MICRO2020
INTERNATIONAL CONFERENCE
23-27 NOVEMBER 2020 LANZAROTE AND BEYOND*
FATE AND IMPACTS OF MICROPLASTICS: KNOWLEDGE AND RESPONSIBILITIES

Endless journey of plastic debris in rivers

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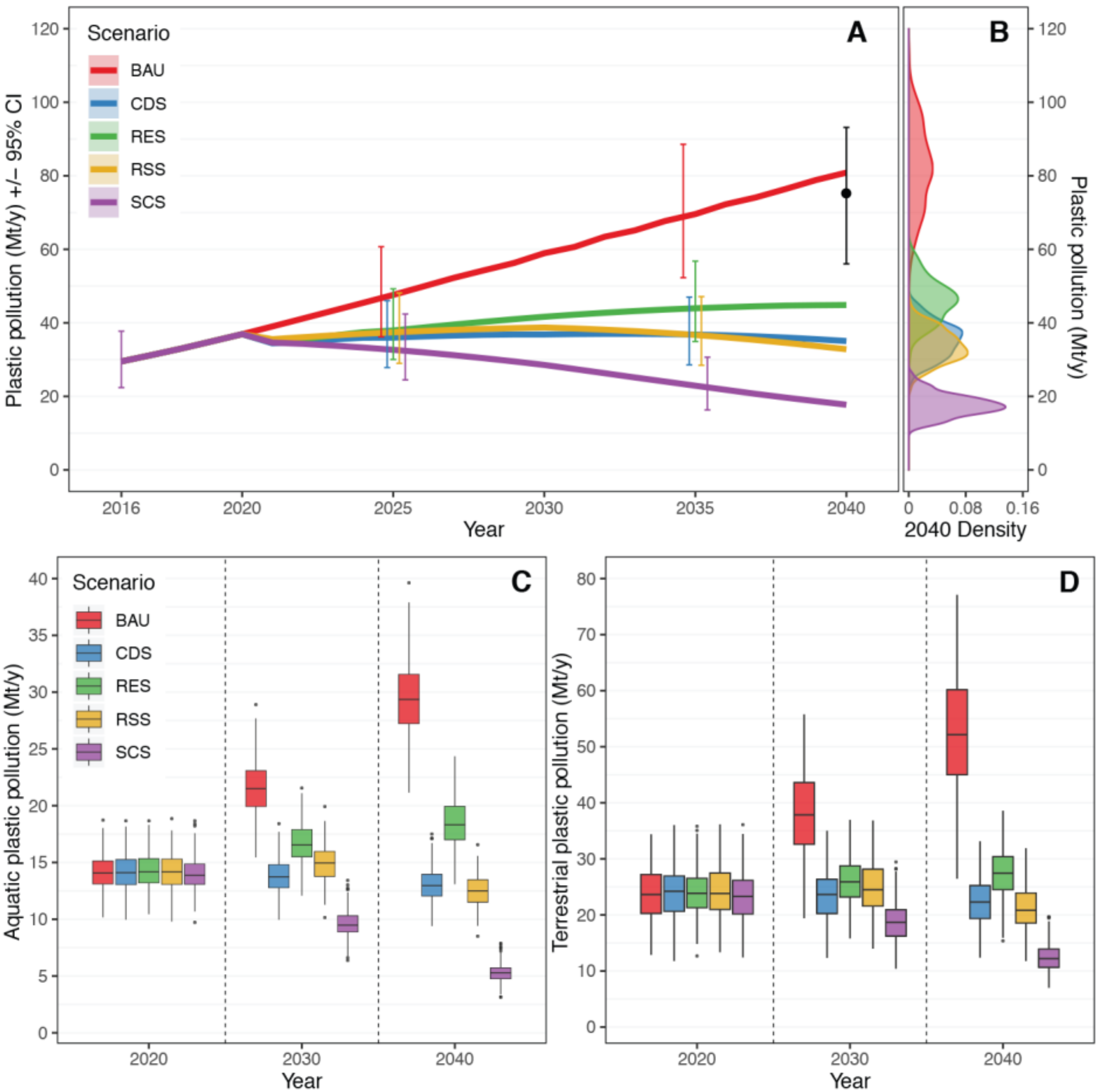
Rivers



- Terrestrial/aquatic interface
- Major pathways between land and ocean

Lau et al. 2020 (Science)

How plastic debris are transported from rivers into the Ocean?

Long-term dynamics (months to decades)

Marine Pollution Bulletin 152 (2020) 110894

Contents lists available at ScienceDirect

ELSEVIER

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Transfer dynamic of macroplastics in estuaries — New insights from the Seine estuary: Part 1. Long term dynamic based on date-prints on stranded debris

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ARTICLE INFO

Keywords:
Residence time
Microlax
Use-by dates
Sources
Pathways

ABSTRACT

Rivers are a major pathway for plastics between lands and the ocean. At the land-ocean interface, estuaries make the transfer dynamic of plastics complex and nonlinear. That is why very little is known about this dynamic. In this respect, a specific marker (i.e. Microlax packaging) showing date-prints was systematically investigated in different riverbanks of the Seine estuary to identify the share of "old" and "recent" litter transiting through the estuary toward the ocean. Up to 70% of Microlax were "old" plastic items probably related to the meandering dynamic of the river over large time and space scales, and hydrodynamic conditions (tides) at smaller scales. This contributes together to increase the residence time of plastics into the estuary up to decades with almost endless transport, deposit and remobilization cycles. Consequently, the Seine estuary may function as a "microplastic factory" resulting from the fragmentation of macroplastics into microplastics well before they reach the ocean.

Short-term dynamics (hours to months)

Marine Pollution Bulletin 160 (2020) 111566

Contents lists available at ScienceDirect

ELSEVIER

Marine Pollution Bulletin

journal homepage: www.elsevier.com/locate/marpolbul

Transfer dynamics of macroplastics in estuaries – New insights from the Seine estuary: Part 2. Short-term dynamics based on GPS-trackers

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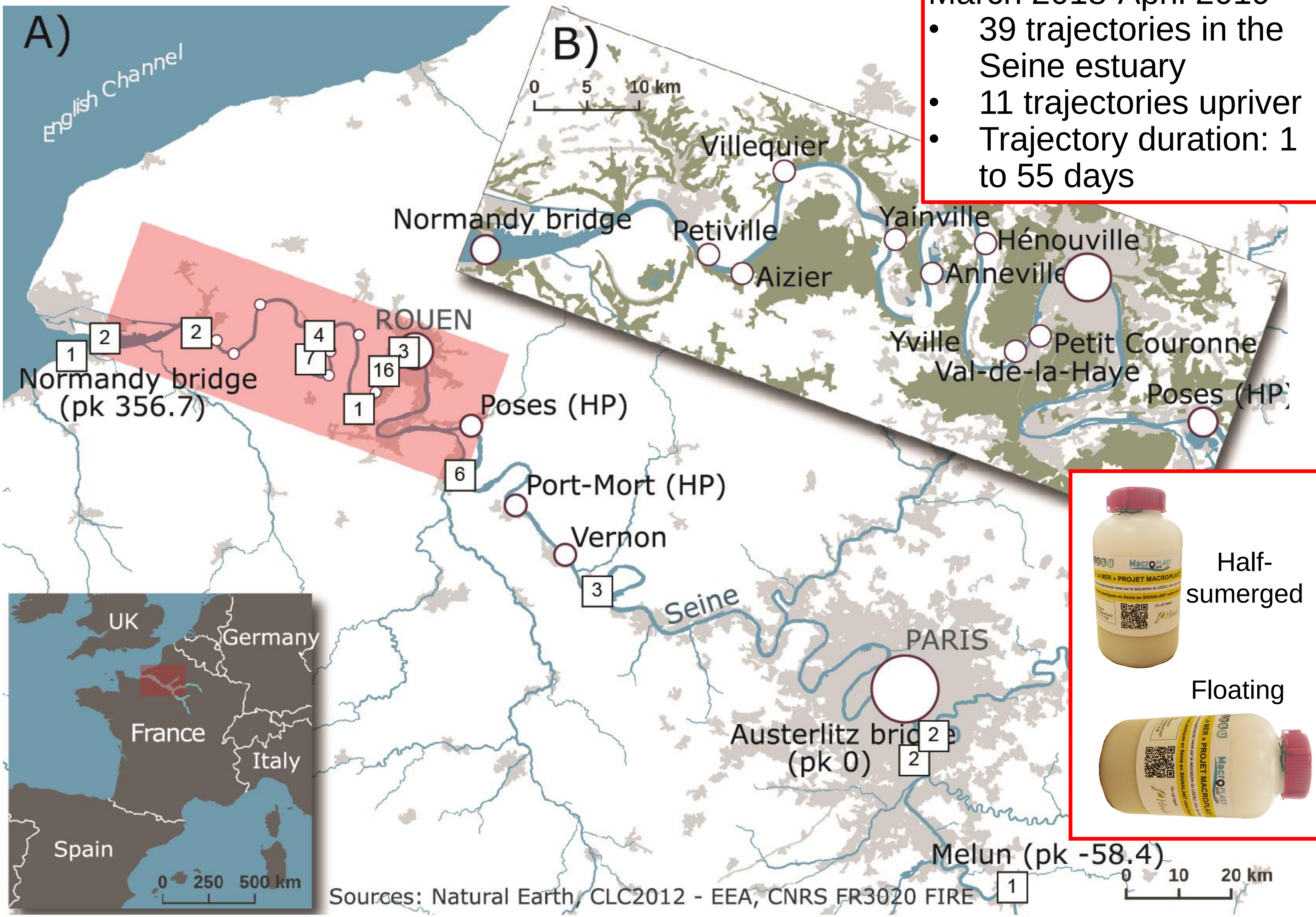
ARTICLE INFO

Keywords:
Flood
Plastic debris
Plastic transport
Residence time
Tides
Tracking

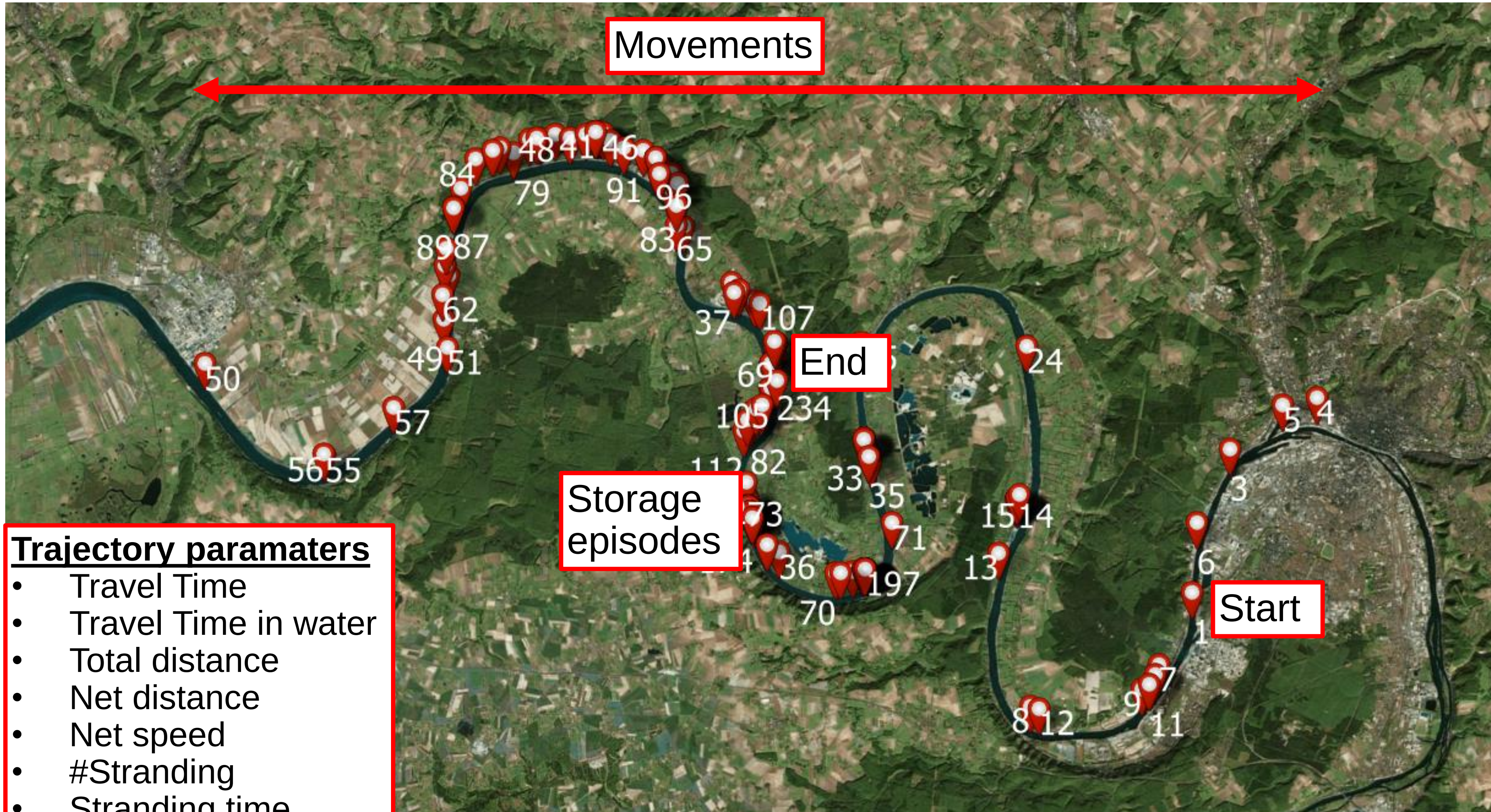
ABSTRACT

The dynamics of plastic debris were assessed in the Seine River, especially in the estuary, using plastic bottles equipped with GPS-trackers. In one year, 50 trajectories were recorded, covering a wide range of hydro-meteorological conditions. Results show a succession of stranding/remobilization episodes in combination with alternating upstream and downstream transport in the estuary. In the end, 100% of the tracked bottles stranded somewhere, for hours or weeks, from one to several times at different sites. The overall picture shows that different physical phenomena interact with various time scales ranging from hours/days (high/low tides) to weeks/months (spring/neap tides and highest tides) and years (seasonal river flow). Thus, the fate of plastic debris is highly unpredictable, but the consequence of those interactions is that the transfer of debris is chaotic and not straightforward, and its residence time is much longer than the transit time of water.

March 2018-April 2019
- 39 trajectories in the Seine estuary
- 11 trajectories upriver
- Trajectory duration: 1 to 55 days



What is a trajectory?



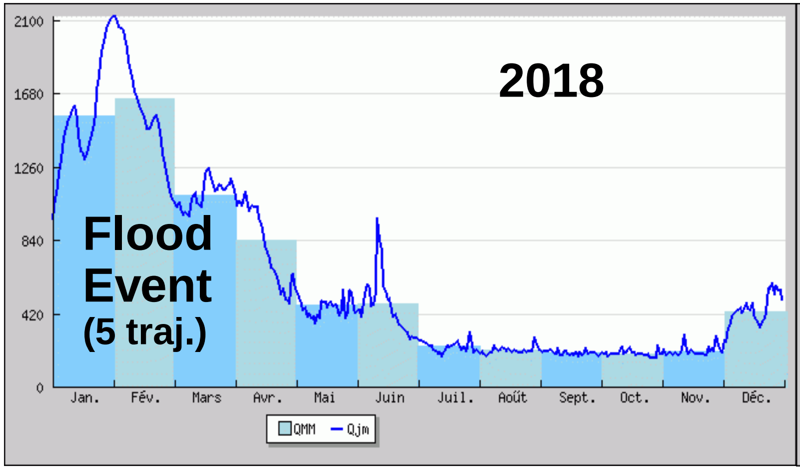
Trajectory paramaters

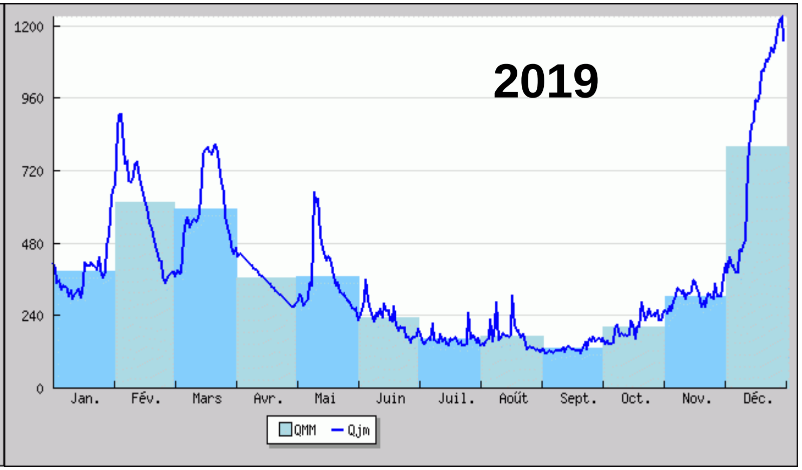
- Travel Time
- Travel Time in water
- Total distance
- Net distance
- Net speed
- #Stranding
- Stranding time
- Etc.

Spatiotemporal variations

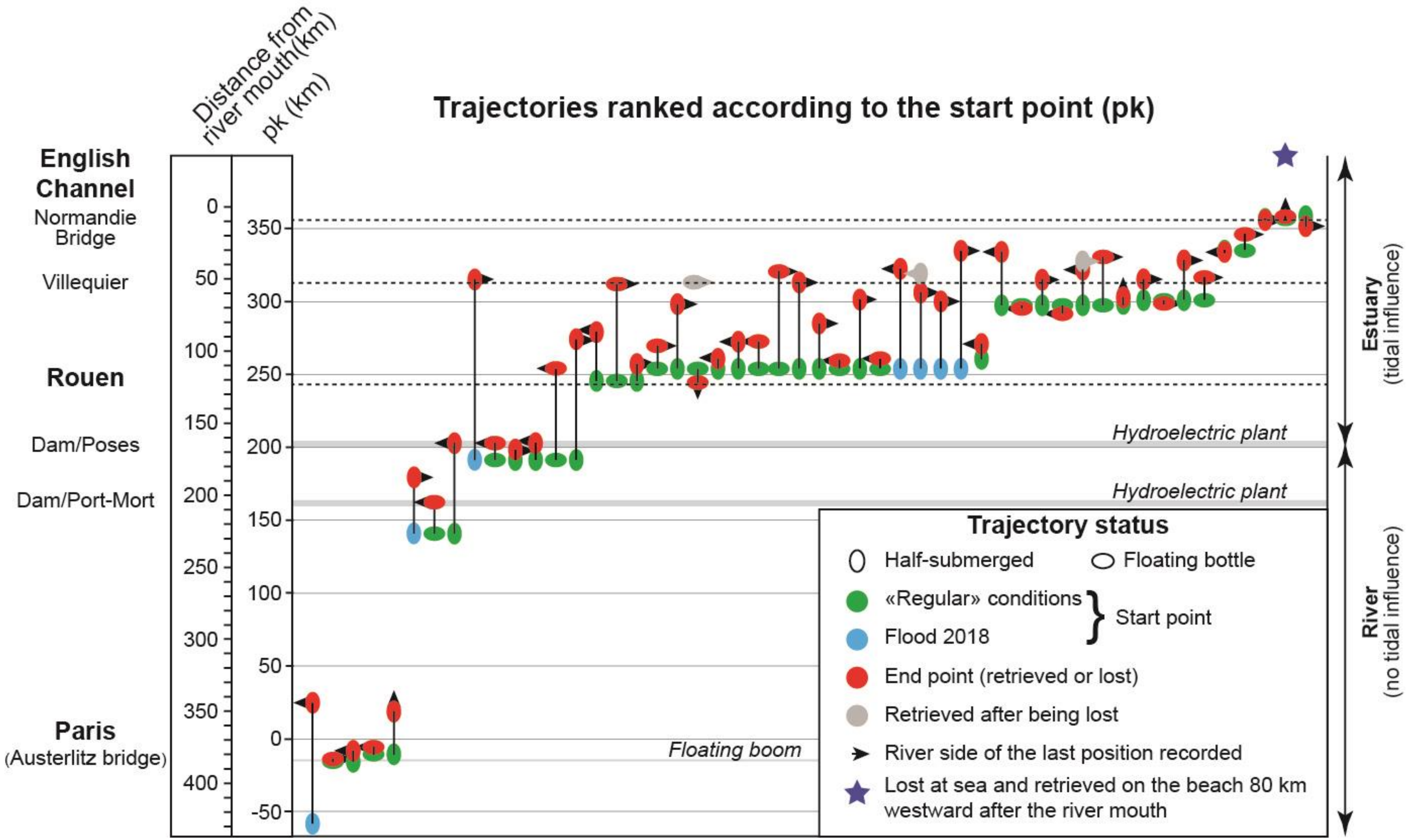
Riverine (11) *versus* estuarine (39) trajectories

High (21 traj.) *versus* low (13 traj.) hydrological conditions
(only for estuarine trajectories)

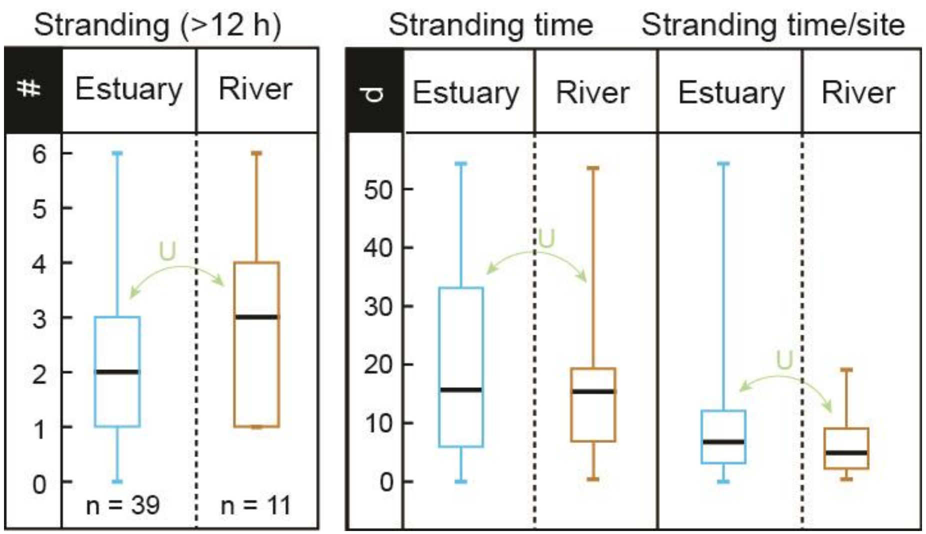




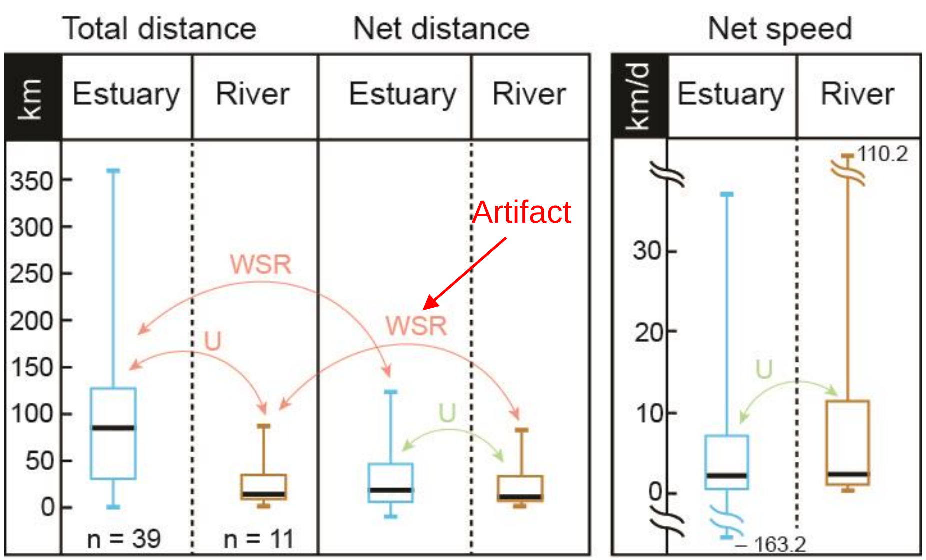
- Median net distance travelled : 66.4 km (2.3 km/d)
- 100% trackers stranded somewhere, only one reached the Sea after 6 months



River *versus* estuary



- No differences in stranding patterns between river and estuary.



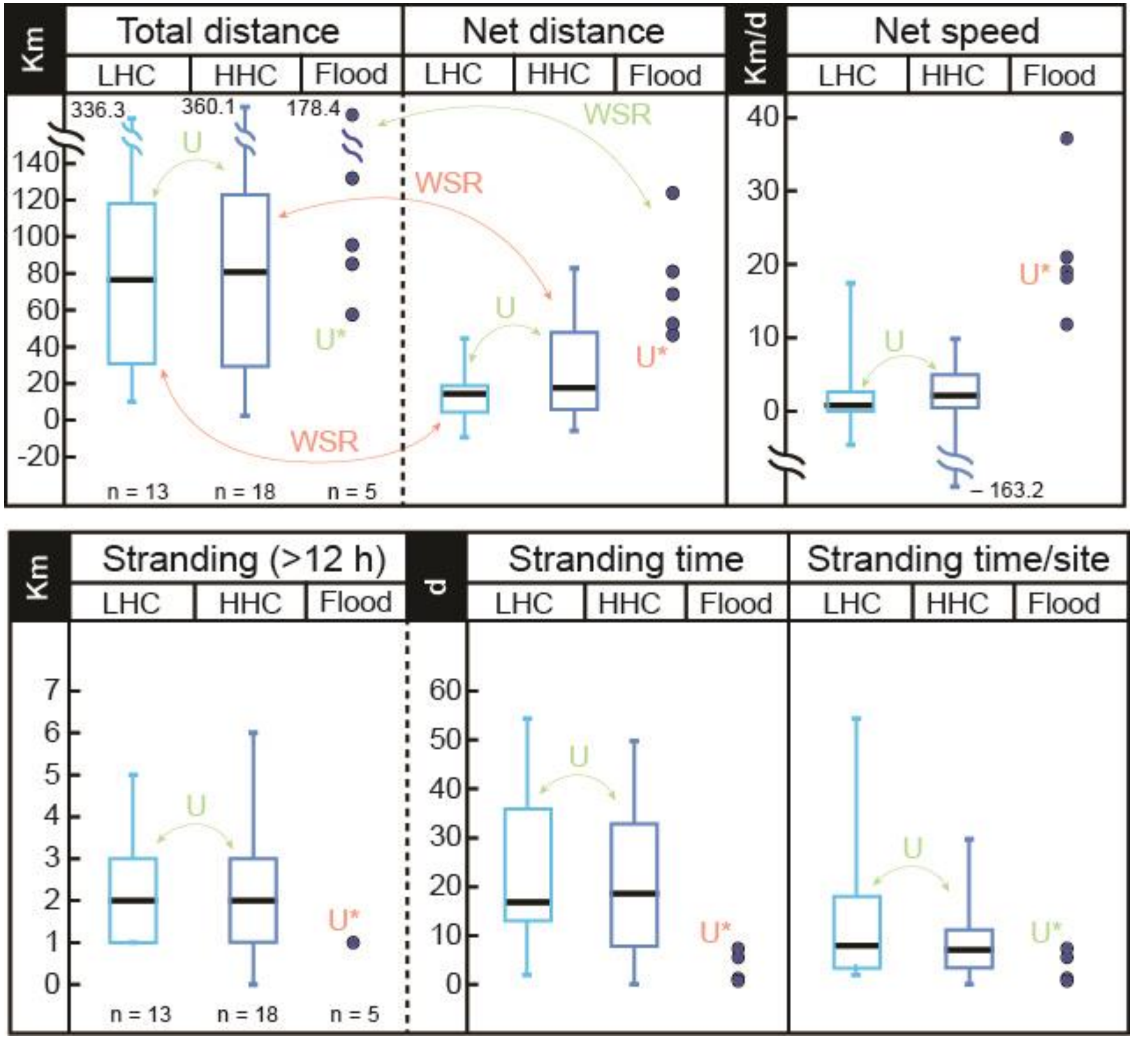
- Net distance travelled is similar between river (11.4 km) and estuary (18.6 km)
- Total distance travelled in estuary is far greater (85.1 km)

➔ Tide influence: back and forth movements

- Net Speed is similar for both segments

Low (LHC) *versus* high (HHC) hydrological conditions

(only estuarine trajectories)



LHC-HHC

- Total >> Net distance

➔ Tide influence > River discharge

Forcing hydrological parameter

Flood

- Total = Net distance

➔ Tide influence < River discharge

Change in forcing hydrological param.

- Higher net distance/speed

➔ Flush out plastics?

- Only **flood trajectories** show different stranding patterns

➔ Storage higher up on riverbanks?

Flood (1 week, 4 trajectories)

Tide influence < River discharge

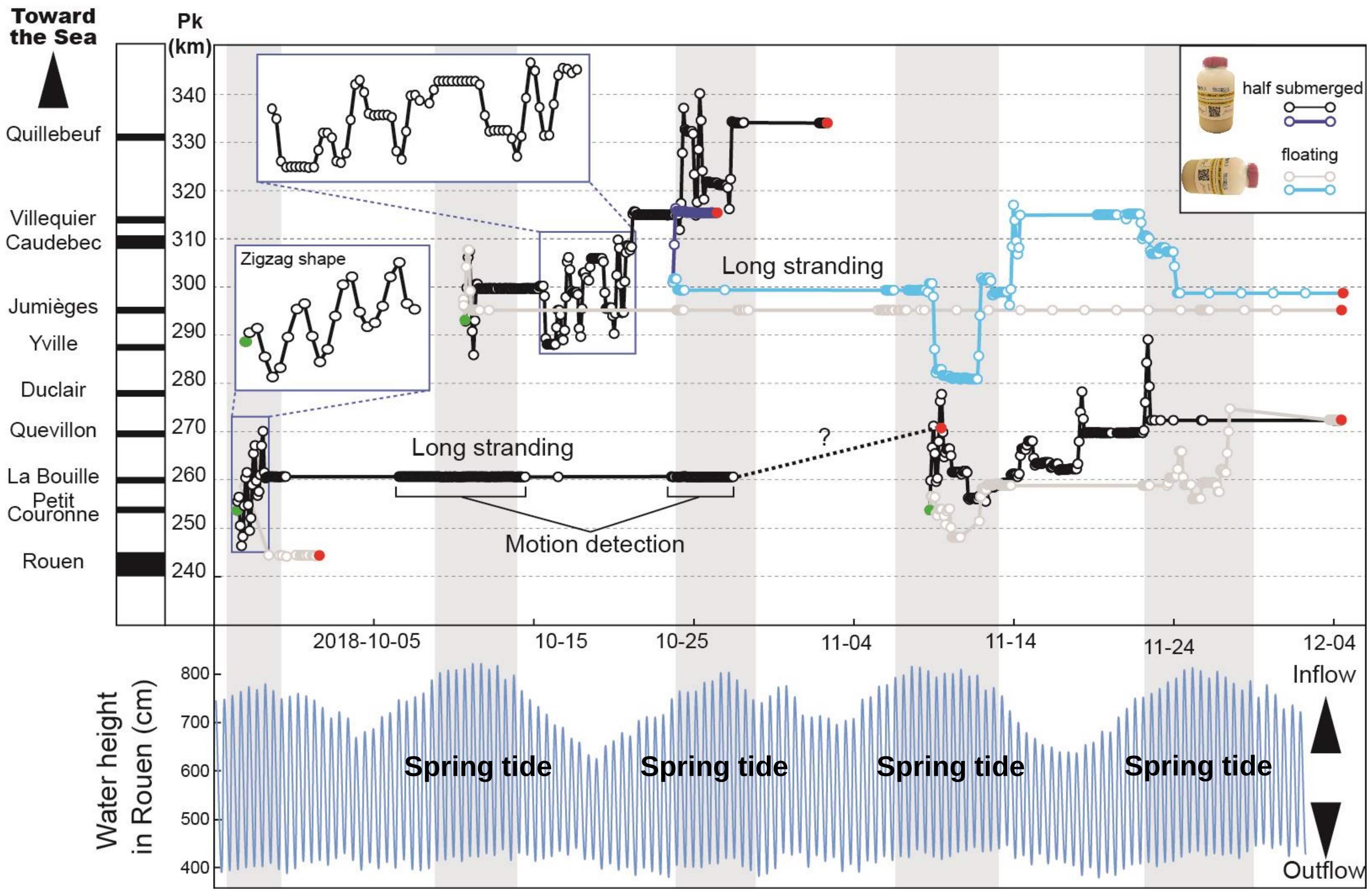
Low Hydro. Conditions (3 weeks)

Tide influence > River discharge

What about wind? Half-submerged (red) *versus* floating bottle (blue)

Chaotic-like trajectories

Graphical representation of 8 trajectories during LHC



Heat map of the GPS-positions

- **Remobilization** episodes and bi-directional transport favored by tides.

- Complex short- and long-term transport dynamics of plastic debris

➔ **chaotic and non straightforward**

- Regular hydrological conditions

➔ Water discharge **<<** tidal influence

- Extreme hydrological conditions (flood)

➔ Water discharge **>>** tidal influence

➔ Flush plastic debris into the sea?

➔ **Remove plastic debris** from riverbanks before they reach the Ocean as **microplastics**.

➔ What remaining fraction finally reach the Ocean? (Coming paper)

Thank you

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