Do you know what that sound is, Highness? Those are the Shrieking Eels — if you don’t believe me, just wait. They always grow louder when they’re about to feed on human flesh. If you swim back now, I promise, no harm will come to you. I doubt you will get such an offer from the Eels.

European eels ([*Anguilla anguilla*](https://en.wikipedia.org/wiki/Anguilla_anguilla)) have it tough. Not only are they depicted as monsters in movies, they are [critically endangered](https://doi.org/10.2305/IUCN.UK.2014-1.RLTS.T60344A45833138.en) in real life. One of the many aspects that is contributing to their decline is the reduced connectivity between their freshwater and marine habitats. Eels are catadromous: they live in freshwater, but migrate to the Sargasso Sea to spawn, a route that is blocked by numerous human structures (shipping locks, sluices, pumping stations, etc.). This animated video gives a quick introduction to his research and the receiver network:

[](https://www.youtube.com/watch?v=7YQVgl3QPyY)

In this blog post, we’ll explore if the migration of one eel is influenced by the tide. It’s a research use case for our R package wateRinfo.

**Meet Princess Buttercup**

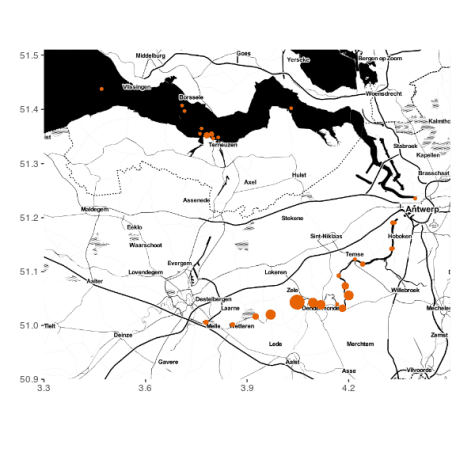
Pieterjan provided us the tracking data for eel with transmitter A69-1601-52622. Let’s call her **Princess Buttercup**, after the princess that almost got eaten by the Shrieking Eels in the classic and immensly quotable movie [The Princess Bride](https://www.imdb.com/title/tt0093779/quotes/). The datafile is attached with this repository.

eel <- read\_csv(here("data", "eel\_track.csv"))

Her tracking data consists of the residence time interval (arrival until departure) at each receiver station that detected her along the [Scheldt](https://en.wikipedia.org/wiki/Scheldt) river. It also contains the calculated residencetime (in seconds), as well as the station name, latitude and longitude.

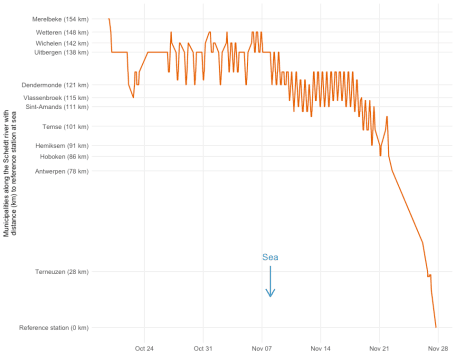
| **date** | **receiver** | **latitude** | **longitude** | **station** | **arrival** | **departure** | **residencetime** |
| --- | --- | --- | --- | --- | --- | --- | --- |
| 2016-10-19 | VR2W-112297 | 51.00164 | 3.85695 | s-Wetteren | 2016-10-19 23:44:00 | 2016-10-19 23:48:00 | 240 |
| 2016-10-19 | VR2W-112287 | 51.00588 | 3.77876 | s-2 | 2016-10-19 16:07:00 | 2016-10-19 19:12:00 | 11100 |
| 2016-10-20 | VR2W-122322 | 51.02032 | 3.96965 | s-2a | 2016-10-20 13:18:00 | 2016-10-20 13:23:00 | 300 |
| 2016-10-20 | VR2W-122322 | 51.02032 | 3.96965 | s-2a | 2016-10-20 02:21:00 | 2016-10-20 02:29:00 | 480 |
| 2016-10-20 | VR2W-115438 | 51.01680 | 3.92527 | s-Wichelen | 2016-10-20 01:01:00 | 2016-10-20 01:09:00 | 480 |
| 2016-10-20 | VR2W-122322 | 51.02032 | 3.96965 | s-2a | 2016-10-20 05:52:00 | 2016-10-20 06:00:00 | 480 |

Using the latitude, longitude and total residencetime for each station, we can map where Princess Buttercup likes to hang out:



**Moving up and down the Scheldt river**

To get a better sense of her journey along the river, we add a distance\_to\_sea (in meters) for the stations, by joining the tracking data. We can now plot her movement over time and distance:



Princess Buttercup’s signal was picked up by receivers in Merelbeke (near Ghent) shortly after she was captured and released there on October 11. She resided in a 40 km stretch of the river (between Wetteren and Sint-Amands) for about a month before migrating towards the sea and starting the long journey towards the Sargasso Sea. The periodic movement pattern up and down the river during the second half of November is of particular interest: it looks like tidal frequency [2](https://ropensci.org/blog/2019/01/22/waterinfo-tidal-eel/#fn:2). It would be interesting to compare the movement pattern with real water level data from the Scheldt river… which is where our wateRinfo package comes in.

**Getting tidal data with the wateRinfo package**

[Waterinfo.be](http://waterinfo.be/), managed by the [Flanders Environment Agency (VMM)](https://en.vmm.be/) and [Flanders Hydraulics Research](https://www.waterbouwkundiglaboratorium.be/), is a website where one can find real-time water and weather related environmental variables for Flanders (Belgium), such as rainfall, air pressure, discharge, and water level. The website also provides an [API](https://www.waterinfo.be/download/9f5ee0c9-dafa-46de-958b-7cac46eb8c23?dl=0) to download time series of these measurements as open data, but compositing the download URL with the proper system codes can be challenging. To facilitate users in searching for stations and variables, subsequently downloading data of interest and incorporating waterinfo.be data access in repeatable workflows, the R package wateRinfo to do just that.

Timeseries in waterinfo.be (identified by a ts\_id) are a combination of a variable, location (station\_id) and measurement frequency (15min by default). For example:

library(wateRinfo)

get\_stations("water\_level") %>%

select(ts\_id, station\_id, station\_name, parametertype\_name) %>%

head()

| **ts\_id** | **station\_id** | **station\_name** | **parametertype\_name** |
| --- | --- | --- | --- |
| 92956042 | 39483 | Kieldrecht/Noordzuidverbinding | H |
| 31683042 | 21995 | Leuven/Dijle1e arm/stuw K3 | H |
| 20682042 | 20301 | StMichiels/Kerkebeek/Rooster | H |
| 96495042 | 10413 | Oudenburg/Magdalenakreek | H |
| 25074042 | 20788 | Schulen/Inlaat A/WB\_Schulensbroek | H |
| 2006042 | 10432 | Merkem/Steenbeek | H |

tidal\_zone\_ts\_ids <- read\_csv(here("data", "tidal\_zone\_ts\_ids.csv"))

From which we select the 10-min frequency tidal timeseries in the Scheldt river:

| **ts\_id** | **station\_id** | **station\_name** | **portal\_bekken** |
| --- | --- | --- | --- |
| 55419010 | 0430087 | Sint-Amands tij/Zeeschelde | Beneden-Scheldebekken |
| 55565010 | 0430029 | Tielrode tij/Durme | Beneden-Scheldebekken |
| 55493010 | 0430081 | Temse tij/Zeeschelde | Beneden-Scheldebekken |
| 54186010 | 0419418 | Dendermonde tij/Zeeschelde | Beneden-Scheldebekken |
| 54493010 | 0430078 | Hemiksem tij/Zeeschelde | Beneden-Scheldebekken |
| 55355010 | 0430091 | Schoonaarde tij/Zeeschelde | Beneden-Scheldebekken |
| 53989010 | 0419484 | Antwerpen tij/Zeeschelde | Beneden-Scheldebekken |
| 54606010 | 0430071 | Kallosluis tij/Zeeschelde | Beneden-Scheldebekken |
| 56088010 | 0430062 | Prosperpolder tij/Zeeschelde | Beneden-Scheldebekken |
| 54936010 | 0430068 | Liefkenshoek tij/Zeeschelde | Beneden-Scheldebekken |
| 55059010 | 0430242 | Melle tij/Zeeschelde | Beneden-Scheldebekken |

This wateRinfo package shows how to download data for multiple stations at once using wateRinfo and dplyr. We use a similar approach, but instead of manually providing the start and end date, we get these from Princess Buttercup’s tracking data:

tidal\_data <-

tidal\_zone\_ts\_ids %>%

group\_by(ts\_id) %>%

# Download tidal data for each ts\_id (time series id)

do(get\_timeseries\_tsid(

.$ts\_id,

from = min(eel$date), # Start of eel tracking data

to = max(eel$date), # End of eel tracking data

datasource = 4

)) %>%

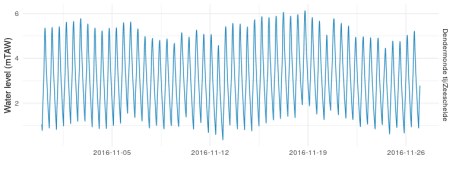
# Join data back with tidal\_zone\_ts\_id metadata

ungroup() %>%

left\_join(tidal\_zone\_ts\_ids, by = "ts\_id")

In just a few lines of code, we downloaded the tidal data for each measurement station for the required time period. 

The water level is expressed in mTAW (meter above mean sea level). Let’s plot the data for a station (here Dendermonde in November 2016) to have a look:



We now have all the pieces to verify if Princess Buttercup *was* surfing the tide back and forth.

**Is Princess Buttercup surfing the tide?**

Let’s add the tidal data to Princess Buttercup’s journey plot we created before. The first step is to join the tidal data with the same distance reference file to know the distance from each tidal station to the sea:

tidal\_data <-

tidal\_data %>%

left\_join(

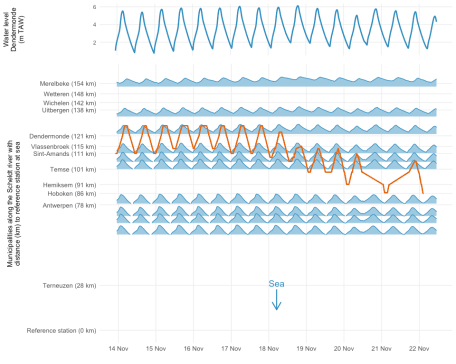
distance\_from\_sea %>% select(station, distance\_from\_sea, municipality),

by = c("station\_name" = "station")

) %>%

filter(station\_name != "Hemiksem tij/Zeeschelde") # Exclude (probably erroneous) data from Hemiksem

To avoid visual clutter, we’ll use ridges (from ggridges) to display the tidal data for each station over time:



Looking at the plot, Princess Buttercup seems to be “lazy” and drift with the tide. Rising water levels push her upstream, while decreasing water levels bring her closer to sea again. On November 22 (see also previous plot), she embarks on her migration for real.

**Conclusion**

In this blogpost we used the wateRinfo package to gain some insight in the movement/migration behaviour of an individual eel. We hope the package can support many more research questions