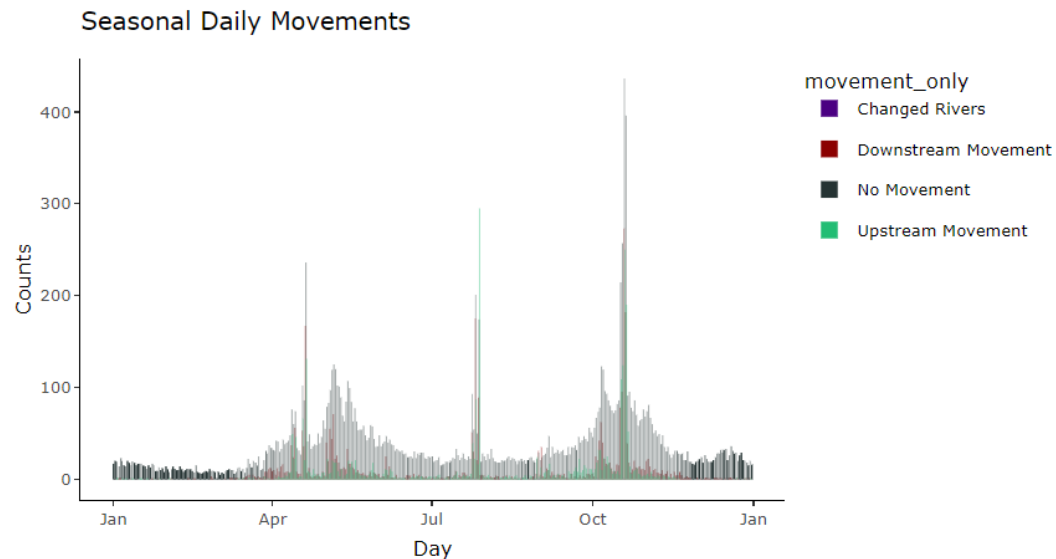
## Plots

- The plots are also controlled by the sidebar filters
- See “types of movements” above for movement definitions
- Fish Movement by Day: simple histogram representation of movements across time, colored by movement type
  - Note: data can be misleading if mobile detections aren’t filtered out, as these cause big spikes in movement activity the day of the mobile run. Activity is also generally higher after release events as well.

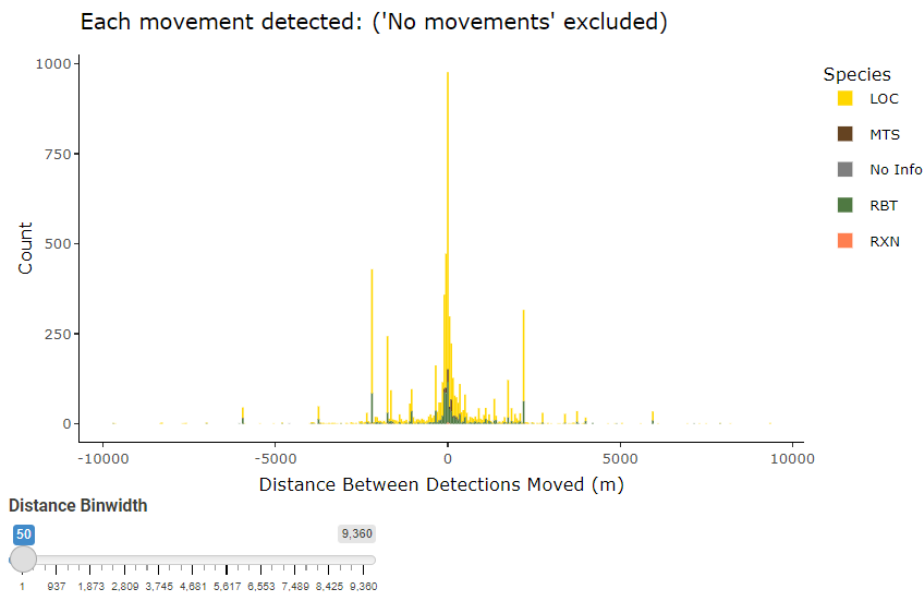


- Seasonal Daily Movements: Same plot as above but grouped by day across the years, which is helpful in seeing seasonal movement trends (big spikes here are probably mobile runs)

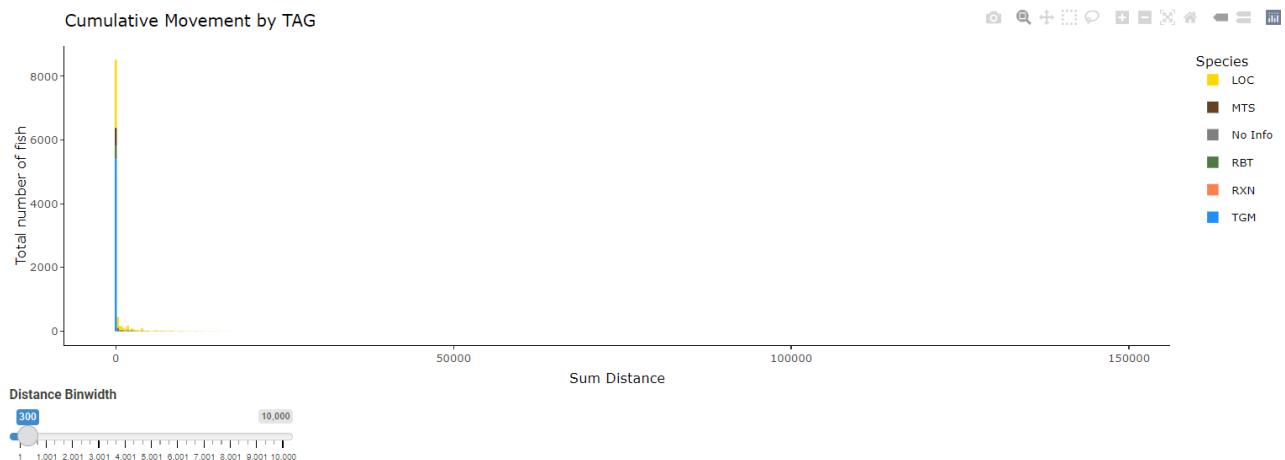




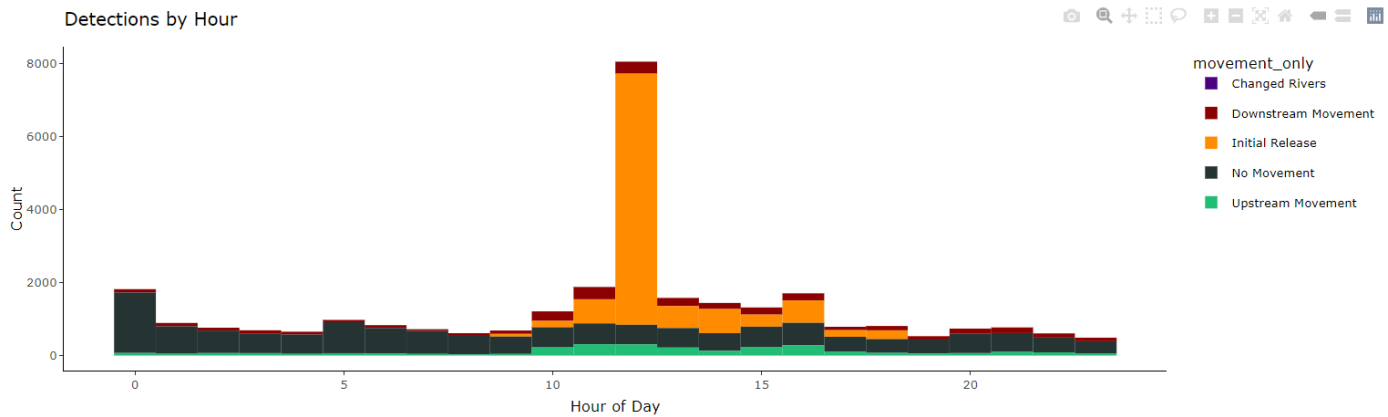
- Individual Movements: showing all the times a fish has moved (upstream, downstream or changed rivers) upstream and changed rivers are positive integers, downstream is negative. Note the spikes around 2200m due to fish travelling between red barn and hitching post, a distance of 2190m according to the stations.



- Cumulative Movement: the amount each fish has moved in absolute distance, in meters, in total over the course of its life.

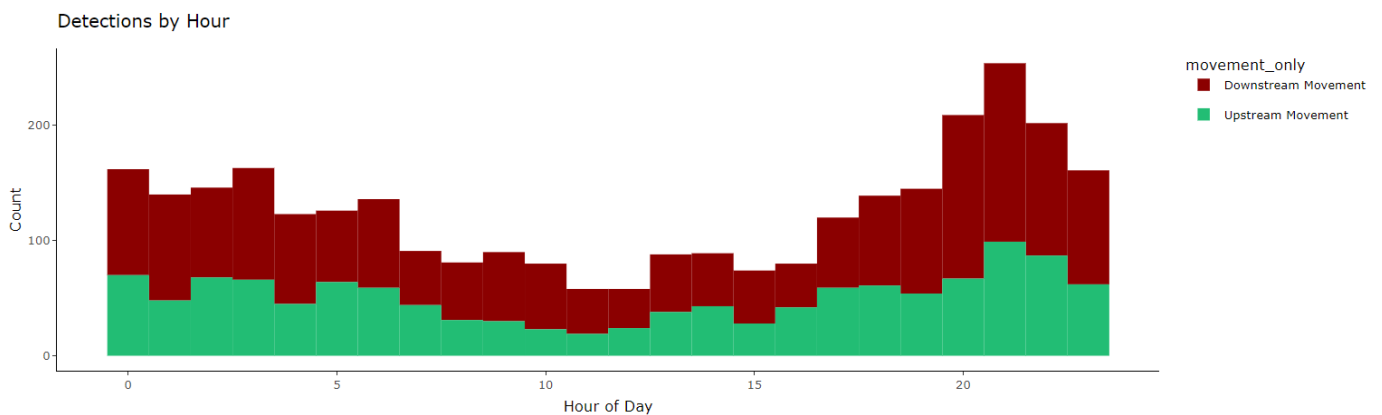


- Movement by hour: displays how many movements have been recorded during each hour of the day. Can be skewed towards hour 0 (12:00 AM) especially if a fish is hanging out on an antenna, since the movements df take the first and last activity of a fish during the day as well as unique events in between.



Data may be misleading. Movements are calculated by the day and if a fish has multiple detections on the same day at the same antenna, the first detection will be used which can fall commonly at hour 0

- If “No Movements” and “initial release” are filtered out from movement type, and “mobile detections”, “release” and “recaptures” are filtered from movement types, you get movements registered by antennas in the river from fish that are not hanging out on antennas for weeks at a time.



## Pressure Transducer, USGS and Detection Distance

This tab shows graphical representation and overlays of data from Pressure Transducers, USGS and Detection Distance from Site Visits.

- Water\_level\_Nolce is the best variable for water level. Ice readings/observations are displayed as 0.
- USGS data is all from the gauge at Hitching Post. It can be misleading if you select a site and see discharge, but it's all from the same gauge.

## Time Series

PT data with the option to overlay USGS data. You can select variables to plot and which Y axis to display it on

Select Sites:  
CONFLUENCE, HITCHING POST, I

Variable to Plot  
Water\_Pres\_psi

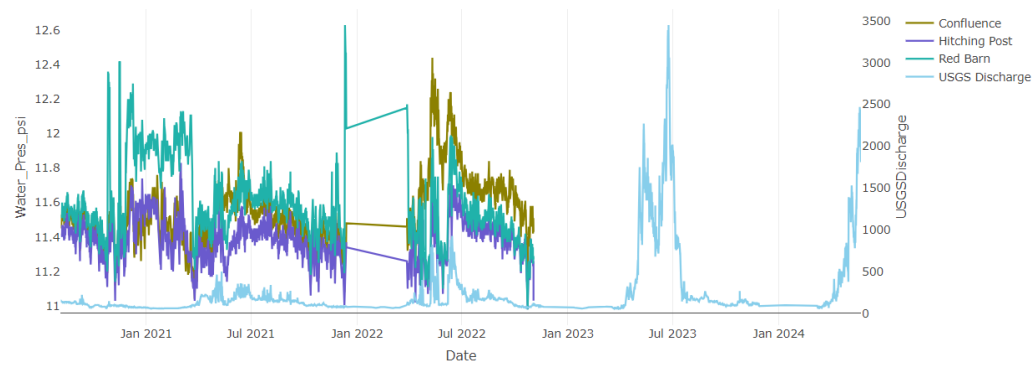
Date  
05 Aug 20 23 May 24

☒ Overlay USGS Data

Select USGS Variable  
USGSDischarge

Primary Y Axis Data  
☒ Pressure Transducer Data  
☐ USGS Data

Environmental Time Series Data



## Movements Overlay

PT/USGS data overlaid with the same movements df displayed and used in the movements tab. All the same filters are available for movements, and the graph used is the Fish Movement by Day histogram of movements across time. Use the tabs in the sidebar to get to different data filters.

MOVEMENT FILTERS ENVIRONMENTAL FILTERS

Filter by TAG  
[Input Field]

Select Movement Type:  
CHANGED RIVERS, DOWNSTRE/

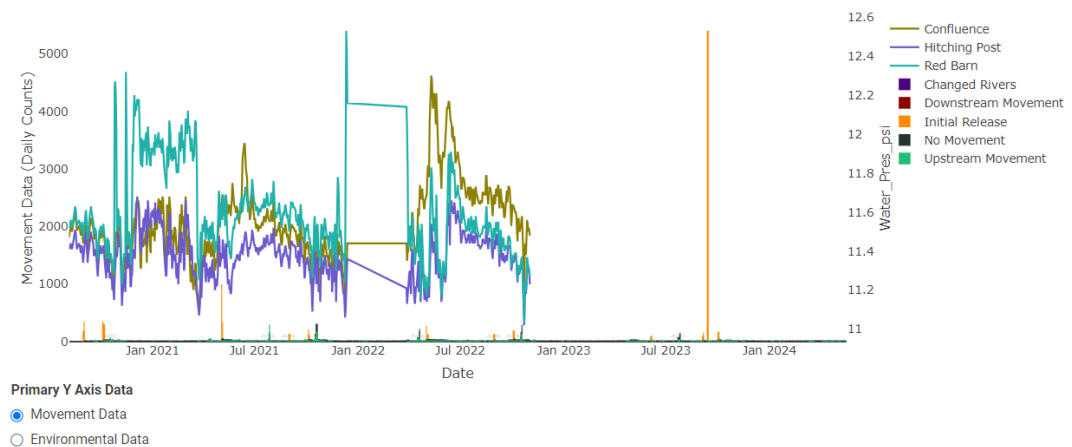
Select Detection Type  
CONFLUENCE STATIONARY ANI

Select Species Type  
LOC, MTS, NO INFO, RBT, RXN, T

Date  
31 Aug 20 17 May 24

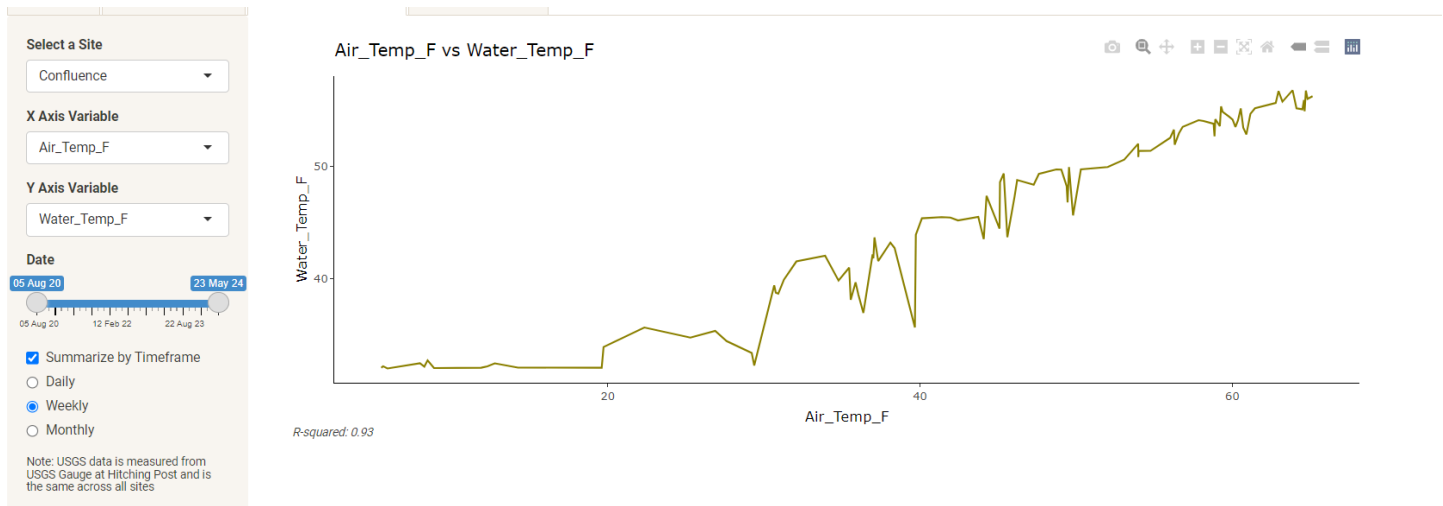
Total distance travelled (m)  
0 148,430

Environmental and Movement Data



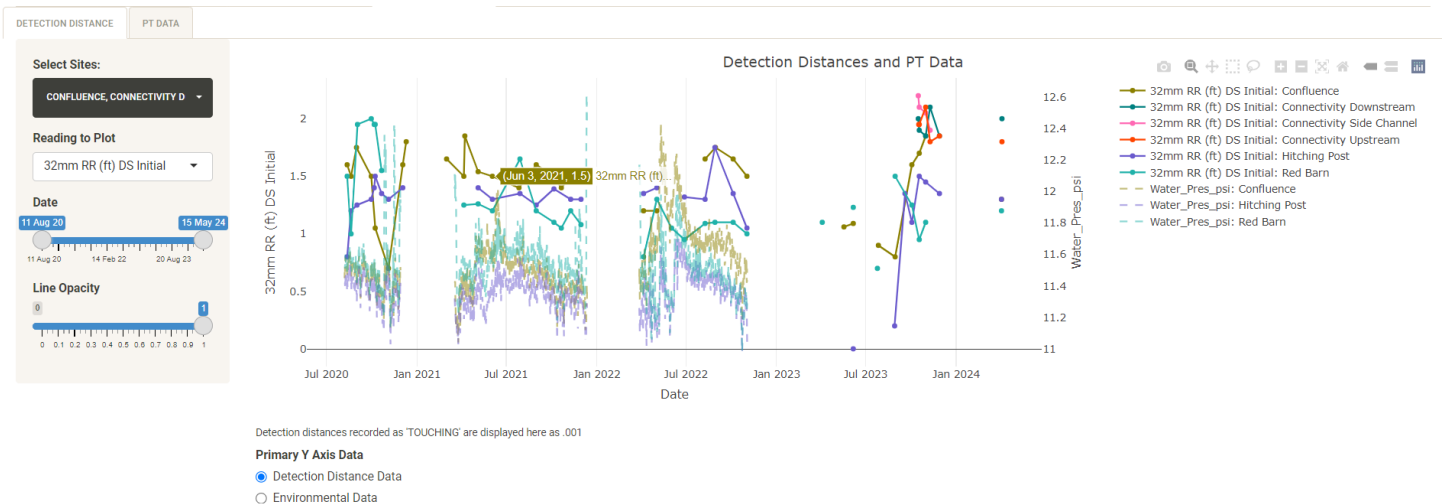
## Variable Correlations

Plot PT/USGS variables against each other. "Summarize by timeframe" is an option used to group data by specified timeframe and can get rid of daily fluctuations. R-squared value in the left graph corner is calculated and found with this function in R: `rquared = summary(lm(variableX ~ variableY))$r.squared`



## Detection Distance

Detection distance from site visits of Biomark and Stationary Sites with PT data overlaid. You can select which reading you'd like to plot from the sidebar. You can change the opacity of the lines for preferred representation as well.



## QAQC Tab

Used to help verify data.

## Marker Tags

Stationary and Biomark Marker Tag Data set from All\_Combined\_events\_function

- Helpful for finding periods of inconsistent marker tag detections, indicating antenna was not functioning properly during these time.
- In this case, there was a gap: closer examination shows there were not detections between May 21 2022 and August 9, 2022 at CF5



## Summarized Marker tag Data for Selected Tags and Sites

Show 10 entries

Date filter does not apply to this table

Site_Code	TAG	totalDetectionsSinceProjectInception
All	All	All
CF5	0000000000000000001570	100927
CF5	0000000000000000004948	81603

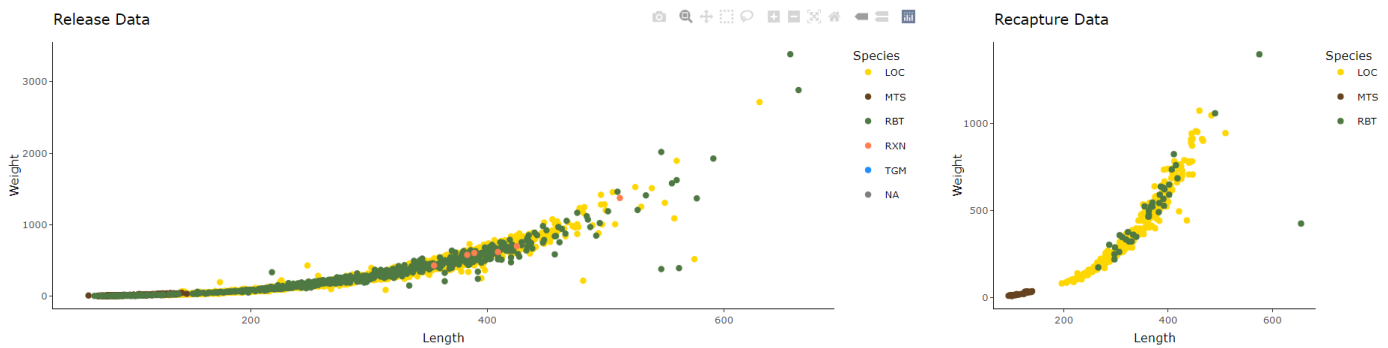
Showing 1 to 2 of 2 entries

Previous 1 Next

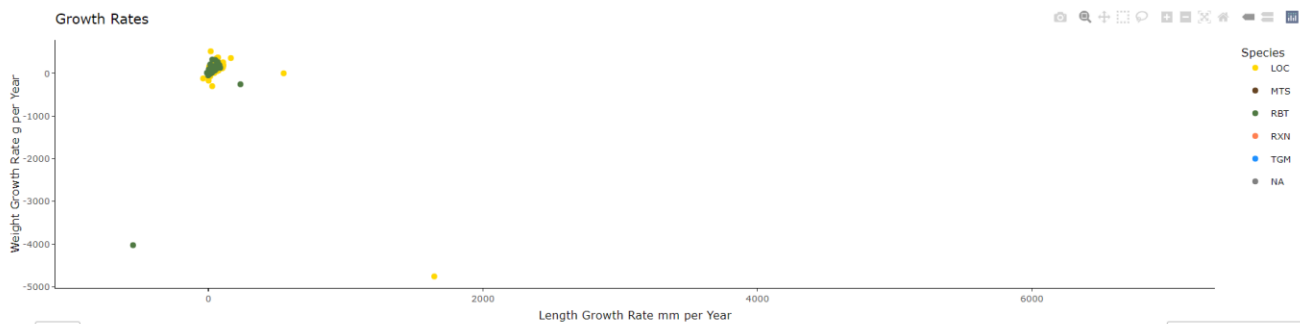
SAVE DATA

## Release and Recap Lengths/Weights, Growth Rates

- The first plots help ensure that there were no length/weight typos in the release and recapture files.



- The Growth Rates plot shows the rate of growth per year between each release/recapture instance of a fish. If a fish has been recaptured multiple times, it will have multiple points on this graph.



Show 10 entries

Data from each time a fish was recaptured

Species	Median Length Growth Rate (g per year)	Median Weight Growth Rate (mm per year)	Mean Length Growth Rate (g per year)	Mean Weight Growth Rate (mm per year)
All	All	All	All	All
LOC	43.38	95.72	66.8	91.98
MTS	7.53	4.01	7.84	3.21
RBT	40.89	124.37	29.68	-0.36
RXN				
TGM				

Showing 1 to 6 of 6 entries

Previous 1 Next

## Unknown Tags

- List of Tags without release info but started with 900\_ initially and have detections on some sort of antenna
- Display of Enc\_hist\_wide\_summary\_function output "Unknown Tags"

Show  entries

Tags that initially started with 900\_ but are not marker tags, test tags, or part of the release file.

TAG	Length	Weight	RB1_n	RB2_n	HI
All					
00000495240232787684					
10240123810058196921					
450115000072106					
00000247620116478391			1		

## Ghost Tag Movements

A df made from the “Ghost Tags” csv input. This shows registered ghost tags that have moved >0m after their assigned ghost date. This is helpful in revising the ghost tags file if one erroneously turns out to be a fish.

- Table is automatically sorted by “total\_distmovedAfterGhostDate” so the most problematic-looking fish are first displayed
- antennasDetectedAfterGhostDate is a vector of all antennas that have detected the tag after the ghost date. If the tag was identified as a ghost tag somewhere near upstream of a stationary antenna, it isn’t uncommon to see the tag be detected on that antenna during a high flow event
  - To get more context, you can check USGS discharge in the “Pressure Transducer, USGS, and Detection Distance” tab, find the discharge associated with that specific detection within 13 hours in “Encounter Histories – All Encounter Histories, or find the daily discharge associated with each daily movement in “Daily Movements” tab – Map and Table – “USGSDischargeDaily” column
- If a fish is moving upstream significantly after its ghost date, it might be worth investigating. This is seen by sorting/clicking the “maxUpstreamDistMovedAfterGhost” column.
- Movements of 10-50m ish between mobile runs can typically be attributed to GPS variation

Ghost Tags To Double Check: each of these tags has moved > 0m since its assigned Ghost Date.

TagID	GhostDate	antennasDetectedAfterGhostDate	total_distmovedAfterGhostDate	maxUpstreamDistMovedAfterGhost	Notes
All	All	All	All	All	All
230000272949	2021-07-28	Mobile Run	230	0	Likely Ghost; Big fish location and probably date of 7-28-21); gho: 26-23
230000142602	2021-07-28	Mobile Run	220	20	confirmed using enc

## Crosstalk QAQC

Marker Tag crosstalk, where the tag goes off on one antenna but also registers on the other antenna as well, has been occurring frequently on CD since its installation. This tab is meant to monitor crosstalk instances of *Fish*, where a non-marker tag is registered at both antennas of a site at the exact same time.

Is created from combinedData\_df\_list\$All\_Events, originally stemming from All\_combined\_events\_function().

- Summary Table shows the percentage of fish detections across the selected timeframe have been recorded at the exact same time
- Individual site tabs show when those simultaneous detections occurred
- There are instances where the simultaneous detections occurs naturally. In the app, milliseconds are not used, but the data coming off the readers do use milliseconds. Sometimes there are instances where a fish is recorded

milliseconds apart on different antennas, but these will show up as the exact same timestamp in the app. However, when CD is doing it far more frequently than the other sites, that probably means something more is going on.

Date

31 Aug 20

03 Feb 24 — 17 May 24

31 Aug 20 14 Jan 21 30 May 21 13 Oct 21 26 Feb 22 12 Jul 22 25 Nov 22 10 Apr 23 24 Aug 23 07 Jan 24 17 May 24

RENDER TABLE

SUMMARY TABLE

RB

HP

CF

CD

CS

CU

Crosstalk Occurrence Percentage

Copy

CSV

Print

% of FISH detections on each antenna with the exact same timestamp. Detections in raw data may differ by milliseconds, but milliseconds are not used in the app data.

AntennaCodes	PercentageOfDetectionsWithSameTimestamp
RB1, RB2	0.13%
HP3, HP4	0.00%
CF5, CF6	0.00%
CD1, CD2	1.26%
CS1, CS2	
CU1, CU2	0.00%

Showing 1 to 6 of 6 entries

May take a few seconds to load

## Detection Distance/Water Level

Shows a color coded table of SiteVisitAndPTData, a joined df of PTdata and Site Visit Data by time to the nearest 13 hours.

- Using the variable “Water\_Level\_Nolce\_ft”, this table colors red the 32mm readings that are *below* the observed water level and green *above or at* the observed water level
- Helpful for identifying periods where detections may have been missed because of high flows.
- Readings that were entered as “TOUCHING” are changed here to .001

Copy CSV Print Show 25 entries Search:

Green cells show where 32mm detection distance is greater than or equal to water level, red is where 32mm detection distance is less than water level. Water level readings are within 13 hours of site visit.

Date	Time	Site	Water_Level_Nolce_ft	32mm RR (ft) DS Initial	32mm RR (ft) US Initial	32mm RR (ft) DS Final	32mm RR (ft) US Final	32mm Center (ft) DS Initial	32mm Center (ft) US Initial
All		/	All	All	All	All	All	All	All
2023-06-06T00:00:00Z	09:00:00	Hitching Post		0.001	0.7				
2023-08-29T00:00:00Z	14:28:00	Hitching Post		0.2	1.2			0.25	1
2023-07-25T00:00:00Z	16:58:00	Red Barn		0.7	1.2			0.65	1
2020-11-04T00:00:00Z	13:20:00	Confluence	0.88	0.7	1.3	0.9	1.3	0.6	
2023-08-30T00:00:00Z	15:34:00	Confluence		0.8	1.3	0.8		0.75	
2020-08-12T00:00:00Z	11:10:00	Hitching Post	0.95	0.8	1.3	1	1.3	0.9	
2022-04-06T00:00:00Z	10:30:00	Red Barn	1.28	0.8	0.2	1	1.55	0.5	
2023-07-27T00:00:00Z	09:07:00	Confluence		0.9	1.5			1.1	
2023-10-17T00:00:00Z	10:10:00	Red Barn		0.9	1.5			1.1	

- Notes: water level data is calibrated to staff gage at antenna site, but actual depths across antennas will vary

## Adding/Removing Dummy rows in the data

Dummy rows were added to the stationary, biomark, and release data using the dummy\_rows.R script to ensure the framework for new antennas was in place.



```

54 ##### This part was for checking if new antennas to be put in will work
55 source("functions/dummy_rows.R")
56 dummy_rows_list <- add_dummy_rows(stationary = Stationary, biomark = Biomark)
57 stationary <- dummy_rows_list$Stationary
58 Biomark <- dummy_rows_list$Biomark
59 Release <- dummy_rows_list$Release
60 #ghost_tag_df <- dummy_rows_list$Ghost_tags #date column is named "Ghost"
61
62

```

The rows remain while the function is ran to set the framework then the rows are removed in the data so this dummy data isn't used. The rows are removed....

- In the get\_movements\_function

```

8 movement_table_notrans <- combined_events_stations %>%
9 ##### removing dummy tag
10 filter(!TAG %in% c("230000999999")) %>%
11 select(Date, Datetime, TAG, det_type, Event, ET STATION, SI

```

- In the reactive for all events in app.r:

```

919 }
920 }
921 ##### filter dummy row
922 all_events_filtered <- all_events_filtered %>%
923 filter(!TAG %in% c("230000999999"))
924
925
926 return(all_events_filtered)
927 }) #end of ENC data list eventReactive
928
30 #daily_unique_events = length(unique(Event))
31 states1 <- wghost_av %>%
32 filter(!TAG %in% c('230000999999')) %>%
33 mutate(

```

- In get\_states\_function:
- After the functions are ran in the following individual datasets in app.r:

```

151 ### taking dummy tag out
152
153 Biomark <- Biomark %>%
154 filter(!DEC.Tag.ID %in% c("900.230000999999"))
155 Release_05 <- Release_05 %>%
156 filter(!TagID %in% c("230000999999"))
157 stationary <- Stationary %>%
158 filter(!TAG %in% c("900_230000999999"))
159
160 # Define UI for application that draws a histogram

```

- In Ind\_tag\_enc\_hist\_wide\_summary function:

```

170
171 ##### dummy rows removal: 1/14/23
172 ENC_Release6 <- ENC_Release6 %>%
173 filter(!TAG %in% c("230000999999"))
174
175

```

To put the dummy rows back in, comment out the code that filters out the dummy rows above.

## Data Used in the App

The following files are used in the app and are manually derived.

Tabular data: WGFP\_dataclean\_vis2.0\data

Stationary detections: WGFP\_Raw\_yyyymmdd.rds

- Combined and cleaned file of all stationary detections. Obtained from the “Combine data RShiny app” found at U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detectors\CodingDetectors\WGFP\_CombiningData\_RShinyApp.
- Most recent file is found at U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detectors\All\_Stationary

#### Mobile: WGFP\_Mobile\_Detect\_AllData.csv

- A combined file of all mobile detections found at U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detectors\MobileRaftAntenna\Mobile\_Detections
- Usually Eric R prepares this
- Column names and order: "Num", "River", "MobileSite", "Date", "Time", "T109\_C", "UTM\_X", "UTM\_Y", "TagType", "TagID", "Event", "Ant", "Pass", "Species", "Length", "Weight", "TagSize", "RS\_Num", "ReleaseSite", "Survey", "Notes"
- Of these, TagID, Date, Time, UTM\_X, UTM\_Y, and Ant are the most important columns

#### Biomark: Biomark\_Raw\_YYYYMMDD.csv

- Combined file of all Biomark detections, found at U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detectors\Biomark
- Made from the “Combine New Data RShiny App”
- Column names and order: "Scan.Date", "Scan.Time", "Download.Date", "Download.Time", "Reader.ID", "Antenna.ID", "HEX.Tag.ID", "DEC.Tag.ID", "Temperature.C", "Signal.mV", "Is.Duplicate", "Latitude", "Longitude", "File.Name"
- Most important columns are Reader.ID, Scan.Date, Scan.Time, DEC.Tag.ID

#### Release: WGFP\_ReleaseData\_Master\_YYYYMMDD.csv

- Master Release file of all tagged fish. Found at U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Tagging
- Column names and order: "RS\_Num", "River", "ReleaseSite", "Date", "Time", "Year", "UTM\_X", "UTM\_Y", "Species", "Length", "Weight", "TagType", "TagID", "QAQC", "TagSize", "Ant", "Event", "FinClip", "Mortality", "Comments"

#### Recaptures: WGFP\_RecaptureData\_Master\_YYYYMMDD.csv

- File of all fish that were recaptured found at U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Recaptures
- Column names and order: "RS\_Num", "River", "RecaptureSite", "Date", "Time", "UTM\_X", "UTM\_Y", "Species", "Length", "Weight", "TagType", "TagID", "QAQC", "TagSize", "Ant", "Event", "FinClip", "Mortality", "Comments"

#### Avian Predation: WGFP\_AvianPredation.csv

- csv of tags succumbed to avian predation with a date of predation found at U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detectors\AvianPredation\WGFP\_AvianPredation.csv
- used in the “States” function to assign a predated state

#### Ghost Tags: WGFP\_GhostTags.csv

- "U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detectors\GhostTags\WGFP\_GhostTags.xlsx" – Need to export/save the “Ghost tags” tab to csv
- csv of ghost tags with date of ghost tag
- used in the “States” function to assign a ghost state
- Column names: RS\_Num, River, ReleaseSite, ReleaseDate, Species, Length, Weight, TagID, TagSize, Event, GhostDate, UTM\_X, UTM\_Y, Comments

#### Metadata: WGFP Metadata.xlsx

- Found in U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detectors
- Used to keep track of antenna names, UTM's and what they're called in the data, as well as test tags, marker tag downtimes, and important stationing variables.
- Includes tabs:
  - Antenna Metadata: Used to help assign names and UTM's to the antennas
    - AntennaSite: Name of Antenna (ie Red Barn (Upstream))
    - SiteName: Name of Site (ie Red Barn Stationary Antenna). **DO NOT CHANGE THIS FIELD** for an antenna
    - FrontendSiteCode: How we want the shorthand code to display in the app. Needs to be just one entry but can be changed as you wish.
    - BackendSiteCode: code(s) that have been used in the data to denote this antenna. Make sure this code is the same ones that come off the readers: SCD field for Stationary, Reader ID for Biomark. It's ok to have multiple names for the Biomark Antennas separated by comma and a space, but not for Stationary ones
    - PressureTransducerSiteName: Name of the Site as it appears in the Pressure Transducer Data. Must be updated if new sites are added
    - DetectionDistanceSiteName: Name of the site as it appears in Site Visit/Detection Distance Data
    - UTM\_X and UTM\_Y: UTM's of the site
    - River: River it's deployed on. **DO NOT CHANGE THIS FIELD** for an antenna
    - Deployment Duration: Dates and times where they have been deployed
    - Notes: any notes on the antenna
  - MarkerTagIssues: used to keep track of downtime periods on the antennas. Displayed in the QAQC tab of Marker Tags under “Downtimes”
  - ImportantStationingVariables: Used to keep track of important sites, used for movement calculations within the app
  - TestTags: Keeps track of all test tags and removes these tag detections from the data
  - Notes: Keeps track of general metadata in the worksheet. Current notes: (5/24/2024)
    - Assumes that for AntennaMetadata, SiteName and River will not be changing. If they do change, you'll have to go into the runscript and a couple functions including "PrepareforMovementsStatesand Summaries" to change how those variables are located
    - For the biomark antennas, I don't think you can actually code the readers to detect as the frontend codes; only codes like A4,B2 etc...hence the need for frontend/backend codes
    - For antenna metadata codes, the frontend code should only have 1 entry. It's ok for the biomark backend codes to have multiple entries, but not the stationary ones
    - For marker color to be assigned correctly, need to have "Biomark Antenna", "Stationary Antenna", and "Mobile Run" in SiteName
    - First data date: 2020-08-06. detections before this date are removed
    - PressureTransducerSiteName needs to line up with the sites that are in the Pressuretransducer data

#### Pressure Transducer: WGFP\_PressureTransducer\_[sitename](#).csv

- U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\Pressure\_Transducer

- Cleaned Pressure Transducer files from each site in csv form are all put into \\WGFP\_dataclean\_vis2.0\data\PressureTransducer
- **ALL FILES MUST HAVE SAME COLUMN NAMES/ORDER**

Site Visits: WGFP\_SiteVisits\_FieldData.xlsx

- U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\SiteVisits
- 2 relevant sheets, Stationary and Biomark used for detection distances.

Spatial Data: WGFP\_dataclean\_vis2.0\gis

Antenna\_sites1.shp: point file of antenna sites locations

Stream\_Centerline\_Post.shp: centerline of the Fraser, Upper Colorado, and Colorado River below windy gap

ReleaseSites2021.shp: point file of release site locations

mobile\_reaches.shp: mobile reaches extents

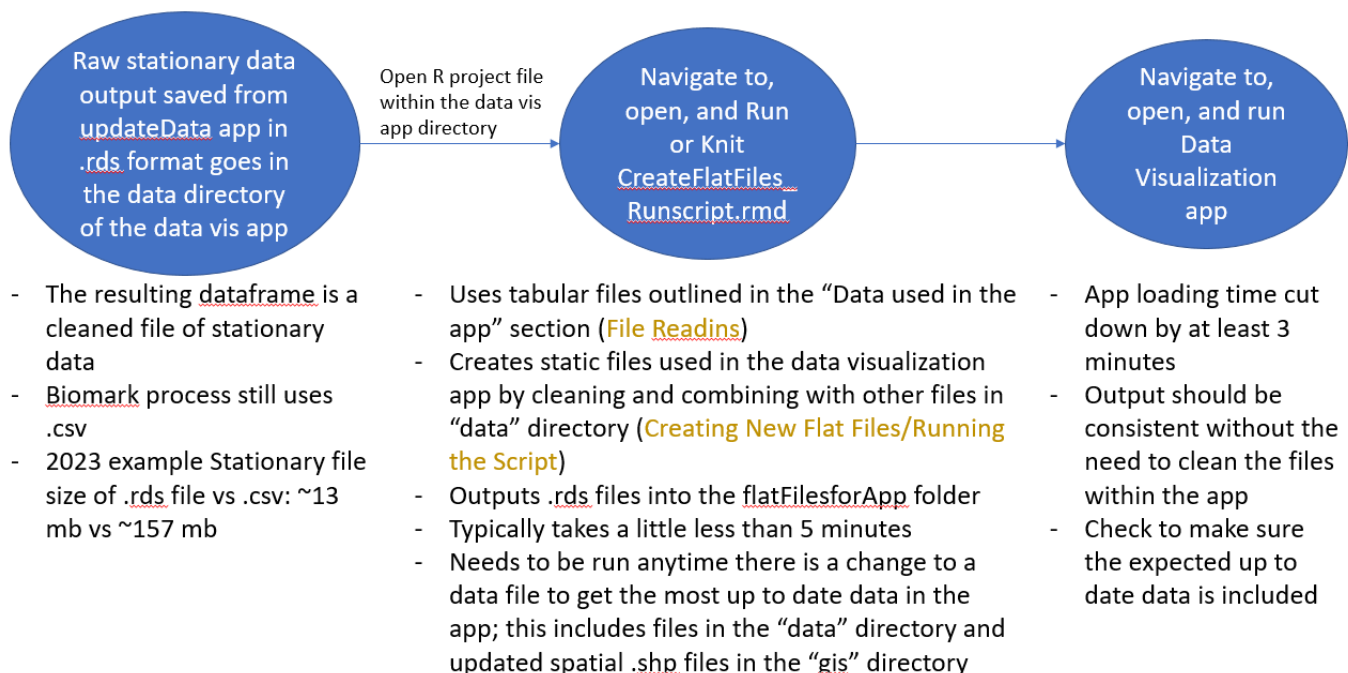
simpleStations.rds: stream centerlines broken into 10 meter sections. Originally from Stations\_10m\_Post.shp, but simplified to 10% of original resolution to improve map loading efficiency (see

## Updating the App

The app data is updated by CreateFlatFiles\_Runscript.R, an RMarkdown (.rmd) file that takes files (see Data Used in the App), wrangles the data with a variety of functions, and saves them as .rds files in

\\WGFP\_dataclean\_vis2.0\data\flatFilesforApp. This wrangling is done outside the app to reduce load time and computations within the actual app as much as possible. Anytime there is new data for any of these files, the runscript must be ran in order to update the data in the app.

The typical workflow for updating the app for new data is below, following the use of UpdateDataApp to combine new detections with the previous detection files.



## File Readins

Anytime there is new data of any of the files ending in `yyyymmdd` listed above, the name of the file must be updated in the Runscript.

**Column names and order matter.** When updating the csv or excel files, make sure the new file has the same column name/order as the old one.\*

Column names outlined below are how they appear when brought into R at the beginning of the app. In Excel, names will appear slightly differently.

*\*If you do need to change the column names or order, you'll have to go into the app and follow where that column is used in the app and change the name*

**Make sure tag is read in correctly.** The way to do this is by saving the Tag column as numeric with 0 decimal places, instead of general (default). If not, the runscript won't run all the way through (see Common Errors)

## Updating file names

To update the file name, change these dates/names for the appropriate file.

```
Stationary <- readRDS("./data/WGFP_Raw_20240514.rds")

Mobile <- read.csv("./data/WGFP_Mobile_Detect_AllData.csv" , colClasses= c(rep(
rep("character", 3)))

Biomark <- read.csv("./data/Biomark_Raw_20221102.csv", dec = ",")

# need to have tagID as a numeric field in the .csv file in order to be read in

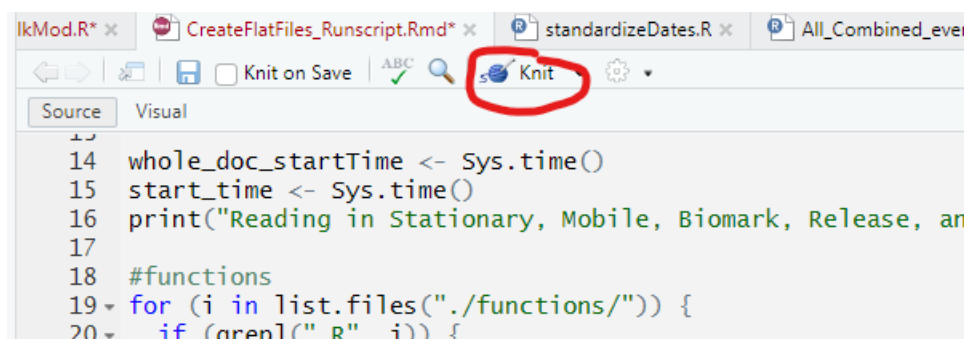
Release <- read.csv("./data/WGFP_ReleaseData_Master_20240520.csv", na.strings =
colClasses=c(rep("character",8), "numeric", "numeric", rep("character",8)))
```

## Other Data Updates

- Pressure Transducer: overwrite the current file with the new one. If a new site is added, add that file to the “data/PressureTransducer” directory. Open “WGPF Metdata.xlsx” (located in the data folder of the app, and U:\Projects\Colorado\_River\Windy\_Gap\_FishMovementStudy\Data\RFID\Detctions) and enter the correct “PressureTransducerSiteName” as it corresponds to the name used in the PT file. Names in the PT file need to match the No need to change anything in the app, it will automatically get read in and combined with the other site data **as long as it has the same columns/order as the other data**
- USGS data: scraped from the USGS server and is updated when the runscript runs.
- All other files: overwrite the previous file, making sure column names/order were the same as the previous one


## Creating New Flat Files/Running the Script

To run the script and update the data in the app, click “Knit”



Progress will show in the “Render” window

```

 .../WGFP_dataclean_vis2.0/CreateFlatFiles_Runscript.Rmd
| ..... | 13% [readins]

processing file: CreateFlatFiles_Runscript.Rmd
| ..... | 27% [USGSData]

```

At the end, the document will output a HTML document just to confirm that the data was saved. On a local machine this usually takes 3-4 minutes, sometimes up to 10 or more when using a vpn or directly on the U drive. Saving the files takes particularly long on the U drive.

## Create Files for App Runscript

Sam Graf

2023-07-06

```
## [1] "Reading in USGS Data took 13.65"
```

```
## [1] "Running All_combined_events_function: Combining and cleaning Stationary, Mobile, Biomark, Release, and Recapture csv inputs....."
## [1] "All_combined_events_function took 1.13 minutes"
```

```
## [1] "Running spatial_join_stations_detections function: Joining detections and events to stations shapefile."
## [1] "Spatial_join_stations_detections took 0.03 minutes"
```

```
## [1] "Running States Function: Assigns letters A, B, C, or G based on position relative to dam, or Ghost/predated tag."
## [1] "States Function took 0.26 minutes"
```

```
## [1] "Running Ind_tag_enc_hist_wide_summary_function: Summarizes detection and movement data from each released Tag."
## [1] "Encounter Histories Summary Wide Function took 0.06 minutes"
```

```
## [1] "Running get_movements_function: Calculates movements of fish based off a change in station."
## [1] "Movements Function took 0.34 minutes"
```

```
## [1] "Saving Files took 0.76 minutes"
```

The whole document took 3.27 minutes to run. Flat Files are saved to the flat files directory and the data vis app is ready to run with the most updated data.

There is some QAQC that happens in this runscript as well, including checking if Tags have multiple entries in the Avian Predation, ghost tag, and release files. If they do, it will show up in the final HTML doc. This also catches if tags were saved incorrectly (see Common Errors).

The resulting flat/static files are saved to data/flatFilesforApp and are automatically used in the app, it's ready to use (see How to Open)!

### Common errors:

Warning: cannot open file './data/Biomar\_Raw\_20221102.csv': No such file or directoryError in file(file, "rt") : cannot open the connection.

- This usually means the filename is spelled wrong or is in the wrong directory

“Error in scan(file = file, what = what, sep = sep, quote = quote, dec = dec, : scan() expected 'a real', got a \_\_\_\_”

- This typically means that there is an incorrect number of columns in the data compared to what the code was expecting. Check the code where the problem file is being read in to see which column types it expects to find

in each place, and/or modify the excel file. If you aren't sure what a chunk of code does, it's helpful to copy and paste it into chatgpt and it will explain it to you.

Runscript is not able to run all the way through and the console spits out that there are multiple tags of the same name (2.3E11, 2.26E11)

- Annoyingly, the tags in one of the csvs didn't save correctly after being opened and closed in excel. In order to get them to save correctly, the best way is to open the problem file in excel, select the TAG column, change the type from General to Numeric, move the decimal place over 2 places so there isn't a decimal at all, and resave it. You may have to go grab the file from the original location on the U drive again as the tag numbers have already been saved as 230000000000 instead of 230000678123

USGS not being read in

- I can't remember exactly what error this throws but it's something related to server connection. This happens sometimes when the USGS server is not working well and so we're unable to scrape the most recent metrics from their site. Sometimes it helps to not use a VPN, but mainly it's not something we can fix on our end and typically this resolves within a few hours. Otherwise, try to run the script tomorrow.

This section of the app adds dummy rows with fake data from CD, CU, B5, and B6. It was added to make sure the functionality for these new antennas was working, and is not currently in use.

```
#### this part was for checking if new antennas to be put in
source("functions/dummy_rows.R")
dummy_rows_list <- add_dummy_rows(stationary = stationary, bi
stationary <- dummy_rows_list$stationary
Biomark <- dummy_rows_list$Biomark
Release <- dummy_rows_list$Release
ghost_tag_df <- dummy_rows_list$ghost_tags #date column is na
```

## Modifying, Updating, Adding New Antenna/Stations

There are 2 parts to adding a new antenna to the app: updating the spatial files and updating the code that wrangles the tabular data. You can just update the tabular data code without updating the spatial file if you want.

## Updating the code and data that wrangles the tabular data

### Metadata

- Add new antenna and its data in with WGFP Antenna Metadata (See Data in app)

AntennaSite	SiteName	FrontendSiteCode	BackendSiteCode	PressureTransducerSiteName	DetectionDistance	UTM_X	UTM_Y	River	DeploymentDur
Biomark test Antenna in random spot	Biomark test Antenna	T1	A5			420727	4437229	Fraser River	

### CreateFlatFilesRunscript

### Metadata Variable names

- In CreateFlatFilesRunscript, add the variable names to the list in the "metadatavariabes" code chunk
  - Do this for a backend variable name and a frontend one. "AntennaSite" column in the metadata is used to identify these codes, so change the code to match what is in AntennaSite

```
##{r metadatavariabes, include=FALSE, echo = FALSE}
##Variables that are used throughout the functions
##Frontend (display) codes
TestBiomarkAntennaFrontendSiteCode <-
as.character(wgfpMetadata$AntennaMetadata[!is.na(wgfpMetadata$AntennaMetadata$AntennaSite) &
wgfpMetadata$AntennaMetadata$AntennaSite == "Biomark test Antenna in random spot", "FrontendSiteCode"])

WindyGapBypassAntennaFrontendSiteCode <-
as.character(wgfpMetadata$AntennaMetadata[!is.na(wgfpMetadata$AntennaMetadata$AntennaSite) &
wgfpMetadata$AntennaMetadata$AntennaSite == "Windy Gap Bypass Channel", "FrontendSiteCode"])
```



- Add these variables to metaDataVariableNames

```
metaDataVariableNames <- list(
  "TestBiomarkAntennaBackendSiteCode" = TestBiomarkAntennaBackendSiteCode,
  "TestBiomarkAntennaFrontendSiteCode" = TestBiomarkAntennaFrontendSiteCode,
  "WindyGapBypassAntennaFrontendSiteCode" = WindyGapBypassAntennaFrontendSiteCode,
  "WindyGapAuxiliaryAntennaFrontendSiteCode" = WindyGapAuxiliaryAntennaFrontendSiteCode,
  "GranbyDiversionAntennaFrontendSiteCode" = GranbyDiversionAntennaFrontendSiteCode,
  "RiverRunAntennaFrontendSiteCode" = RiverRunAntennaFrontendSiteCode,
  "FraserRiverCanyonAntennaFrontendSiteCode" = FraserRiverCanyonAntennaFrontendSiteCode
)
```

### Dummy Rows

If the antenna doesn't have any new data yet, you will need to set up the functions to account for that antenna. This is done by using the function `dummy_rows.r`

- Navigate to `dummy_rows.r` (in the functions directory) and add a row to the biomark or stationary data depending on which antenna type we want to add. The only columns that are important are adding the dummy tag number (230000999999) and making sure we've got the right reader ID that lines up with what we put in the metadata

```
Biomark <- biomark1 %>%
  add_row(Scan.Date = "2022-12-07", Scan.Time = "12:52:10.810", Download.Date = "9/16/2022", Download.Time = "11:30:41",
    Reader.ID = "A3", Antenna.ID = 1, HEX.Tag.ID = "384.358D14F739",
    DEC.Tag.ID = "900.230000999999", Temperature.C = NA, Signal.mV = NA, Is.Duplicate = "Yes", Latitude = NA, Longitude = NA,
  add_row(Scan.Date = "2022-12-08", Scan.Time = "12:52:10.810", Download.Date = "9/16/2022", Download.Time = "11:30:41",
    Reader.ID = "A4", Antenna.ID = 1, HEX.Tag.ID = "384.358D14F739",
    DEC.Tag.ID = "900.230000999999", Temperature.C = NA, Signal.mV = NA, Is.Duplicate = "Yes", Latitude = NA, Longitude = NA,
  add_row(Scan.Date = "2022-12-09", Scan.Time = "12:52:10.810", Download.Date = "9/16/2022", Download.Time = "11:30:41",
    Reader.ID = "A5", Antenna.ID = 1, HEX.Tag.ID = "384.358D14F739",
    DEC.Tag.ID = "900.230000999999", Temperature.C = NA, Signal.mV = NA, Is.Duplicate = "Yes", Latitude = NA, Longitude = NA,
```

- Comment out the lines of code that remove the dummy tag from the data (add them back in when there is actual data for the antenna)
  - In `Runscript`:

```
355
356 ### taking dummy tag out
357
358 Biomark <- Biomark %>%
359   #filter(!DEC.Tag.ID %in% c("900.230000999999"))
360 cleanedRelease <- cleanedRelease %>%
361   #filter(!TAG %in% c("230000999999"))
362 Stationary <- Cleaned_Stationary_FishdetectionsOnly %>%
363   #filter(!TAG %in% c("900230000999999"))
364
```

- In `get_statesFunction2.r`

```
##daily_unique_events = fengdailyunique(events)
states <- eventswithGhostDatesAndAvianPredation %>%
  #filter(!TAG %in% c('230000999999')) %>%
  mutate(
    #the case_when apply with priority, so it's important
    state = case_when(Date >= GhostDate ~ "G",
```

- In `get_movements_function`

```
5
6   dailyMovementsTable <- combined_events_stations %>%
7     ### removing dummy tag
8     #filter(!TAG %in% c("230000999999")) %>%
9     select(Date, Datetime, TAG, det_type, Event, ET_STATION)
```

- In `Ind_tag_enc_hist_wide_summary_function.r`:



```

149
150 ##### dummy rows removal: |
151 encountersAndRelease6 <- encountersAndRelease6# %>%
152   #filter(!TAG %in% c("230000999999"))
153

```

- In All\_combined\_events.R

```

147 condensedAllEventsWithReleaseandEnvironmentalInfo <- condensedAllEventsWithReleaseandEnvironmentalInfo
148   replace_na(list(Species = "No Info", ReleaseSite = "No Info",
149     Site = "No Site Associated")) %>%
150   dplyr::filter(!TAG %in% c("230000999999"))
151

```

- In AllEncountersMod, twice

```

421 ##### filter dummy row
422 all_events_filtered <- all_events_filtered #>%
423   #filter(!TAG %in% c("230000999999"))
424
464
465 output$alleventsrequencies1 <- renderDataTable({
466   frequenciesSummarized <- all_events_data() %>%
467     #filter(!TAG %in% c(230000999999)) %>%
468     count(Event name = "Raw Detections")
469

```

### All\_combined\_events function

- In this function, add the following line to the case\_when() function based off the Frontend and Backend variable codes

```

12 biomarkCleaned <- Biomark %>%
13   mutate(TAG = str_replace(DEC.Tag.ID, "\\.", ""),
14     # i wish this could be a join, but when there are 2 dif codes (A1, B1, etc) used for backend na
15     Reader.ID = case_when(
16       Reader.ID %in% TestBiomarkAntennaBackendSiteCode ~ TestBiomarkAntennaFrontendSiteCode,
17       Reader.ID %in% WindyGapBypassAntennaBackendSiteCode ~ WindyGapBypassAntennaFrontendSiteCode,

```

### Ind\_tag\_hist\_summary\_wide\_function:

- Add in your antennaFrontend Variable in column order

```

18 #column order is just nice to have for the user
19 columnOrder <- c(RedBarnFrontendCodes, HitchingPostFront
20   MobileRunFrontendCodes, WindyGapBypassA
21   GranbyDiversionAntennaFrontendSiteCode,
22   TestBiomarkAntennaFrontendSiteCode)

```

- Add the frontend site code to these lines of code. If it's a biomark antenna, add it to "TotalBiomark", and if its a Stationary antenna, add to TotalStationary

```

57 mutate(
58   TotalEncounters = rowSums(select(., all_of(c(RedBarnFrontendCodes, HitchingPostFronte
59   ConnectivityChannelDownstreamFrontendCod
60   ConnectivityChannelUpstreamFrontendCodes
61   WindyGapBypassAntennaFrontendSiteCode, W
62   RiverRunAntennaFrontendSiteCode, FraserR
63   TestBiomarkAntennaFrontendSiteCode))) ==
64   TotalAntennas = rowSums(select(., all_of(c(RedBarnFrontendCodes, HitchingPostFrontend
65   ConnectivityChannelDownstreamFrontendCodes
66   ConnectivityChannelUpstreamFrontendCodes,
67   WindyGapBypassAntennaFrontendSiteCode, Win
68   GranbyDiversionAntennaFrontendSiteCode,
69   RiverRunAntennaFrontendSiteCode, FraserRiv
70   TestBiomarkAntennaFrontendSiteCode))) == T
71   TotalStationary = rowSums(select(., all_of(c(RedBarnFrontendCodes, HitchingPostFronte
72   ConnectivityChannelDownstreamFrontendCod
73   ConnectivityChannelUpstreamFrontendCodes
74
75   TotalMobile = rowSums(select(., all_of(MobileRunFrontendCodes)) == TRUE),
76   TotalBiomark = rowSums(select(., all_of(c(WindyGapBypassAntennaFrontendSiteCode, Wind
77   GranbyDiversionAntennaFrontendSiteCode,
78   RiverRunAntennaFrontendSiteCode, FraserRive
79   TestBiomarkAntennaFrontendSiteCode))) == TR
80   TotalRedBarn = rowSums(select(., all_of(RedBarnFrontendCodes)) == TRUE),
81   TotalHitchingPost = rowSums(select(., all_of(HitchingPostFrontendCodes)) == TRUE).

```

With that, you are ready to Run the CreateFlatFilesRunscript. Once the data is updated, run the app. Check to make sure your antenna has been integrated correctly in the data by filtering for the dummy tag in the Ecnounters dataframes, movements, and States tabs where it will also have dummy Release Data.

Show 10 entries Search:

TAG	Date	Time	Datetime	Event	Species	Release_Length	Release_Weight	ReleaseSite	Release_Date
All						All	All	All	All
230000999999	2020-09-01	12:00:00	2020-09-01T12:00:00Z	Release	LOC	566	600	Fraser River Ranch	2020-09-01
230000999999	2022-12-07	12:52:10.810	2022-12-07T12:52:10Z	RR1	LOC	566	600	Fraser River Ranch	2020-09-01
230000999999	2022-12-08	12:52:10.810	2022-12-08T12:52:10Z	FC1	LOC	566	600	Fraser River Ranch	2020-09-01
230000999999	2024-05-24	12:52:10.810	2024-05-24T12:52:10Z	T1	LOC	566	600	Fraser River Ranch	2020-09-01

Showing 1 to 4 of 4 entries Previous 1 Next

Figure 1 All Encounters History with Dummy Data

T1\_n Rec:

1	1
---	---

Figure 2 column was automatically created in All EncountersHistory SummaryWide for that new antenna

Show 10 entries

Date	weeks_since	TAG	State	det_type	ReleaseSite	Species
2020-09-01	0	230000999999	B	Release	Fraser River Ranch	LOC
2022-12-07	118	230000999999	B	River Run Biomark Antenna	Fraser River Ranch	LOC
2024-05-24	194	230000999999	B	Biomark test Antenna	Fraser River Ranch	LOC

Showing 1 to 3 of 3 entries

Figure 3 States df with dummy data

Filter by TAG

Select Movement Type:

CHANGED RIVERS, DOWNSTREAM

Select Detection Type

CONFLUENCE STATIONARY ANT

Select Species Type

LOC, MTS, NO INFO, RBT, RXN, T

Date

31 Aug 20 25 May 24

MAP AND TABLE MINICHARTS MAP MOVEMENT GRAPHS

only	det_type	dist_moved	MPerSecondB
	All	A	All
	Release		
ers	River Run Biomark Antenna	3820	0.0000
ers	Fraser River Canyon Biomark Antenna	14940	0.
Movement	Test Biomark Antenna	-6090	-0.000

Next

Figure 4 Movements table with dummy data

## Adding or updating layers on the map

- In GIS, go to the GIS database and export desired layer as shapefile, saving it in "gis" folder within the app directory
  - Right click on layer in left column, scroll down to data -> export

- Using the sf package, read in the .shp file with the name of your layer

```

8 layerLocation <- file.path("./gis/")
9 latLongCRS <- st_crs("+proj=longlat +datum=WGS84 +no_defs") #should be same as +init=epsg:4326
10
11 antenna_sites <- st_transform(read_sf(file.path(layerLocation, "antenna_sites1.shp")), latLongCRS)
12

```

- The `epsg:4326` converts the projection to lat/longs able to be plotted with leaflet
- If the layer is very large, it might be good to convert the .shp file to a .rds file, which decreases resolution. For example, the stations file is a .rds file and was converted below. It keeps 10% of the original resolution

```

stations_10m <- readOGR(dsn = layer_location, layer = "stations_10m")
stations_10m <- sp::spTransform(stations_10m, CRS("+init=epsg:4326"))
simple_stations1 <- ms_simplify(stations_10m, keep = .1)
write_rds(simple_stations1, file = file.path(paste0(layer_location, "/"), paste0("simple_stations.rds")))

```

- It is read in like so and is much faster than when read in as a shapefile

```
simple_stations2 <- read_rds(file.path("./gis/simple_stations.rds"))
```

- If you make a new layer (not just updating an existing antenna, stations or stream centerline layer that is already included on the map) that you want to display, you'll have to add it to the code that makes the map, found in movementsMod.R.
- Add\_polylines is used to bring in lines like stream\_centerline, addMarkers is used for SpatialPoints, addPolygons is used for polygons.
- Add a Group argument to the data and add it in the addLayersControl function to make sure it shows up

```
addAwesomeMarkers(data = releasesites@coords,
  icon = release_icons,
  clusterOptions = markerClusterOptions(),
  label = releasesites@data$ReleaseSit,
  popup = paste("Release Date:", releasesites@data$ReleaseDat, "<br>", "Release Da
  group = "Release Sites") %>%
addPolylines(data = simple_stations2,
  label = simple_stations2@data$ST_STATION,
  labelOptions = labelOptions(noHide = T, textOnly = TRUE, style = label_style),
  group = "Stations (m)") %>%
addLayersControl(overlayGroups = c("Antennas", "Detections", "Release Sites", "Stream Centerlines"
hideGroup(c("Stream Centerlines", "Stations (m)", "Antennas", "Release Sites", "Mobile Reaches"))
```

### Adding New Antenna to map

The data will still be displayed spatially on the movements map even without an updated antenna file, but if you want to display the antenna on the map (and you should), then here are a couple options to do this. The first option is to add it in GIS, then export the layer (see above) and read in that later.

The second option is to modify the already existing Antenna layer within R. This can be done with already-written code in map\_polygon\_readins.R starting on line 57.

- Modify the UTM coordinates and other relevant fields to fit the antenna.

```
57 #####adding new antenna to data
58
59 utm_x <- 420727
60 utm_y <- 4437229
61 new_point <- st_sfc(st_point(c(utm_x, utm_y)), crs = 32613) # EPSG:32613 is UTM zone 13N
62
63 # Transform the new point to the desired CRS (latLongCRS)
64 new_point_transformed <- st_transform(new_point, st_crs(latLongCRS))
65
66 new_row <- tibble(
67   OBJECTID = NA,
68   SiteName = NA,
69   Objective = NA,
70   StudyPerio = NA,
71   SiteLabel = NA,
72   AntennaNam = NA,
73   WaterName = NA,
74   Channelwid = NA,
75   UTM_X = utm_x,
76   UTM_Y = utm_y,
77   Notes = NA,
78   geometry = new_point_transformed
79 )
```

- Add this row to the data and save it in the correct location with st\_write. This WILL overwrite the previous file.

```

1 antenna_sites1 <- antenna_sites %>%
2   add_row(new_row)
3
4 output_file <- file.path(layerLocation, "antenna_sites1.shp")
5
6 # Write the updated sf object to a new shapefile
7 st_write(antenna_sites, output_file)
8

```

- Once the new layer is saved, comment out those lines of code from lines 57 to 87 to make sure these lines aren't ran again.

## Functions

Here are some of the main functions of the app.

If you don't know what a chunk of code does, it is helpful to copy and paste the chunk into chatGPT and it does a good job explaining it. There is also a specific chatGPT called ["R wizard"](#) that was recently released that seems promising.

Note: some variables used in the functions are not included as arguments, but are read in earlier in the Runscript so should always exist before running.

### All\_Combined\_events\_function

- Main function that combines and cleans detections and release files
- Takes Stationary, Mobile, Biomark, Release, and Recapture files as arguments
- **Returns:**
  - WGFP Clean: a clean dataset of all stationary detections, no weird tags or marker tags, or duplicate rows. All timestamps and dates are in the same format. 900\_ is taken off of the tags
  - All\_Events: cleaned dataset of all 5 input datasets, containing every detection/event from each tag that hit an antenna, complete with release info.
  - Marker\_Tag\_data: file of just marker tags, to be used in QAQC
  - Recaps\_detections: a file of all antenna detections and recaptures, but no release data. This is just to be used in enc\_hist\_wide\_summary\_function

### About the Code

Stationary data has already been semi "cleaned" in the WGFPCombineFiles app. The function addUTMsAndReformatStationary() in this app includes changing antenna names based off metadata, formatting dates, assigning UTM's for each antenna, and removing duplicate rows if there are any.

Biomark dataset is then cleaned, including changing the reader ID since we want it in the format specified in the metadata file, changing date format, filtering out test tags and marker tags, assigning UTM's, and removing duplicate rows.

```
# biomark cleaning, getting dates into uniform format,
biomarkCleaned <- Biomark %>%
  mutate(TAG = str_replace(DEC.Tag.ID, "\\.", ""),
    # i wish this could be a join, but when there are 2 dif codes (A1, B1, etc) used for backend name, this is a bit simpler
    Reader.ID = case_when(
      Reader.ID %in% WindyGapBypassAntennaBackendSiteCode ~ WindyGapBypassAntennaFrontendSiteCode,
      Reader.ID %in% WindyGapAuxiliaryAntennaBackendSiteCode ~ WindyGapAuxiliaryAntennaFrontendSiteCode,
      Reader.ID %in% GranbyDiversionAntennaBackendSiteCode ~ GranbyDiversionAntennaFrontendSiteCode,
      Reader.ID %in% RiverRunAntennaBackendSiteCode ~ RiverRunAntennaFrontendSiteCode,
      Reader.ID %in% FraserRiverCanyonAntennaBackendSiteCode ~ FraserRiverCanyonAntennaFrontendSiteCode,
      TRUE ~ Reader.ID),
    #make a column for Scan>Date if parentheses are detected in the string, that means the format is in mdy
    # and we want to convert it to YYYYMMDD format. elsewise, leave it as is
    Scan.Date = ifelse(str_detect(Scan.Date, "("),
      as.character(mdy(Scan.Date)),
      Scan.Date)
  ) %>%
  #we want to filter out test tags here, but not marker tags
  filter(!TAG %in% test_tags) %>%
  #get UTM's based off what is in metaDataTable
  #left_join() is faster than merge()
  left_join(wgfpMetadata$AntennaMetadata, by = c("Reader.ID" = "FrontendSiteCode")) %>%
  distinct()
```

Then Mobile, Stationary, and Biomark columns are all renamed and then they are joined together. Mobile data requires a little Tag cleaning but not much.

```
###Create one big clean dataset
WGFP_condensed <- WGFP_clean %>%
  select(DTY, ARR, TAG, SCD, UTM_X, UTM_Y) %>%
  rename(Scan_Date = DTY, Scan_Time = ARR, Site_Code = SCD, UTM_X = UTM_X, UTM_Y = UTM_Y)

Biomark_condensed <- biomark2 %>%
  mutate(TAG = ifelse(str_detect(TAG, "^900"), str_sub(TAG, 4,-1), TAG)) %>%
  select(Scan.Date, Scan.Time, TAG, Reader.ID, UTM_X, UTM_Y) %>%
  rename(Scan_Date = Scan.Date, Scan_Time = Scan.Time, Site_Code = Reader.ID, UTM_X = UTM_X, UTM_Y = UTM_Y)

Mobile_condensed <- Mobile %>% #gonna have to just change to mobile eventually
  rename(TAG = TagID) %>%
  mutate(TAG = ifelse(str_detect(TAG, "^900"), str_sub(TAG, 4,-1), TAG),
    Date = ifelse(str_detect(Date, "("),
      as.character(mdy(Date)),
      Date)) %>% #end of mutate
  select(Date, Time, TAG, Ant, UTM_X, UTM_Y) %>%
  rename(Scan_Date = Date, Scan_Time = Time, Site_Code = Ant)

WG_bio <- bind_rows(WGFP_condensed,Biomark_condensed)
All_detections <- bind_rows(WG_bio, Mobile_condensed)
```

Data is filtered to only include detections past the study start date, and datetime is put in a good format

```
cleanedAllDetections <- allDetections %>%
  filter(Scan_Date >= as.Date("2020-08-06")) %>% #right before the first date of marker tag detections on stationary antennas
  mutate(
    Scan_DateTime = ymd_hms(paste(Scan_Date, Scan_Time))) %>%
  select(Scan_Date, Scan_Time, Scan_DateTime, TAG, Site_Code, UTM_X, UTM_Y)
```

Release and recapture files are brought in and timestamps are cleaned. There is need for this because sometimes the way that times are entered in the spreadsheet are not uniform. Columns are renamed for joining.

```

#getting timestamps in order and getting relevant columns
cleanedRelease <- Release %>%
  rename(TAG = TagID) %>%
  mutate(TAG = str_trim(TAG),
         Date = mdy(Date),
         DateTime = lubridate::ymd_hms(paste(Date, Time))) %>%
  select(RS_Num, River, ReleaseSite, Date, Time, DateTime, UTM_X, UTM_Y, Species, Length, Weight, TAG, TagSize, Ant, Event)

#getting timestamps in order and getting relevant columns
cleanedRecaptures <- Recaptures %>%
  rename(TAG = TagID) %>%
  filter(!Date %in% c("", " ", NA)) %>%
  mutate(TAG = str_trim(TAG),
         Date = mdy(Date),
         DateTime = ymd_hms(paste(Date, Time))) %>%
  select(RS_Num, River, RecaptureSite, DateTime, Date, Time, UTM_X, UTM_Y, Species, Length, Weight, TAG, TagSize, Ant, Event) %>%
  rename(
    Recap_Length = Length,
    Recap_Weight = Weight
  )

```

Reformatting the all detections file to also be ready to join, then binding release and recap data to the df. Binding the release df to the main df makes it so there will be an event for “release”, and then left joining will then give release info for each fish for each detection.

```

#getting all detections file ready to merge with encounters
allDetectionsForBinding <- cleanedAllDetections %>%
  mutate(Date = ymd(Scan_Date)) %>%
  rename(
    Time = Scan_Time,
    DateTime = Scan_DateTime,
    Event = Site_Code
  )

# this file is used in enc_hist_summary_wide
recapturesAndDetections <- bind_rows(allDetectionsForBinding, cleanedRecaptures)

allEvents <- bind_rows(recapturesAndDetections, cleanedRelease)

# bind rows vs left join; bind rows will make it so there is a "release" or "recapture" event and also make columns with relevant
#fills in release info so it is known at any row of detection
allEventsWithReleaseInfo <- left_join(allEvents, cleanedRelease, by = c("TAG"))

```

Then there's some minor formatting/renaming for display purposes in the app

```

condensedAllEventsWithReleaseInfo <- allEventsWithReleaseInfo %>%
  select(Date.x, Time.x, DateTime.x, TAG, Event.x, Species.y, Length.y, Weight.y, ReleaseSite.y, Date.y,
         rename(Release_Date = Date.y,
                Date = Date.x,
                Time = Time.x,
                Datetime = DateTime.x,
                Event = Event.x,
                Species = Species.y,
                Release_Length = Length.y,
                Release_Weight = Weight.y,
                ReleaseSite = ReleaseSite.y,
                UTM_X = UTM_X.x,
                UTM_Y = UTM_Y.x) %>%
  #gets rid of all duplicate rows but keeps all info
  distinct(Datetime, TAG, Event, .keep_all = TRUE)

Tags_only <- cleanedRelease %>%
  select(TAG)

```

This line makes sure that the tags displayed are from the release file. There is a tab in the QAQC tab to see unknown tags histories.



```
#makes sure all events are from tags ONLY in the release file
filled_in_release_rows_condensed <- left_join(Tags_only, filled_in_release_rows_condensed, by = "TAG")
```

PT/environmental data is added to the data with `combineEnvironmentalandDetectionsData()` function. USGS data are attached to each detection within one hour of the detection, and PT data is associated to that detection within 13 hours.

```
##add temp/environmental data to that
#these arguments come from the createFlatFilesRunscript
condensedAllEventsWithReleaseandEnvironmentalInfo <- combineEnvironmentalandDetectionsData(Detections = condensedAllEvents
allPressureTransducerDataWithDischarge = allPressureTransducerDataWithDischarge
DischargeData = windyGap
)
```

This data frame condenses detections down to their daily summary; so it will take the first detection a fish had that day, and the last detection a fish had that day, and all unique detections in between. This reduces a fish to the “most relevant” detections. This df is ultimately used in the movements df, but first in joining with the Stations Data, which is the next function. **WARNING:** It’s important to note that if a fish has a day where the movement sequence is like “RB1, RB2, HP4, HP3, HP4, RB2, HP3, HP4”, then for that day, the sequence will register as “RB1, RB2, HP4, HP3, HP4”.

```
### This is getting the events dataframe to only the data relevant for joining with stations
all_events_relevant_to_stations <- filled_in_release_rows_condensed %>%
  #this part is for making sure the sequence of events will make sense
  # if there's no tag input then have to group_by TAG as well
  group_by(Date, TAG) %>%
    mutate(first_last = case_when(Datetime == min(Datetime) ~ "First_of_day",
                                  Datetime == max(Datetime) ~ "Last_of_day",
                                  Datetime != min(Datetime) & Datetime != max(Datetime) ~ "0"))
  ) %>%
  ungroup() %>%
  distinct(TAG, Event, Date, first_last, UTM_X, UTM_Y, .keep_all = TRUE) %>%
  arrange(Datetime) %>%
  select(-first_last)
```

Little bit more reformatting and this is the final df that is shown in Encounters History tab

```
#this is the final df
)

#Change na to "No info" in select columns so that it will register with the Picker input in the app
#pretty sure that's just a bug on the DT or shinywidgets end that it can't select by NA
# 87 rows were not even showing up on the all_events app because the Species was NA -12/14/21 SG
condensedAllEventsWithReleaseandEnvironmentalInfo <- condensedAllEventsWithReleaseandEnvironmentalInfo %>%
  replace_na(list(Species = "No Info", ReleaseSite = "No Info",
                  Site = "No Site Associated")) %>%
  dplyr::filter(!TAG %in% c("230000999999"))
```

## Spatial\_join\_function

- Joins detections and events to the shapefile of stations in order to later help calculate states and distance moved for each fish.
- Takes condensed events (arg 1), made from `all_combined_events_function` (`all_events_most_relevant`). Also takes `simple_stations` (arg2), which is usually read in as `simple_stations2` in the `polygon_read_ins.r` file
- Returns a dataframe of `condensed_events` with all station data attached.

## About the Code

This function first converts the utm’s to numeric, assigns a projection/zone/datum, converts to lat/long, then to a spatial points object, then to sf object, then joins with the stations shapefile, also converted to an sf



object. The joining is by the nearest feature, so if a detection is not quite on top of the station, it will get assigned the closest one.

```
## converting to lat/longs instead of UTM
condensed_events <- condensed_events %>%

  mutate(
    X = as.numeric(UTM_X),
    Y = as.numeric(UTM_Y)
  ) #end of mutate

# assigning projection to ready df lat/longs for plotting
attr(condensed_events, "zone") = "13"
attr(condensed_events, "projection") = "UTM"
attr(condensed_events, "datum") = "GRS80"

# need a column that has x and y for this
# converts lutm to lat/long
condensed_events <- convUL(condensed_events, km=FALSE, southern=NULL)

#converting lat/long entries to spatial points dataframe
# needs to have a df of just coordinates (xy)
xy <- condensed_events %>%
  select(X, Y)

spdf <- SpatialPointsDataFrame(coords = xy, data = condensed_events,
                              proj4string = CRS("+init=epsg:4326"))

## making sf objects
detections_sf <- st_as_sf(spdf)
stations_sf <- st_as_sf(simple_stations)

joined <- st_join(detections_sf, stations_sf, st_nearest_feature)
#need to convert class sf object back to dataframe so that it goes faster in combine_events_stations_function
station_data <- as.data.frame(joined)
```

## PrepareforStatesMovementsandSummary\_function.R

- Puts stations onto a condensed All\_events dataframe
- Takes StationData returned from spatial\_join function.
- Returns:
  - All\_events\_days1: a condensed dataframe of all pertinent daily detection info for each tag with stations attached.
    - Row entries for tags with multiple detections on the same UTM\_X, UTM\_Y, at the same antenna, on the same day are filtered out. Leaving the first and last detections of the day, and all detections on unique antennas and UTM's in between.

## About the Code

The columns are renamed and the River is assigned for specific antennas

```
mutate(
  #River also needs to be assigned for new detections
  River = case_when(
    (Event %in% c("RB1", "RB2")) ~ "Colorado River", # there is no is.na here because RB UTM
    (Event %in% c("HP3", "HP4")) ~ "Colorado River",
    (Event %in% c("CF5", "CF6")) ~ "Colorado River",
    (Event %in% c("CD7", "CD8", "CD9", "CD10", "CU11", "CU12")) ~ "Connectivity Channel",
    (Event %in% c("B3", "B5")) ~ "Colorado River",
    (Event %in% c("B4", "B6")) ~ "Fraser River",
    TRUE ~ River
  ),
```

This part accounts for stations up the Fraser River, because those stations start at 0. This adds the station where the Colorado/Fraser confluence to the Fraser stationing. Then duplicate rows are taken out (shouldn't be any) and relevant columns are selected

```

# this part is needed because stations are assigned from 0 up the fraser river starting at the confluence
# new antennas weren't showing up because I didn't include connectivity channel to river
# this assigns a station, then in the get_movements function the distance moved is calculated
ET_STATION = case_when(River %in% "Fraser River" ~ ET_STATION + 10120, #10120 is above Fraser River confluence; pre-construction was 9566
  River %in% c("Colorado River", "Connectivity Channel") ~ ET_STATION,
  TRUE ~ ET_STATION)

# this line just makes the df smaller if there are duplicates; usually doesn't change anything since All_events has a line that does this also
distinct(Datetime, Event, TAG, .keep_all = TRUE) %>%
select(Date, Time, Datetime, TAG, Event, Species, Release_Length, Release_Weight, ReleaseSite, Release_Date, RecaptureSite, River, Recap_Length,

```

This part gets the number of daily unique events and detections for a fish, lets you know if a detection was above and below the dam. The type of movement is condensed to a "detection type" field. This is helpful in the movements map where it doesn't necessarily matter which antenna specifically is hit, only if the stationing is different between events.

```

# getting number of daily events
DailyMovements_withStations <- DailyMovements_withStations %>%
  group_by(Date, TAG) %>%
  mutate(c_number_of_detections = n(),
    daily_unique_events = length(unique(Event))
  ) %>%
  ungroup()
# generating generic event title for movements map
DailyMovements_withStations <- DailyMovements_withStations %>%
  mutate(
    # this part is used in movemnets map
    det_type = case_when(str_detect(Event, "RB1|RB2") ~ "Red Barn Stationary Antenna",
      str_detect(Event, "HP3|HP4") ~ "Hitching Post Stationary Antenna",
      str_detect(Event, "CF5|CF6") ~ "Confluence Stationary Antenna",
      str_detect(Event, "CD7|CD8|CD9|CD10") ~ "Connectivity Channel Downstream Stationary Antenna",
      str_detect(Event, "CU11|CU12") ~ "Connectivity Channel Upstream Stationary Antenna",
      str_detect(Event, "B3") ~ "Windy Gap Dam Biomark Antenna",
      str_detect(Event, "B4") ~ "Kaibab Park Biomark Antenna",
      str_detect(Event, "B5") ~ "River Run Biomark Antenna",
      str_detect(Event, "B6") ~ "Fraser River Canyon Biomark Antenna",
      str_detect(Event, "M1|M2") ~ "Mobile Run",
      Event == "Recapture" ~ "Recapture",
      TRUE ~ Event),
    # need to check this function out given new stationing and connectivity channel
    above_below = case_when(
      ET_STATION >= 8330 ~ "Above the Dam",
      ET_STATION < 8330 ~ "Below the Dam"
    )
  )

```

## Ind\_tag\_enc\_hist\_wide\_summary\_function

- Makes a summary dataframe of all released/tagged fish with over 60 columns of summary info, like "total number of antenna encounters", "total distance travelled", "moved through dam or not"
- Takes recaps\_and\_all\_detections from All\_Combined\_events\_function, Release data, combined\_events\_stations from PrepareforStatesMovementsandSummary\_function, and States\_summarized from the Get\_states\_function
- It doesn't take All Events from All\_combined\_Events\_function because we want to do some operations on the events that aren't Releases, before bringing the release data back in for joining.
- Returns:
  - ENC\_Release\_wide\_summary : Summary "wide" dataframe of each tagged fish and summary info
  - Unknown\_Tags: dataframe of tags that have encounters, but have no release info

## About the Code

This part counts the number of Events for each fish. It then pivots the data to wide format, so each fish/tag has a row. Columns are then renamed. This is the start of the summary file.

```
all_enc12 <- recaps_and_all_detections %>%
  count(TAG, Event, name = "Encounters")

all_enc12 <- pivot_wider(data = all_enc12, id_cols = TAG, names_from = Event, values_from = Encounters)

x <- all_enc12 %>%
  replace_na(list(species = "No Info", Releasesite = "No Info"))

#all_enc12[is.na(all_enc12)]=0
#### NEED To make this compatible with new antennas!!

ENC_ALL <- all_enc12 %>%
  rename(RB1_n = RB1,
         RB2_n = RB2,
         HP3_n = HP3,
         HP4_n = HP4,
         CF5_n = CF5,
         CF6_n = CF6,
         CD7_n = CD7,
         CD8_n = CD8,
         CD9_n = CD9,
         CD10_n = CD10,
         CU11_n = CU11,
         CU12_n = CU12,
         M1_n = M1,
         M2_n = M2,
         B3_n = B3,
         B4_n = B4,
         B5_n = B5,
         B6_n = B6,
         Recap_n = Recapture
  ) %>%
  select(TAG, RB1_n, RB2_n, HP3_n, HP4_n, CF5_n, CF6_n, CD7_n, CD8_n, CD9_n, CD10_n, CU11_n, CU12_n, M1_n,
```

The release data is then joined to the summary file. This is also when the unknown tags df is made (displayed later in qaqc). These tags all start with 900. They are probably cormorants or mergansers that have swallowed other PIT tagged trout and chubs from glenwood ;)

```
#### Combine Release data ####
Release1 <- release_data %>%
  rename(TAG = TagID) %>%
  mutate(TAG = str_trim(TAG)) %>%
  replace_na(list(species = "No Info", Releasesite = "No Info"))

# was getting a massive dataframe because the Release df is ca
#need to actually join on full join not merge
ENC_Release <- full_join(Release1, ENC_ALL, by = "TAG")

#gets tag list that wasn't in release file
unknown_tags <- ENC_Release %>%
  filter(is.na(Releasesite)) %>%
  select(TAG, where(is.numeric))
```

If there wasn't a count for a fish, that NA gets changed to 0. True/false columns are made on whether a fish hit a specific antenna or was recaptured.

```

#ENC_Release1$TAG[3433:nrow(ENC_Release1)]
ENC_Release[is.na(ENC_Release)]=0 #gets rest of the number count columns to 0 from NA

#### Make 1 or 0 for encounter history rather than counts ###
#gets df with TF of whether a fish was detected at a antenna
ENC_Release1 <- ENC_Release %>%
  mutate(RB1 = (RB1_n >0),
         RB2 = (RB2_n >0),
         HP3 = (HP3_n >0),
         HP4 = (HP4_n >0),
         CF5 = (CF5_n >0),
         CF6 = (CF6_n >0),
         CD7 = (CD7_n >0),
         CD8 = (CD8_n >0),
         CD9 = (CD9_n >0),
         CD10 = (CD10_n >0),
         CU11 = (CU11_n >0),
         CU12 = (CU12_n >0),
         M1 = (M1_n >0),
         M2 = (M2_n >0),
         B3 = (B3_n >0),
         B4 = (B4_n >0),
         B5 = (B5_n >0),
         B6 = (B6_n >0),
         Recapture = (Recap_n > 0))

```

Here some summary statistics based on the previous columns are calculated. It tells the number of detections a fish may have at a paired antenna. Also a T/F column to see if a fish was detected at a paired antenna. The fish with unknown release data are also filtered out here.

```

totalcols <- ncol(ENC_Release1)

ENC_Release2 <- ENC_Release1 %>%
  #counts number of TRUE across specified rows. -SG
  # need to have parentheses (totalcols-1) that's why i was getting bad numbers on
  #added 8 new columns for new antennas
  mutate(
    TotalEncounters = rowSums(ENC_Release1[(totalcols-18):totalcols] == TRUE),
    TotalAntennas1 = rowSums(ENC_Release1[(totalcols-18):(totalcols-1)] == TRUE),
    TotalStationary = rowSums(ENC_Release1[(totalcols-18):(totalcols-7)] == TRUE),
    TotalMobile = rowSums(ENC_Release1[(totalcols-6):(totalcols-5)] == TRUE),
    TotalBiomark = rowSums(ENC_Release1[(totalcols-4):(totalcols-1)] == TRUE),
    TotalRB = rowSums(ENC_Release1[(totalcols-18):(totalcols-17)] == TRUE),
    TotalHP = rowSums(ENC_Release1[(totalcols-16):(totalcols-15)] == TRUE),
    TotalCF = rowSums(ENC_Release1[(totalcols-14):(totalcols-13)] == TRUE),
    TotalCD = rowSums(ENC_Release1[(totalcols-12):(totalcols-9)] == TRUE),
    TotalCU = rowSums(ENC_Release1[(totalcols-8):(totalcols-7)] == TRUE),
  ) %>%
  # just says if the fish was ever detected at these sites
  mutate(RB = (RB1_n > 0 | RB2_n >0),
         HP = (HP3_n > 0 | HP4_n >0),
         CF = (CF5_n > 0 | CF6_n >0),
         CD = (CD7_n > 0 | CD8_n >0 | CD9_n > 0 | CD10_n >0),
         CU = (CU11_n > 0 | CU12_n >0),
         Biomark = (B3_n > 0 | B4_n >0 | B5_n > 0 | B6_n >0),
         Mobile = (M1_n > 0 | M2_n >0)) %>%
  filter(!UTM_X %in% c(0, NA)) # one way to filter out tags that don't have any so

```

This part brings the condensed df with stations back in for summaries. It first counts the number of encounters each fish had above and below the dam. Then describes that event (eg “Mobile Detection above the dam”). Then it pivots the data wider to get each fish its own row and get in a format for joining back to the original release summary file. It also changes the NA’s to FALSE, because when you use count(), you only sum fish that have had encounters.

```
above_below_counts <- combined_events_stations %>%
  count(TAG, det_type, above_below, name = "Encounters") %>%
  mutate(combined_event = paste(det_type, above_below),
         EncounterSTF = ifelse(Encounters > 0,
                              TRUE,
                              FALSE))

above_below_counts1 <- pivot_wider(data = above_below_counts, id_cols = TAG)
above_below_counts2 <- above_below_counts1 %>%
  select(TAG, `Release Above the Dam`, `Release Below the Dam`, `Recapture`,
         #turns all the NA's made to FALSE
         above_below_counts2[is.na(above_below_counts2)] = FALSE
```

The data is joined with the original summary file. A column is made based on those new joined columns describing if a fish went through the dam or not.

```
ENC_Release3 <- left_join(ENC_Release2, above_below_counts2, by = "TAG")
### need to figure out how connectivity channel fits into this part?
ENC_Release4 <- ENC_Release3 %>%
  mutate(through_dam = case_when(
    (RB1|RB2|HP3|HP4|B3)`Release Below the Dam`|`Recapture Below the Dam`
    (RB1|RB2|HP3|HP4|B3)`Release Below the Dam`|`Recapture Below the Dam`
    (RB1&RB2&HP3&HP4&B3)`Release Below the Dam`&`Recapture Below the Dam`
  ))
```

The states\_summarized dataframe is then brought in and added. This has data about how a fish got through the dam, if it used the connectivity channel or not.

```
# left joining states summary to enc_release
ENC_Release5 <- left_join(ENC_Release4, States_summarized, by = "TAG")
#rearranging so that Tag is first column shown
ENC_Release5 <- ENC_Release5 %>%
  select(TAG, 1:ncol(ENC_Release5))
```

The distance a fish moved is then calculated from the condensed df detections (see the All Events Combined description to see how this is formed). Here, some data might be lost since it is using the condensed “most relevant” daily rather than every single detection, but it’s pretty rare that that will matter anyway, because most fish that that warning/edge case would apply to have actually been predated.

The total movement is calculated for each fish in the sequence of its encounter history. This is then joined to the summary dataframe as well.

Dummy rows are also taken out

```

#####joining on column with sum data
#same code appears in movements function
sum_dist1 <- combined_events_stations %>%
  group_by(TAG) %>%
  arrange(Datetime) %>%
  mutate(dist_moved = ET_STATION - lag(ET_STATION, order_by = Datetime),
         sum_dist = (sum(abs(diff(ET_STATION, na.rm = TRUE))))
  ) %>% #end of mutate
  distinct(TAG, .keep_all = TRUE) %>%
  select(TAG, sum_dist)

ENC_Release6 <- ENC_Release5 %>%
  left_join(sum_dist1, by = "TAG")

#### dummy rows removal: 1/14/23
ENC_Release6 <- ENC_Release6 %>%
  filter(!TAG %in% c("230000999999"))

```

### Get\_movements\_function

- Makes a condensed dataframe of fish “movements”; see “movements defined” for more info
  - A movement is defined as a change in stationing (assigned to detections in the spatial\_join function). A fish that continuously hits RB1 and RB2 for example would register as a “No Movement”, but a fish that goes from RB2 to HP3 would register as an “Upstream Movement” on HP3. All data is incorporated in this calculation, so if a fish was released below red barn, hit the red barn stationary antenna, then was detected by a mobile run upstream of red barn, then was recaptured downstream of that mobile detection, it will register as a “Initial release”, “Upstream Movement”, “Upstream Movement”, “Downstream Movement”. The absolute total of this distance is also summed and displayed as a column in the Encounter Histories Summaries Wide tab.
- Takes all\_events\_days1 from PrepareforStatesMovementsandSummary\_function
- Returns:
  - Movement\_table\_no\_trans: dataframe where only daily movements are included per tagged fish on unique antennas and UTM's. See “Movements defined” for about them

### About the Code

The code first groups by each tag and arranges each tag in order by their first, then subsequent events. It then calculates the distance moved between each event for each fish, based on the stationing. The code accounts for Fraser/Colorado River transitions by first calculating the distance to the confluence from the last event, then finding the distance from the confluence to the present event, then adding those together. Otherwise, it's just the difference between the last event and the current one.

The sum distance is then calculated as an absolute value of each movement that was calculated for a fish.

Marker Colors and icon colors are then assigned for later mapping.

Lastly in this code chunk, X and Y are defined as columns in preparation for changing the utms to lat/longs. Note: there are a couple places in the app where UTM's are converted to lat/longs, and the code would be a little more elegant if these were just all made to sf objects, but this stuff also all works fine.



```

movement_table_notrans <- combined_events_stations %>%
  ### removing dummy tag
  filter(!TAG %in% c("230000999999")) %>%
  select(Date, Datetime, TAG, det_type, Event, ET_STATION, Species, Release_Length, Release_Weight, ReleaseSite, Release_Date, Recapture)
  #grouping by TAG and arranging by datetime makes sure that total distance moved is totalled and summed in order
  group_by(TAG) %>%
  arrange(Datetime) %>%
  #dist_moved would be the place to fenagle new movements based on previous event...ie hitting wg biomark followed by connectivity chan
  #trickier but doable for mobile runs
  ### accounting for FRASER/UPPER COLORADO MOVEMENTS
  #if previous station is above the confluence and current station is above the confluence and you changed rivers,
  #then take the previous station and subtract the confluence station to get distance travalled to the confluence (A), then subtract th
  # otherwise, just subtract current station from previous
  mutate(dist_moved = case_when(lag(ET_STATION, order_by = Datetime) > 10120 & ET_STATION >10120 & River != lag(River, order_by = Datet
    TRUE ~ ET_STATION - lag(ET_STATION, order_by = Datetime)
  ),
  sum_dist = (sum(abs(dist_moved), na.rm = TRUE)),

  movement_only = case_when(lag(ET_STATION, order_by = Datetime) > 10120 & ET_STATION >10120 & River != lag(River, order_by = Da
    Event %in% c("Release", "Recapture and Release") ~ "Initial Release",
    dist_moved == 0 ~ "No Movement",
    dist_moved > 0 ~ "Upstream Movement",
    dist_moved < 0 ~ "Downstream Movement"),

  #this is for mapping later on
  #MARKERCOLOR options: limited because markers rely on static image
  #red", "darkred", "lightred", "orange", "beige", "green", "darkgreen", "lightgreen", "blue", "darkblue", "lightblue", "purple"
  # these also correspond to the movements maps, so if you add or change a color you should change it on the movements map as w
  marker_color = case_when(movement_only == "No Movement" ~ "black",
    movement_only == "Upstream Movement" ~ "green",
    movement_only == "Downstream Movement" ~ "red",
    movement_only == "Initial Release" ~ "orange",
    movement_only == "Changed Rivers" ~ "purple",
    #str_detect(movement_only, "Initial Release (or recapture and release)") ~ "yellow"
  ),

  icon_color = case_when(str_detect(det_type, "Stationary Antenna") ~ "orange",
    str_detect(det_type, "Biomark Antenna") ~ "yellow",
    str_detect(det_type, "Mobile Run") ~ "purple",
    det_type %in% c("Release", "Recapture and Release") ~ "blue",
    det_type == "Recapture" ~ "brown",
  ),
  X = as.numeric(UTM_X),
  Y = as.numeric(UTM_Y)
) #end of mutate

```

The UTM's are fully converted to Lat/longs, then the df is parred down with the distinct() function like it has before, but this time, it takes “movement” into account instead of “first/last”. Movement\_table\_notransitions is what is mapped and filtered in the app.

```

# assigning projection to ready df lat/longs for plotting
attr(movement_table_notrans, "zone") = "13"
attr(movement_table_notrans, "projection") = "UTM"
attr(movement_table_notrans, "datum") = "GRS80"

# need a column that has x and Y for this
# converts lutms to lat/long
movement_table_notrans <- convUL(movement_table_notrans, km=FALSE, southern=NULL)
#as of now, movement table still has rows reminiscent from first_last etc which are helpful when you want to know wher
#but if you want to know concise movments, then this will eliminate unneeded rows
#example: 230000142723
movement_table_notrans1 <- movement_table_notrans %>%
  distinct(Date, TAG, det_type, movement_only, UTM_X, UTM_Y, .keep_all = TRUE) %>%
  select(Date, Datetime, TAG, movement_only, det_type, dist_moved, sum_dist, ET_STATION, Species, Release_Length, Rele

#giving id column to make map proxy easier
# actually the id column needs to be remade every time a filter is applied. See the movements_df_reactives
#movement_table_notrans1$id <- seq.int(nrow(movement_table_notrans1))

```

## Get\_States\_function

- Makes dataframe of weekly “states” either above or below the dam. Below the dam is state A and above is B. State C is a detection in the connectivity channel. Ghost state is G, and Predated state is P
  - Any detection, recapture, or release is registered as a state
  - A fish is inferred to remain in that state until it becomes a ghost tag or is detected/recaptured again.
- Takes combined\_events\_stations from PrepareforStatesMovementsandSummary\_function, the Ghost tags df, and the aviation predation df.

- Returns:
  - All\_States: Dataframe of daily States of fish. Certain assumptions are made to infer transitions, such as if a fish hits 1/2 antennas at a site then hits an upstream antenna, it is said that an upstream transition originally occurred and it just missed 1 antenna. For more assumptions see the Daily States Tab section
  - Days\_and\_states\_wide: same data as all\_states but in wide format where days are the columns, TAG is the first column, and values are states
  - Flagged Movements: States that couldn't be accounted for in the code

## About the Code

The 3 dataframes are joined then the df is cut down to the most succinct: rows with a distinct combo of Tag, Event, Datetime, UTM's, and first and last event of day.

```
# these dates are cleaned before they go into this function
ghost_tag_df <- GhostTags %>%
  rename(TAG = TagID) %>%
  select(TAG, GhostDate)

av_pred_df <- AvianPredation %>%
  rename(TAG = TagID) %>%
  select(TAG, PredationDate)

#joining with ghost tag df
wghost_date <- left_join(combined_events_stations, ghost_tag_df, by = c("TAG"))
# joining with avian predation
#Shouldn't matter really, but this just cuts down unnecessary rows. left_joining creates more rows than df1 if there are duplicate \
#some new rows are created then when joining to the ghost tag df because many of the ghost tags have multiple detections after the
# I'm just cutting out these excess rows but I think they would get cut down anyway later in this function. As long as each ghost
wghost_av <- left_join(wghost_date, av_pred_df, by = c("TAG")) %>%
  distinct(TAG, Event, Datetime, UTM_X, UTM_Y, first_last, .keep_all = TRUE)
```

The states are then assigned based on above/below the dam, ghost tag, and predation date

```
states1 <- wghost_av %>%
  filter(!TAG %in% c('230000999999')) %>%
  mutate(
    #the case_whens also are a priority list, so important not to rearrange these
    #might have to readjust 8330 stationing
    state1 = case_when(Date >= GhostDate ~ "G",
                      Date >= PredationDate ~ "P",
                      str_detect(Event, "CD7|CD8|CD9|CD10|CU11|CU12") ~ "C",
                      ET_STATION <= 8330 ~ "A",
                      ET_STATION > 8330 ~ "B")
  )
```

The states are then kinda “squished” together into one row on a weekly basis, and duplicated letters in a row are removed, because a fish doesn't need a weekly states history that says “AAAA”, it just needs “A”. A column is also calculated to get the amount of weekly unique events.

The df then gets rid of duplicated rows, since each fish has multiple rows of states in the same week at this point. Relevant columns are selected and renamed

Some summary information for the fish are then calculated based off these states. In the states\_summarized df, the states are “squished” together for all states the fish has. From there, you can see if a fish went above/below the dam, and used the channel, which is what the new columns check. These columns are eventually joined back into the encounter histories summaries wide dataframe.



```

states2 <- states1 %>%
  group_by(weeks_since, TAG) %>%
  #arranging my datetime ensures that all states will be recorded in the correct order
  arrange(Datetime) %>%
  mutate(
    teststate_2 = paste(state1, collapse = ""),
    teststate_3 = gsub('([[:alpha:]]+)', '\\1', teststate_2), #removes consecutive letters
    weekly_unique_events = length(unique(Event))
  )

#this is now a weekly chart
states_final <- states2 %>%
  distinct(weeks_since, TAG, teststate_3, .keep_all = TRUE) %>%
  select(Date, weeks_since, TAG, teststate_3, det_type, ReleaseSite, Species, Release_Length, Release_weight, c_number_of_detection)
  rename(State = teststate_3)

# this makes some columns from all states of fish
states_summarized <- states1 %>%
  group_by(TAG) %>%
  arrange(Datetime) %>%
  mutate(teststate_2 = paste(state1, collapse = ""),
    teststate_3 = gsub('([[:alpha:]]+)', '\\1', teststate_2), #removes consecutive letters
    #new columns to say if fish stayed above or below?
    went_above_dam_noChannel = str_detect(teststate_3, "AB"),
    went_below_dam_noChannel = str_detect(teststate_3, "BA"),
    went_below_dam_throughChannel = str_detect(teststate_3, "BCA"),
    went_above_dam_throughChannel = str_detect(teststate_3, "ACB"),
    entered_channel_from_DS = str_detect(teststate_3, "AC"),
    entered_channel_from_US = str_detect(teststate_3, "BC"),
  ) %>%
  select(TAG, went_above_dam_noChannel, went_below_dam_noChannel, went_below_dam_throughChannel, went_above_dam_throughChannel, entered_channel_from_DS, entered_channel_from_US)
  distinct(TAG, .keep_all = TRUE)

```

This is an idea to put all the wonky states in place so it would be easy to see, but it isn't fully compatible with the app yet and therefore isn't used. My idea is that instead they would be in one tab on the states page so less one manual parsing is needed.

```

checking <- states_final %>%
  group_by(TAG) %>%
  arrange(Date) %>%
  mutate(through_dam1 = case_when(det_type == "Release" ~ "Initial Release",
    str_sub(State,-1,-1) == "A" & lag(str_sub(State,-1,-1)) %in% c("B", "C"), order_by = Date) ~ "Went Below Dam",
    str_sub(State,-1,-1) == "B" & lag(str_sub(State,-1,-1)) %in% c("A", "C"), order_by = Date) ~ "Went Above Dam",
    State %in% c("BA", "CA", "BCA") ~ "Went Below Dam",
    State %in% c("AB", "CB", "ACB") ~ "Went Above Dam",
    State == lag(str_sub(State,-1,-1), order_by = Date) ~ "No state change",
    # TRUE ~ NA
  )

unknown_states <- checking %>%
  filter(is.na(through_dam1) & !det_type %in% c("Release", "Recapture and Release", "Recapture"))

```

## Shapefile/Polygon Readins

The file "map\_polygon\_readins.R" reads in all shapefiles for the movements map. Also contains some graphics options for release sites, stationary antenna sites, and labels for stations.

```

#mapping
source("map_polygon_readins.R")

```

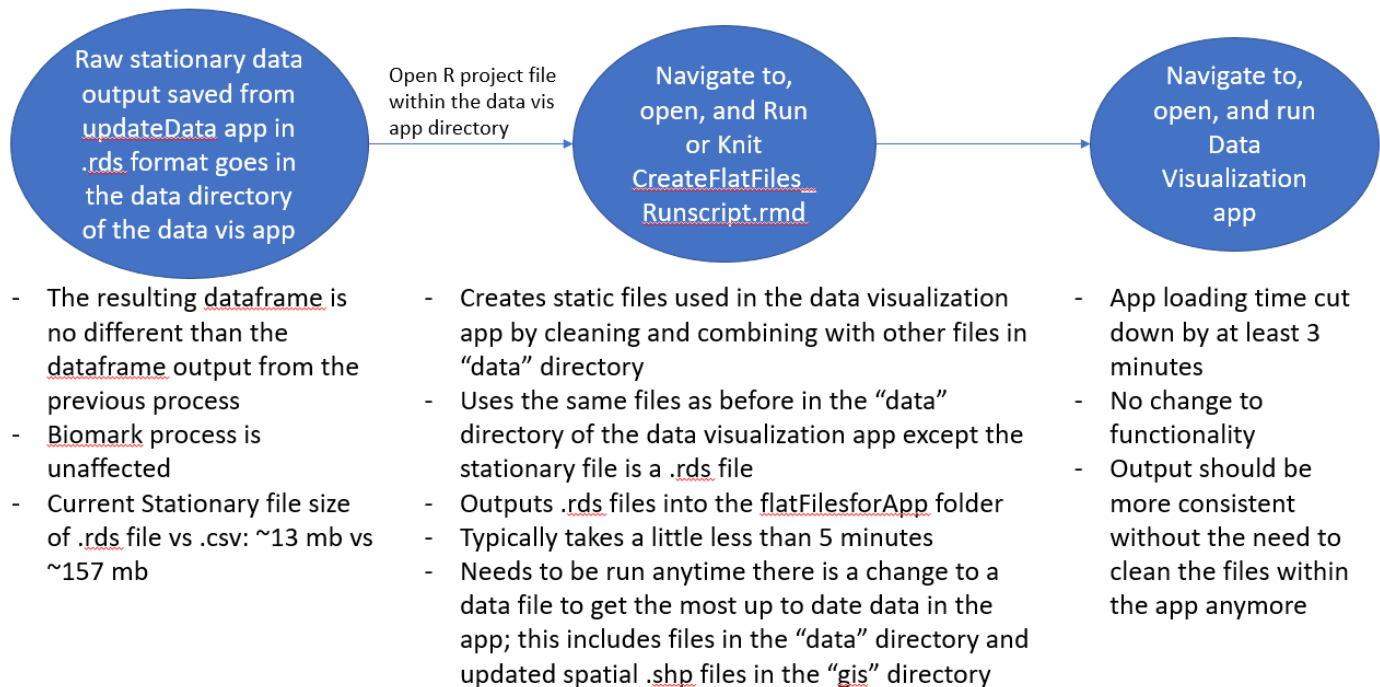
## .Rds files

.rds files in R are a binary format used to save R objects, such as data frames, lists, or models, preserving their internal structure and attributes. Unlike CSV files, which store data in a plain text format, .rds files maintain the integrity of R-specific data types and structures, allowing for more complex objects to be saved and loaded efficiently. For example, if you have a data frame df that you want to save as an .rds file, you can use the saveRDS(df, "data.rds") function. To load this data back into R, you would use df <- readRDS("data.rds"). Editing an .rds file involves loading the object, making the desired changes, and then saving it again.

## Advantages of .rds files in this app

- Easy to save data and reload it again across different R projects without losing any metadata or attributes
  - Helpful when saving Stationary data from CombineDataApp and moving over to this app
- Preserves data types and structures
  - Ensures that when the data is read into R, it preserves the same format, vs a csv which saves data in plaintext, sometimes necessitating type conversion to change the data back to its original structure when opened in Excel. This is currently seen when we open and save data in Excel that have tag numbers, and every time we save/modify it in Excel, we have to make sure the tag number is saved as a numeric type rather than general (see Creating New Flat Files/Running the Script: Common errors). This was also causing issues with the timestamps in the stationary data, leading to the decision to keep the Stationary Data in .rds form.
- Ability to save objects other than DFs
  - This enables us to save lists and spatial files as flat files created in the runscrip, reducing computational load within the app for faster speed
- Efficiency
  - .rds files are smaller than csvs of the same data. This leads to quicker read-in times and easier file transfers across projects.

As of late 2023, WGFP\_Raw (containing all Stationary Antenna data) has been saved as a .rds file in from the update Data app. The new resultant workflow is as follows as it affects this app.



## Shiny Modules

Each tab is split up into its own module. This makes the code reusable (can plug the ui and server into any app easily with the right arguments) and organized. This is where the data processing occurs from the sidebar filters and how graphs and tables are rendered. Read more about Shiny Modules [here](#).

## Site, Movement and Species Colors

The colors of the Sites, movements and species used in the app are determined by this chunk of code in the beginning of the app.R file

```
#colors
#rainbow trout color pallete used to assign to Sites:
# "Confluence, Connectivity Downstream, Connectivity Side Channel, Connectivity Upstream, Hitching Post,
# Kaibab Park, Red Barn, Windy Gap Auxiliary, Windy Gap Bypass Channel"
rainbow_trout_colors <- c("#8B8000", "#008080", "#FF69B4", "#FF4500", "#6A5ACD", "#32CD32", "#20B2AA", "#FF1C55", "#4682B4")
#currently "Changed Rivers", "Downstream Movement" "Initial Release", "No Movement", "Upstream Movement" (5/17/24)
#note: these are a little different than what we see in the map because the map/marker color options are very limited.
movementColors <- c("#4B0082", "#8B0000", "#FF8C00", "#253333", "#228B22") #, "#66FF00"
# currently "LOC" "MTS" "RBT" "RXN" "TGM" (5/17/24)
speciesColors <- c("#FFD700", "#654321", "#4F7942", "#FF7F50", "#1E90FF", "#008080", "#DAA520", "#D2691E", "#9A5ECB")
```

Rainbow\_trout\_colors is used to assign colors to site in succession of the colors: so Confluence gets assigned #8b8000, Connectivity Downstream is assigned #008080, etc. When a new site is added to the data, it will automatically get assigned a color based off the rainbow\_trout\_colors vector, provided that the number of sites is less than the length of rainbow\_trout\_colors. As of 5/24/2024, there are 9 sites and 15 colors in the vector, so we can add 6 more antenna sites that won't require adjustment to this code.

MovementColors and SpeciesColors are similar to rainbow\_trout\_colors. If we want to change the colors for a given species/movement etc, then change the colors in this code. Note: changing movementColors does not affect the color shown in the map, just the graphs. Go to get\_movements\_function.R to edit the movement colors on the map.

## Known Bugs

There are a few bugs in the app that occasionally show up. Typically, the best remedy is to restart the app. Try to clear your R environment and close and restart R studio if none of that works.

### Sequences

Sometimes when you click "add site" or "drop site", multiple boxes appear/disappear when there should just be one. When displaying the data, there might be error messages in the console. I believe it's related to assigning Ids and maybe not subsequently destroying them effectively. This bug rarely happens and is fixed with a restart on the app.

### Movements

- If there aren't any data to display that fit the filter criteria and you click "render:", then the app will crash and the following error message appears in the console:

```
Warning: Error in $<-:data.frame: replacement has 2 rows, data has 0
```

You can restart the app and everything works fine, just know that those filters meant there were no data to show.

### Crosstalk QAQC

Sometimes when you click this tab, the tabs for each individual site are rendered many times. I believe it's related to assigning Ids and maybe not subsequently destroying them effectively. Restarting the app and navigating right to the tab works to fix this.

Let me know if there are other questions and concerns, I'm happy to add to this if needed. Let me know

[sfigraf@gmail.com](mailto:sfigraf@gmail.com)