

Archival satellite data reveals seasonal changes in vertical movement and year-round coastal association in pregnant spurdog (*Squalus acanthias* Linnaeus, 1758)

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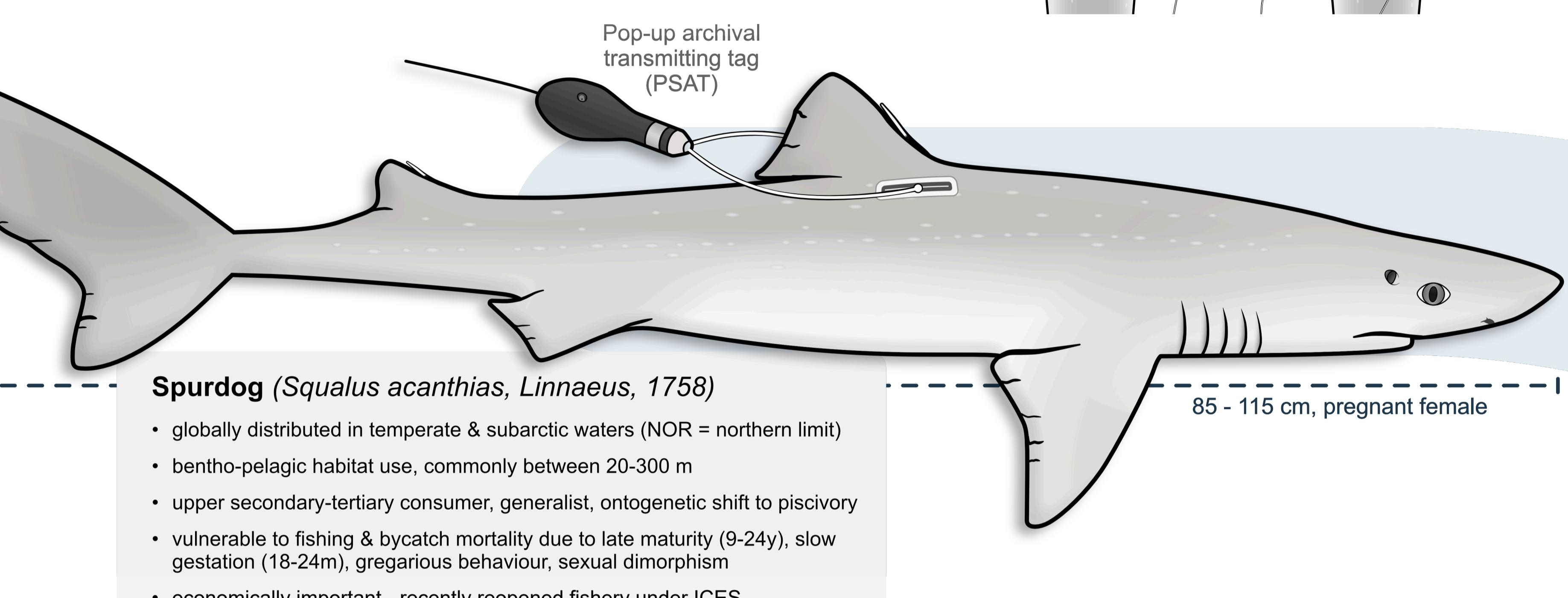
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OBJECTIVES

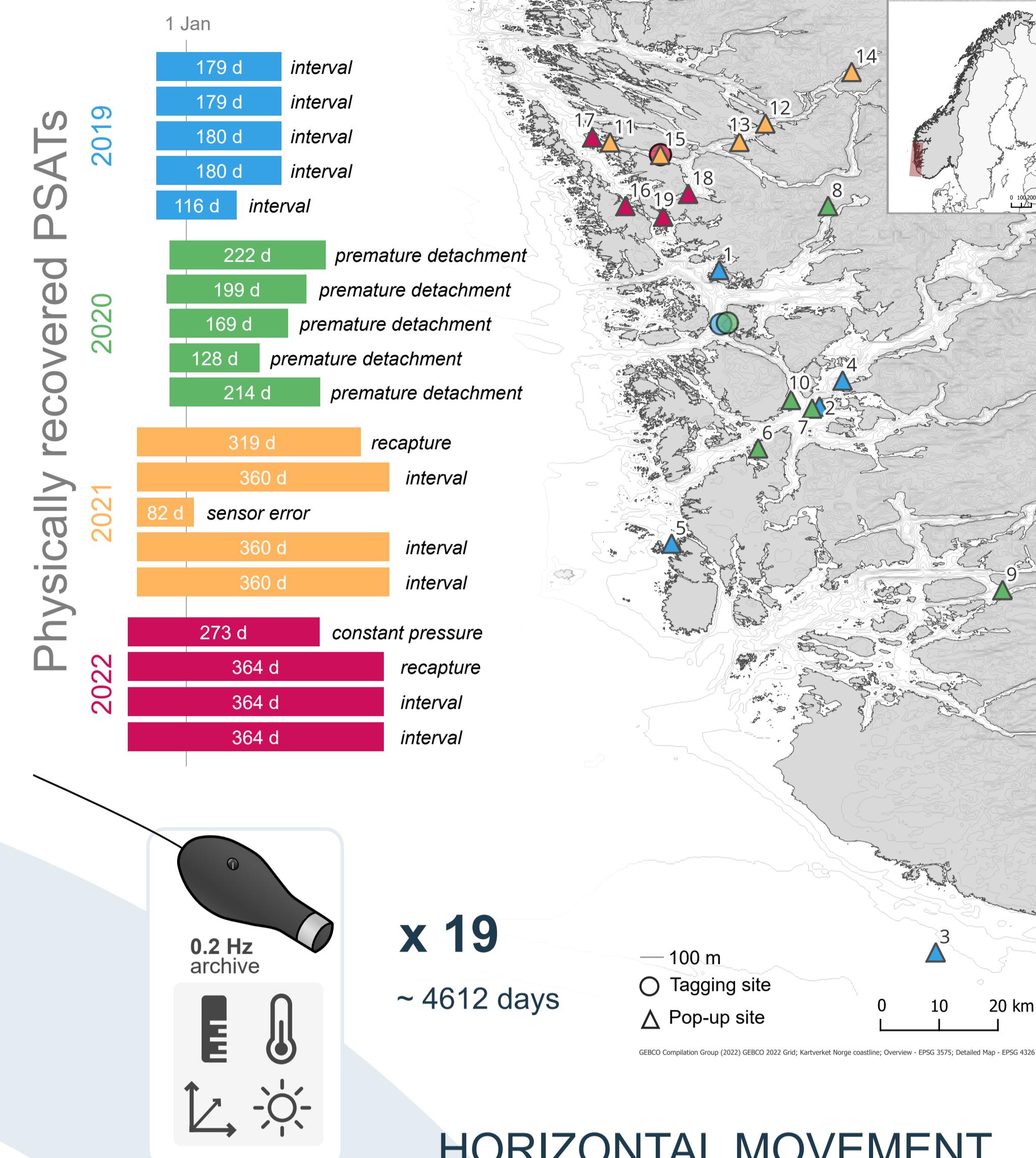
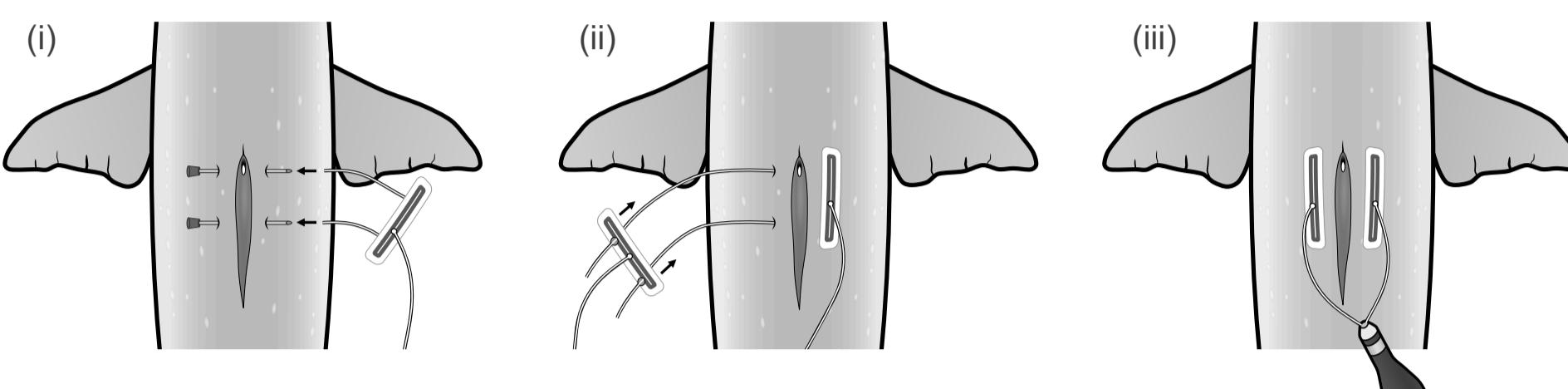
- I Develop a PSAT attachment method for year-long deployments.
- II Investigate the horizontal extent of movement behaviour.
- III Examine the realised environmental niche.
- IV Identify dominant periods in vertical depth use and variations across individuals and season.
- V Explore possible drivers of vertical movement patterns.



TAG ATTACHMENT

Two plastic plates were attached below either side of the first dorsal fin and fixed via a stainless-steel wire **through the musculature**. A silicone pad was placed between the plates and the fish to prevent skin injuries. PSATs were attached to the plates with braided nylon cord making up a **harness**.

In 2019 and 2020, plates were placed slightly posterior to the first dorsal fin. Following premature detachments in 2020, this was **optimised by moving the plates forward** in subsequent years resulting in year-long deployments.

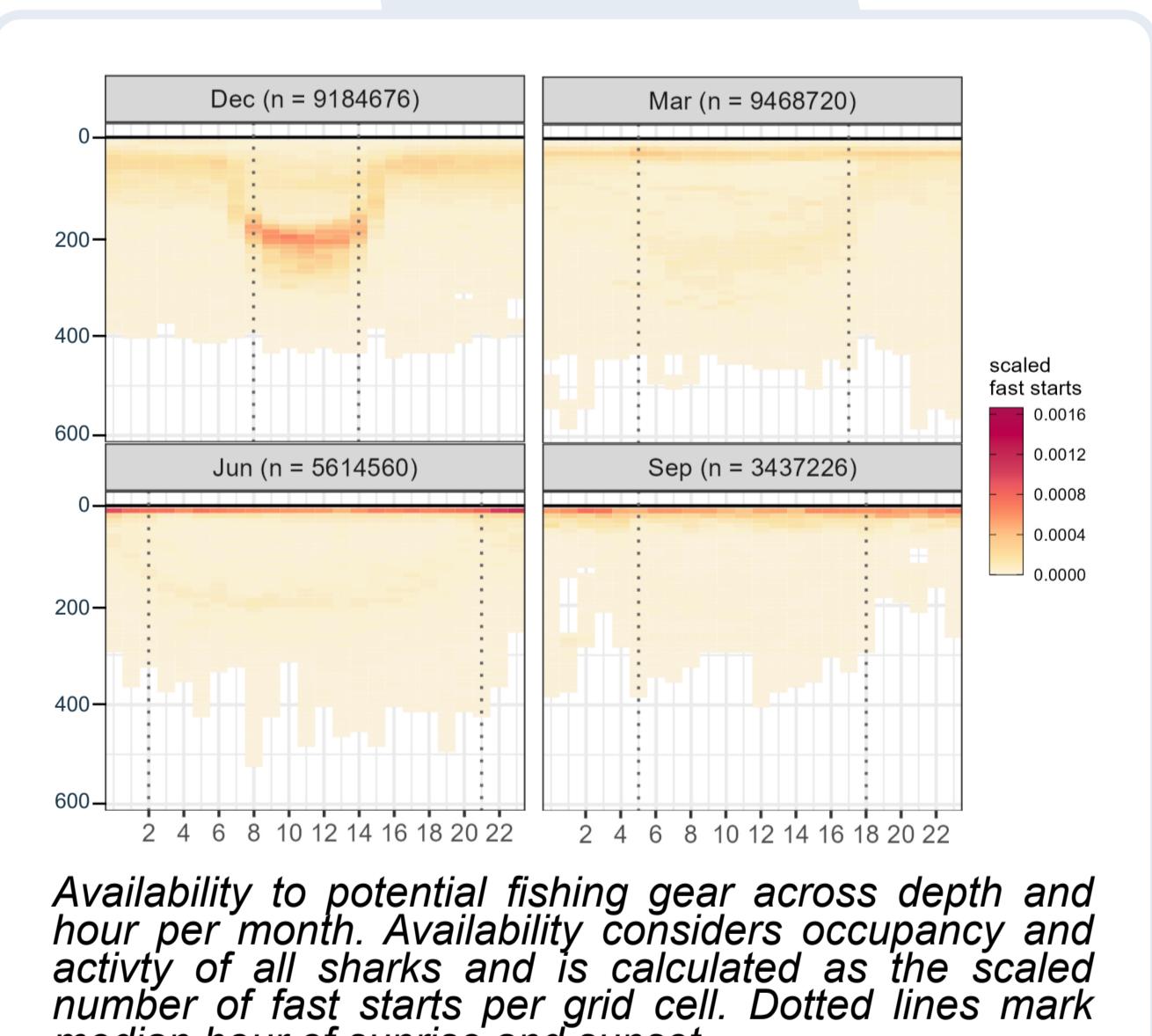


FUTURE RESEARCH

Together with future studies investigating the fine-scale horizontal movement, thermal and oxygen preferences, and sex- and age-specific differences in spurdog this starts building a more comprehensive picture of the movement ecology of habitat use of this economically important yet enigmatic species.

MANAGEMENT

With elevated importance of pregnant females for stock recruitment and the overexploitation history of this species, findings help to **direct bycatch mitigation** and the distribution of a reopened fishery. Between June and September, females are particularly available to gear in the top 20 m. In winter they are especially vulnerable at 150 - 250m during the day.



Availability to potential fishing gear across depth and hour per month. Availability considers occupancy and activity of all sharks and is calculated as the scaled number of fast starts per grid cell. Dotted lines mark median hour of sunrise and sunset.

KEY FINDINGS

I ATTACHMENT METHOD

New PSAT attachment method suited for year-long deployments.

II HORIZONTAL MOVEMENT

Indication for year-round coastal association of pregnant female spurdog; no reliable geolocation during deployment.

III REALISED NICHE

Active use of the upper 300 m ($\mu = 56.5$ m, IQR 21.5 - 128m, range 0 - 644.0m).

Selected water temperatures between 8 - 11°C ($\mu = 9.6^\circ\text{C}$, IQR 8.3 - 11.1°C, range 4.5 - 18.2°C) with warm waters selected in summer and <6°C avoided in winter.

IV PERIODICITY

Dominant diel oscillation in vertical movement commonly with dusk ascent and dawn descent (normal diel vertical migration, nDVM).

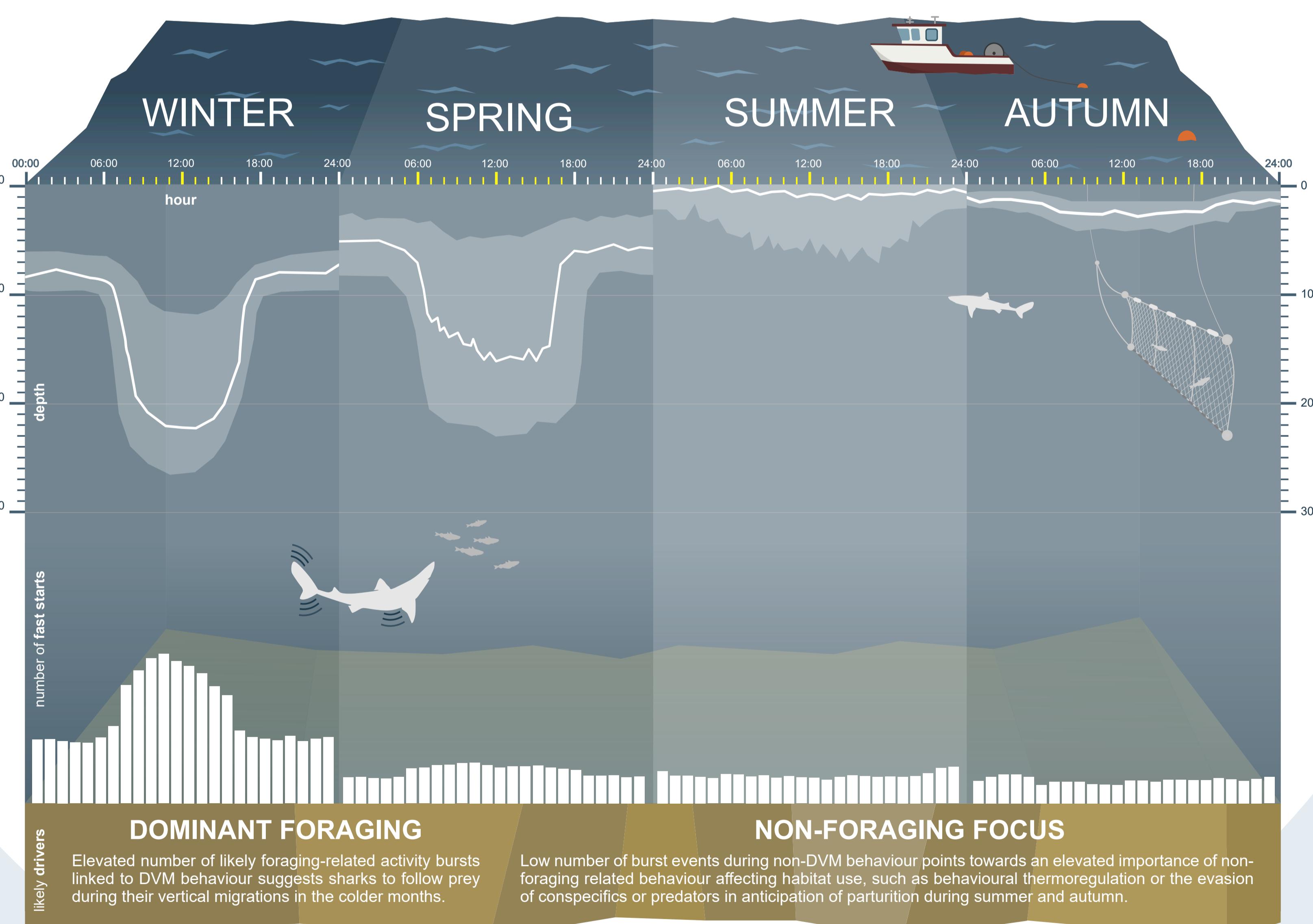
Variability across individuals and season: DVM mostly present in winter, rare DVM behaviour in summer.

V POSSIBLE DRIVERS

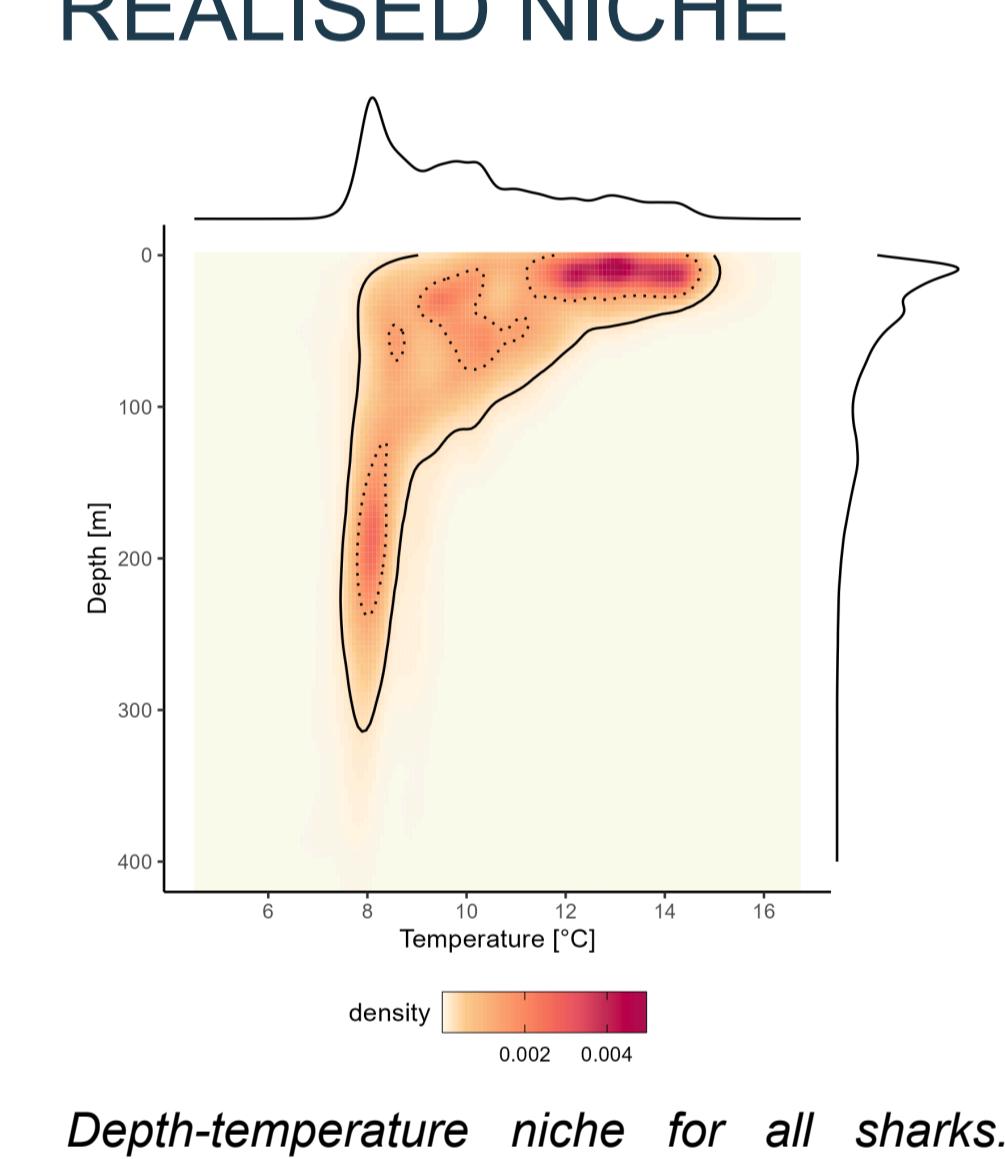
WINTER | DVM, elevated fast starts
Likely foraging-related behaviour.

SUMMER | shallow, rare DVM, few fast starts
Likely non-foraging related behaviour e.g. behavioural thermoregulation in anticipation of parturition.

vertical habitat use and activity patterns in pregnant spurdog

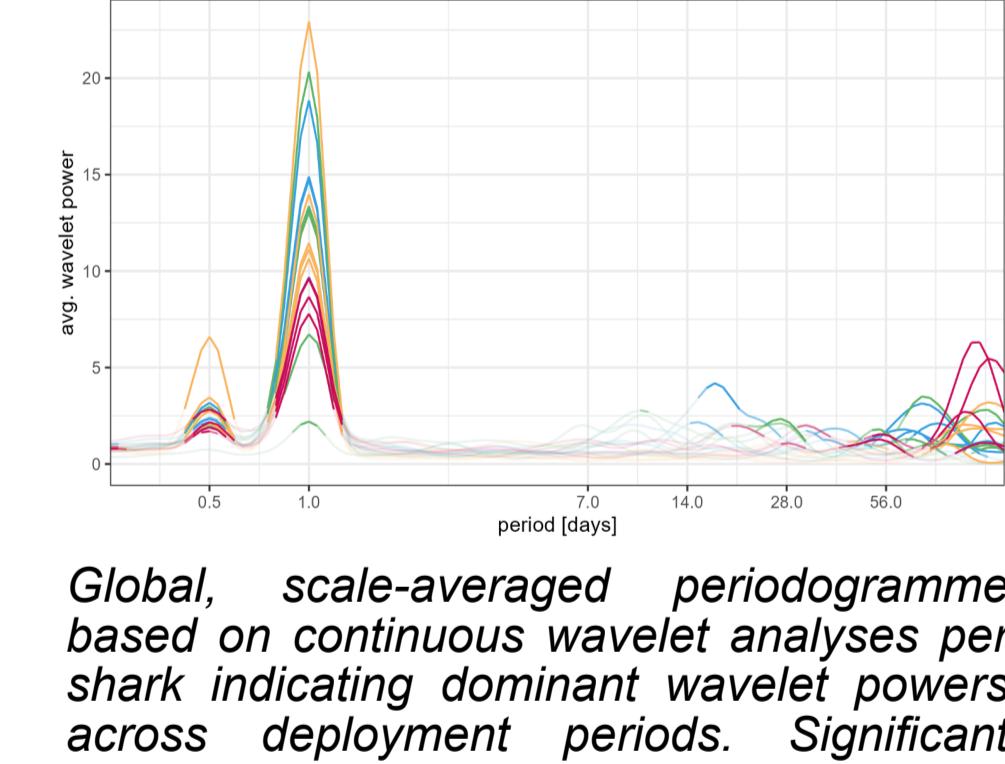


REALISED NICHE



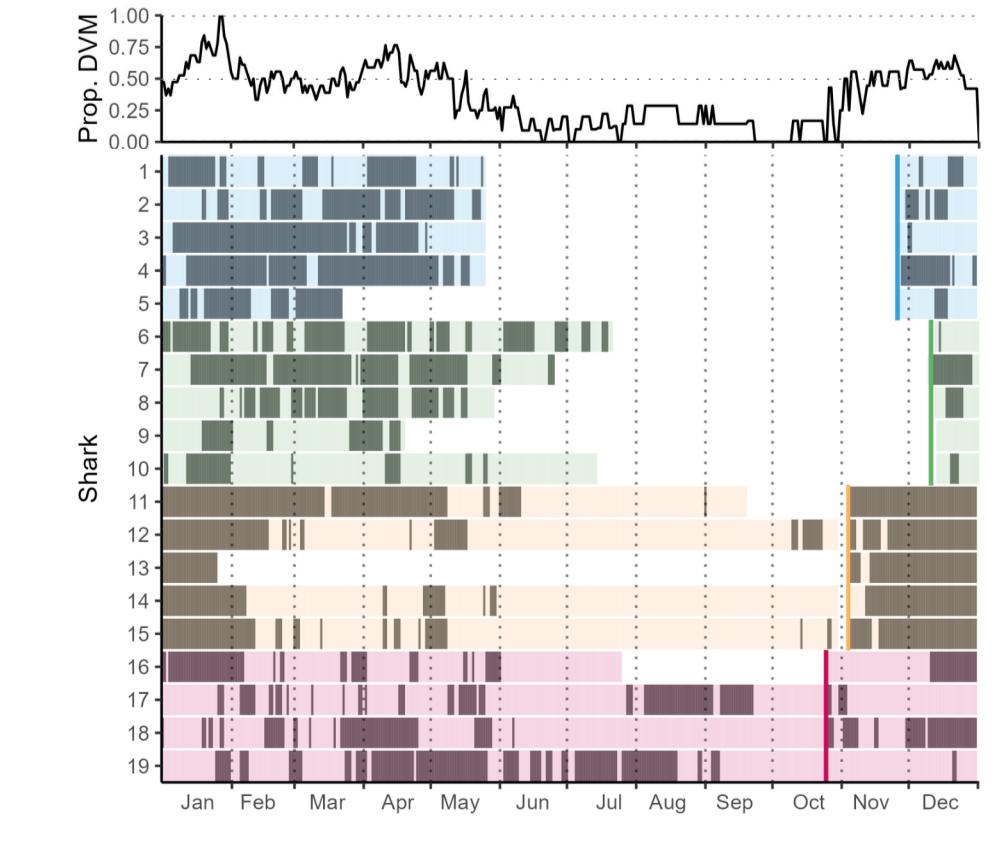
Depth-temperature niche for all sharks. Densities of hourly data weighted by the reciprocal of points per Julian day. Dotted and solid lines mark niche space encompassing 50% and 95% of points.

DIEL PATTERN



Global, scale-averaged periodogram based on continuous wavelet analyses per shark indicating dominant wavelet powers across deployment periods. Significant powers ($p \leq 0.05$) shown in full opacity.

VARIATION IN DVM



Individual variation in occurrence of diel vertical migration (DVM) across a year with overall proportions above. Dark bars indicate significant DVM, colours tagging years. Vertical bars highlight time point of tagging.