Developing methods to survey glass eels in a large and dynamic estuary

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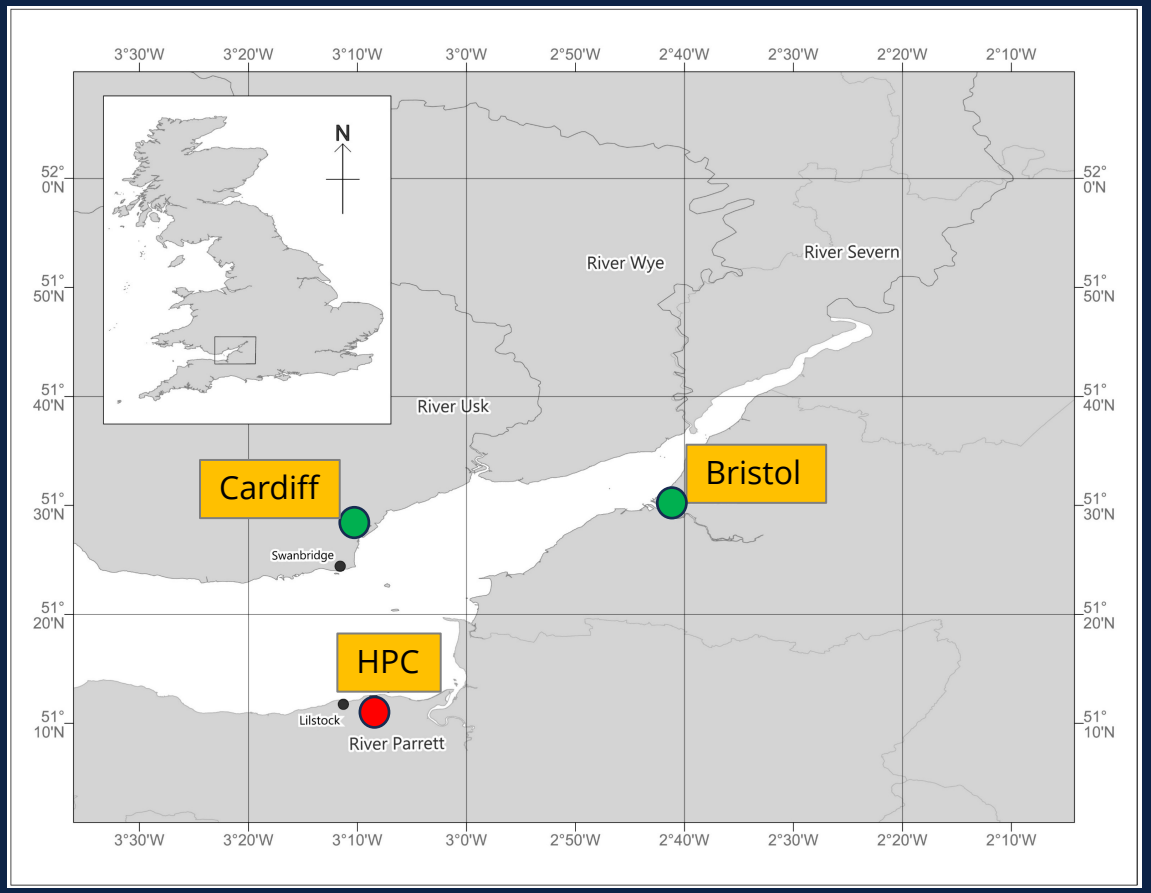
Introduction - BEEMS

- HPC Co. is building a new nuclear power station (HPC), next to the former HPA & HPB stations in the Severn Estuary

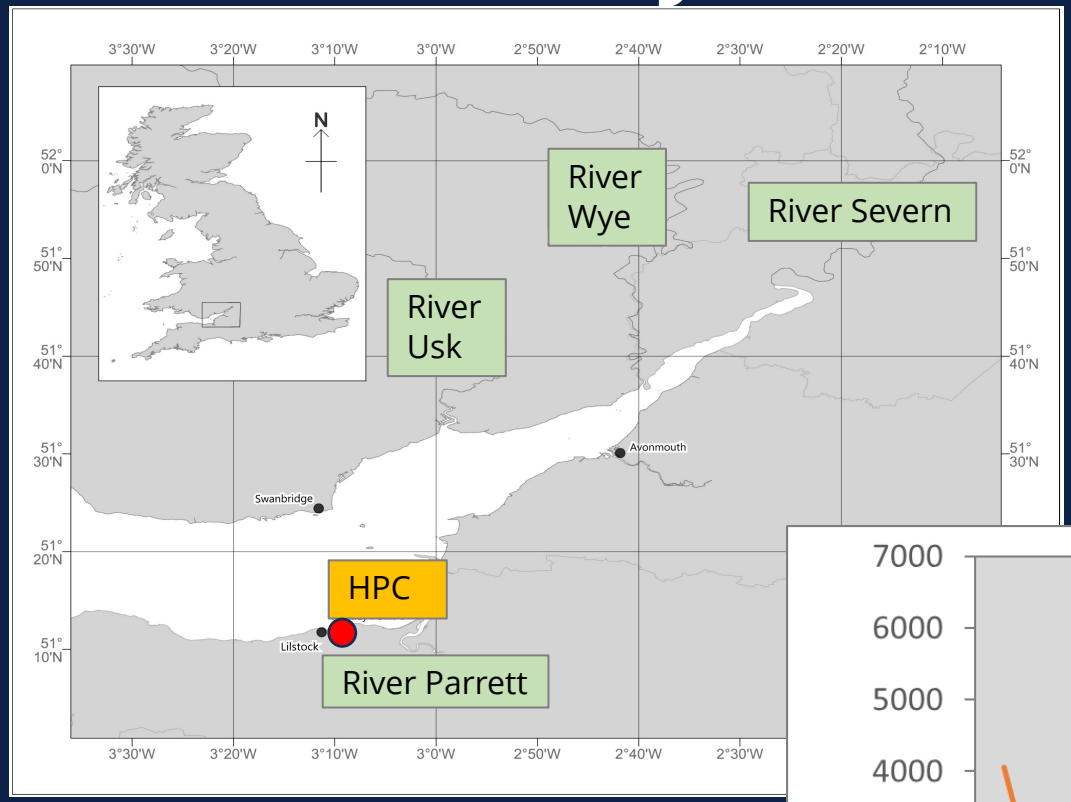


- To build and operate the new station, HPC Co. must evaluate the effects that seawater abstraction may have on the marine environment
- Estuary has the 2nd largest tidal range in the world after Bay of Fundy
- Many km^2 of intertidal areas in parts of the Estuary

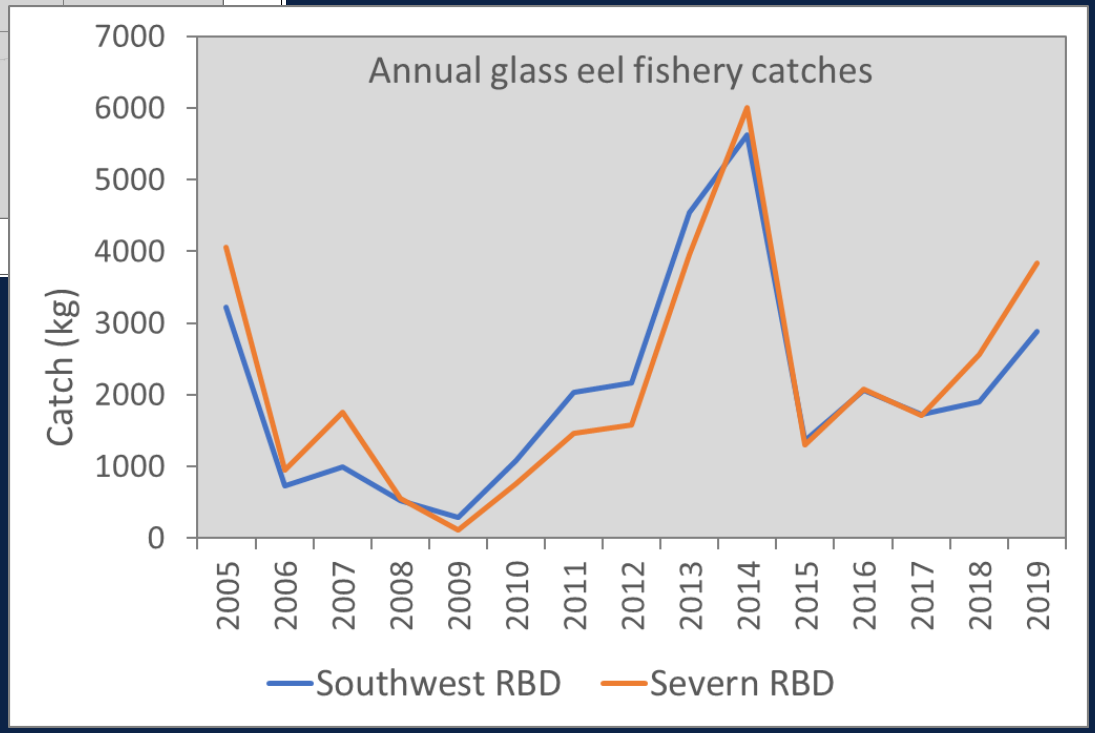
BEEMS sampling

- Beginning in 2008 - offshore fish, plankton & benthos surveys
- Onshore impingement sampling
- Characterise the marine fauna, assess entrapment effects
- Methods not appropriate for glass eels; new approach needed.

Severn Estuary/Bristol Channel eels

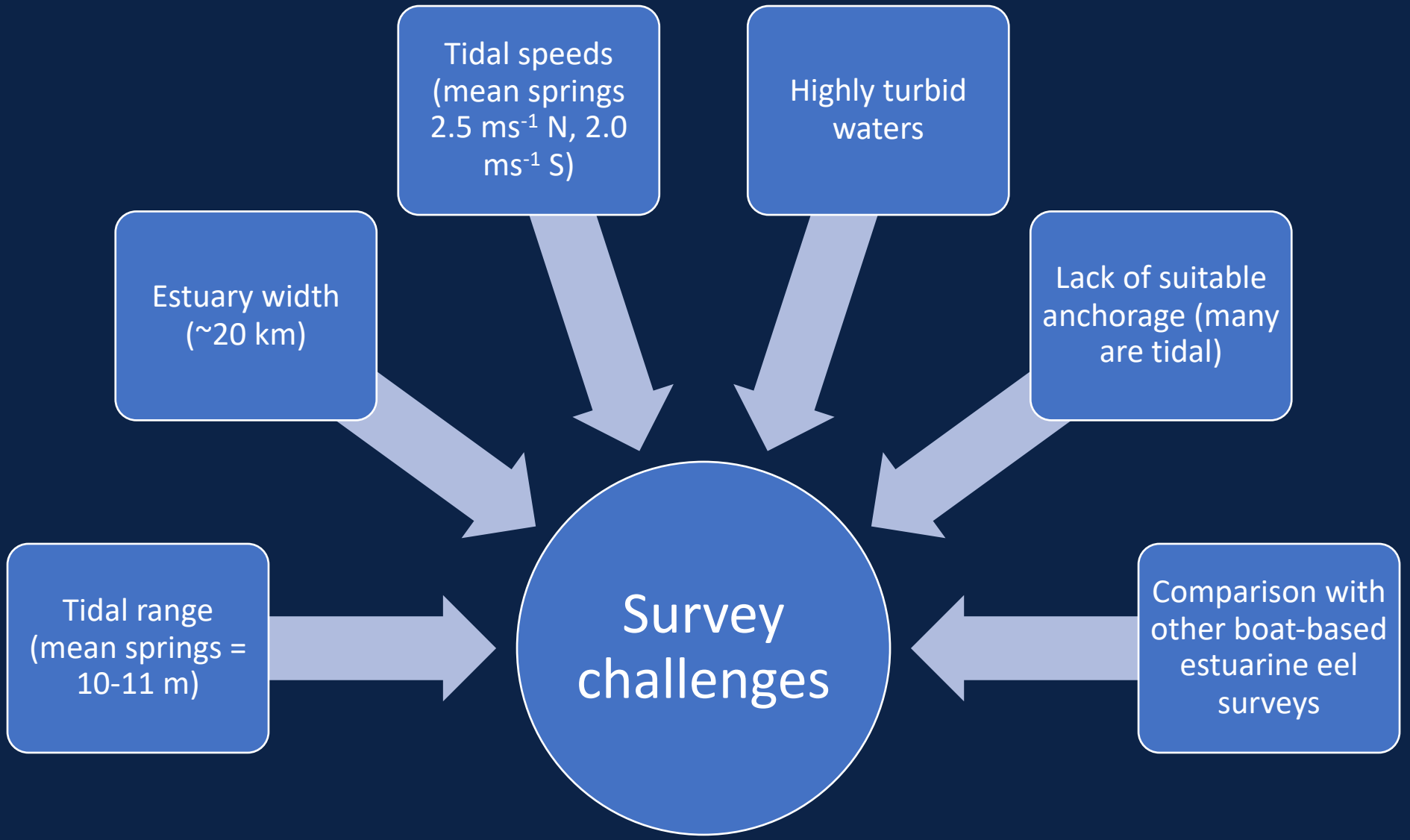


- Estuary experiences largest run of glass eels in the UK
- Two River Basin Districts - the Severn (Rivers Severn, Wye & Usk; the Southwest (River Parrett)

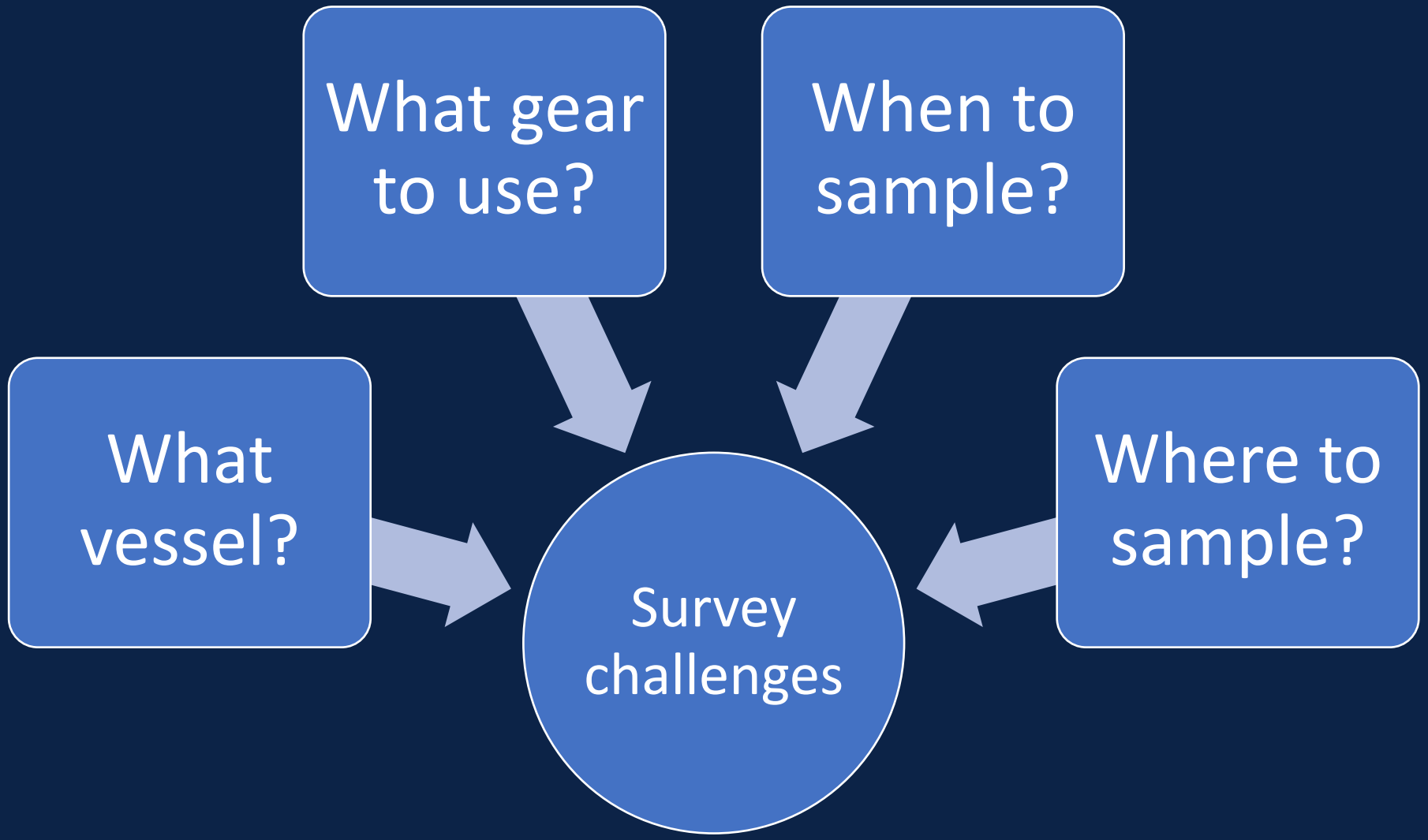


- Exploited in rivers by fishers using hand-held dipnets
- Mean catches 2009-2019 for each of RBD of >2,000 kg.

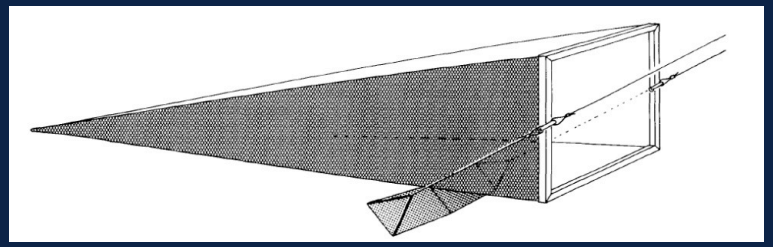
Physical sampling challenges



Logistical sampling challenges



Survey gear



- Commercial trawler with relatively shallow draft
- Frame trawl – 1.4m^2 frame, 7 m long net, 2 mm mesh, heavy depressors
- CTD to measure temperature
- PAM beacon to allow control of depth
- Flowmeter to record volume of water.

Survey design

Strata 1-9 - the HBP/HPC intakes, & along the English/Welsh coasts

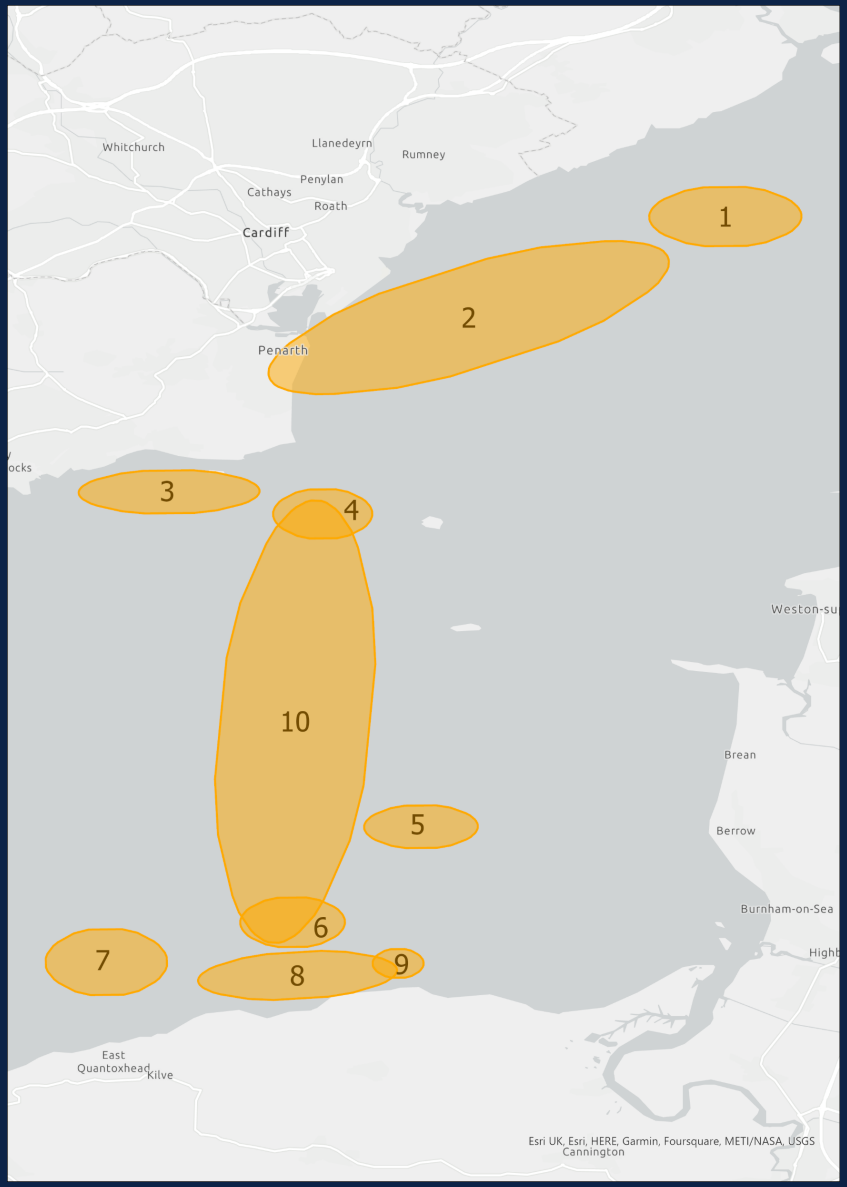
Stratum 10 - comprises 9 locations along a transect across the estuary

Stratum - 0 m , 4 m, 7 m (where possible); 15-min tows

Transect - 'V' tows - 0 m – 7 m; 15-min tows

Vessel facing into the tide; ~1 kt speed

Sampling February, March & April - period of upstream movement



Survey summary

Survey	Survey dates	Fishing days	Tows
1	16 Feb–5 Mar 2012	16	128 (122)
2	19 Feb–4 Mar 2013	14	130 (115)
3	4–12 April 2013	7	63 (63)
Total		37	321 (300)

- Three surveys – funded through collaborative agreement between HPC Co. & the Environment Agency
- Generally sampling from neap-spring-neap in the tidal cycle
- 37 fishing days, sampling during daylight, dusk & night
- Because of scale of the estuary - one stratum per fishing day
- 321 fishing tows, 300 on the flood tide
- In an estuary of this scale, considered to be a big achievement.

Sampling summary

- All samples fully sorted - all fish measured
- 29 species of fish; sprat (3,972), sand goby (1,220), whiting, herring & grey mullet
- 2,781 glass eels (2,544 on the flood tide) – caught in all tree surveys.

Survey	No. species	No. fish	No. eels
Feb/Mar 2012	18	3,296 (38.6%)	517 (493)
Feb/Mar 2013	23	4,668 (54.7%)	1,930 (1,717)
Apr 2013	13	574 (6.7%)	334 (334)
Total	29	8,538	2,781 (2,544)

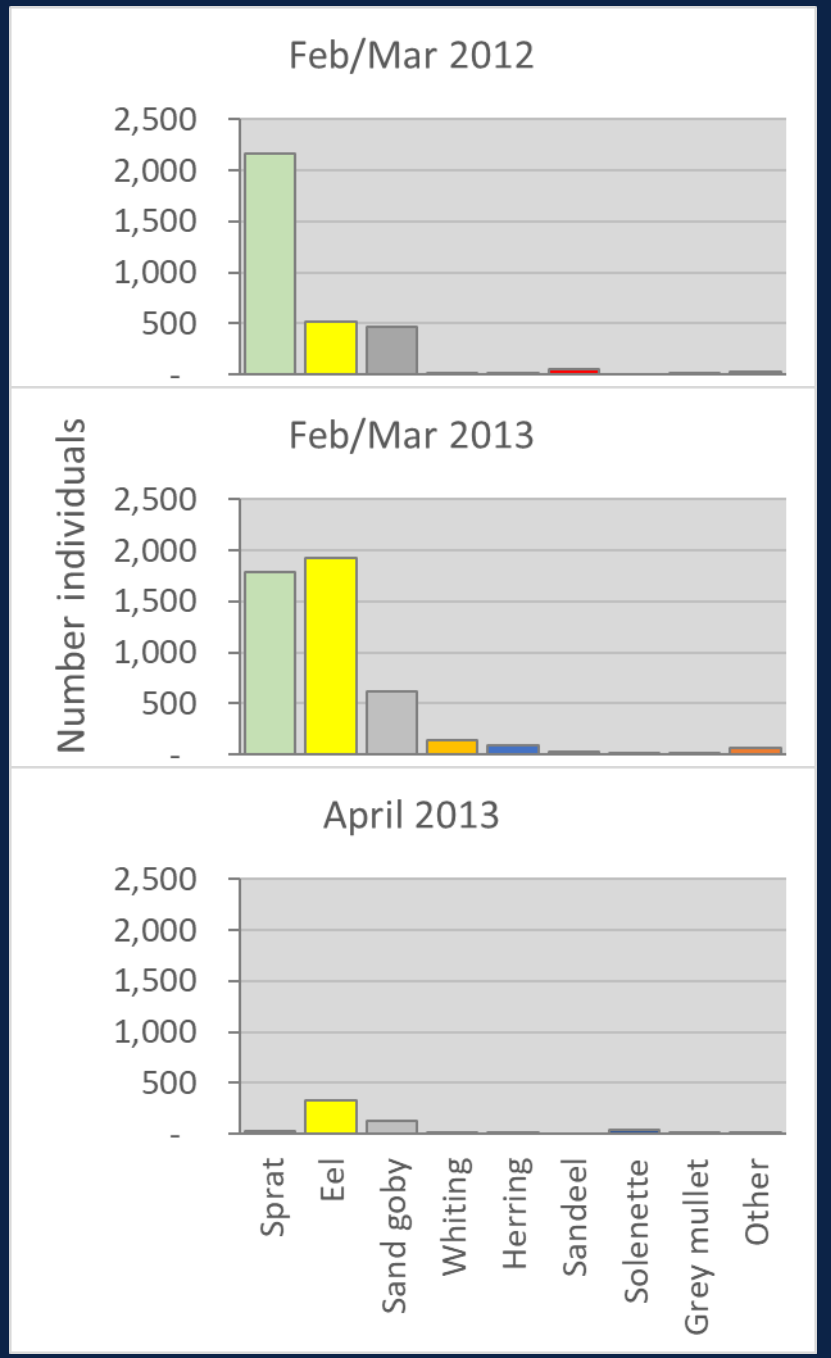
Sampling summary

8 species contributed 98.8% of total numbers

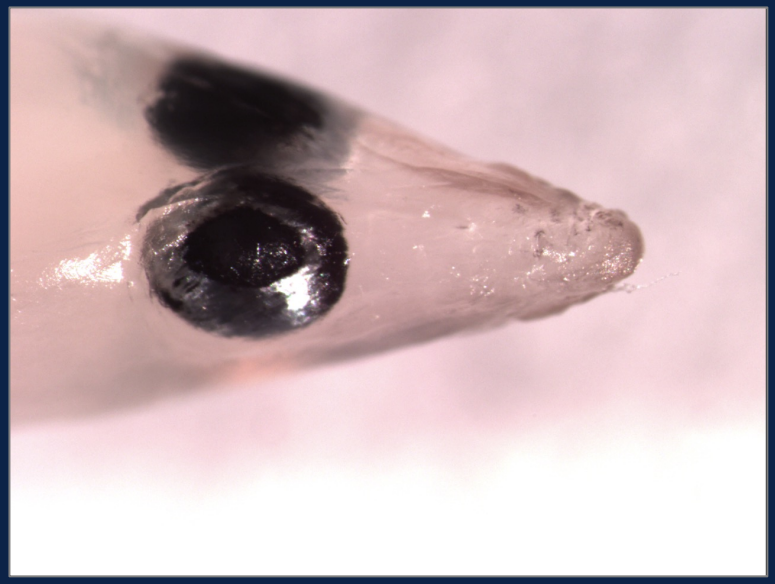
Sprat dominated catches in Feb/Mar 2012, followed by eels and sand goby

Sprat and eels in similar number in Feb/Mar 2013, followed by sand goby

Eel most abundant species in April 2013; sprat virtually absent.



Data analysis



- Density per m^3 calculated from numbers of eels/volume of water filtered
- One method of estimating entrainment would be to use density calculated from samples at the HPC intake location
- Using the from all three surveys, gives a density of 0.00309 $ind.m^{-3}$ (*n* samples = 51, *n* eels = 366)
- However, it is likely that density will be affected by additional factors
- Considering these additional factors will aid in applying suitable levels of uncertainty around estimates of eel density and potential entrainment.

Data analysis and results

- Initially, for each survey, density was investigated by fishing site, depth, and salinity:

Significantly higher density in Feb/Mar 2013 than Feb/Mar 2012; consistent with increase in glass eel fishery catches for those years

Significantly higher density in the first 7 days of Feb/Mar 2013 compared to the 7 days in April 2013 (same tidal state)

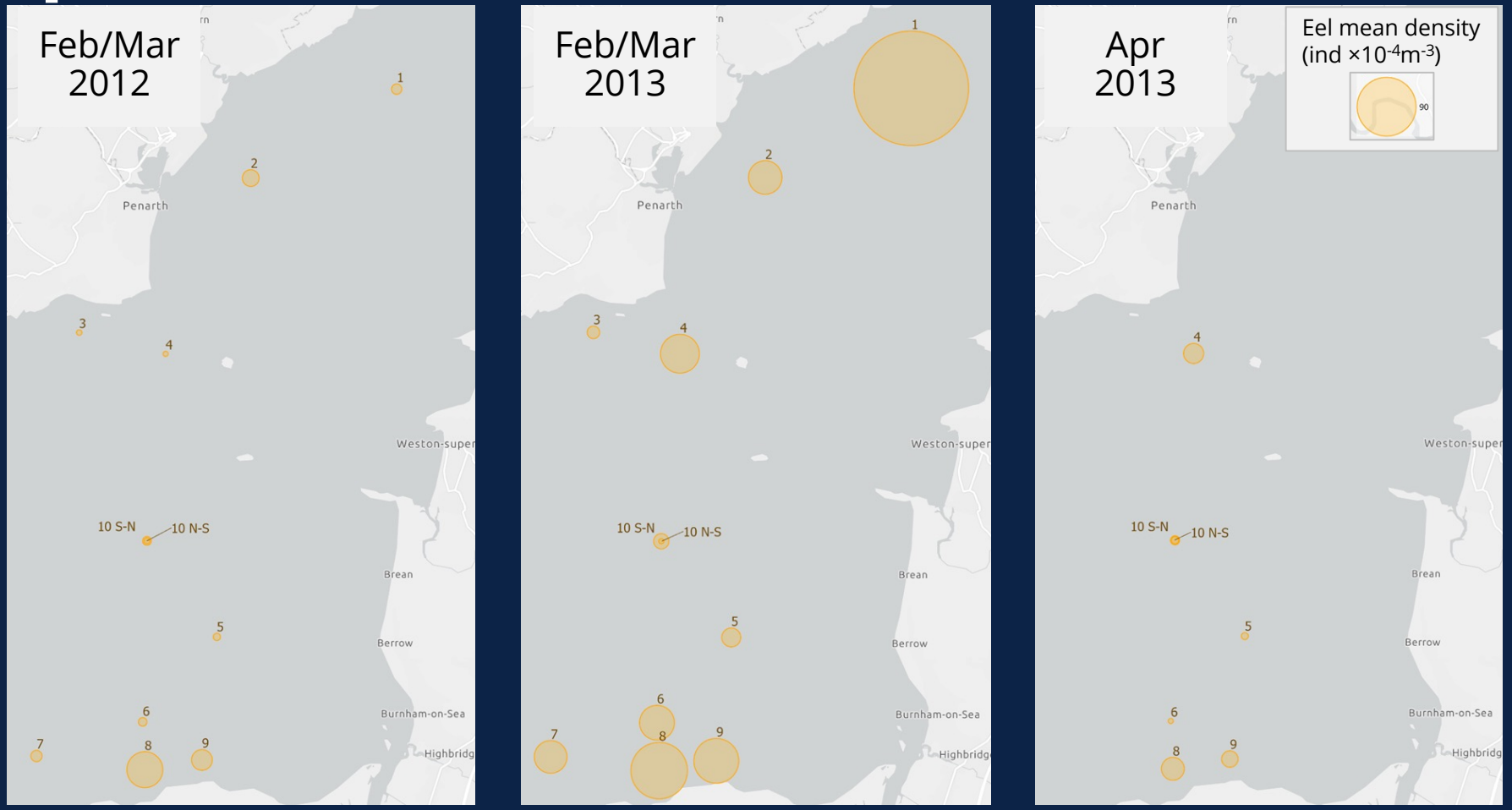
Consistently greater density at the surface than at 7 m (not always significant)

Generally greater density at 4 m than 7 m (not always significant)

Consistently higher density at low salinities than high salinities (not always significant).

(Walmsley *et al*. 2018 ICES Journal of Marine Science, 75(2), 727–737. doi:10.1093/icesjms/fsx182)

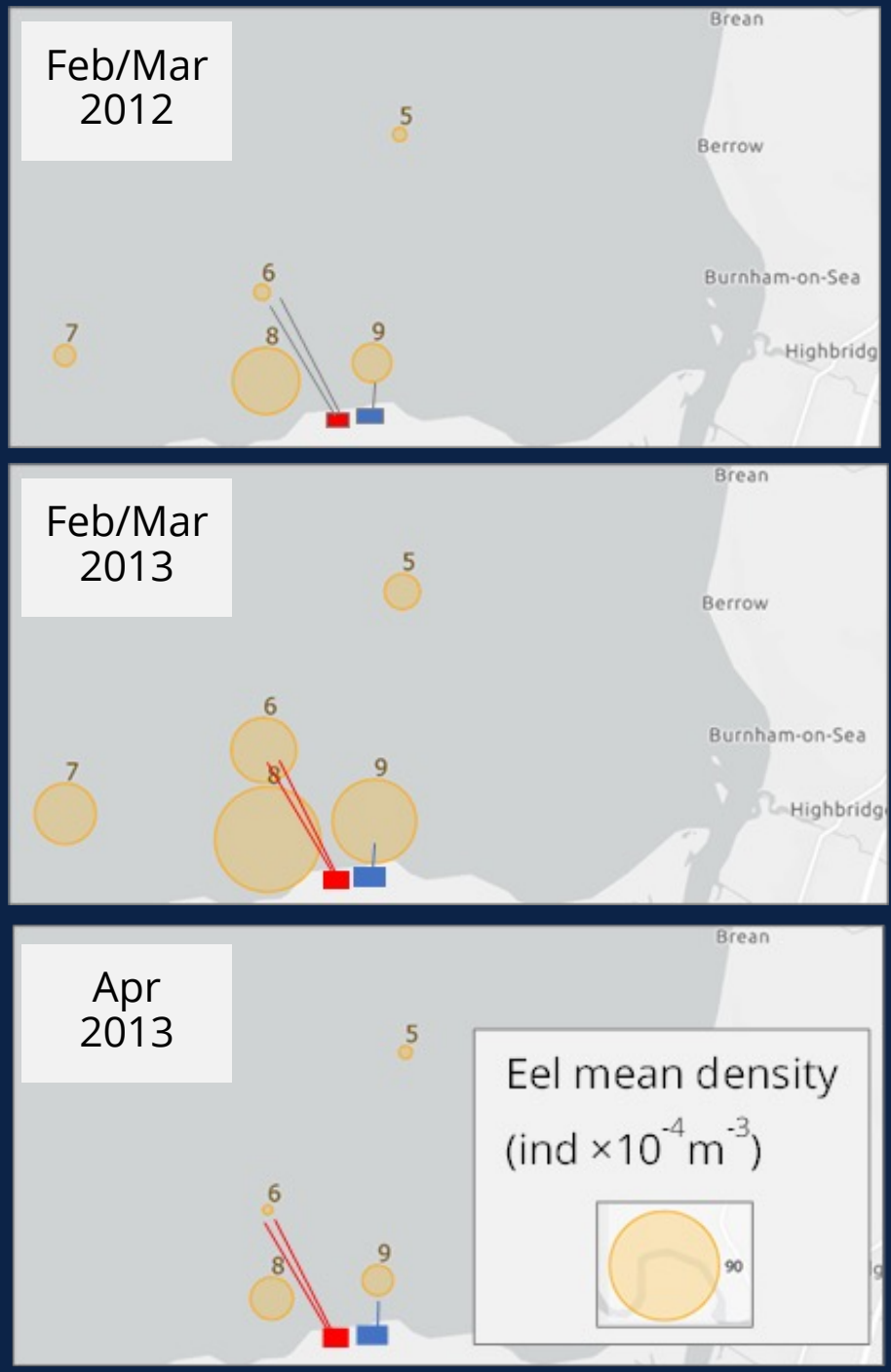
Spatial effects



- South - density at Sites 8 and 9 (HPB) consistently higher than Site 6 (HPC), not always significant.
- North – density at Sites 1 and 2 consistently higher than HPC, not always significant.

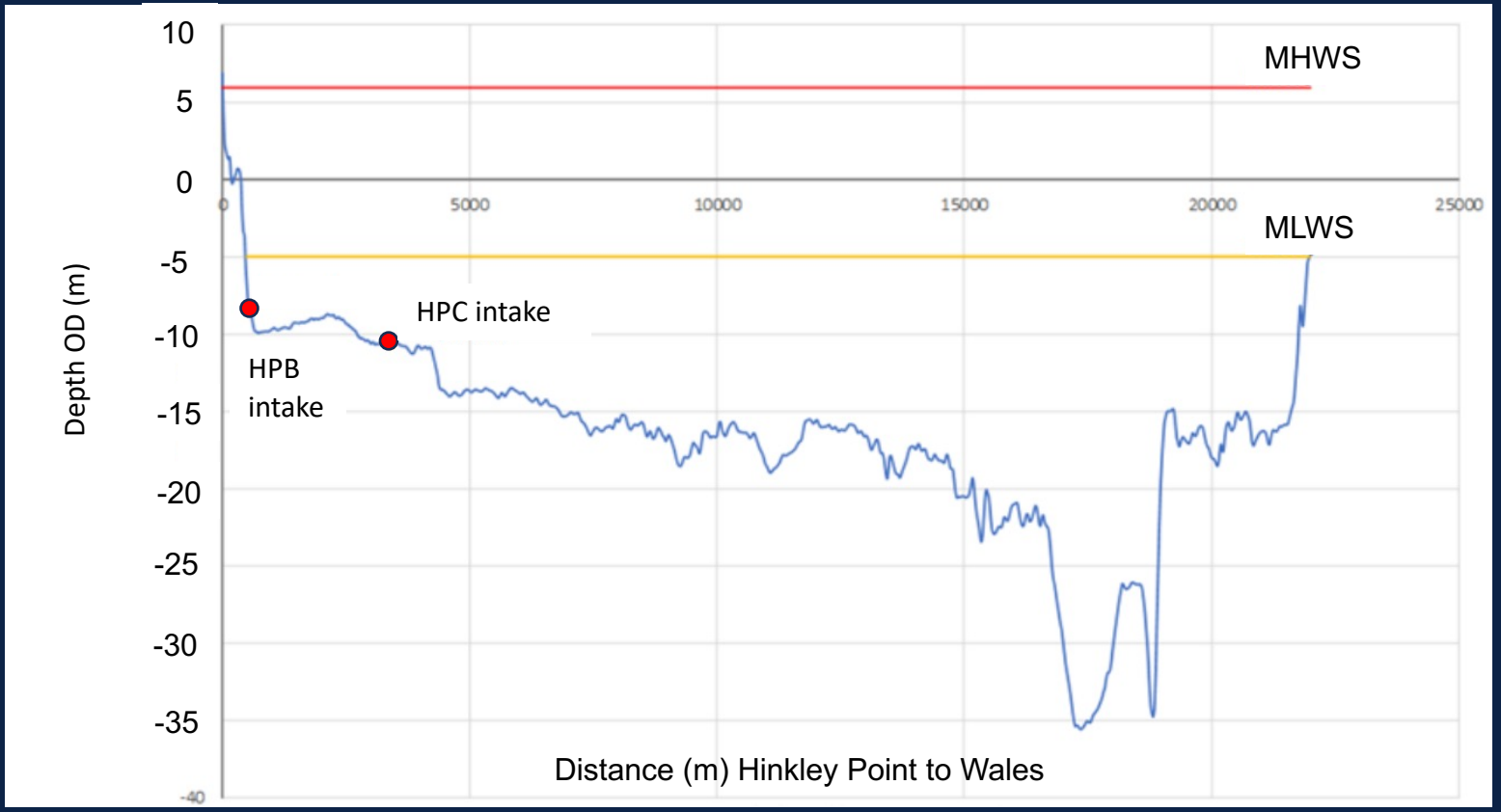
Spatial effects

- Density at Sites 8 and 9 (HPB) consistently higher than Site 6 (HPC), not always significant
- Density at Sites 5 and 7 was not consistent.

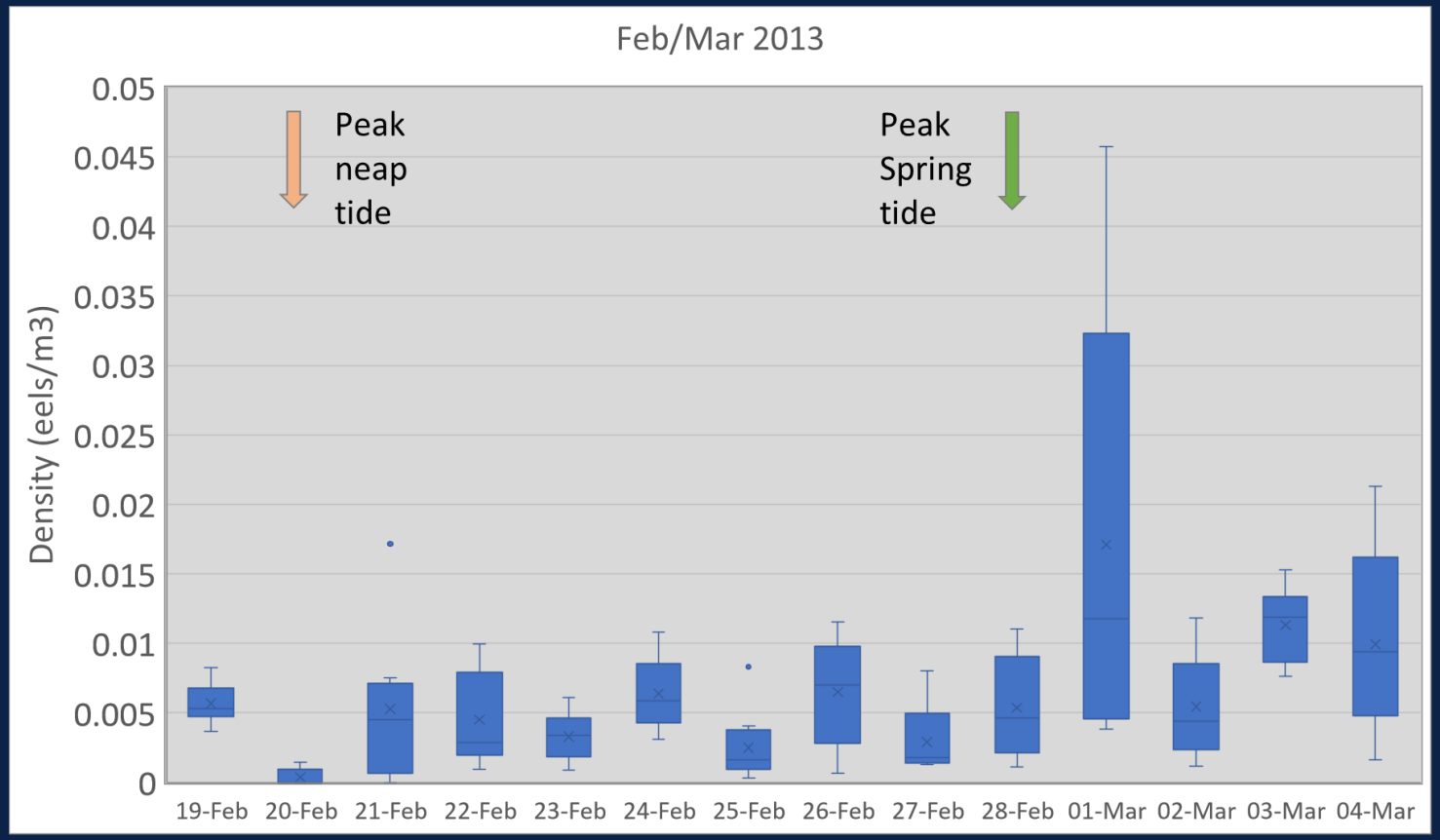


Effect of depth

- Effect of depth on density is of relevance due to the position of the HPC intakes relative to HPB
- HPC intakes will be further offshore than HPC, in deeper water
- At MLWS, approx. ~10 m water above the top of the intake head



Temporal effects



- Feb/Mar 2013 density higher than Apr 2013
- Daily density *v.* tidal state: peak, 1-2 days after peak springs
- Suggests other temporal effects on density

Application of results

- Number of eels entrained annually calculated from the density of eels at the HPC intakes, the HPC pumping capacity and duration of the glass eel recruitment period
- Losses calculated by applying entrainment mortality
- Information on the effect of variables on eel density from data collected throughout the survey will be used to provide uncertainty in the entrainment estimates

Summary

- The Severn Estuary/Bristol Channel poses significant challenges for small boat-based survey work
- Most boat-based surveys for glass eels have taken place in smaller estuary environments
- The BEEMS programme designed and delivered surveys to evaluate the distribution and abundance of glass eels in this environment
- The results can be applied to generate estimates of eel entrainment by the HPC station.

Thank you for listening

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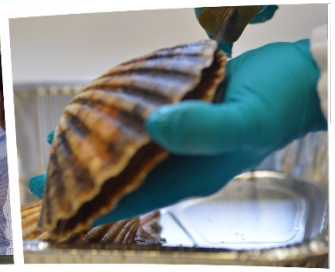

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