

Motus R Package Review

In the next couple of months we will be releasing a basic R-package that will allow users to access their data directly from the Motus database. We plan to improve this package over time to include tools to manage, explore and analyze detection data. To ensure that the R package is tailored for the needs of Motus collaborators, please take some time to review some of the current functions.

Load R Packages

First, we load some packages. If you do not have these packages installed, you need to first install them using `> install.packages("dplyr")`.

```
require(dplyr)
require(ggplot2)
require(ggmap)
require(RgoogleMaps)
require(lubridate)
require(sensorgnome)
require(geosphere)
require(knitr)
require(pander)
```

Getting Data

```
## read in detection data
tags <- read.csv("./sample_data.csv")
tags <- rename(tags, port = ant)
## read in deployment data
rec <- read.csv("./receiver-deployments.csv")
## read in antenna data
ant <- read.csv("./antenna-deployments.csv")
## merge deployment data with antenna data
rec <- merge(rec, ant, by = c("recvDeployID", "motusRecvID", "receiverID",
                             "recvProjectID", "deploymentStatus"), all = TRUE)
## merge receiver data with detection data by receiver deployment ID
tags <- merge(tags, rec, by = c("recvDeployID", "motusRecvID", "receiverID",
                              "recvProjectID", "port"), all.x = TRUE)
## convert ts to POSIXct date format
tags$ts <- as.POSIXct(tags$ts, origin = "1970-01-01", ts = "GMT")
tags$mfgID <- as.factor(tags$mfgID)
```

Basic Data Manipulations

Add sunrise/sunset times, as well as time to/from sunrise/sunset to detection files

```
sun <- timeToSunrisset(tags, units = "mins")
sun[100:105, c(1, 2, 3, 4, 5, 8, 9, 22, 32, 37, 38, 58, 59, 60, 61, 62, 63, 64)]
```

```
##      recvDeployID motusRecvID      receiverID recvProjectID port
## 100      2237      691 SG-5113BBBK0489      3      3
## 101      2237      691 SG-5113BBBK0489      3      3
## 102      2237      691 SG-5113BBBK0489      3      3
## 103      2237      691 SG-5113BBBK0489      3      3
## 104      2237      691 SG-5113BBBK0489      3      3
## 105      2237      691 SG-5113BBBK0489      3      3
##      ts      sig mfgID deploymentName latitude longitude
## 100 2015-09-01 23:46:46 -60.4792 181 D'Estimauville 46.89298 -71.21108
## 101 2015-09-01 23:46:52 -60.4709 181 D'Estimauville 46.89298 -71.21108
## 102 2015-09-01 23:46:58 -60.6831 181 D'Estimauville 46.89298 -71.21108
## 103 2015-09-01 23:47:04 -61.4633 181 D'Estimauville 46.89298 -71.21108
## 104 2015-09-01 23:47:10 -61.3071 181 D'Estimauville 46.89298 -71.21108
## 105 2015-09-01 23:47:16 -60.9561 181 D'Estimauville 46.89298 -71.21108
##      polarization2      sunrise      sunset ts_to_set
## 100      NA 2015-09-01 03:04:01 2015-09-01 16:24:50 996.1419
## 101      NA 2015-09-01 03:04:01 2015-09-01 16:24:50 996.0387
## 102      NA 2015-09-01 03:04:01 2015-09-01 16:24:50 995.9355
## 103      NA 2015-09-01 03:04:01 2015-09-01 16:24:50 995.8322
## 104      NA 2015-09-01 03:04:01 2015-09-01 16:24:50 995.7290
## 105      NA 2015-09-01 03:04:01 2015-09-01 16:24:50 995.6258
##      ts_since_set ts_to_rise ts_since_rise
## 100      441.9247 198.5570 1242.740
## 101      442.0279 198.4537 1242.844
## 102      442.1311 198.3505 1242.947
## 103      442.2343 198.2473 1243.050
## 104      442.3376 198.1441 1243.153
## 105      442.4408 198.0409 1243.256
```

Get dataframe of “transitions” - consecutive detections at different sites - for each tagID

```
transitions <- siteTrans(tags)
transitions[1:5,]
```

```
## Source: local data frame [5 x 14]
## Groups: mfgID [2]
```

```
##      mfgID      ts.x latitude.x longitude.x deploymentName.x
##      (fctr)      (time)      (dbl)      (dbl)      (fctr)
## 1      94 2015-09-08 04:05:54 51.6578 -80.5676 Piskwamish
## 2      94 2015-09-08 05:00:57 51.8231 -80.6912 Longridge
## 3      94 2015-09-08 06:42:33 51.2913 -80.1168 Netitishi
## 4      94 2015-09-09 09:43:19 51.4839 -80.4500 North Bluff
## 5     378 2015-09-11 08:35:45 51.4839 -80.4500 North Bluff
## Variables not shown: ts.y (time), latitude.y (dbl), longitude.y (dbl),
##      deploymentName.y (fctr), tot_ts (dfft), dist (dbl), rate (dbl), bearing
##      (dbl), rhumbline_bearing (dbl)
```

We are also hoping to add functions for identifying periods of activity, quiescence, or movement, based on signal strength thresholds, and frequency of detections on antennas or stations.

Data Summaries

Get overall summary of each tag; first and last detection time, first and last detection site, first and last detection location, total time, distance, overall bearing, and average speed (m/s) between first and last detection, and total number of detections

```
tag_summary <- tagSum(tags)
head(tag_summary)
```

```
##      mfgID      first_ts      last_ts first_site last_site
## 1    174 2015-08-17 06:46:07 2015-08-17 06:55:10 Netitishi Netitishi
## 2    180 2015-08-20 11:42:33 2015-08-22 15:19:37 North Bluff North Bluff
## 3    378 2015-09-11 08:35:06 2015-10-26 05:41:29 North Bluff      <NA>
## 4    379 2015-09-15 13:13:07 2015-12-07 03:02:19 North Bluff Swallowtail
## 5    181 2015-08-22 19:28:45 2015-12-07 03:15:01 Netitishi Swallowtail
## 6     94 2015-09-08 03:46:11 2016-01-11 14:36:28 Piskwamish Koffler
##      latitude.x longitude.x latitude.y longitude.y      tot_ts
## 1      51.2913     -80.1168      51.2913     -80.1168 5.425501e+02 secs
## 2      51.4839     -80.4500      51.4839     -80.4500 1.858243e+05 secs
## 3      51.4839     -80.4500         NA         NA 3.877583e+06 secs
## 4      51.4839     -80.4500      44.7650     -66.7366 7.138152e+06 secs
## 5      51.2913     -80.1168      44.7650     -66.7366 9.189977e+06 secs
## 6      51.6578     -80.5676      44.0241     -79.5371 1.084262e+07 secs
##      dist      rate      bearing num_det
## 1      0.0 0.00000000 -180.0000      141
## 2      0.0 0.00000000 -180.0000      73
## 3      NA      NA      NA      656
## 4 1261731.1 0.17675878 120.9254      88
## 5 1230823.6 0.13393109 120.8921     1151
## 6 852242.6 0.07860119 174.4205     1116
```

Summarise first and last detections of all tags by site

```
tag_site_summary <- tagSumSite(tags, units = "mins")
head(tag_site_summary)
```

```
## Source: local data frame [6 x 6]
## Groups: mfgID [1]
##
##      mfgID deploymentName      first_ts      last_ts
##      (fctr)      (fctr)      (time)      (time)
## 1     94      Borgles 2015-09-10 09:19:39 2015-09-10 09:29:31
## 2     94      COBEQUID3 2015-09-10 08:31:30 2015-09-10 08:45:31
## 3     94 D'Estimauville 2015-09-10 02:03:12 2015-09-10 02:04:43
## 4     94      Fundy NP 2015-09-10 06:52:38 2015-09-10 06:53:27
## 5     94      Huggins 2015-09-10 07:50:21 2015-09-10 07:58:28
## 6     94  JONSONSMILLS 2015-09-10 07:02:27 2015-09-10 07:10:47
## Variables not shown: tot_ts (dfft), num_det (int)
```

Summarise the detections of all tags by site for each day; first and last detection, total detection time, total number of tags, total number of detections)

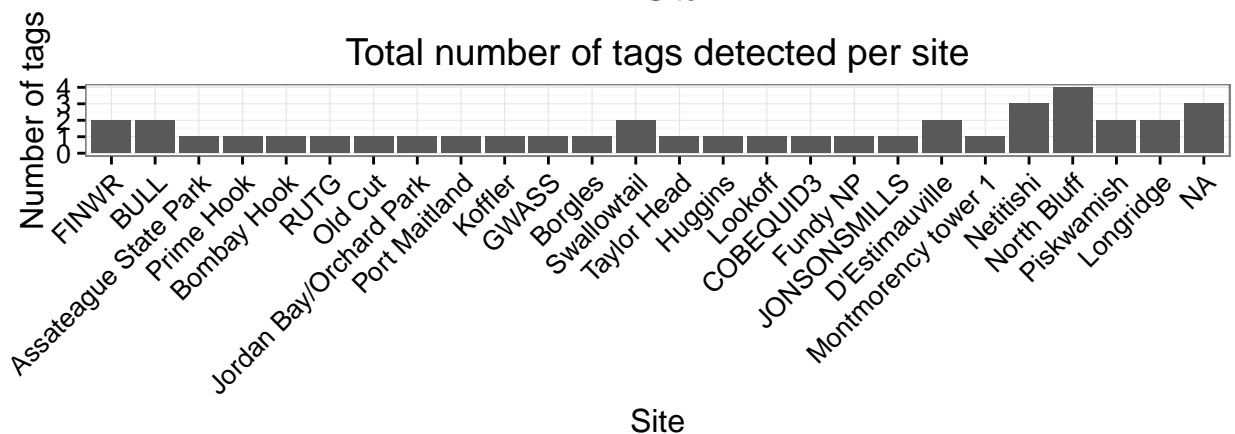
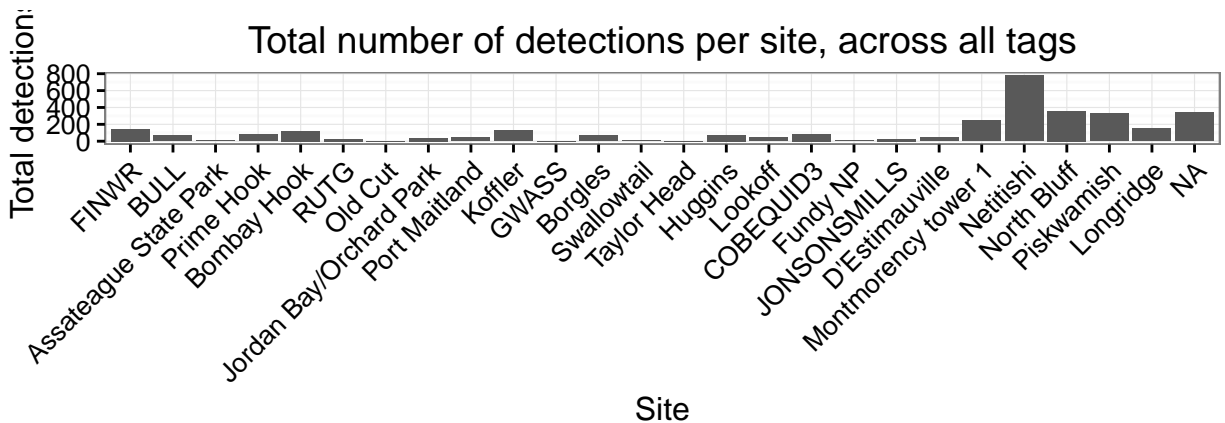
```
daily_site_summary <- siteSumDaily(tags, units = "mins")
head(daily_site_summary)
```

```
## Source: local data frame [6 x 7]
## Groups: deploymentName [5]
```

```
##
##      deploymentName      date      first_ts      last_ts
##      (fctr)      (date)      (time)      (time)
## 1 Assateague State Park 2015-09-13 2015-09-13 03:12:50 2015-09-13 03:14:40
## 2      Bombay Hook 2015-09-12 2015-09-12 07:45:07 2015-09-12 07:52:20
## 3      Borgles 2015-09-10 2015-09-10 09:19:39 2015-09-10 09:29:31
## 4      BULL 2015-09-19 2015-09-18 22:59:34 2015-09-18 23:08:31
## 5      BULL 2015-10-26 2015-10-26 14:49:58 2015-10-26 14:50:36
## 6      COBEQUID3 2015-09-10 2015-09-10 08:31:30 2015-09-10 08:45:31
## Variables not shown: tot_ts (dfft), num_tags (int), num_det (int)
```

Summarize and plot detections of all tags by site, can specify units that total time is displayed in

```
site_summary <- siteSum(tags, units = "mins")
```



```
print(site_summary)
```

```
## Source: local data frame [26 x 6]
```

```
##
##      deploymentName      first_ts      last_ts
##      (fctr)      (time)      (time)
## 1      FINWR 2015-09-18 22:48:32 2015-10-26 15:49:50
## 2      BULL 2015-09-18 22:59:34 2015-10-26 14:50:36
## 3 Assateague State Park 2015-09-13 03:12:50 2015-09-13 03:14:40
## 4      Prime Hook 2015-09-13 01:58:28 2015-09-13 02:01:49
## 5      Bombay Hook 2015-09-12 07:45:07 2015-09-12 07:52:20
## 6      RUTG 2015-09-11 10:28:23 2015-09-11 10:31:07
## 7      Old Cut 2015-11-10 17:22:11 2015-11-10 17:23:24
```

```
## 8   Jordan Bay/Orchard Park 2015-09-02 07:53:05 2015-09-02 07:57:21
## 9           Port Maitland 2015-09-02 06:50:00 2015-09-02 06:54:34
## 10           Koffler 2016-01-11 12:38:11 2016-01-11 14:36:28
## ..           ...           ...
## Variables not shown: tot_ts (dfft), num.tags (int), num.det (int)
```

Get a dataframe consisting of simultaneous detections at multiple sites

```
sim <- simSiteDet(tags)
sim[1:5, c(1, 2, 3, 4, 5, 8, 9, 22, 32, 37, 38)]
```

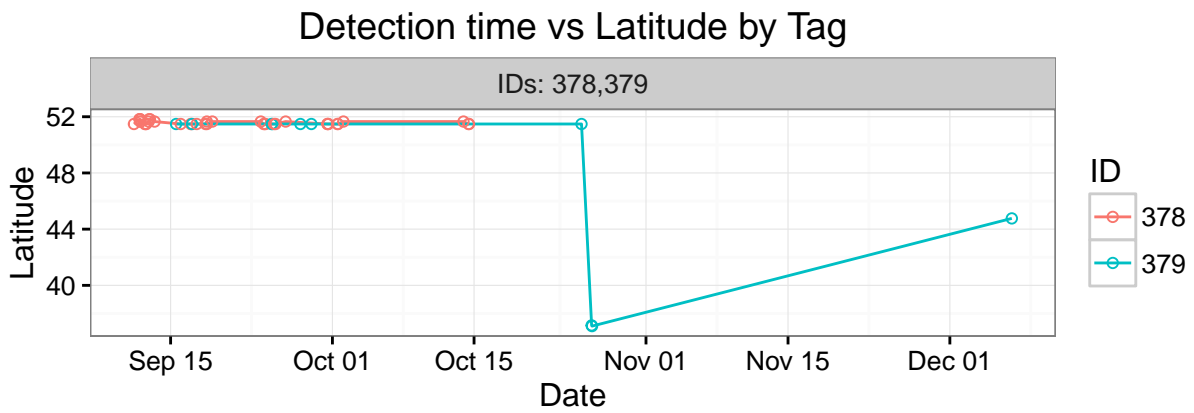
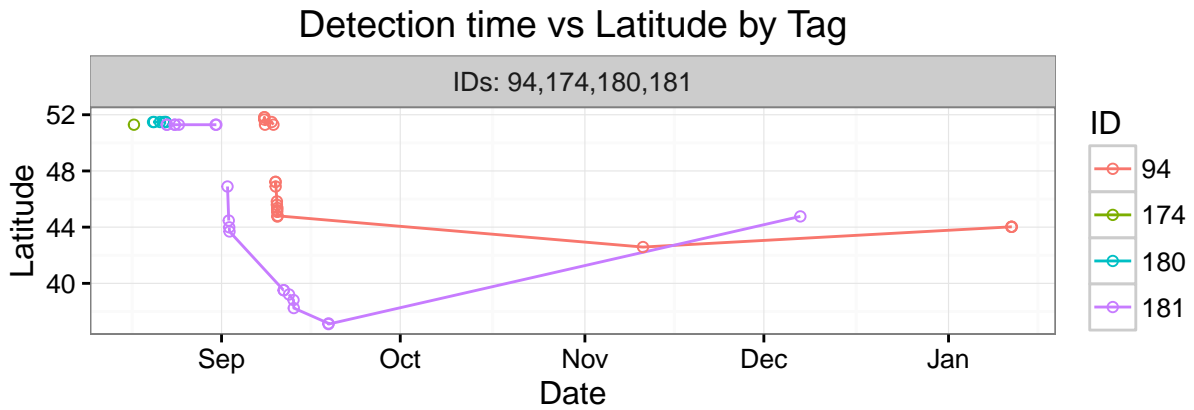
```
##      recvDeployID motusRecvID      receiverID recvProjectID port
## 3067          3675         1962 SG-1012BB012075          10    5
## 62           2191          441 SG-1614BBBK1603           2    3
## 3071          3675         1962 SG-1012BB012075          10    5
## 39           2191          441 SG-1614BBBK1603           2    1
## 3085          3675         1962 SG-1012BB012075          10    5
##      ts      sig mfgID deploymentName latitude longitude
## 3067 2015-09-10 07:46:29 -69.0937    94      <NA>      NA      NA
## 62   2015-09-10 07:46:29 -71.4641    94      Lookoff 45.207 -64.3978
## 3071 2015-09-10 07:47:12 -66.8268    94      <NA>      NA      NA
## 39   2015-09-10 07:47:12 -67.7233    94      Lookoff 45.207 -64.3978
## 3085 2015-09-10 07:49:20 -66.4919    94      <NA>      NA      NA
```

Data Visualizations

Plot Detection data

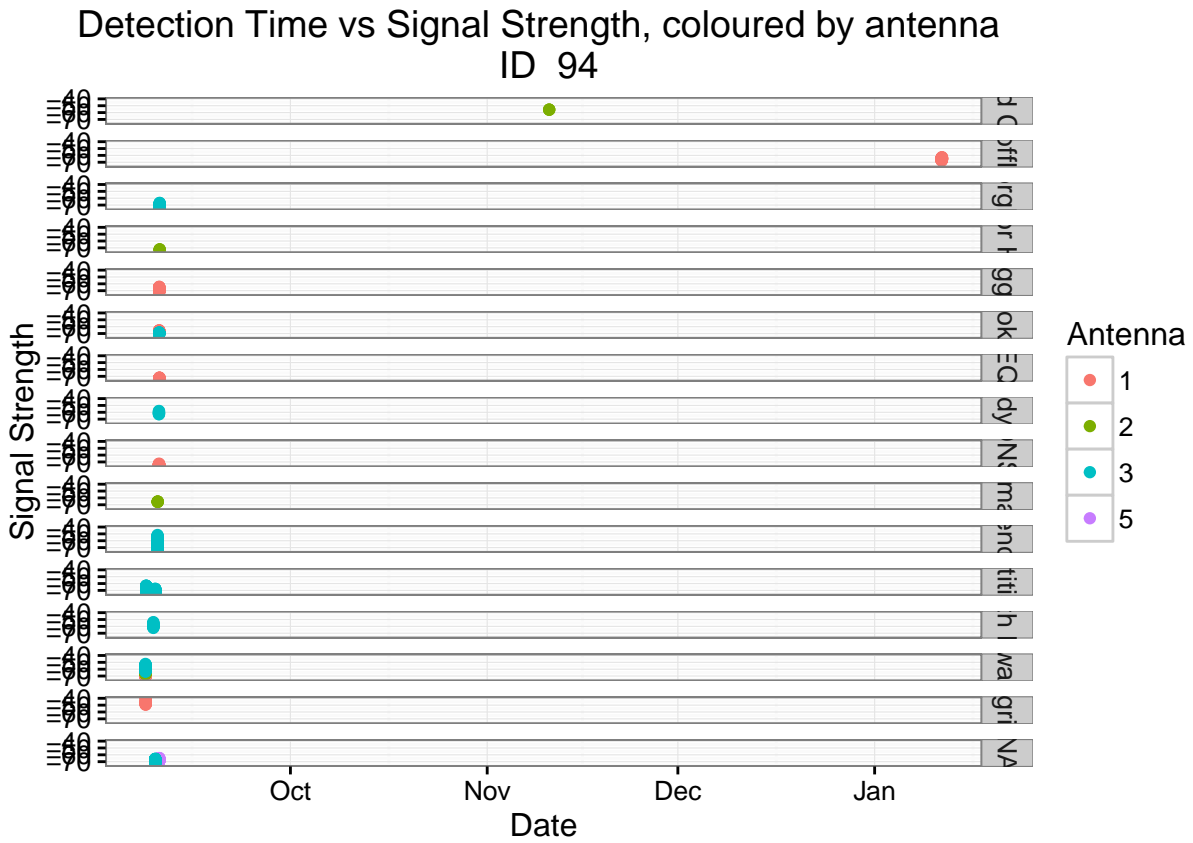
Plot all tags by latitude, you can adjust the number of tags visible in each facet by adjusting “tagsPerPanel”

```
plotAllTagsLat(tags, tagsPerPanel = 4)
```



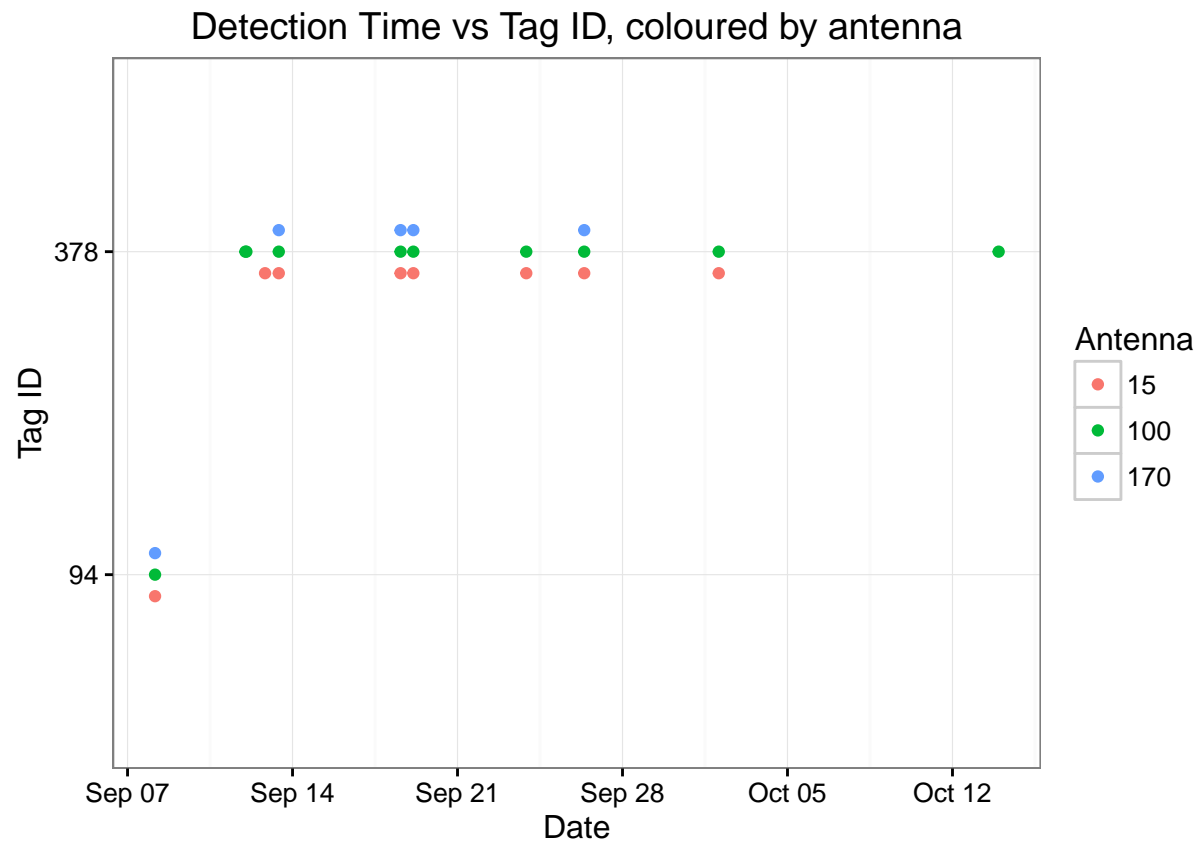
Plot all detections of a specified tag by site

```
plotTagSig(tags, tag = 94)
```



Plot all tags by site, you can adjust the number of tags visible in each facet by adjusting “tagsPerPanel”

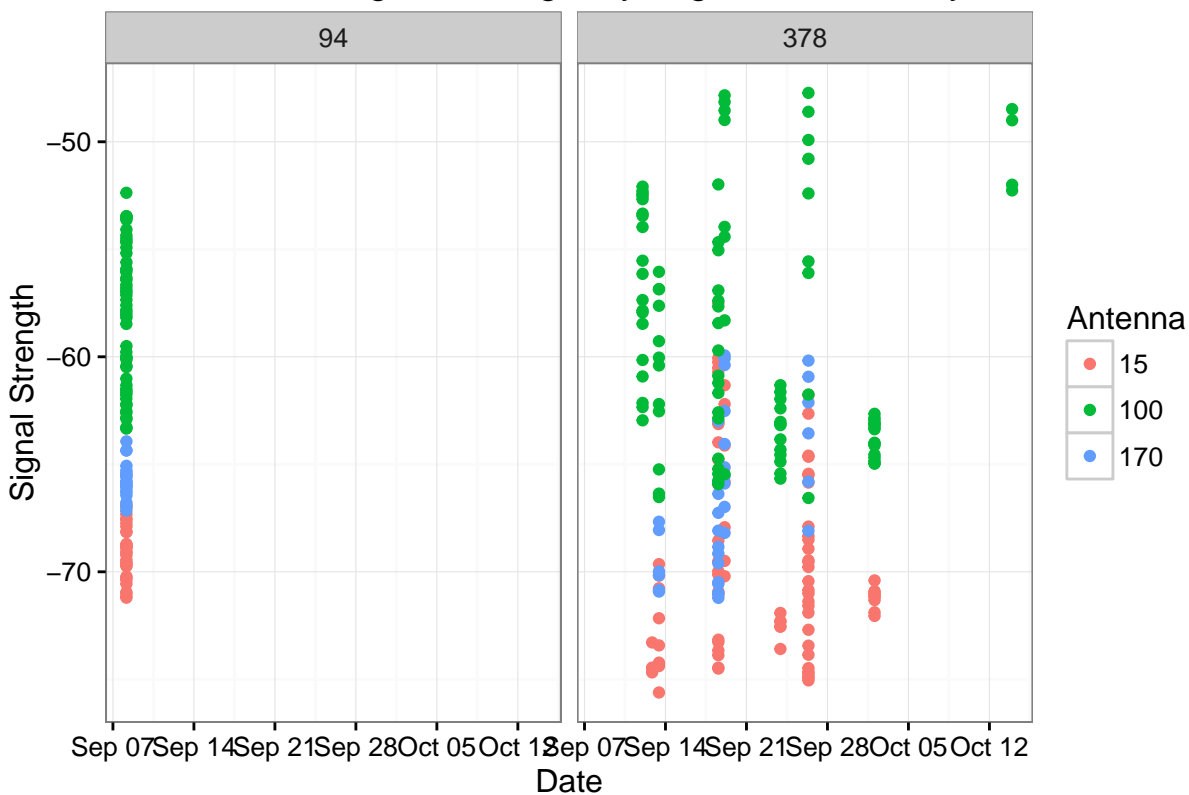
```
plotAllTagsSite(tags, tagsPerPanel = 2)
```

Plot signal strength of all tags at a specified site

```
plotSiteSig(tags, depName = "Piskwamish")
```

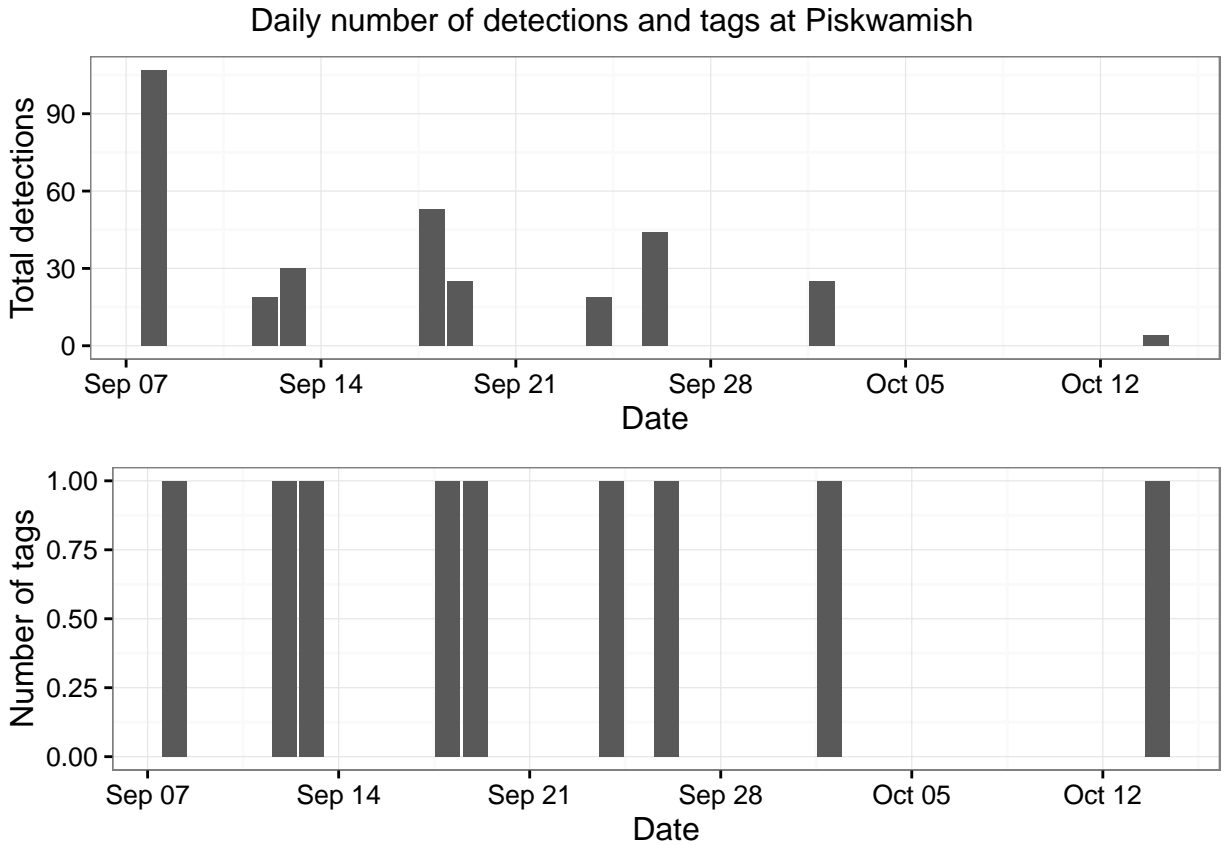
Detection Time vs Signal Strength by Tag ID, coloured by antenna



Plot site detection summaries

Plot the total number of detections across all tags, and the total number of tag detected per day for a specified site.

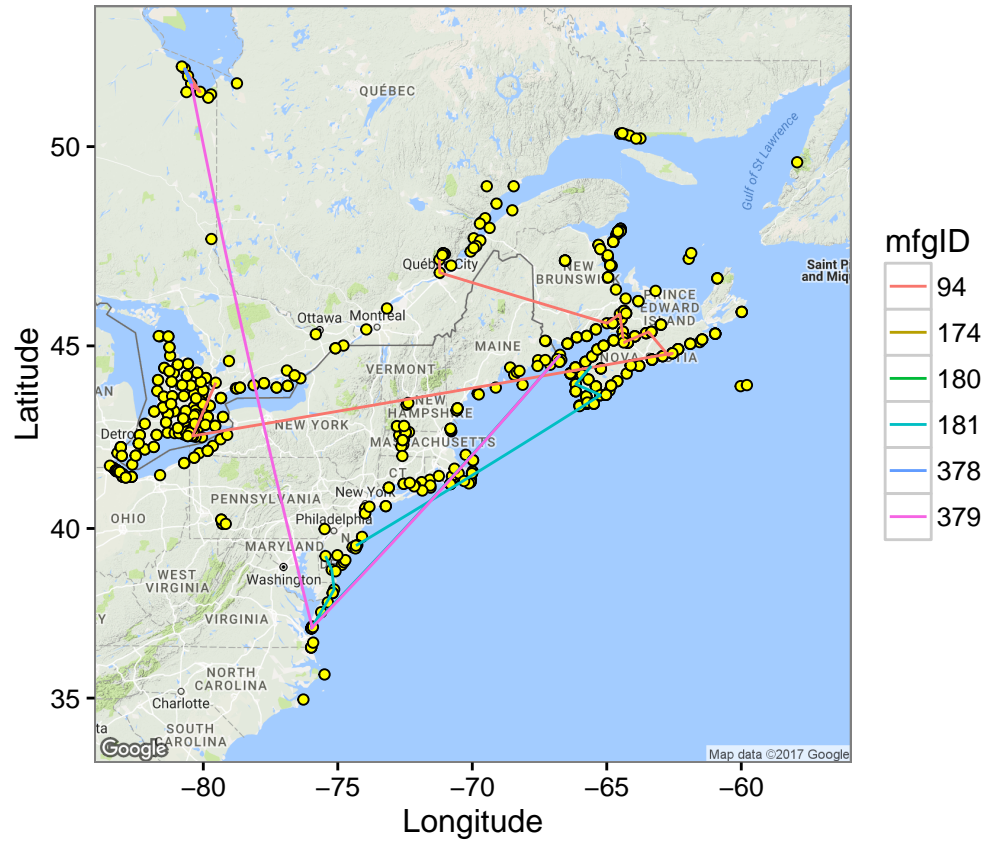
```
plotDailySiteSum(tags, Site = "Piskwamish")
```



Plot Route Maps

Plot route estimates coloured by ID, with all sites. You can specify `maptype` (terrain, satellite, roadmap, hybrid), map center (`latCentre/lonCentre`), zoom, and the time frame for active receivers to be displayed.

```
plotRouteMap(site_data = rec, detection_data = tags, maptype = "terrain",  
latCentre = 44, lonCentre = -70, zoom = 5, startTime = "2016-01-01", endTime = "2016-12-31")
```



We are also hoping to add functions for station operation plots (active/inactive periods for stations, antenna, and gps), as well as maps of receivers active during a specified time period including antenna directions and range estimates.

After reviewing these functions, are there any other tools that you would like to see included? If already have scripts for other tools and would like to contribute to the R package, please let us know at motus@birdscanada.org