

Summary of Lemon Shark and Whale Shark movement and habitat use within and adjacent to Ningaloo Marine Park

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WESTERN COASTAL/OCEAN & ATMOSPHERE
www.csiro.au

Ningaloo Outlook is a BHP-CSIRO Industry-Science Marine Research Partnership investing A\$5.4 million over five years to gather new knowledge on the Ningaloo reef and its important ecological values



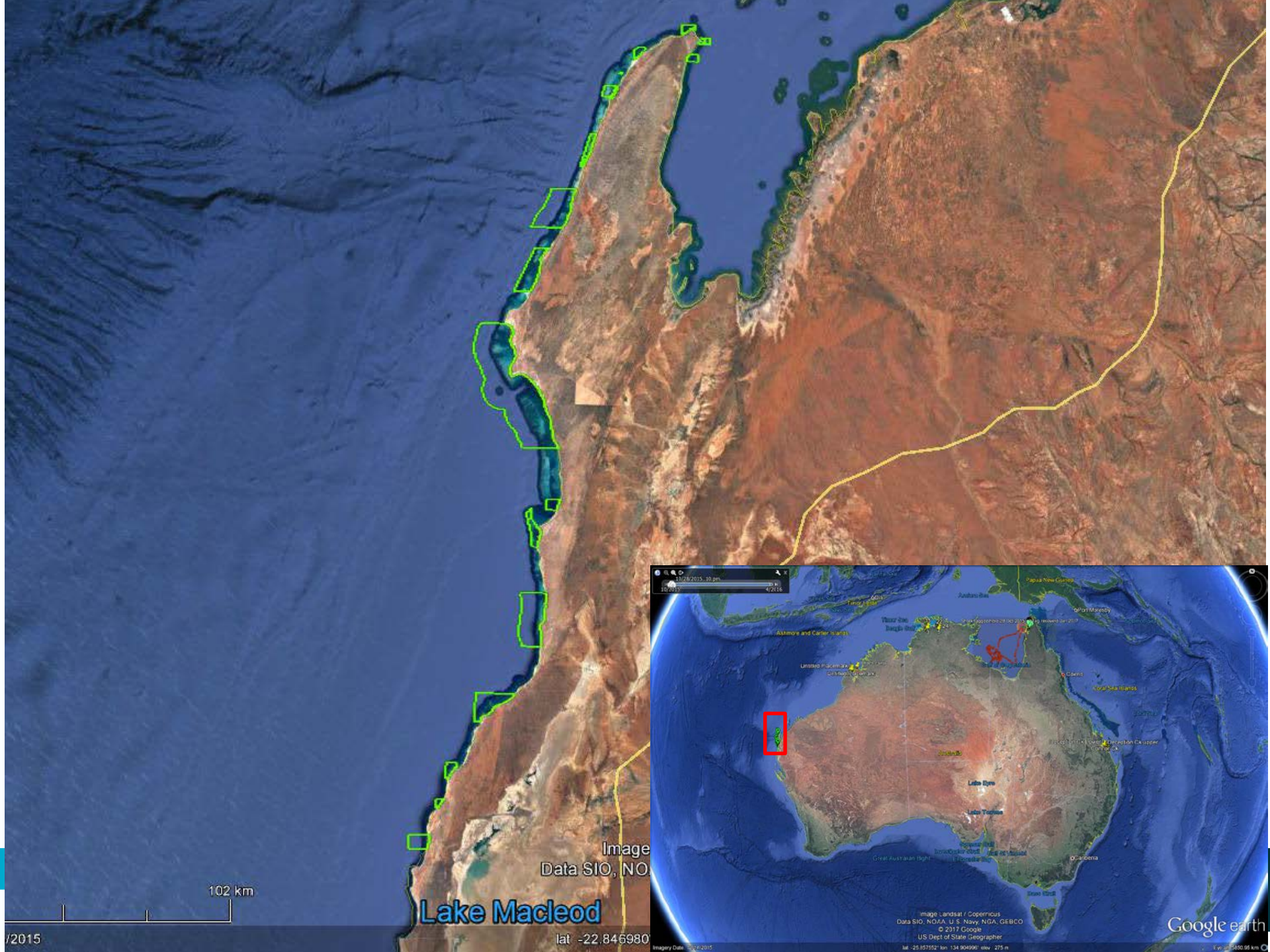


Image
Data SIO, NOAA

Lake Macleod

lat -22.846980



Image Landsat / Copernicus
Data SIO, NOAA, U.S. Navy, NGA, GEBCO
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US Dept of State Geographer

Google earth

Why Lemon Sharks?

- Limited data on movement of adult sharks
- Previous studies limited by small sample size and short duration of tracking
- Abundant lagoon predator
- Juvenile nursery area in the study area
- Long lived, slow growing and have undergone significant declines in some parts of their range
- Part of long term research on shark ecology at Ningaloo Reef
- Implications for spatial management

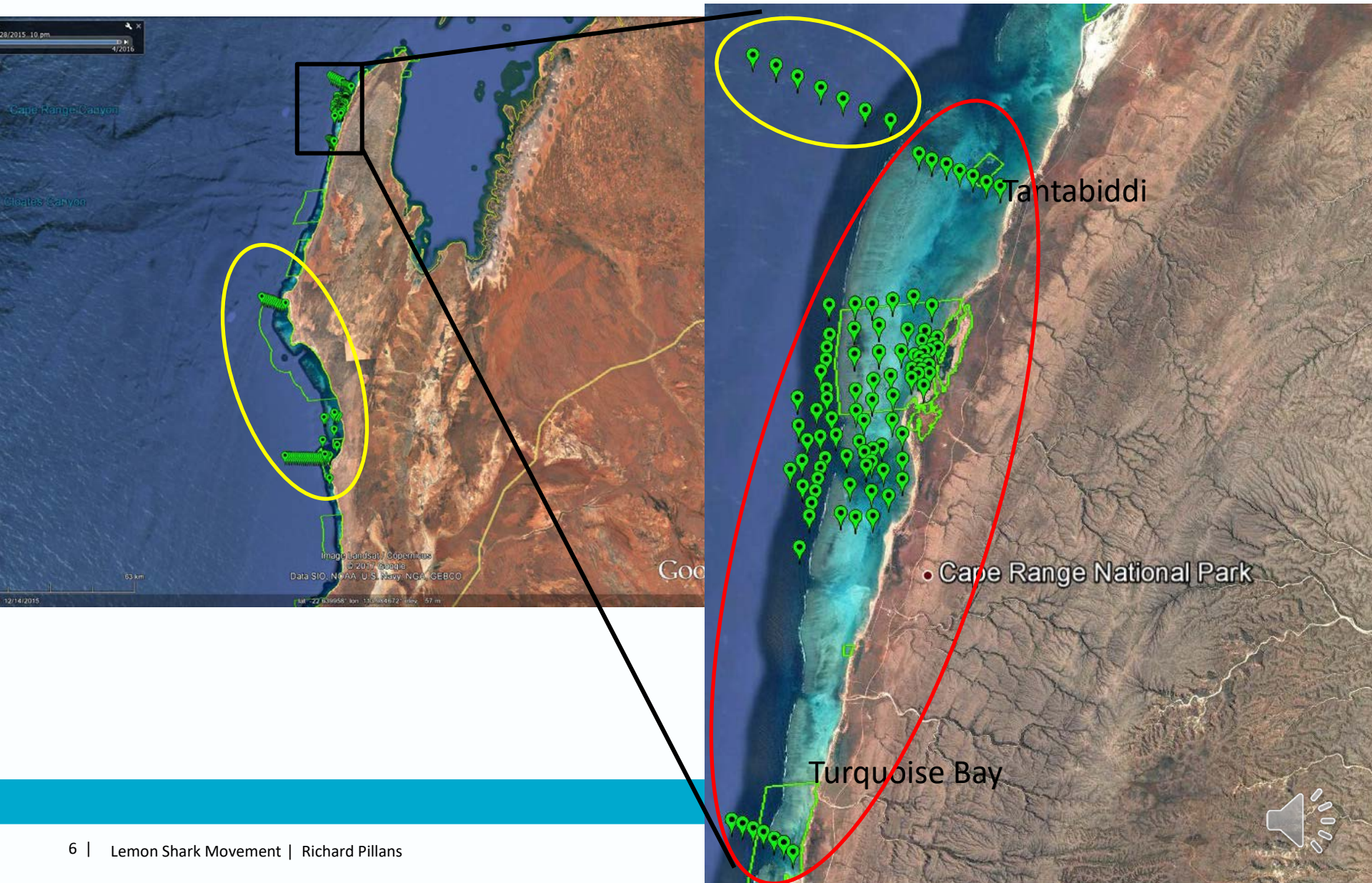
Acoustic telemetry

VEMCO VR2W

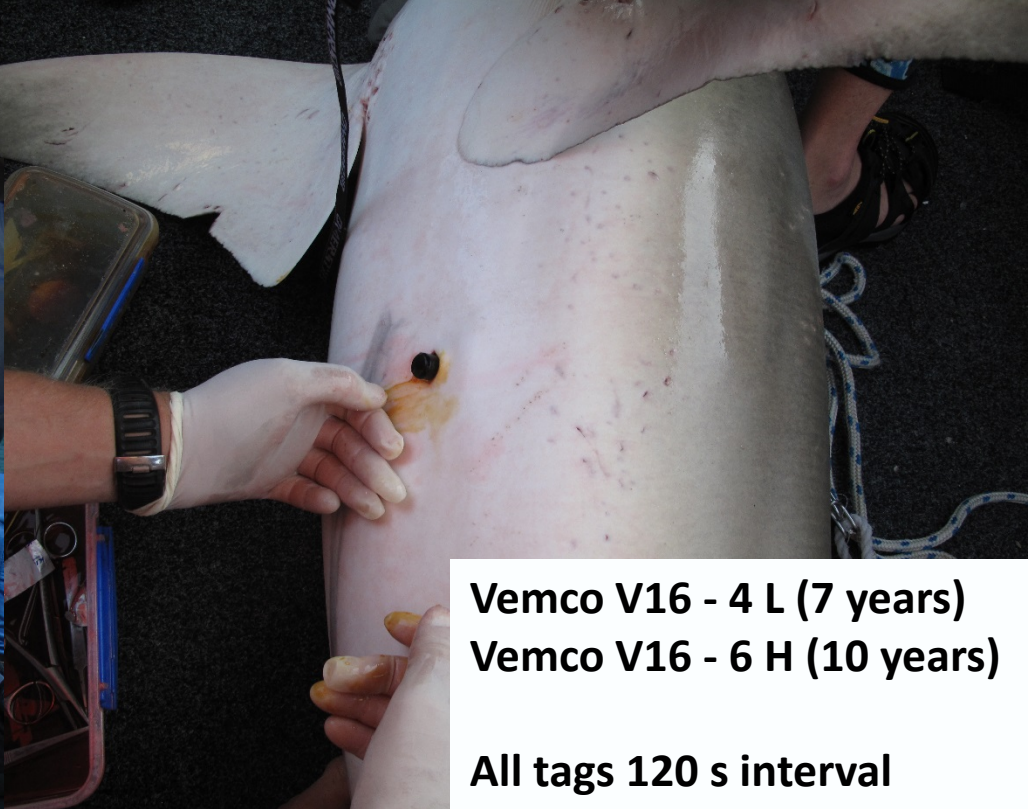
VEMCO VR2WAR



Ningaloo Reef acoustic array design

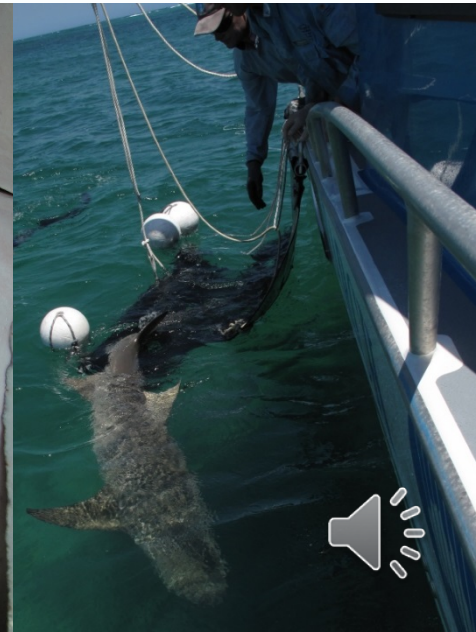


Shark tagging



Vemco V16 - 4 L (7 years)
Vemco V16 - 6 H (10 years)

All tags 120 s interval

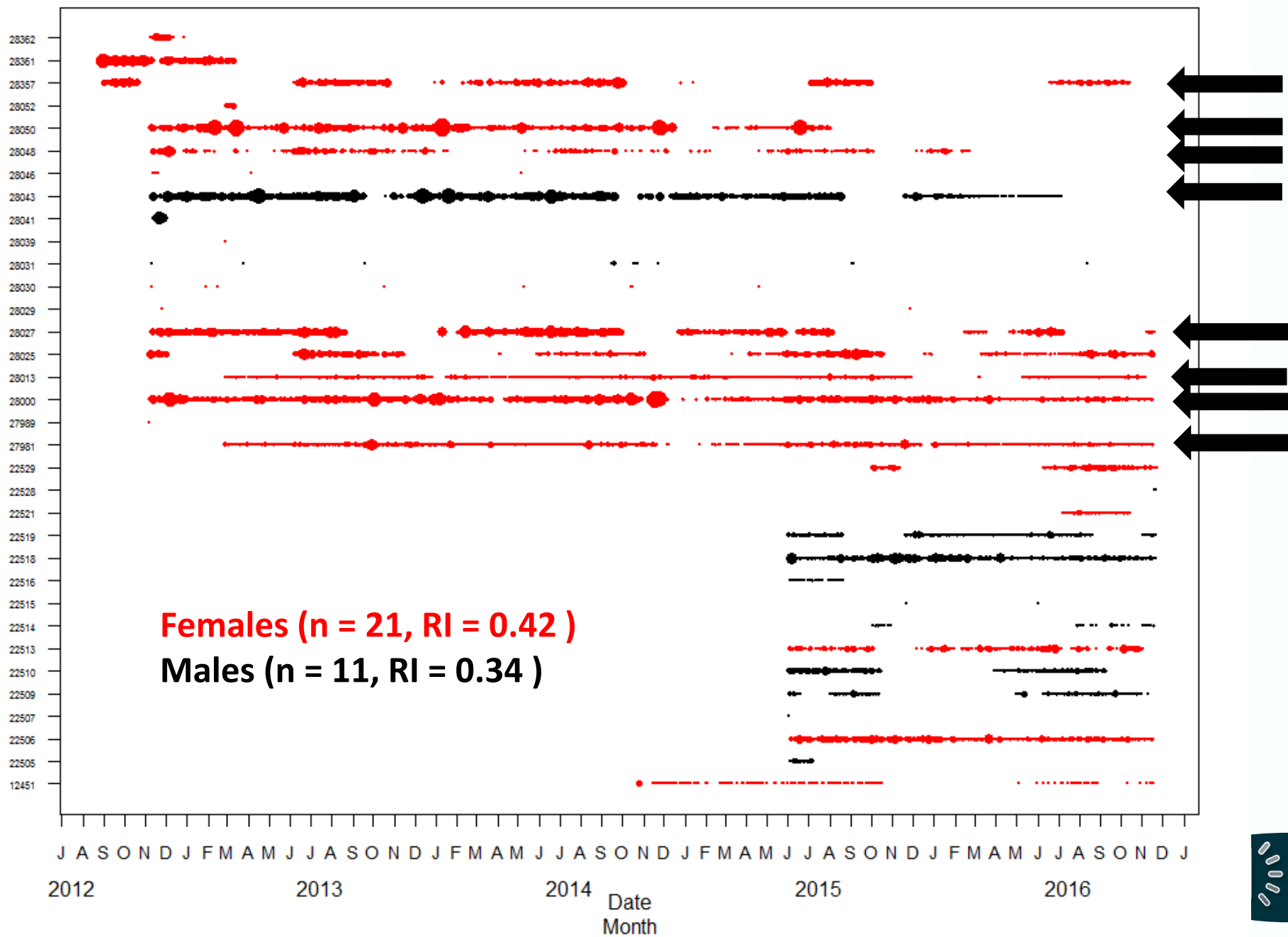


Analysis

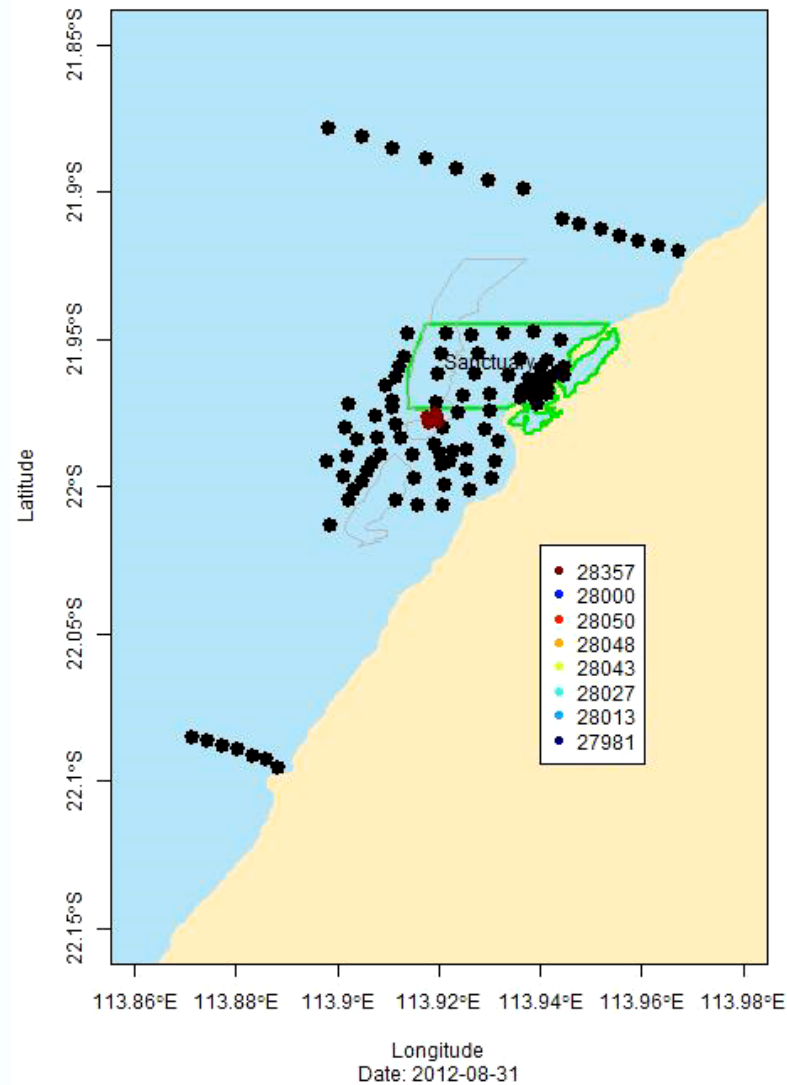
- ~ 250 000 detections of 50 individuals
- Detection span, proportion days detected and Residence Index
- All detections assigned to tide height, tide time and diurnal state
- Home range (50 and 95 % KUD)
- Analysis performed in R using *adehabitatHR*
- Habitat preference calculated using Ivlev's index of electivity

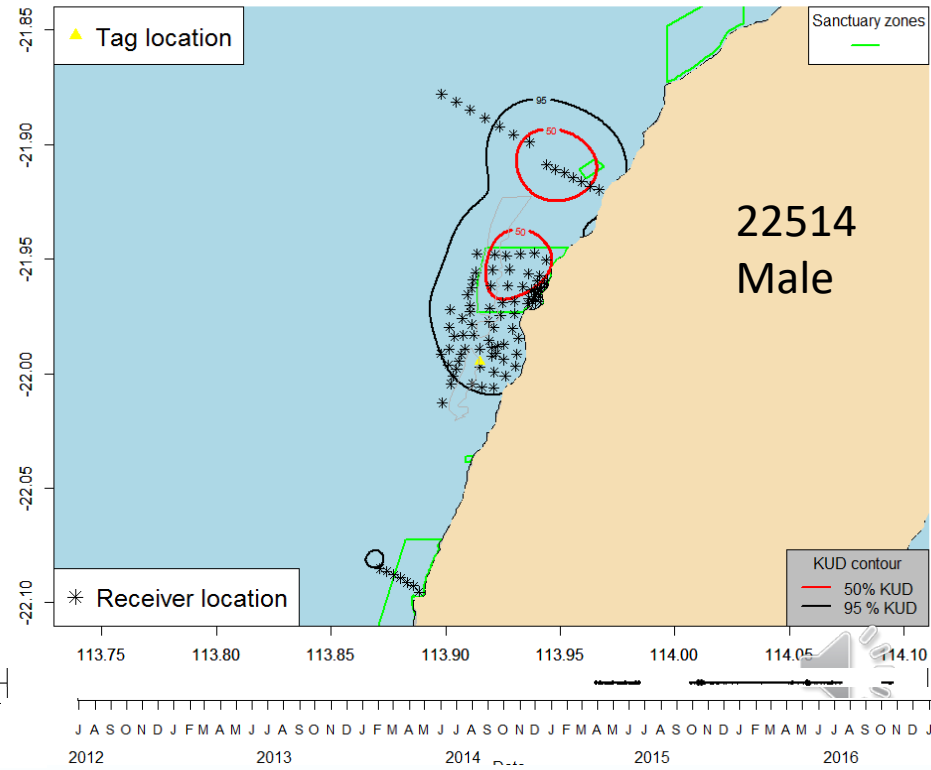
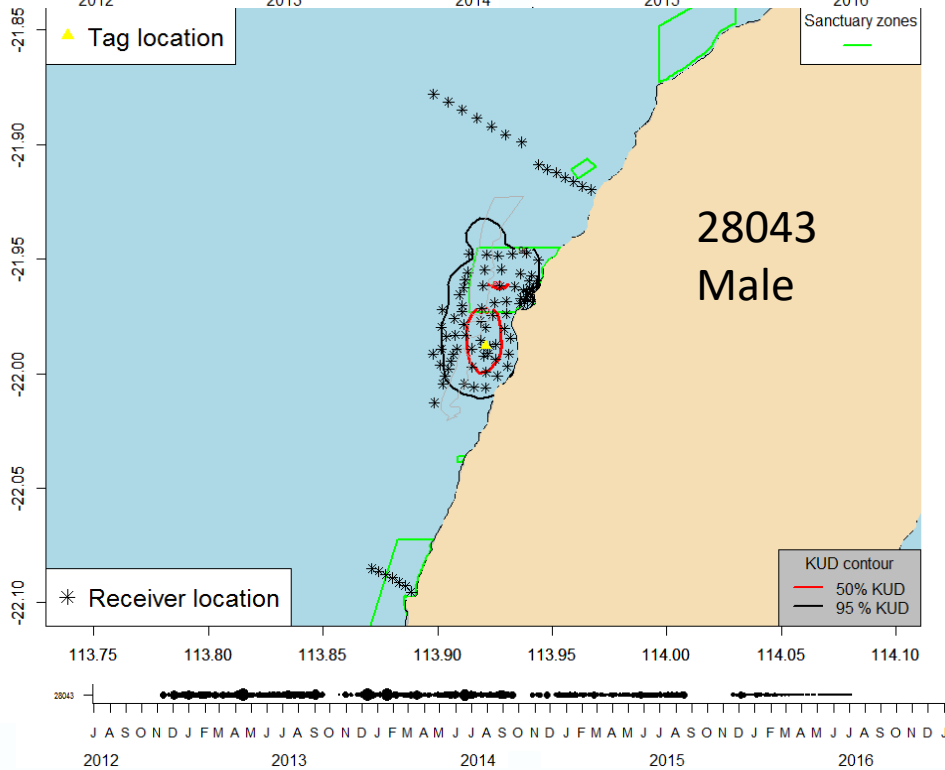
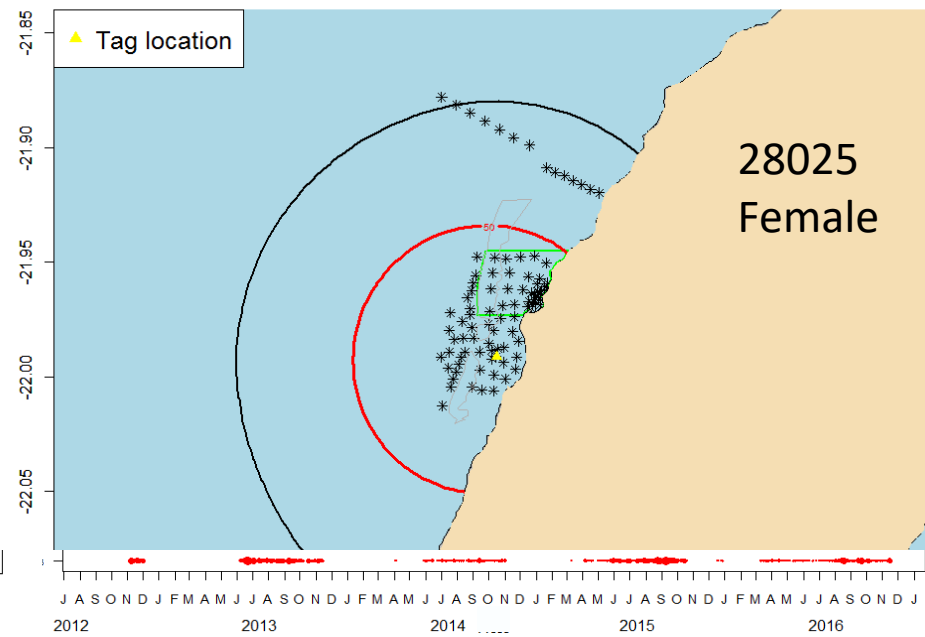
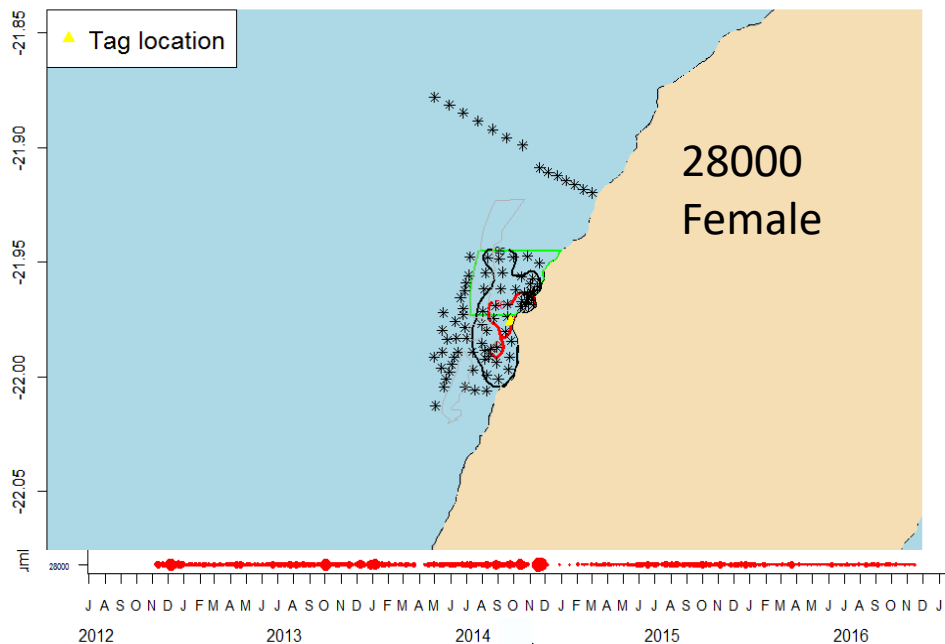
• 81.4 • 162.8 • 244.2 • 325.6 • 407

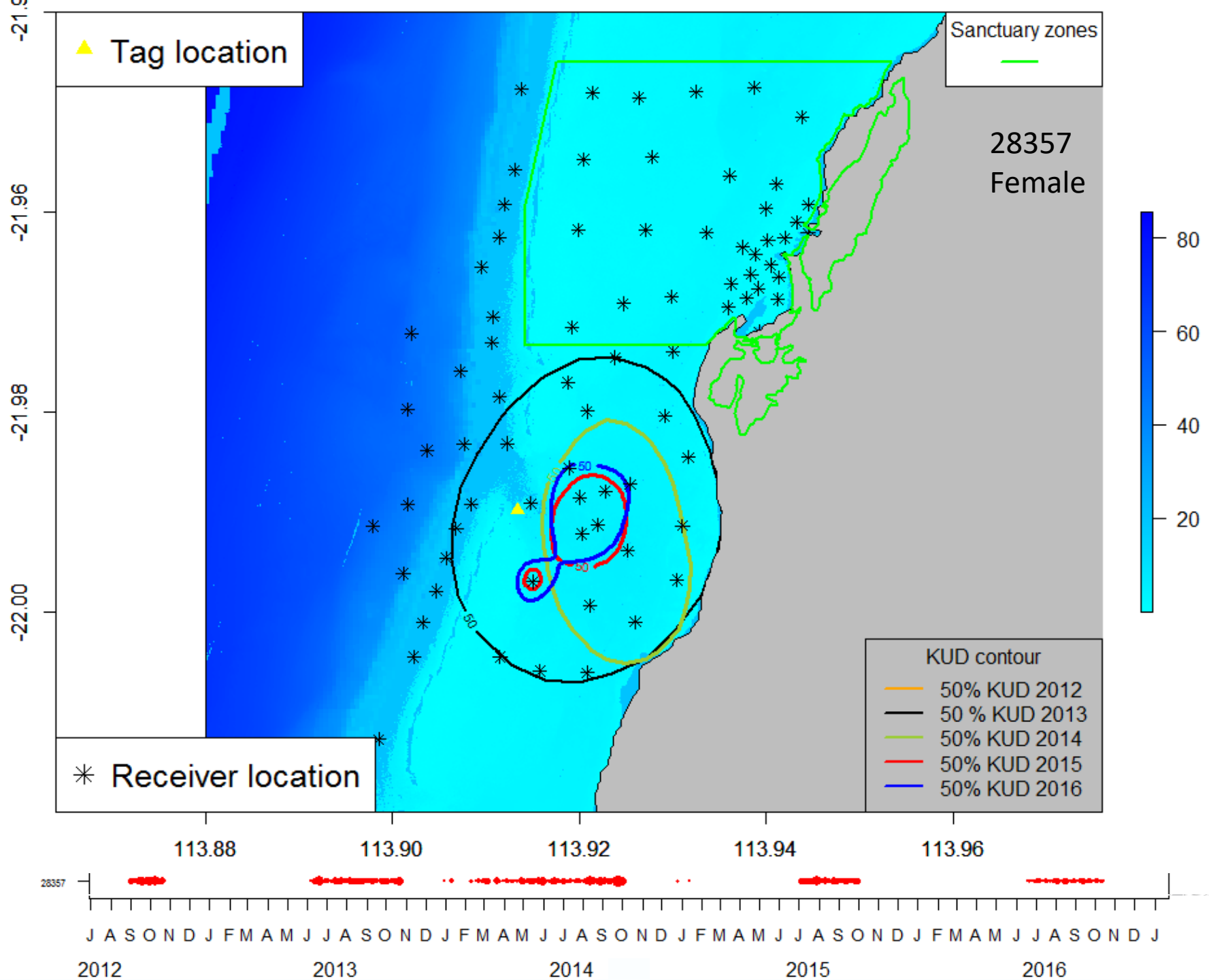
Tag number

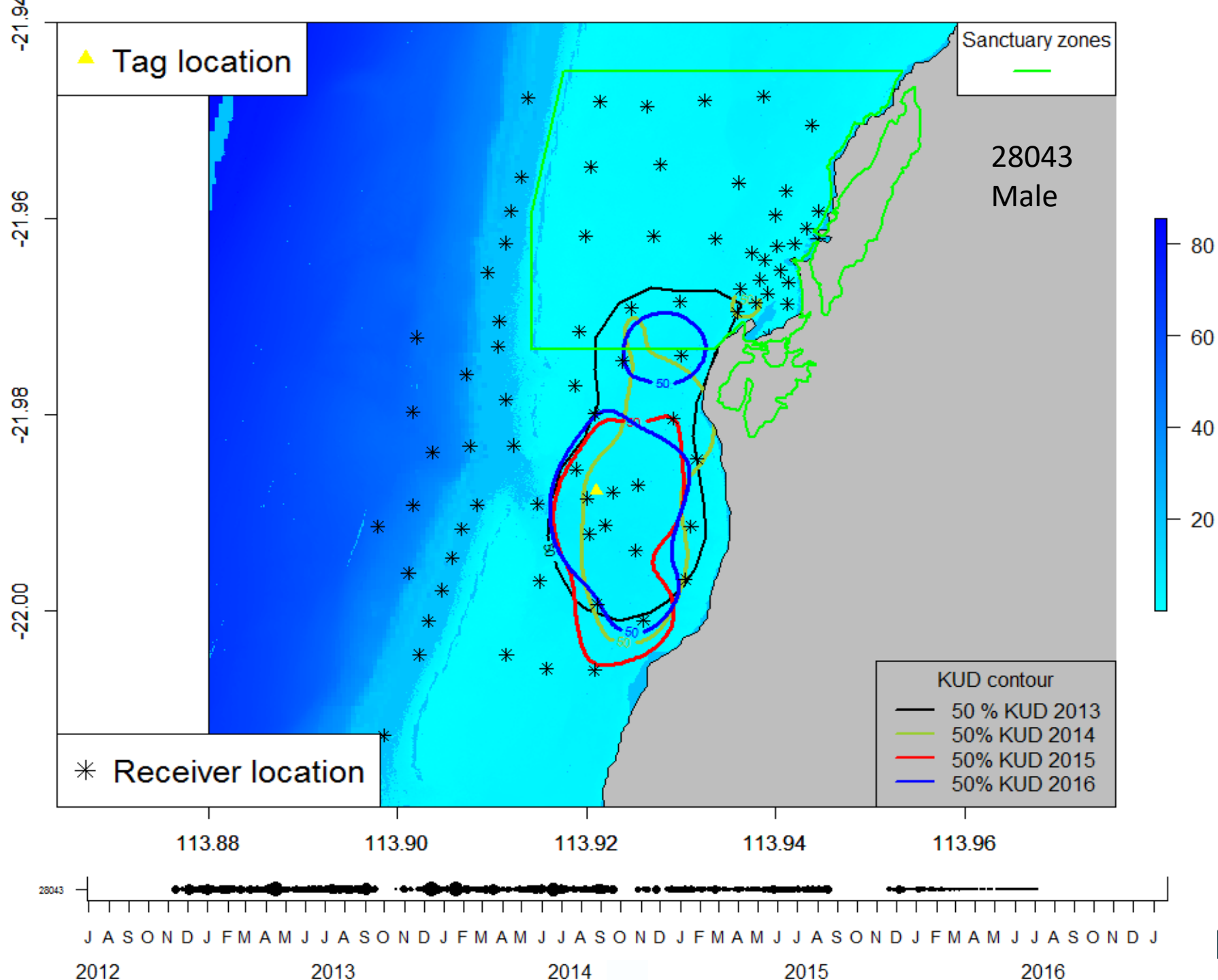


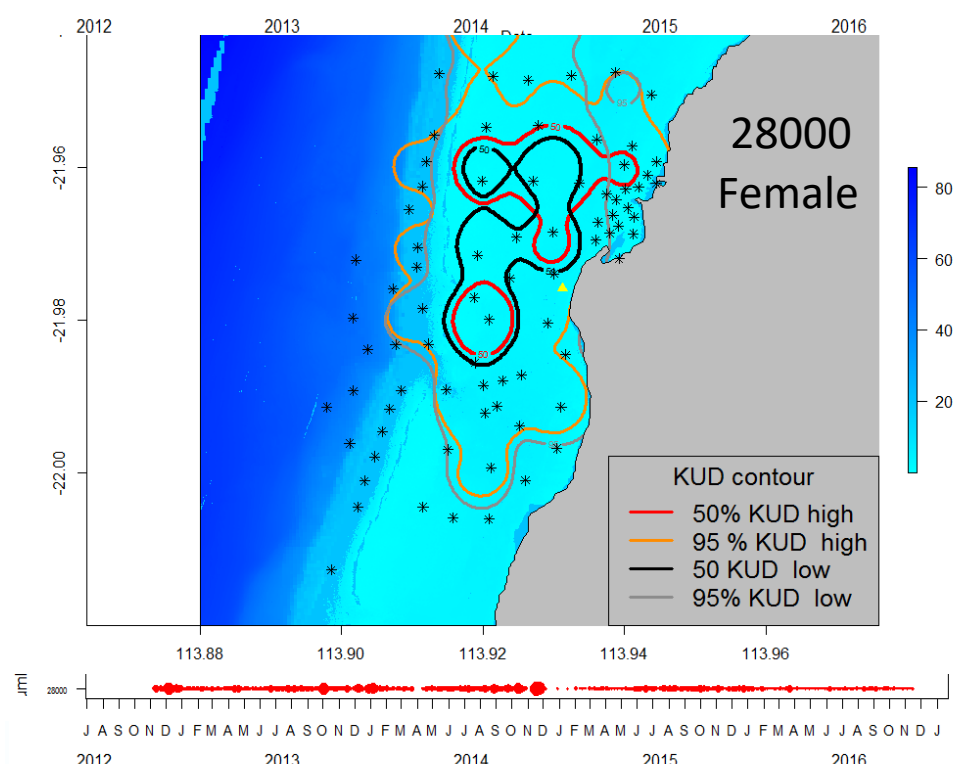
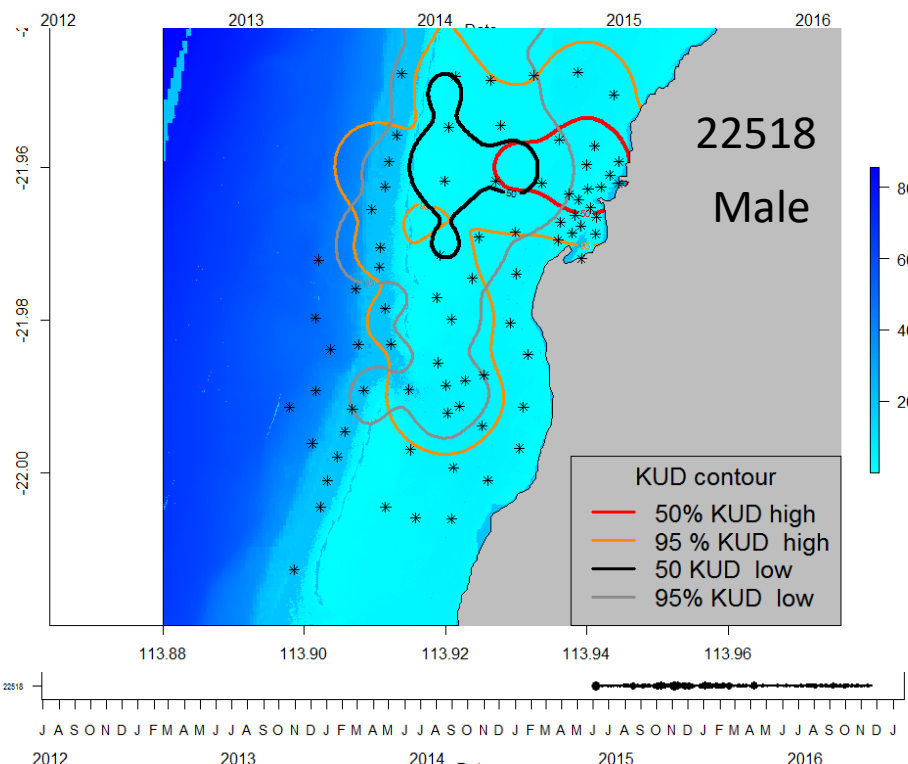
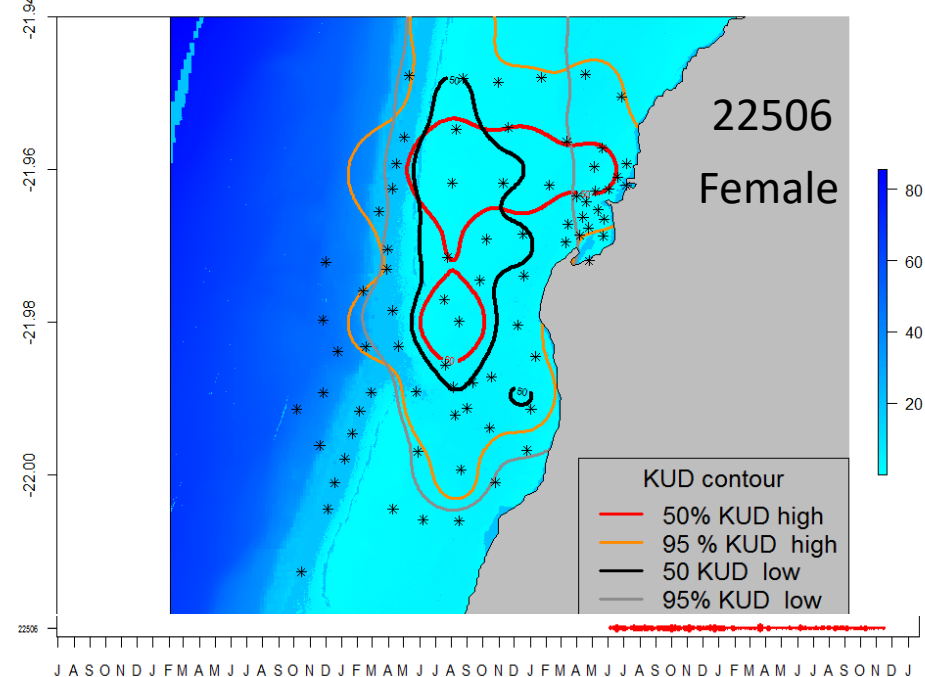
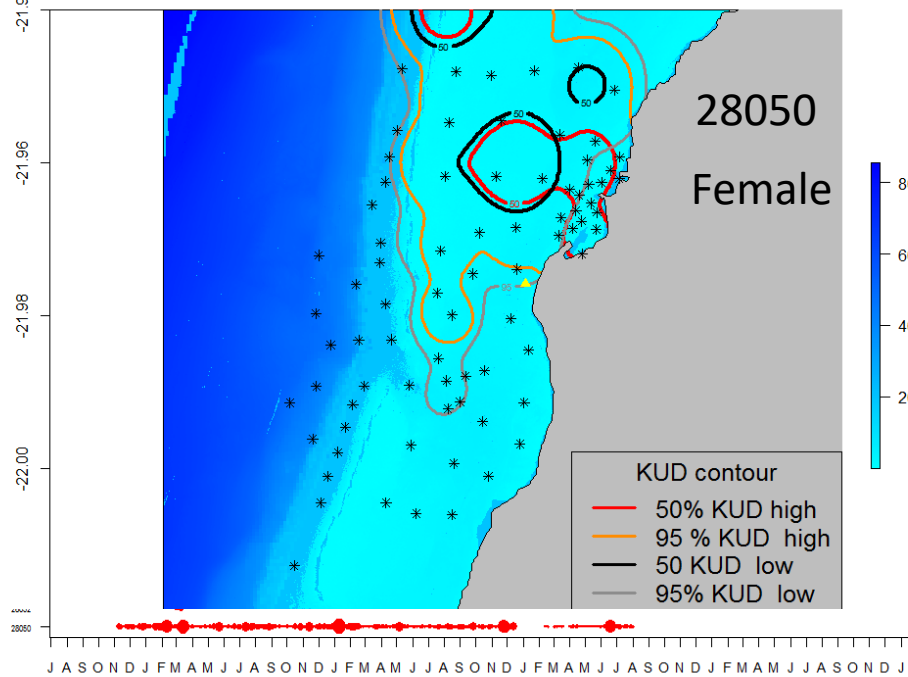
Lemon Shark Movement

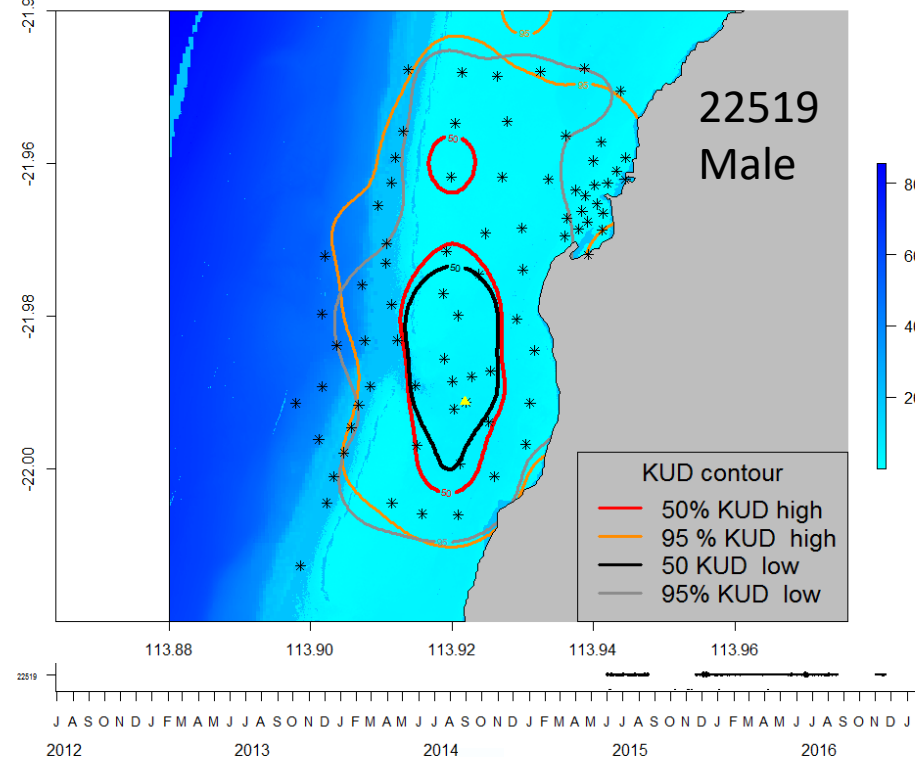
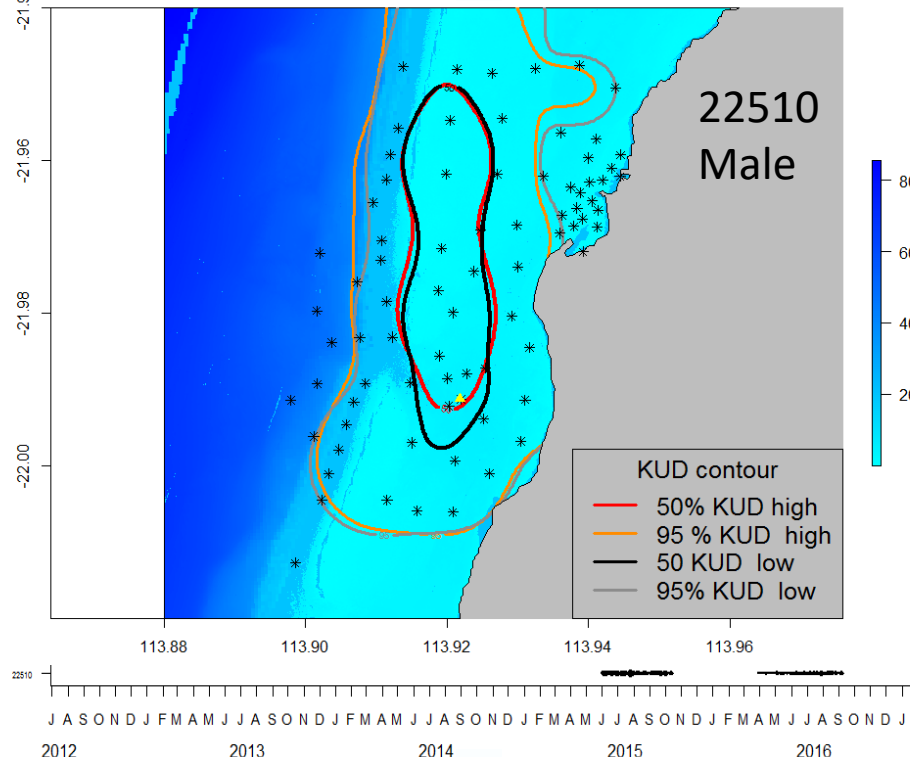
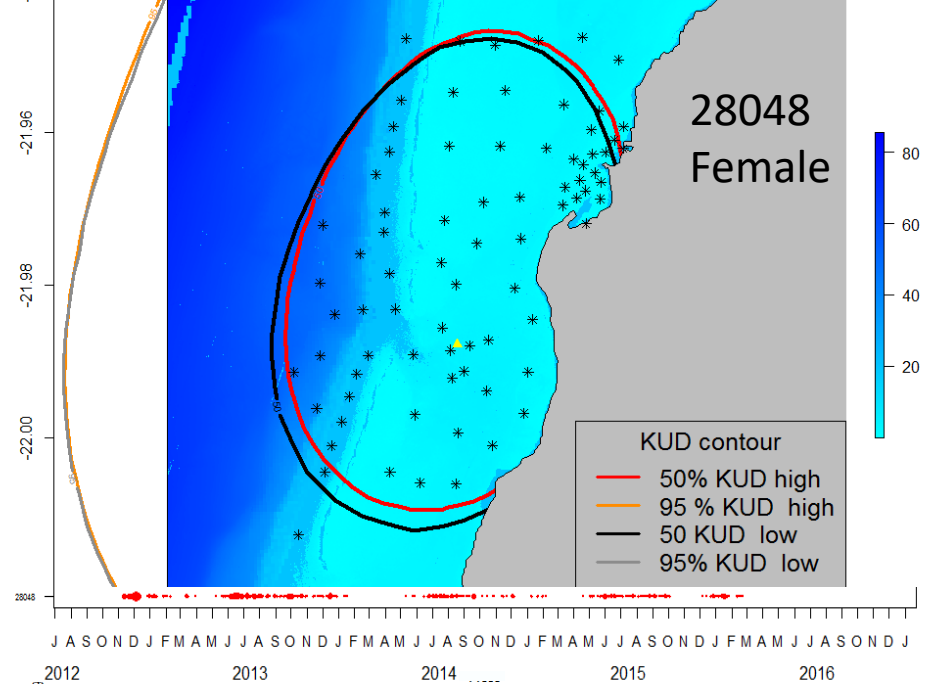
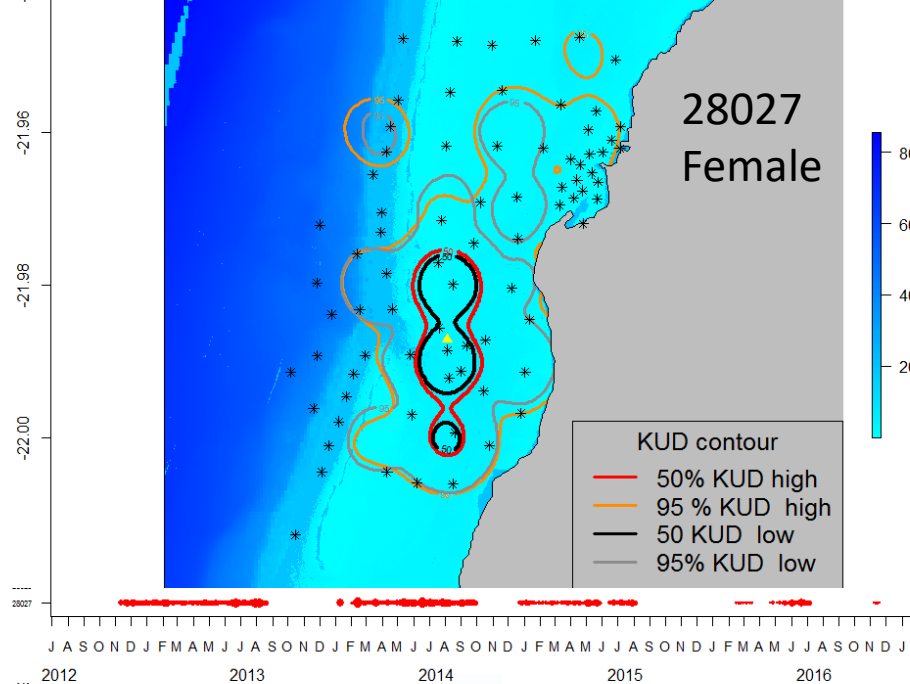










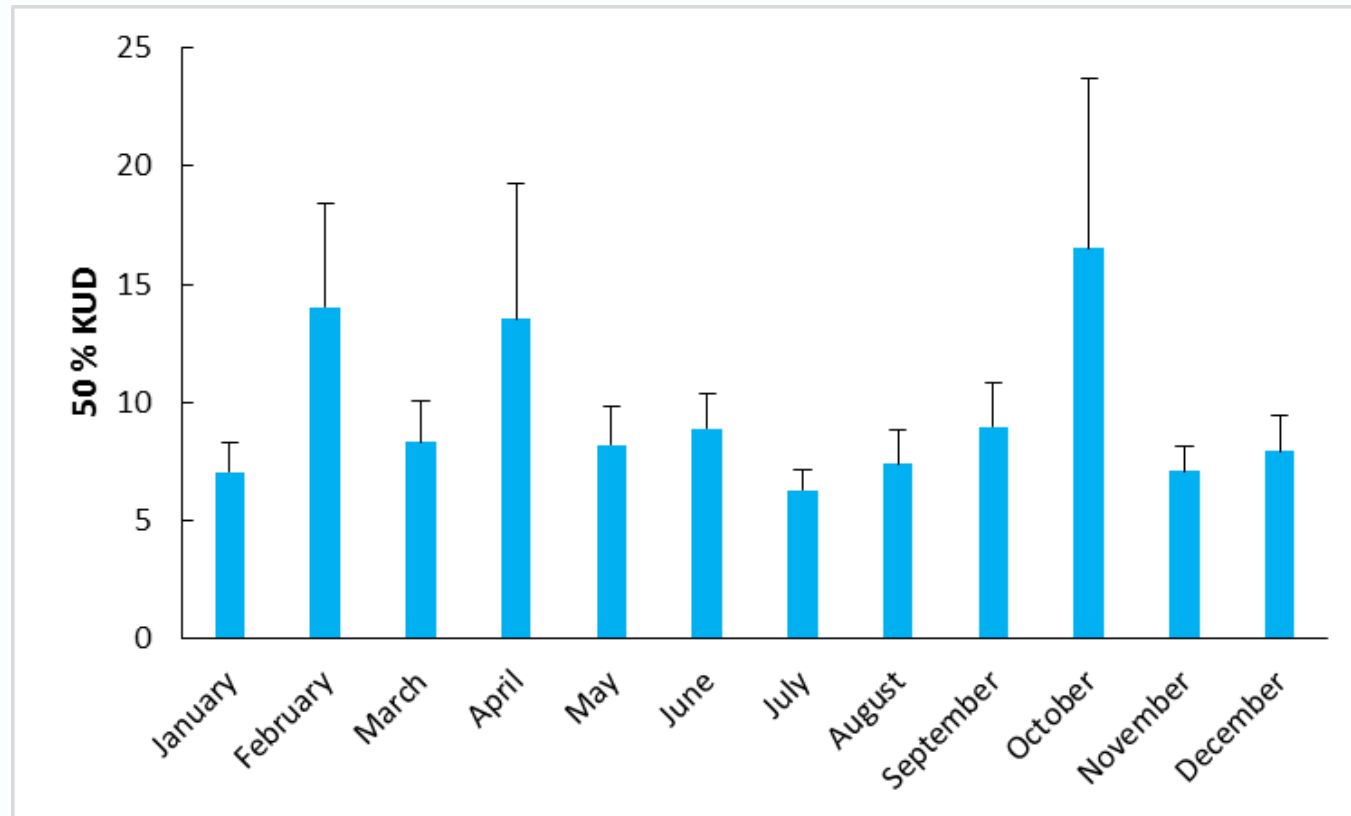


Long distance movements

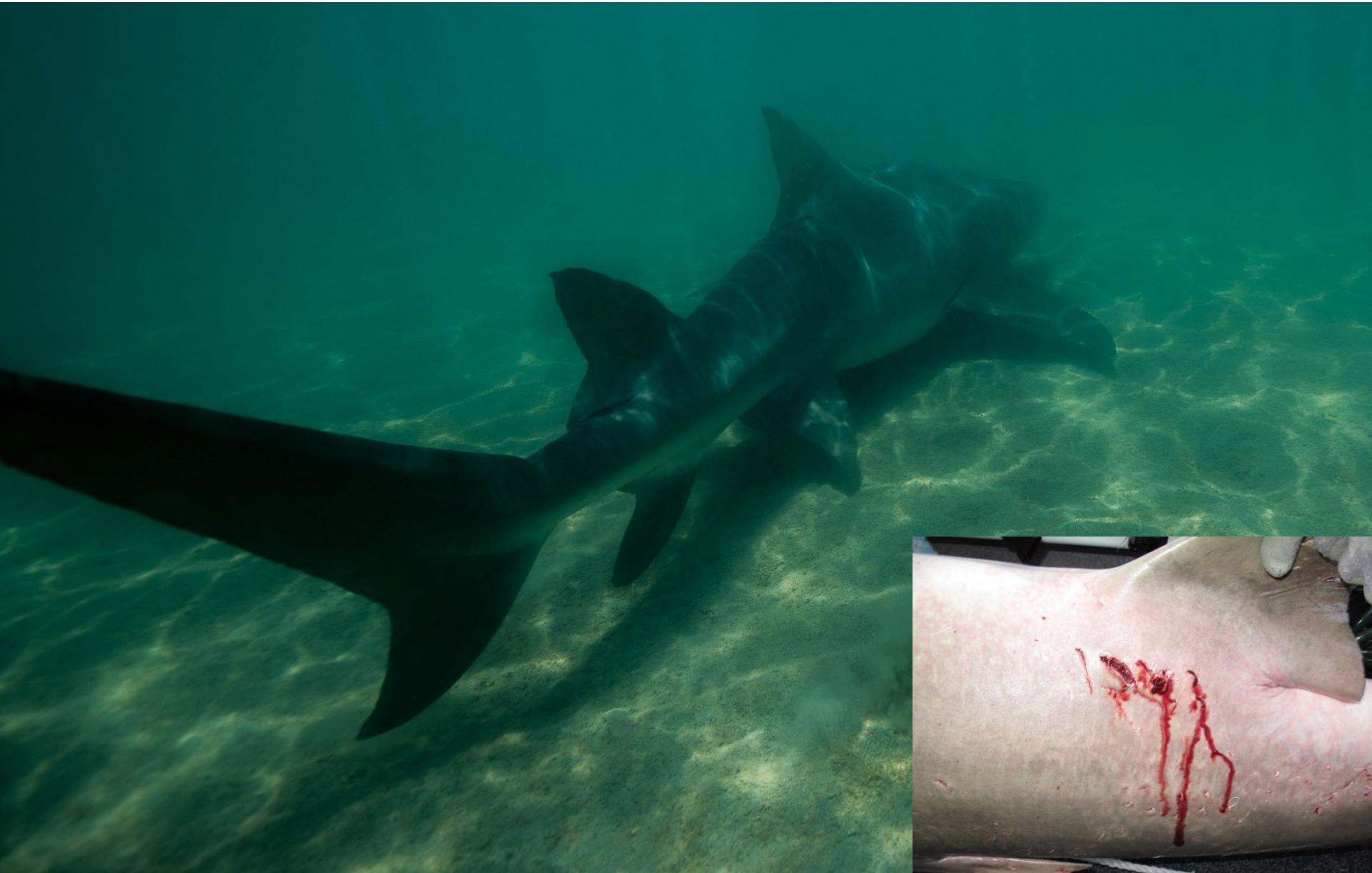


Seasonal home range

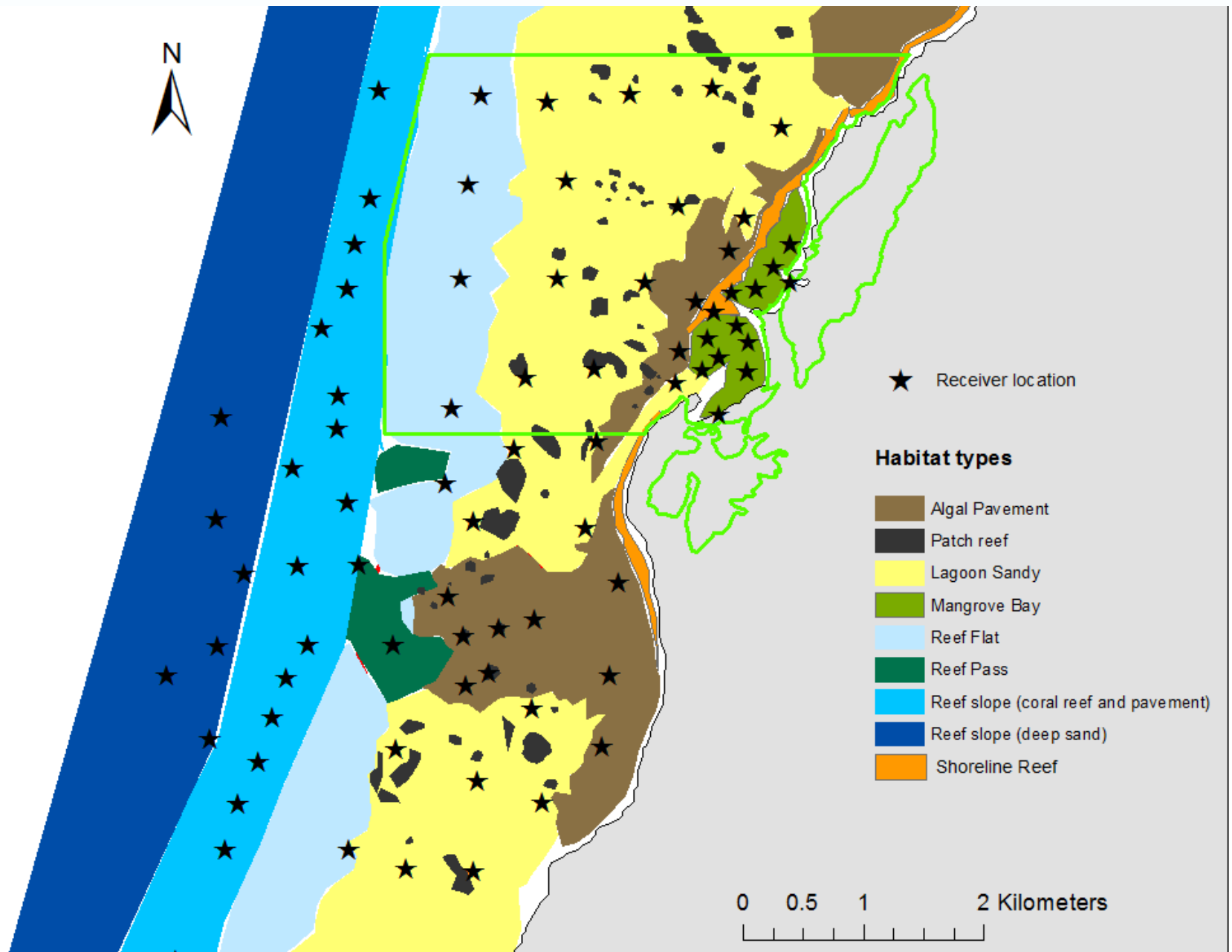
Average of all animals over 4 years



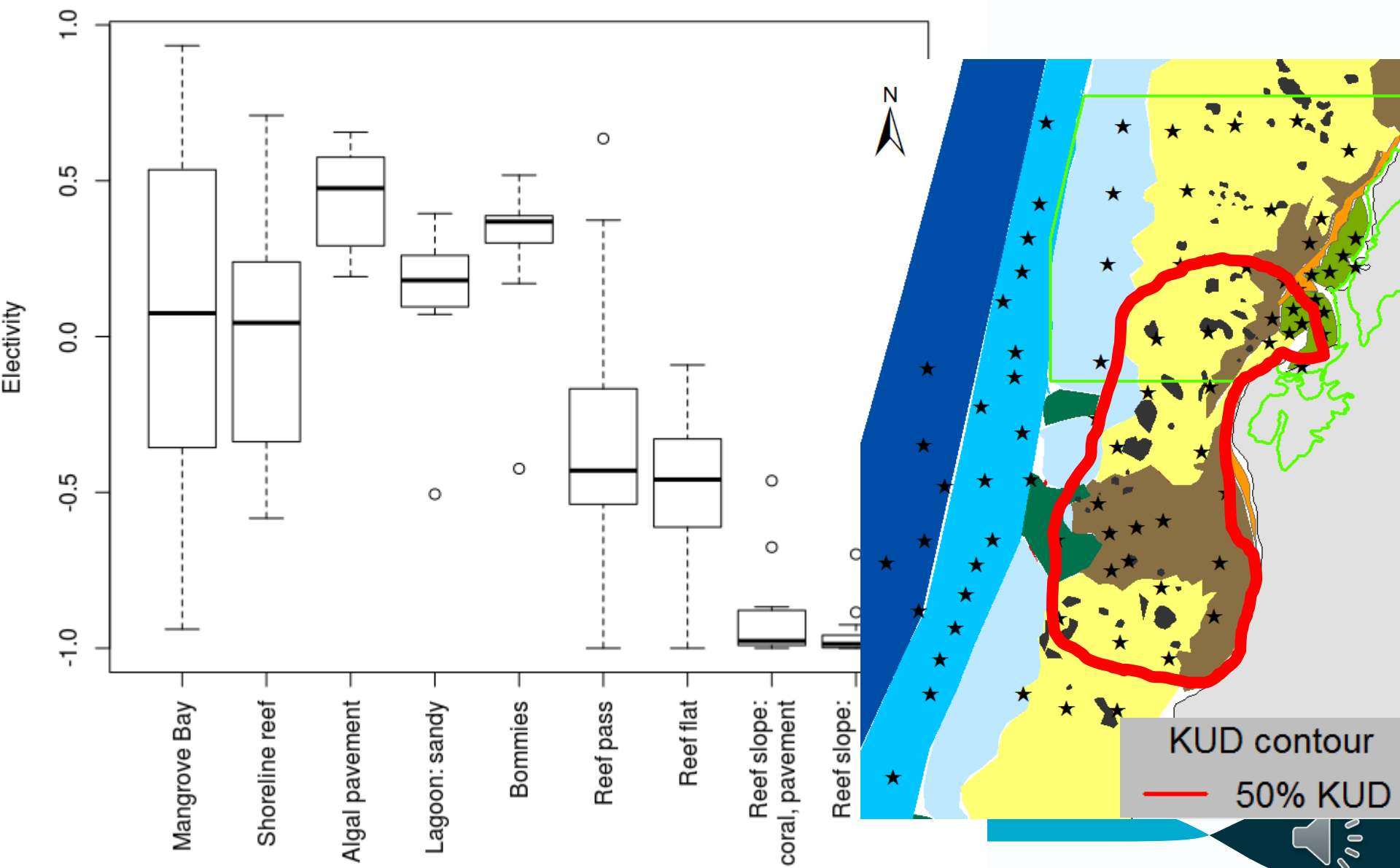
Seasonal movement – why?



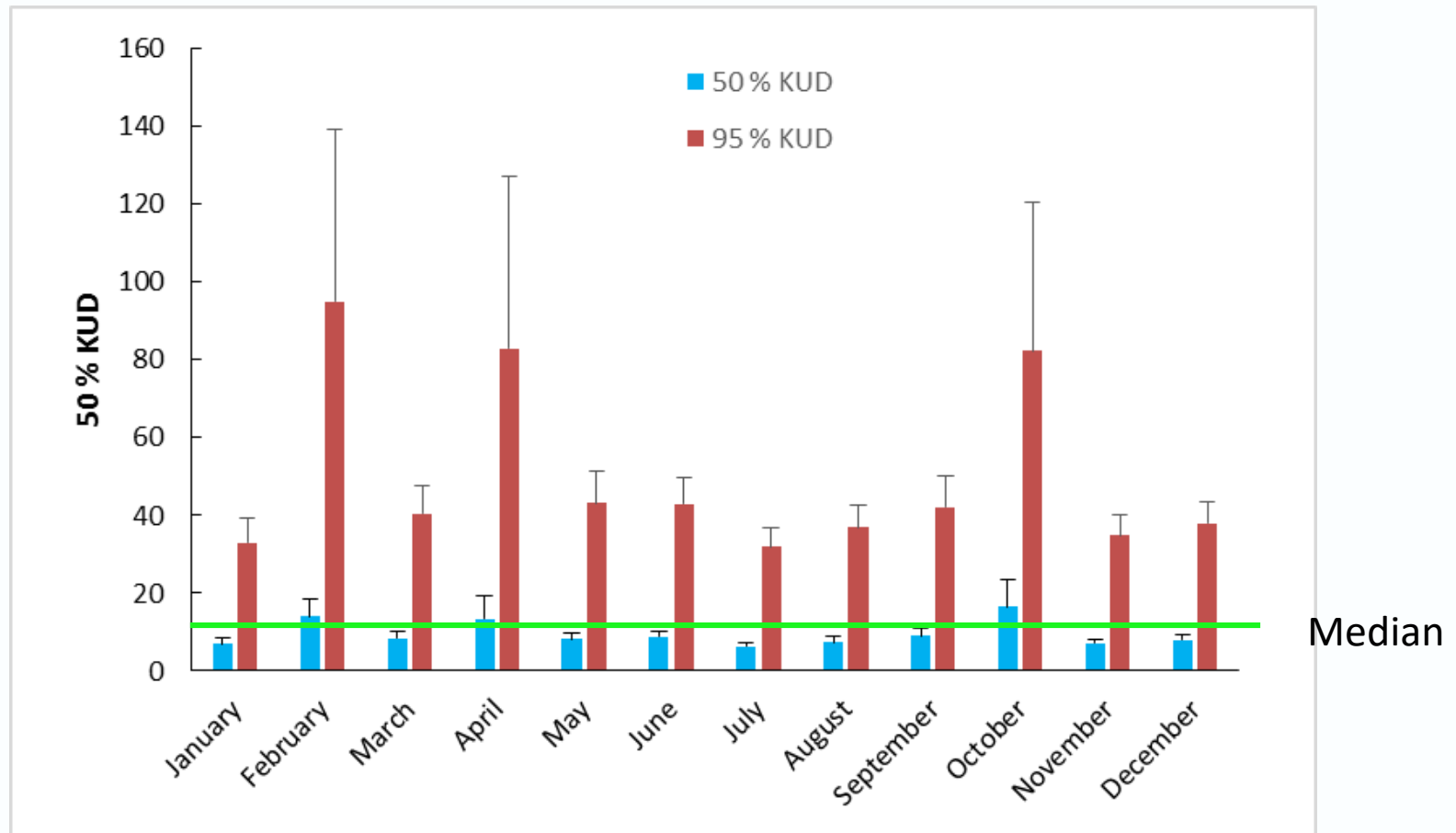
Habitat use



Ivlev's electivity for each individual and habitat



Spatial management implications



Conclusions

- Approx. 45% resident with small and stable home range
- Resident animals undertake annual movements
- Timing of movement not always consistent - some movements coincide with parturition and mating
- Some individuals have activity centres up to 160 km apart
- High degree of fidelity upon return
- Individual variation at fine and broad scale
- Additional data on full extent of long-shore movements as well movements into Exmouth Gulf are required
- Current zoning does not adequately encompass the range of movements displayed by adult lemon sharks



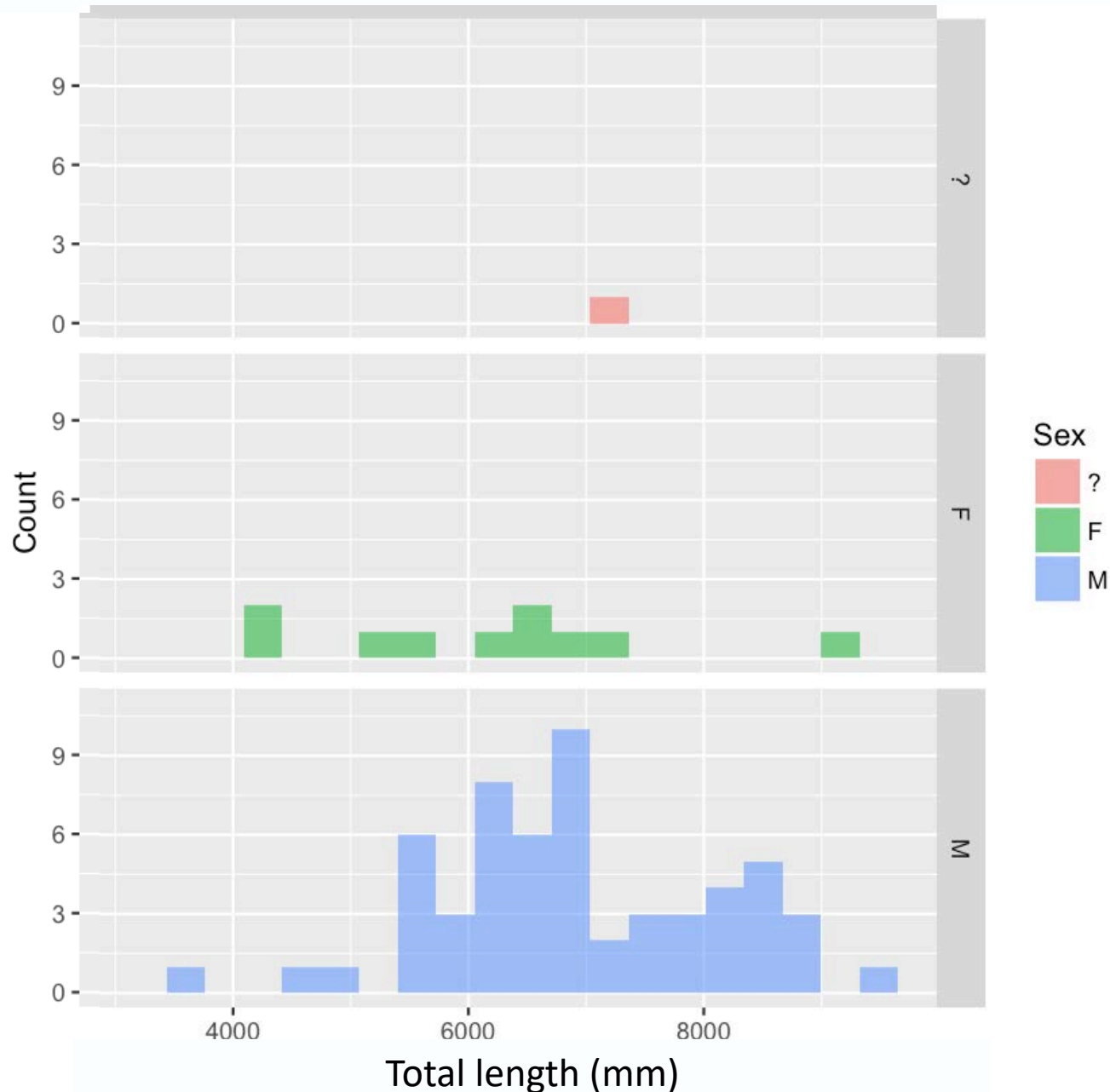
Photo ID, length, sex and tagging



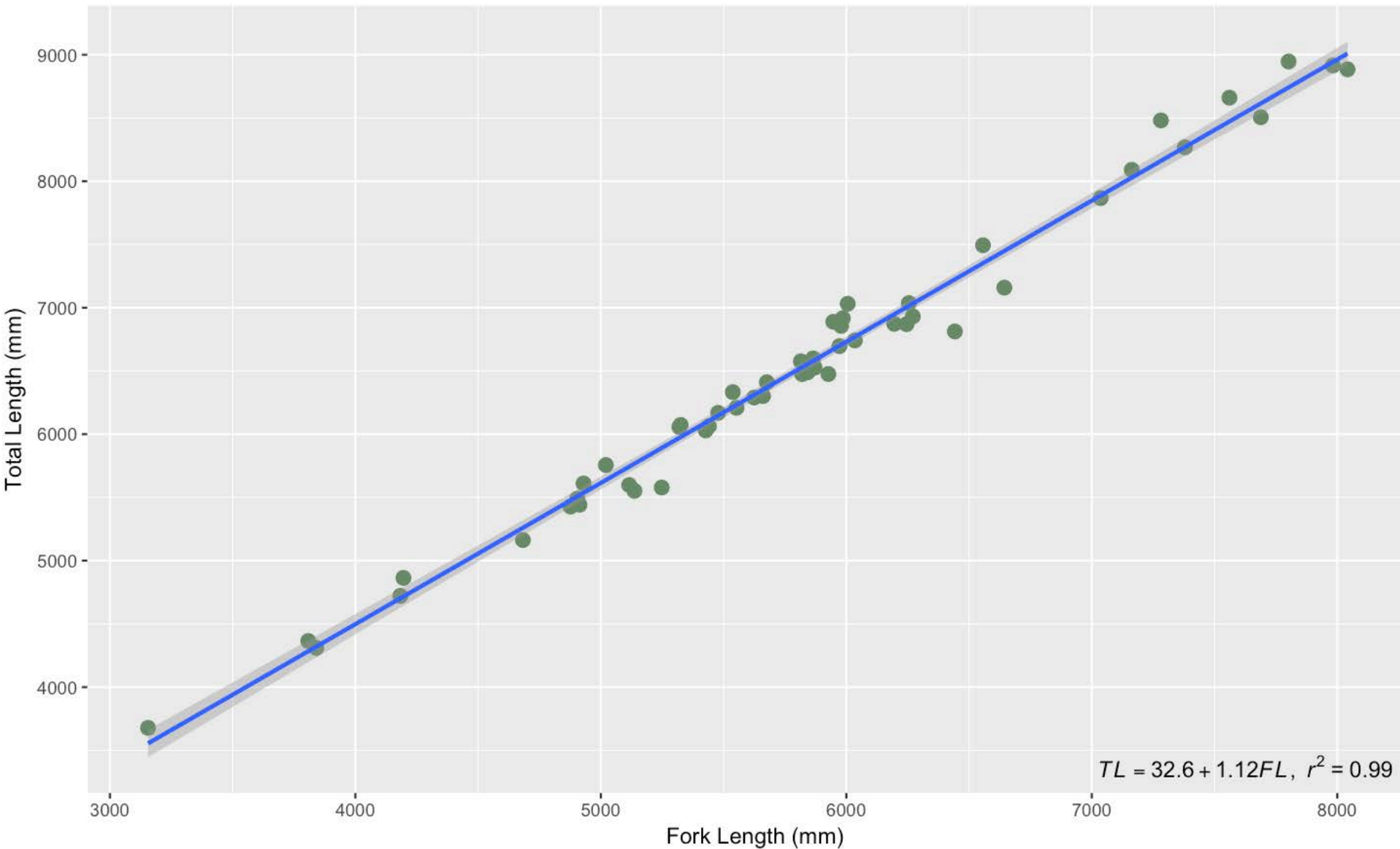
Tagging and tissue sampling procedure



Tissue samples and length measurements



Stereo DOV length measurements



Why genetics, length and sex measurement?

THE CONVERSATION

Academic rigour, journalistic flair

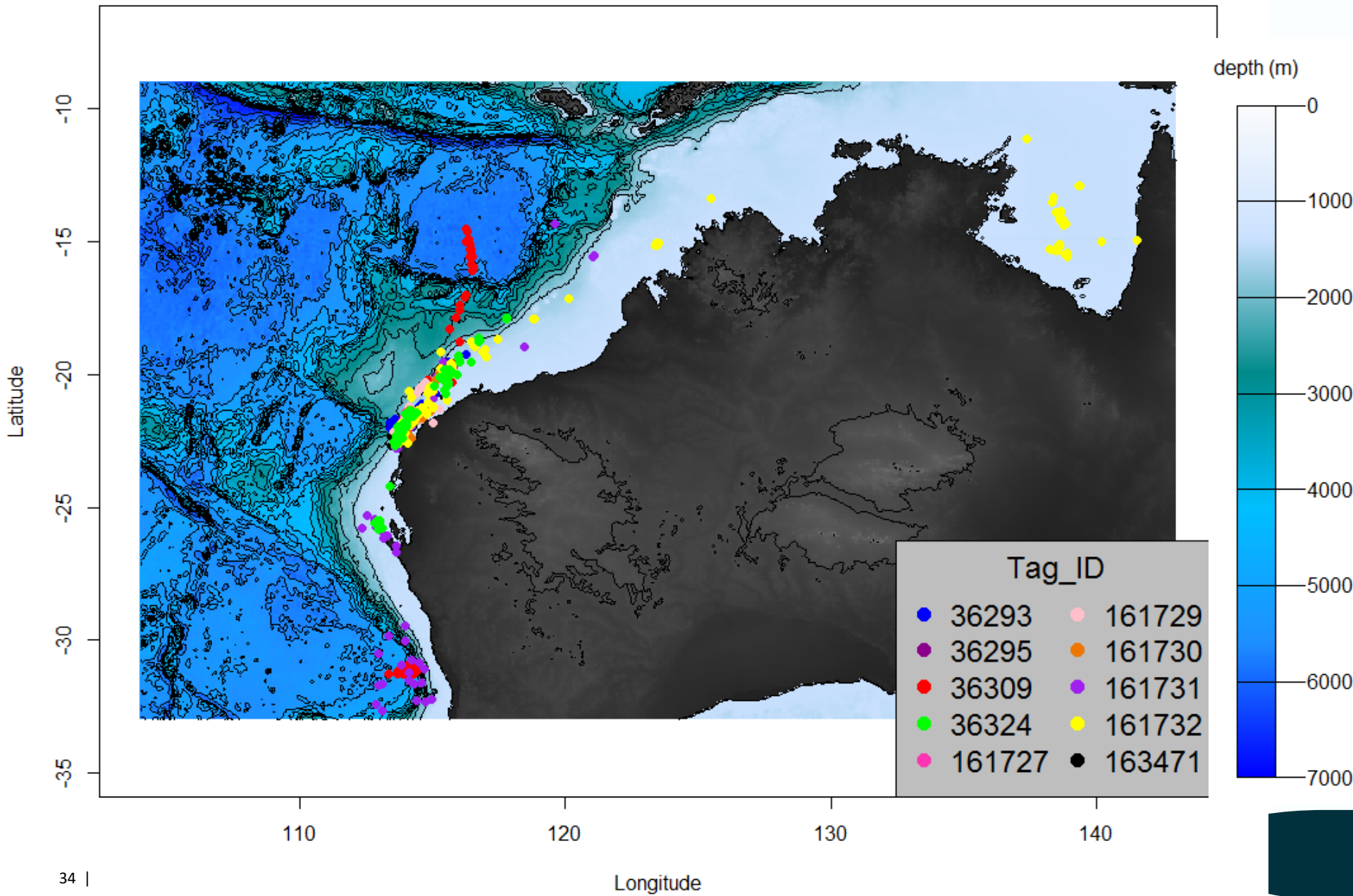
Search analysis, research, academics...

Arts + Culture Business + Economy Cities Education **Environment + Energy** FactCheck Health + Medicine Politics + Society Science + Technology

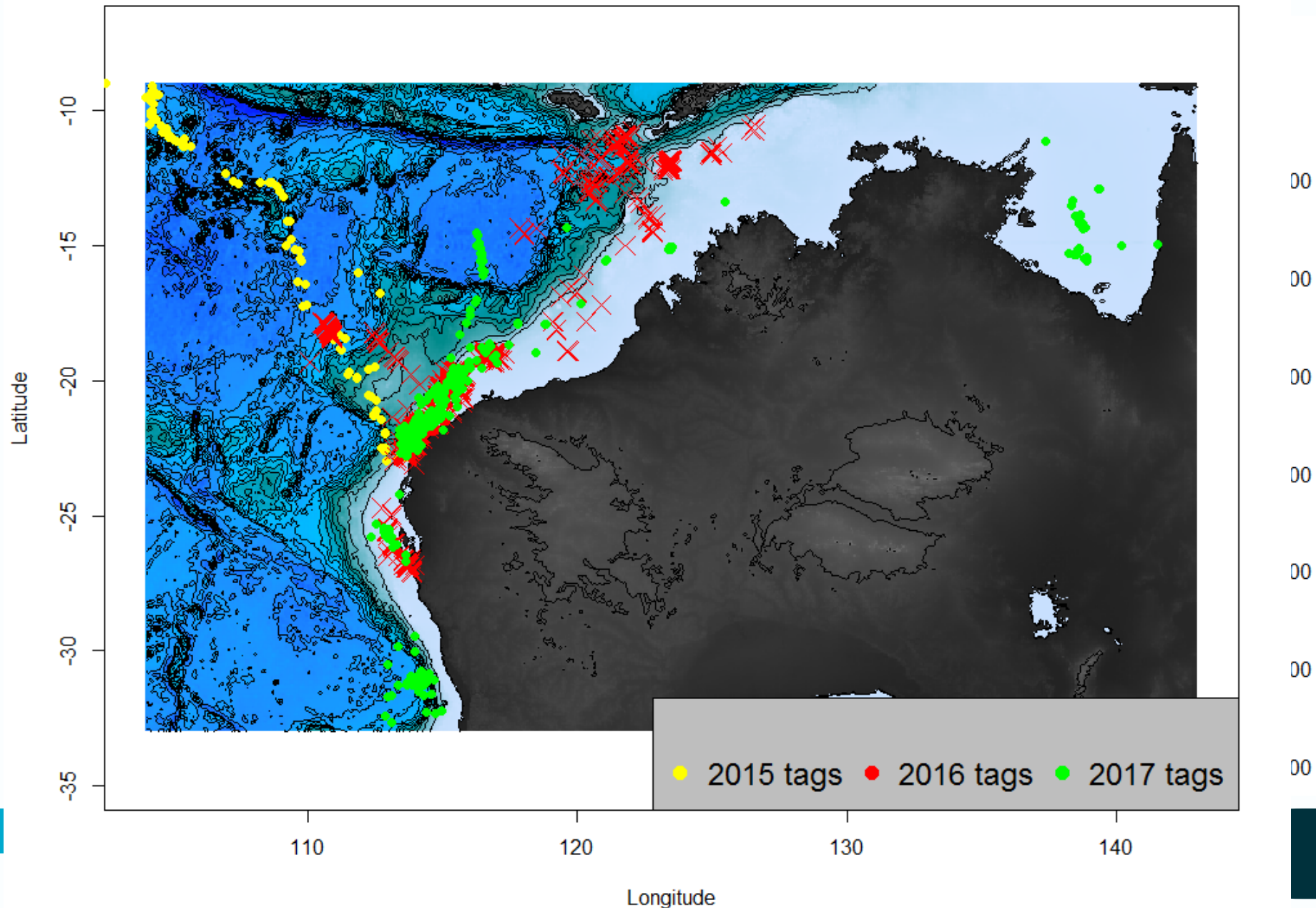
World-first genetic analysis reveals Aussie white shark numbers

February 8, 2018 9:02pm AEDT

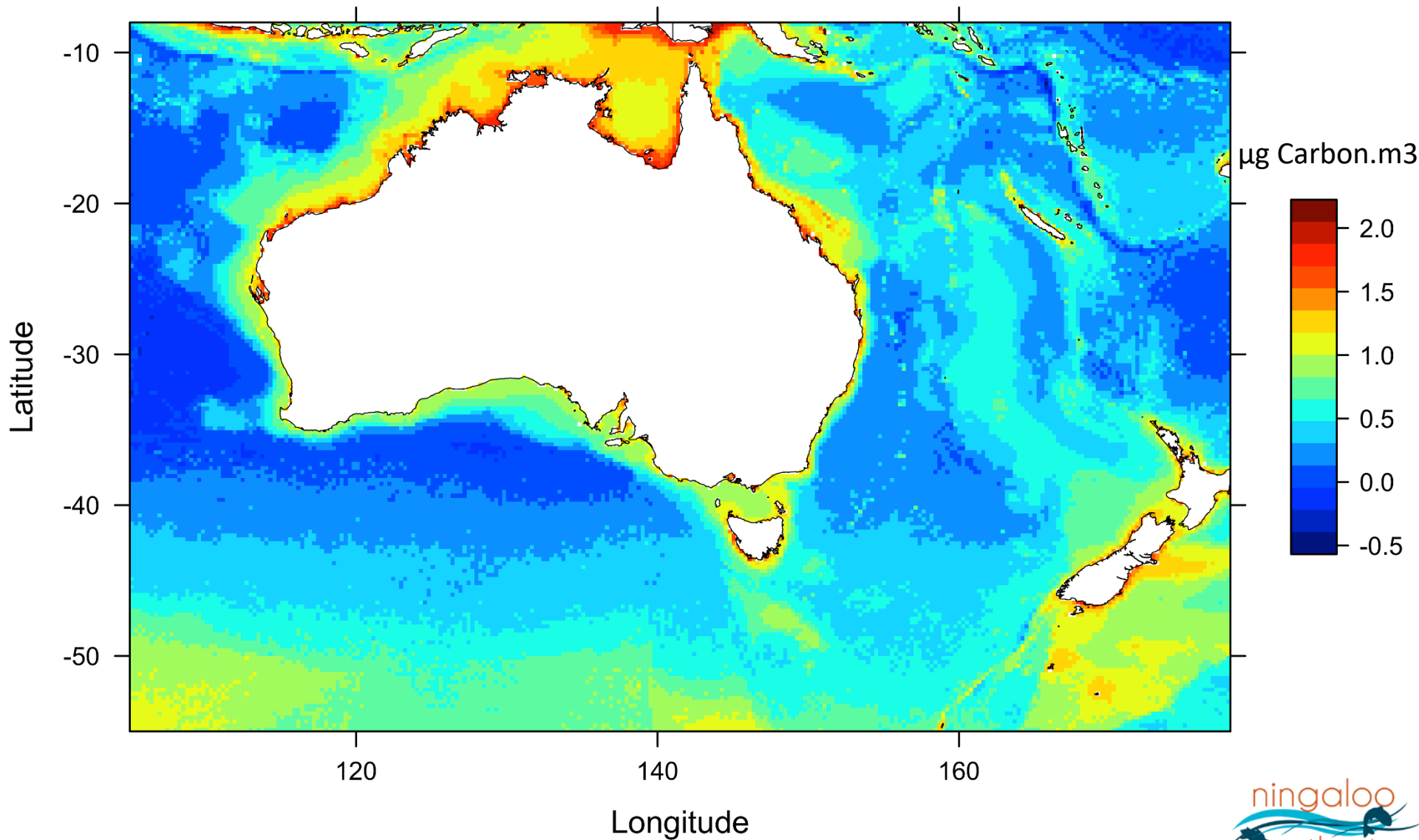
2017 Whale Shark satellite tracks



Summary of movement – satellite tags

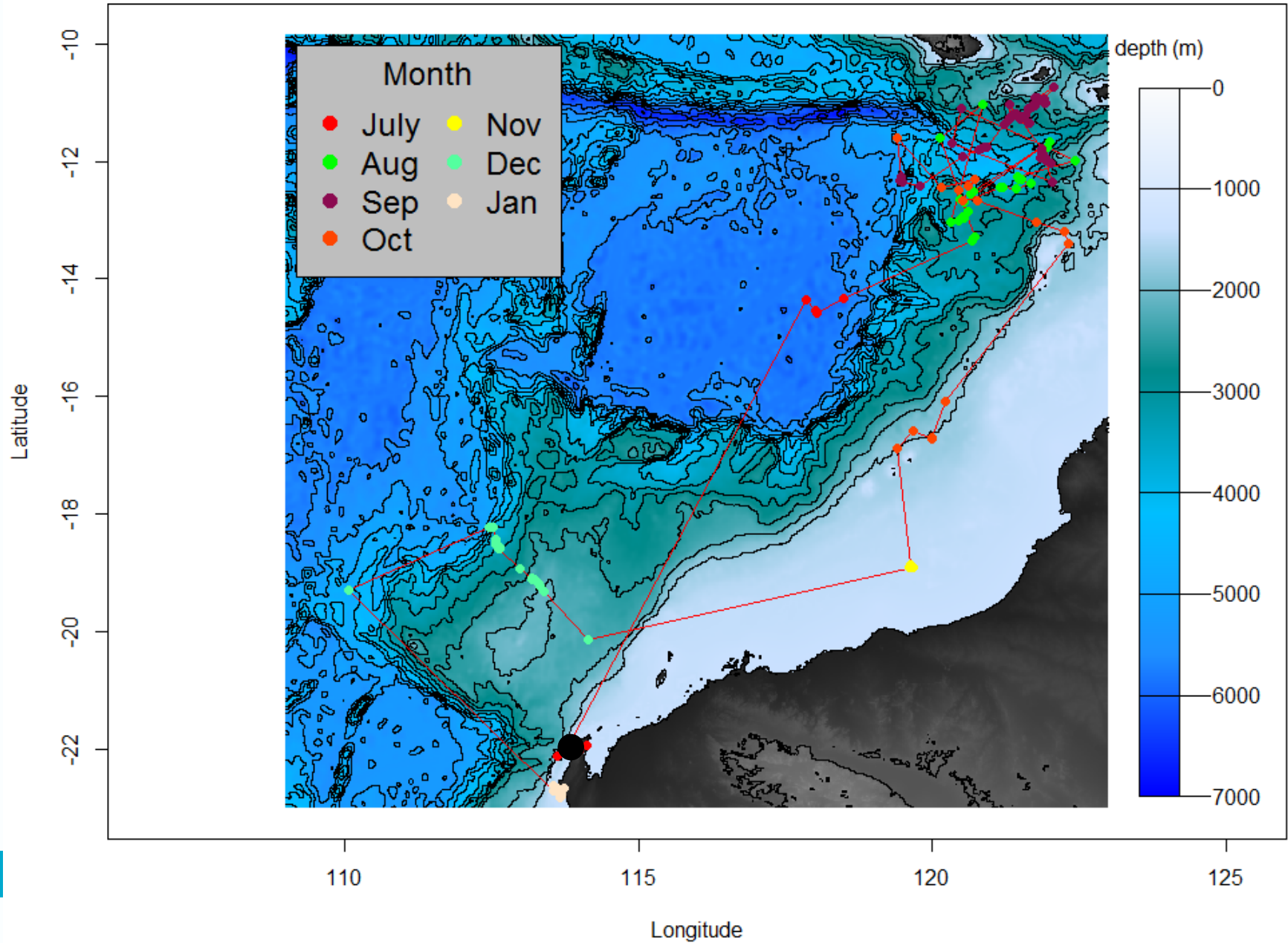


Habitat selection – why on shelf?



Richardson et al. (in preparation)

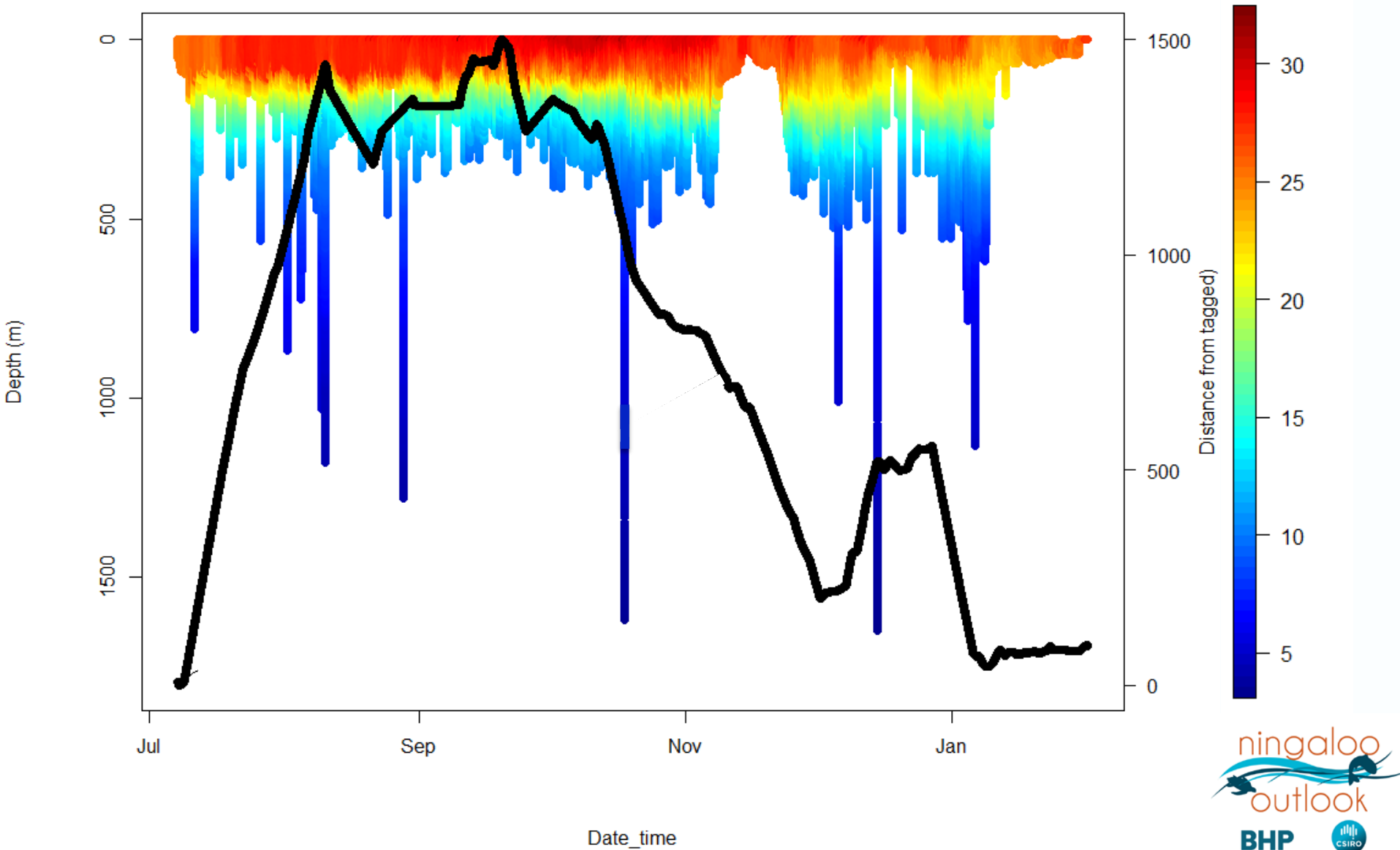
Highlights – Big Mumma (163470)



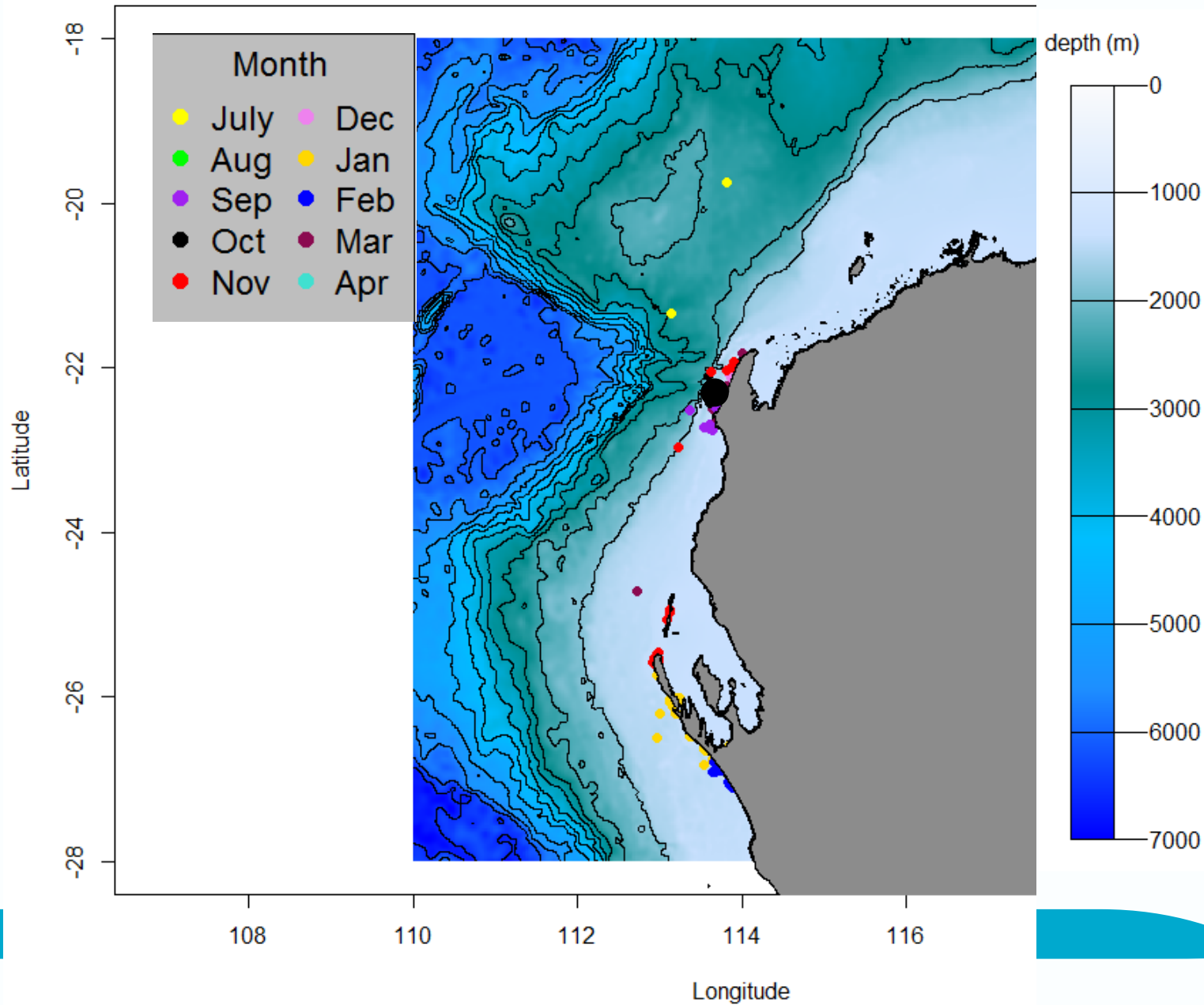
Big Mumma – sometimes its better to be lucky than Good!



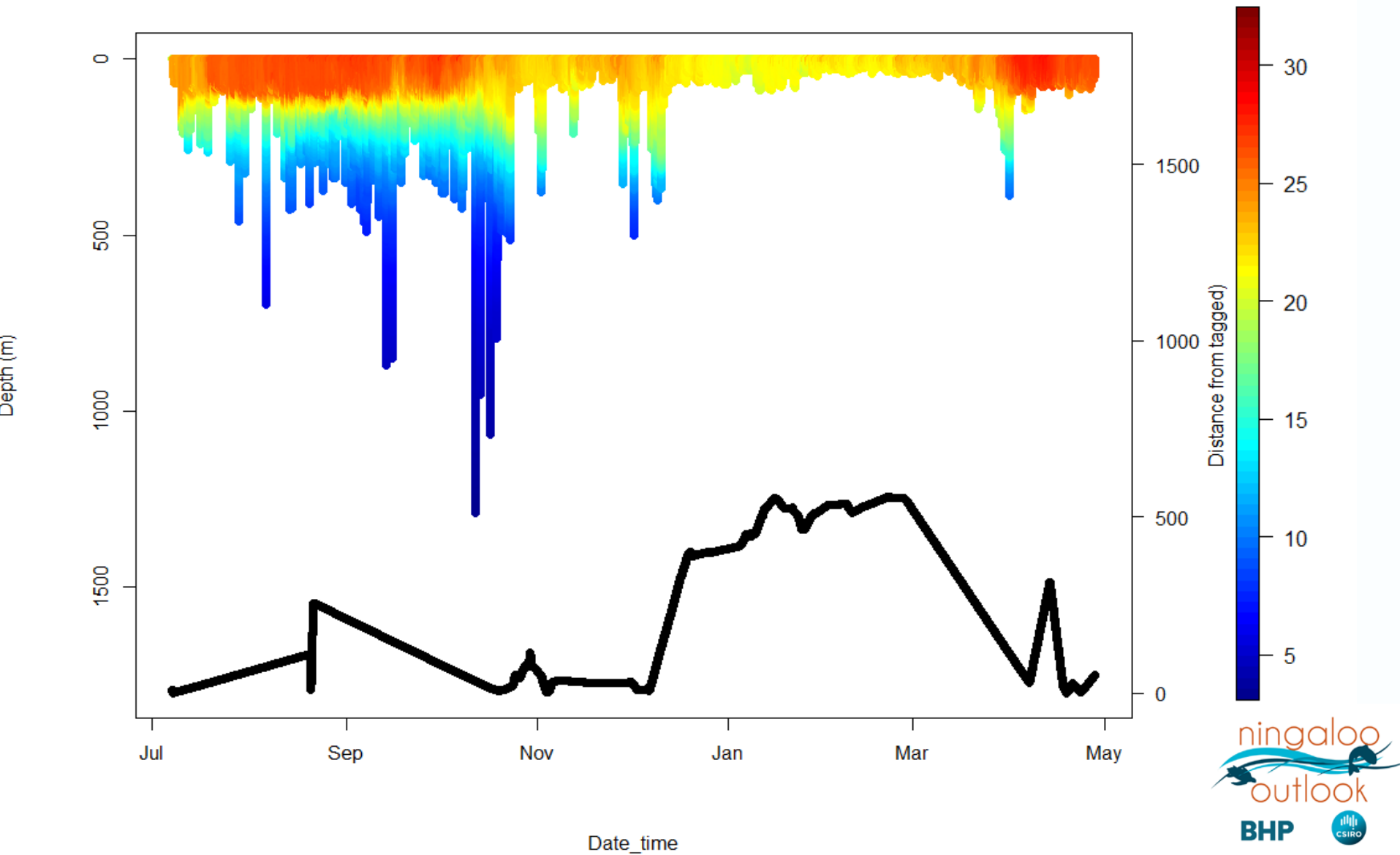
Depth & temperature profile (Big mumma)



163471

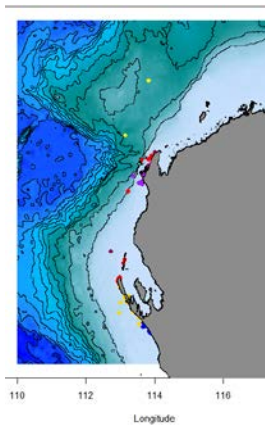


Depth & temperature profile 163471

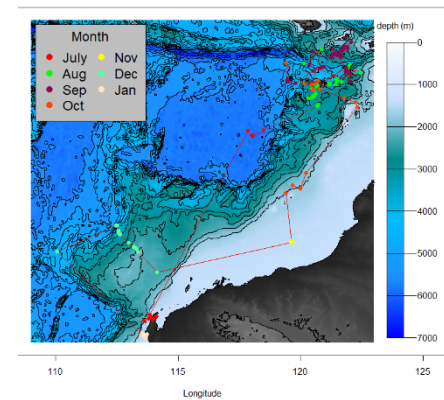


Individual variability in dive behaviour

163471



163470



1200-1800
800-1200
400-800
300-400
200-300
100-200
50-100
30-50
20-30
15-20
10-15
6-10
3-6
0-3
0

-0.4

-0.3

-0.2

-0.1

0.0

0.1

0.2

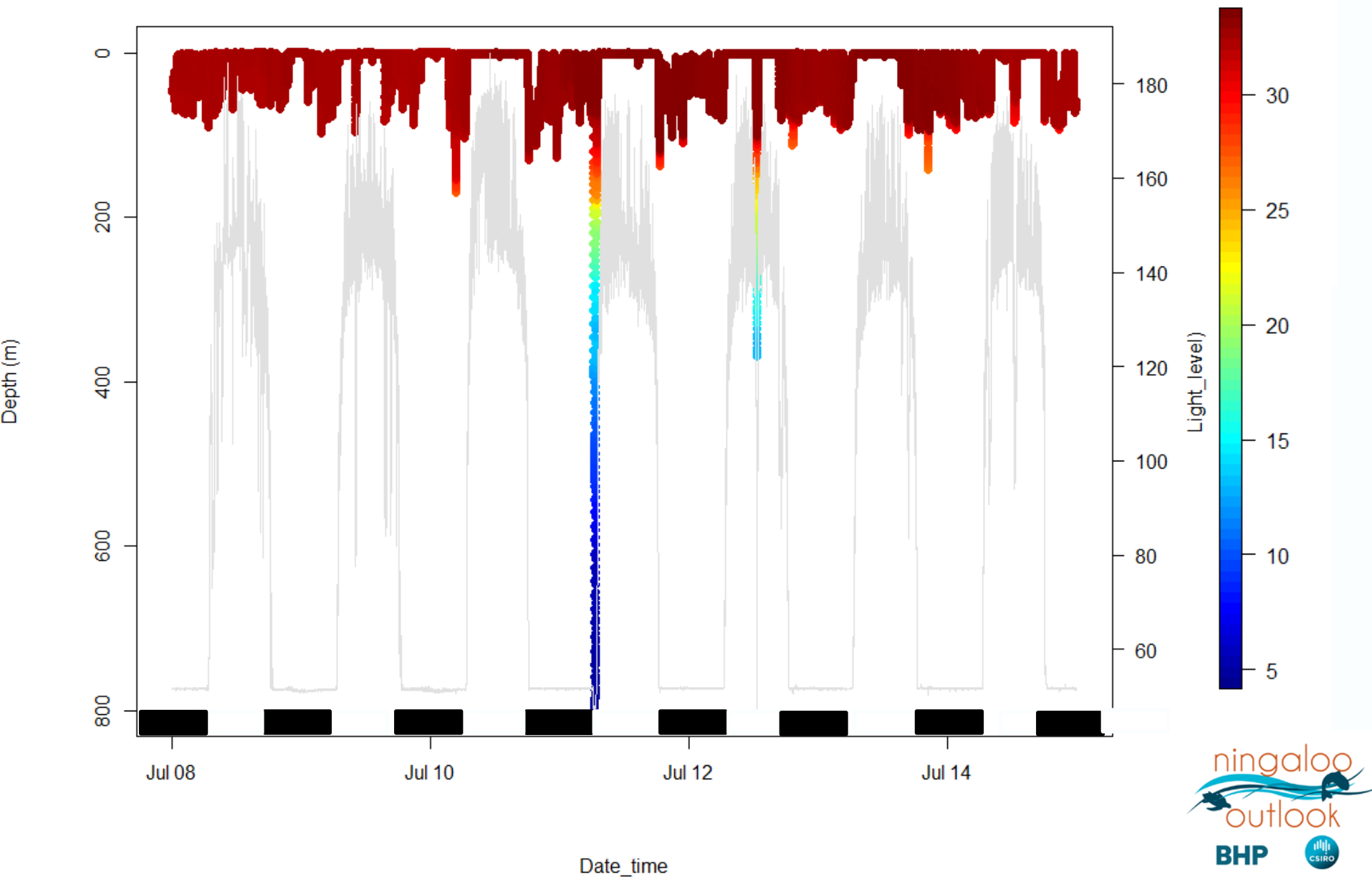
0.3

0.4

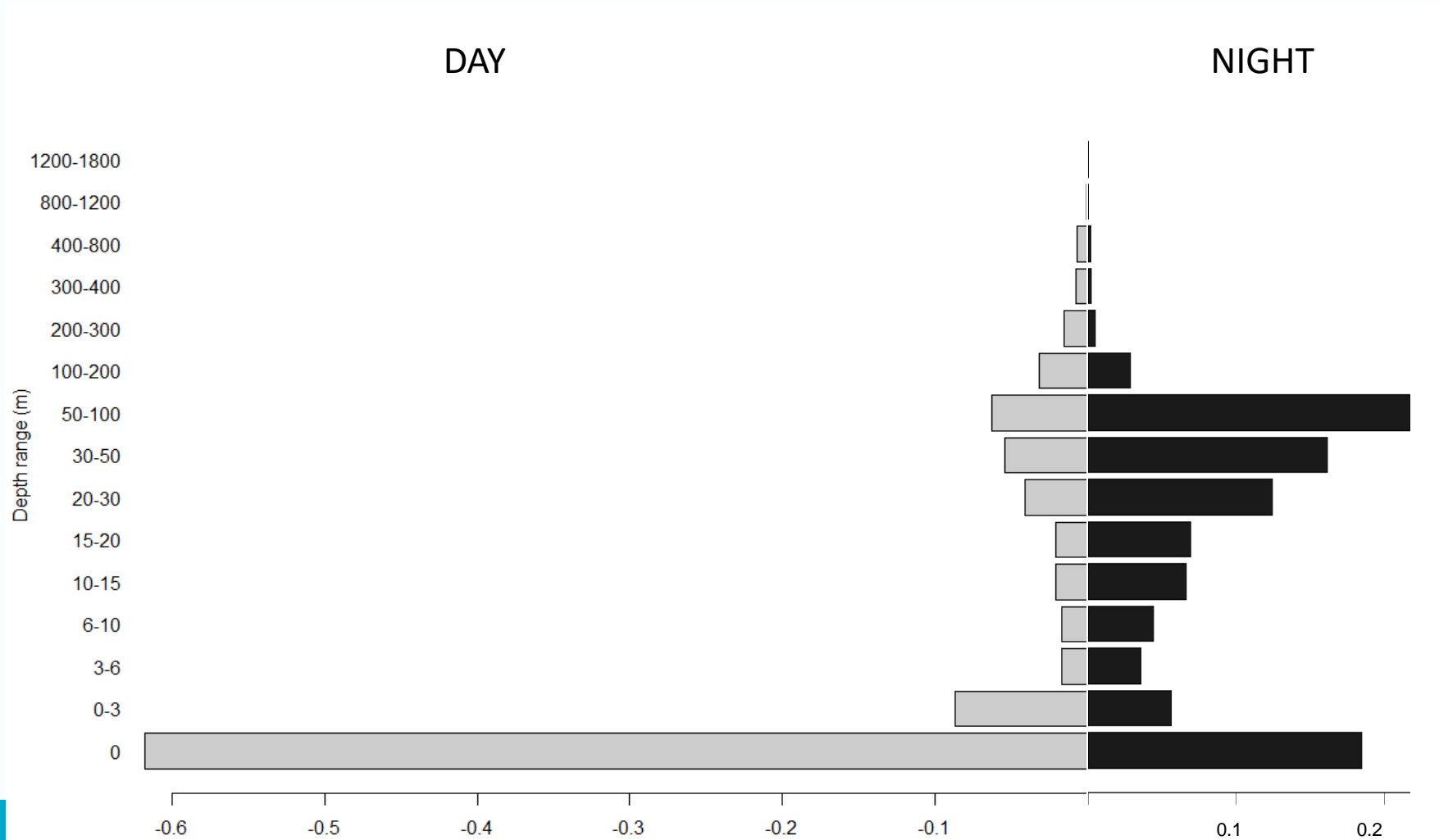
Relative frequency

Relative frequency

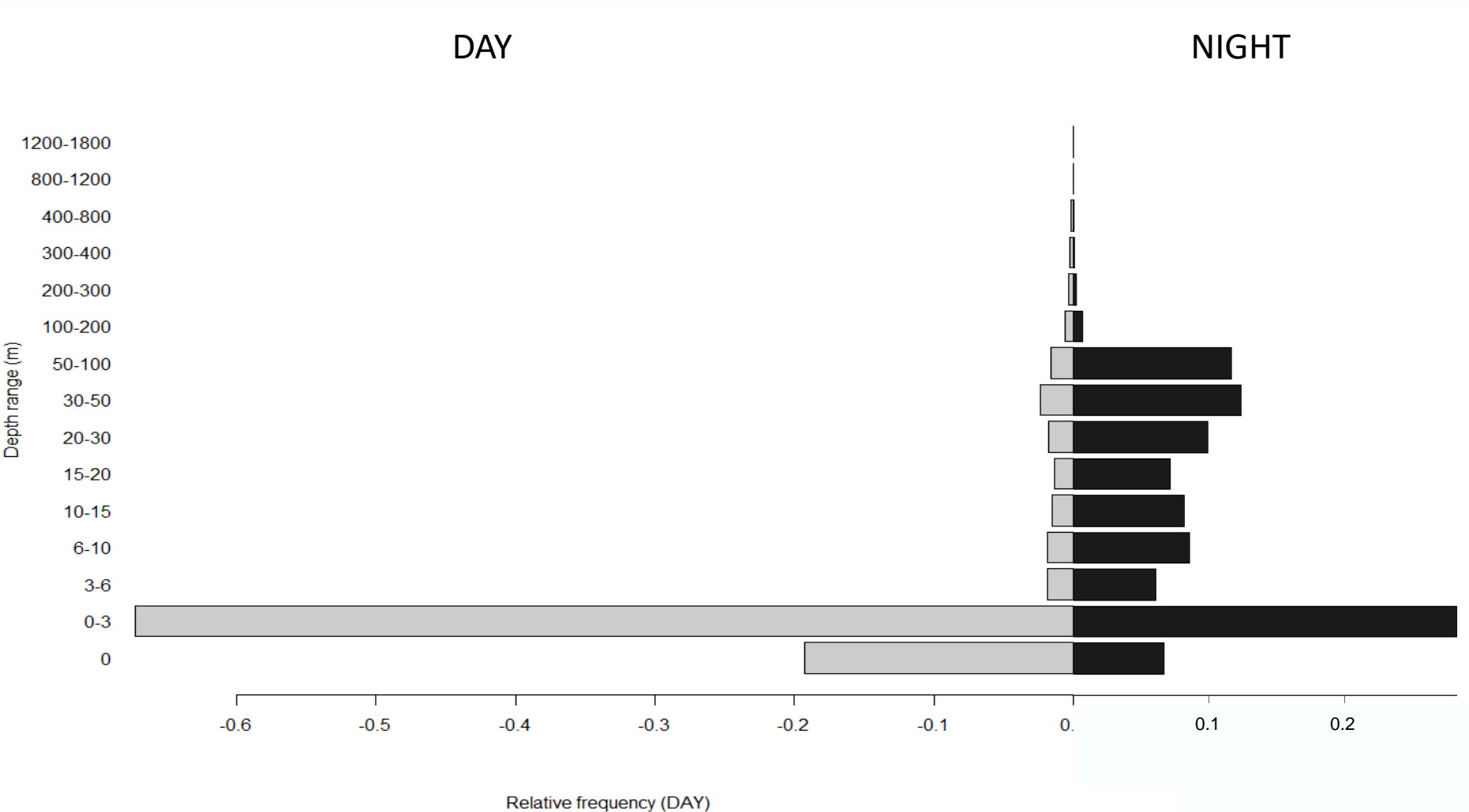
Deep at night, shallow during the day



Day vs night depth use (163470)

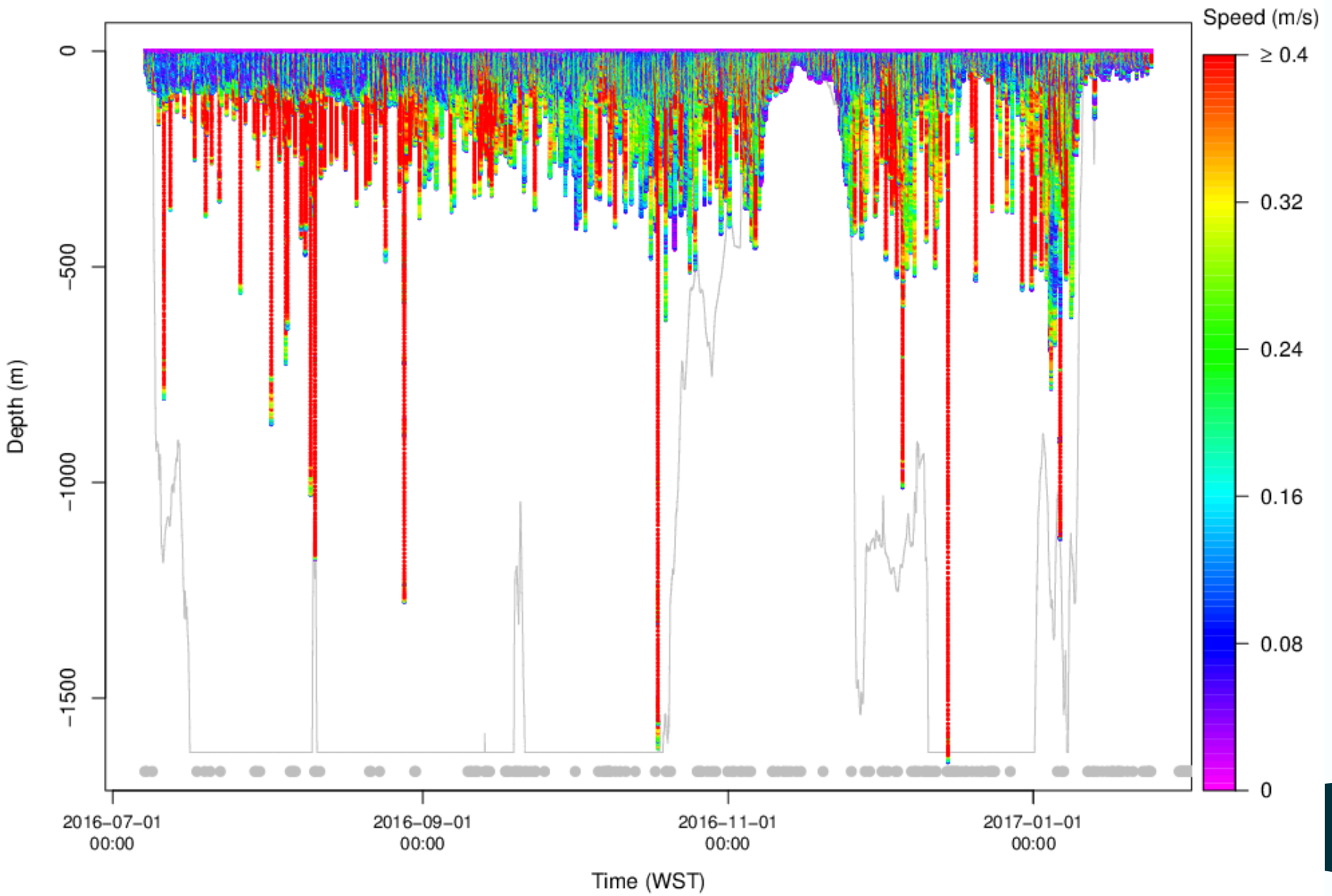


Day vs night depth use (163471)



Rate of vertical movement

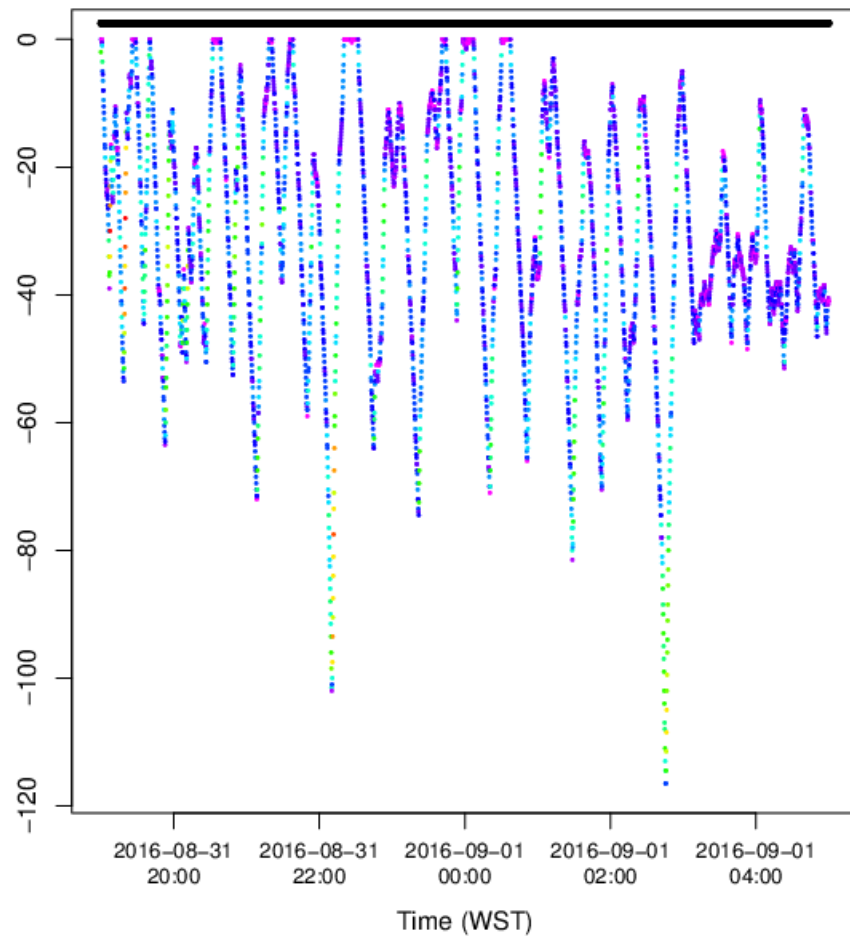
Depth and vertical speed (tag 163470)



Vertical movement more frequent and slower at night

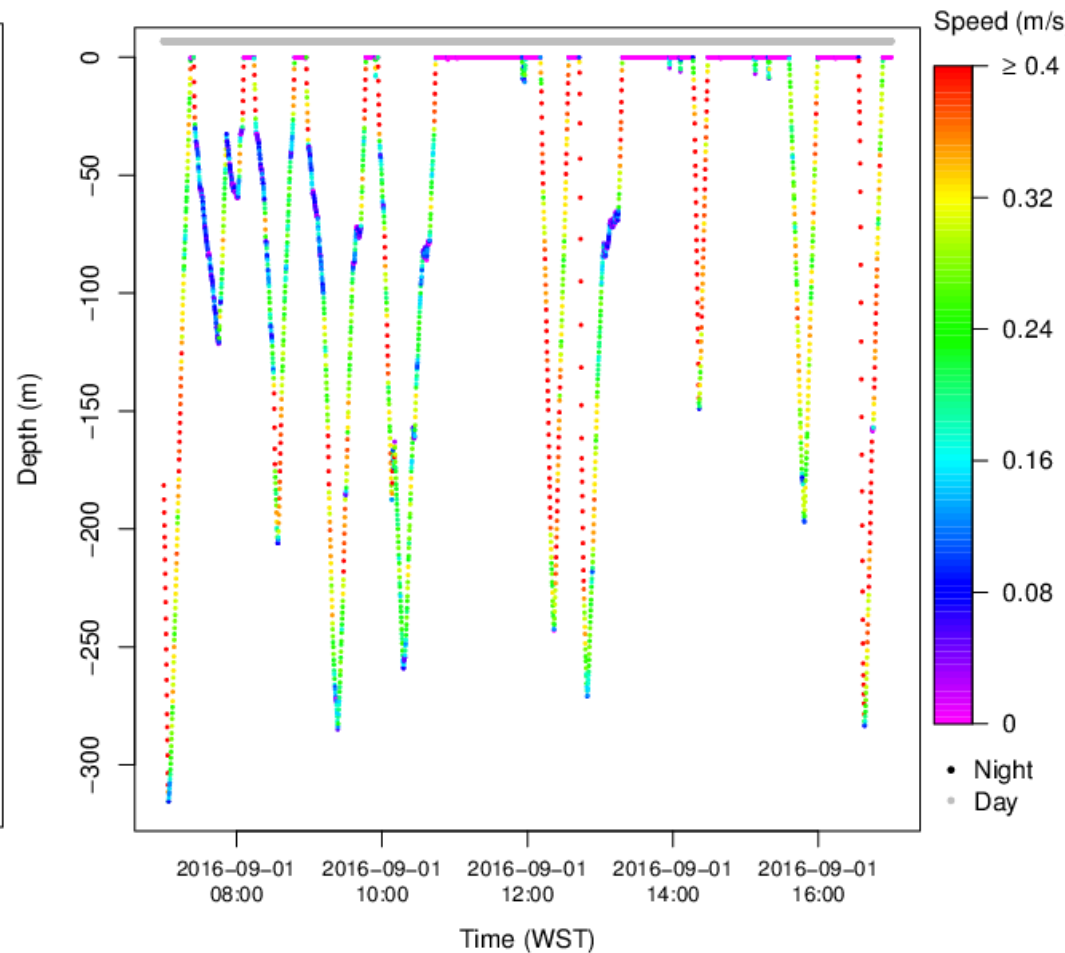
NIGHT

Depth and vertical speed: night (tag 163470)

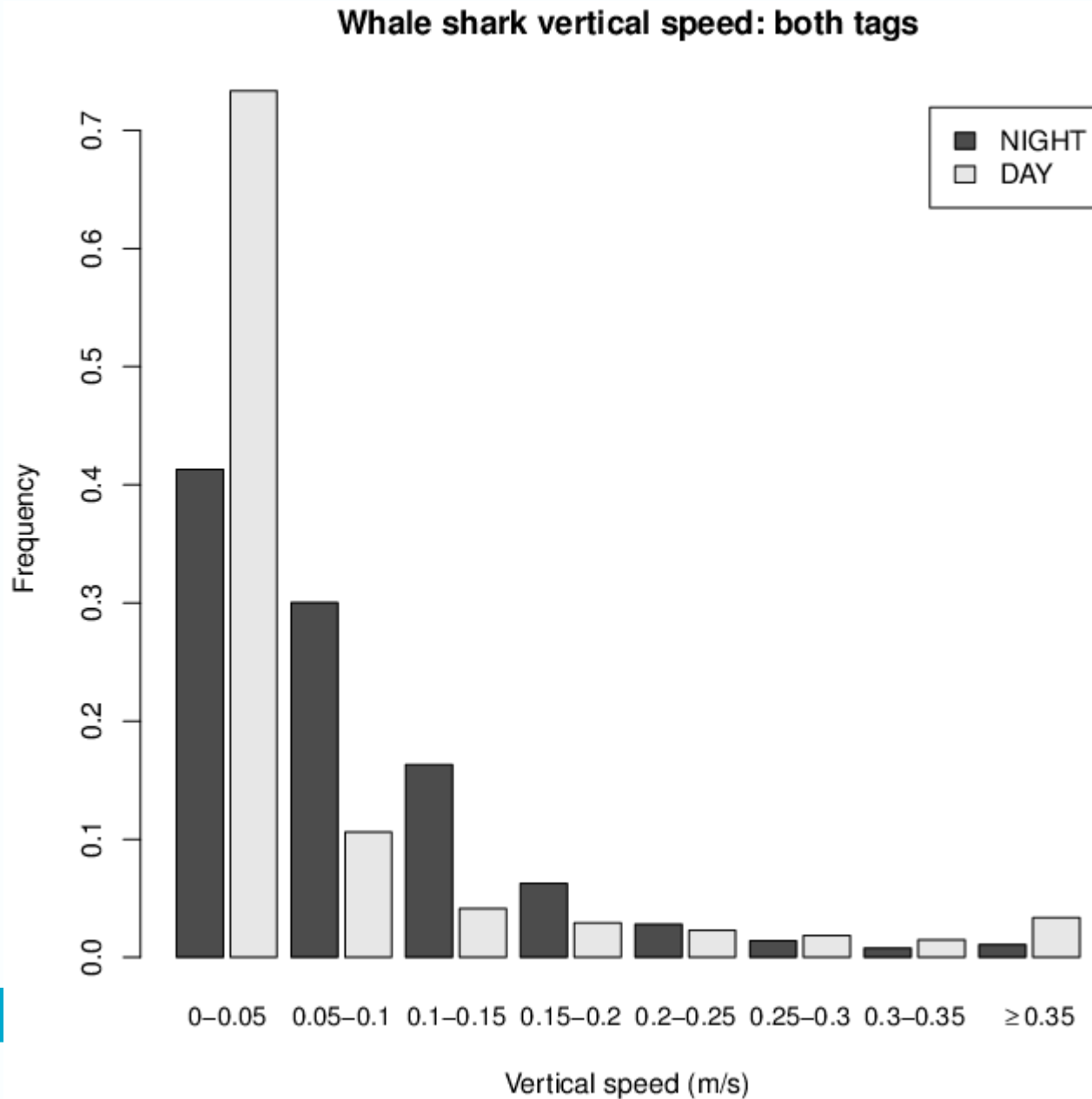


DAY

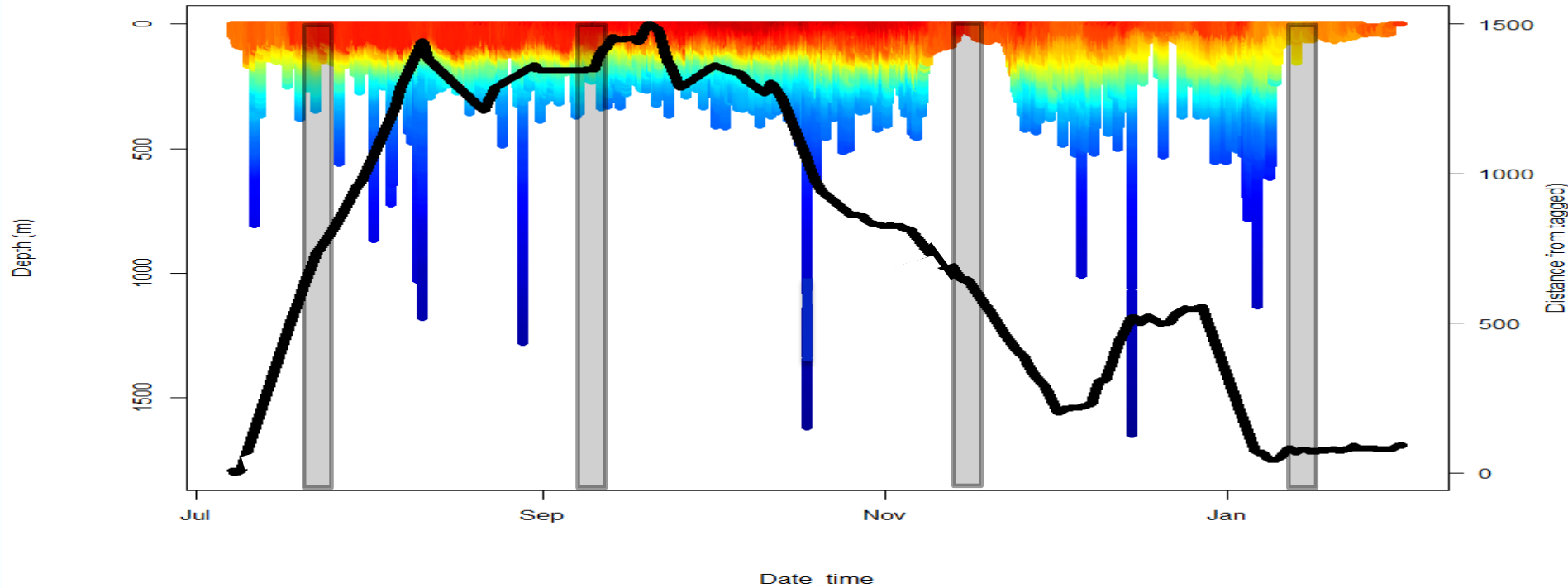
Depth and vertical speed: day (tag 163470)



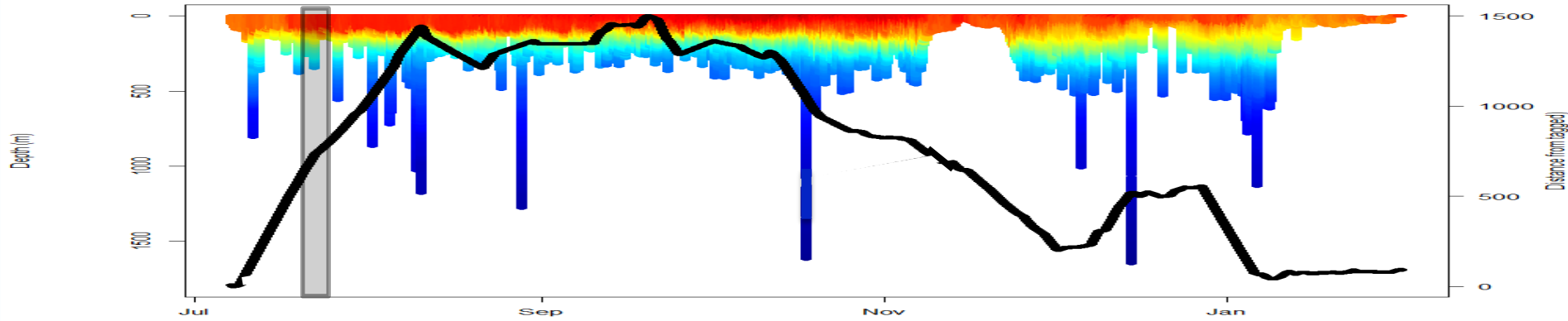
Vertical movement - summary



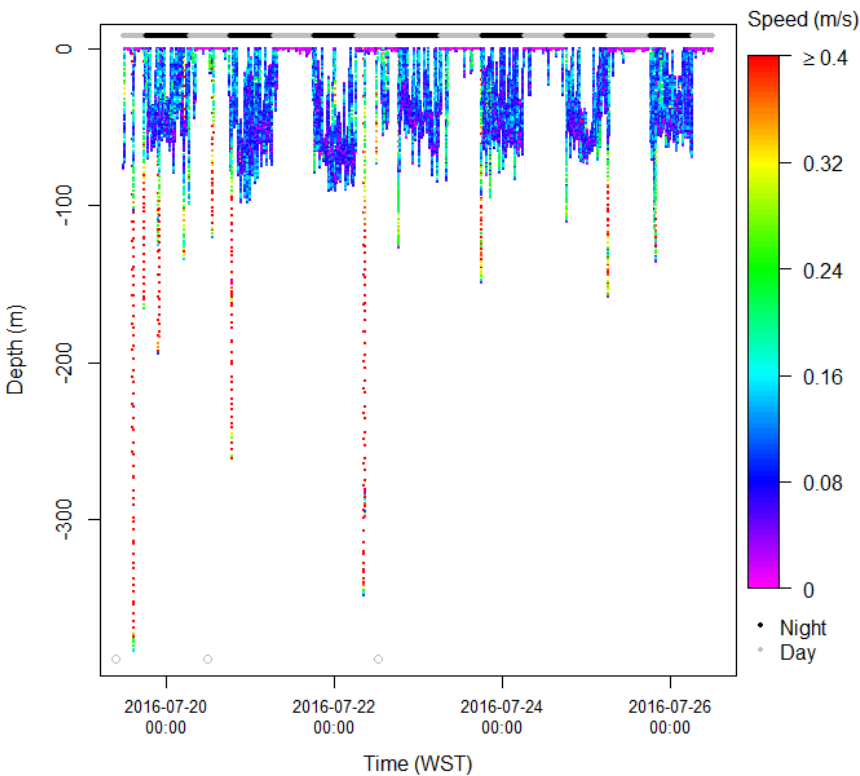
Examples of variation in dive behaviour: influence of habitat and water depth



Variation in dive behaviour



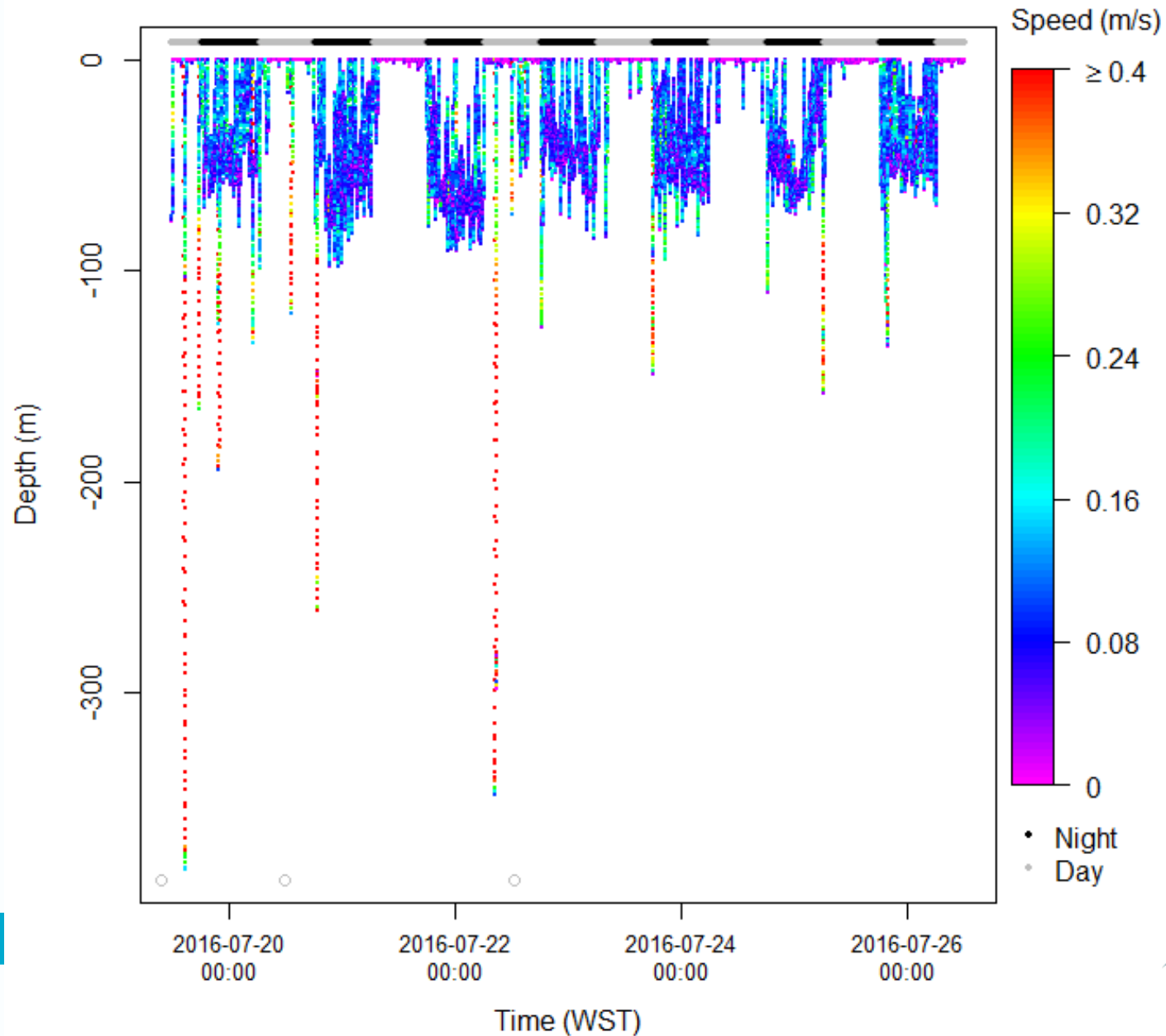
Whale shark depth



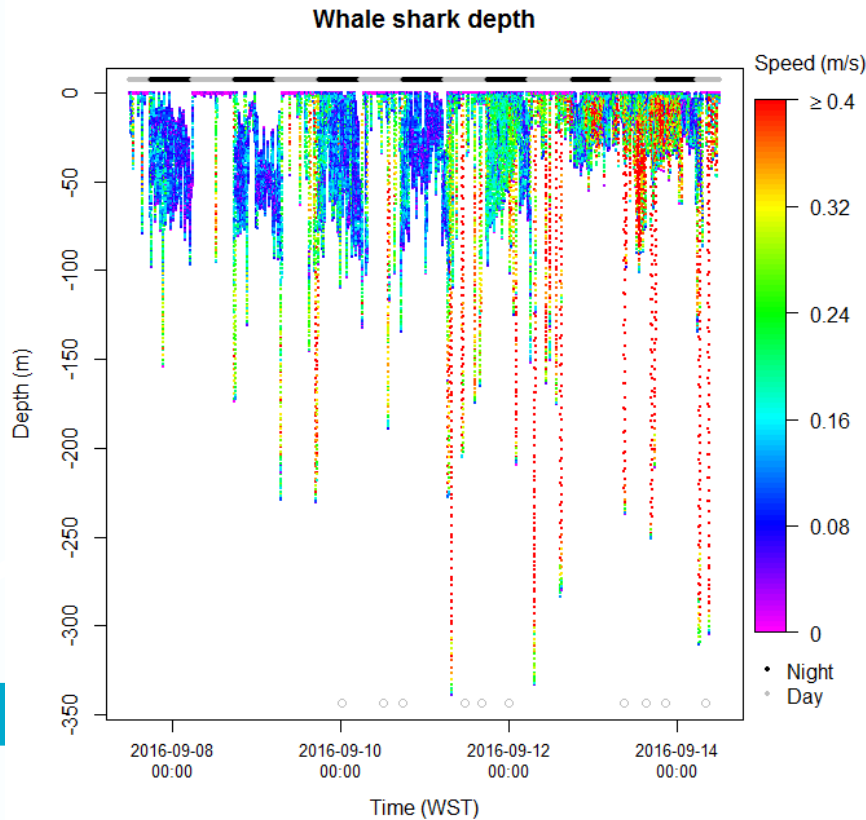
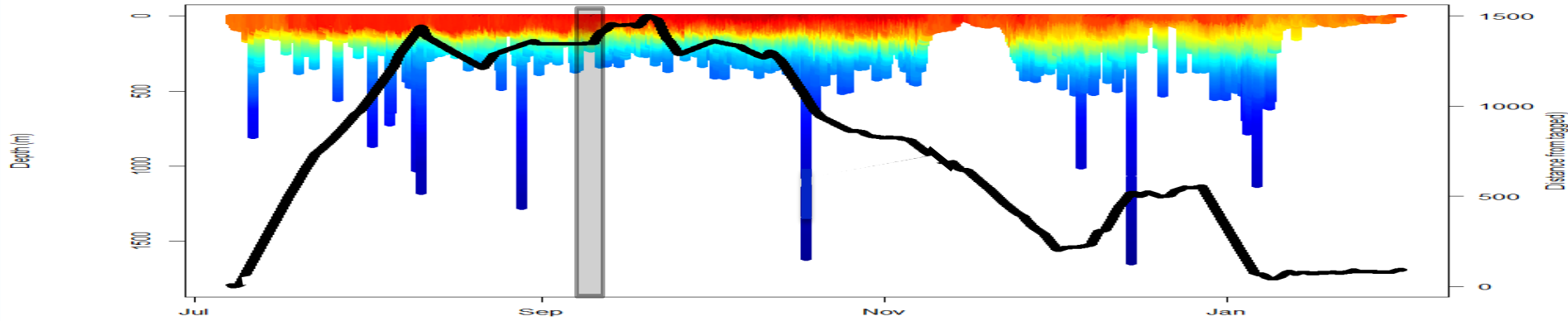
Date_time



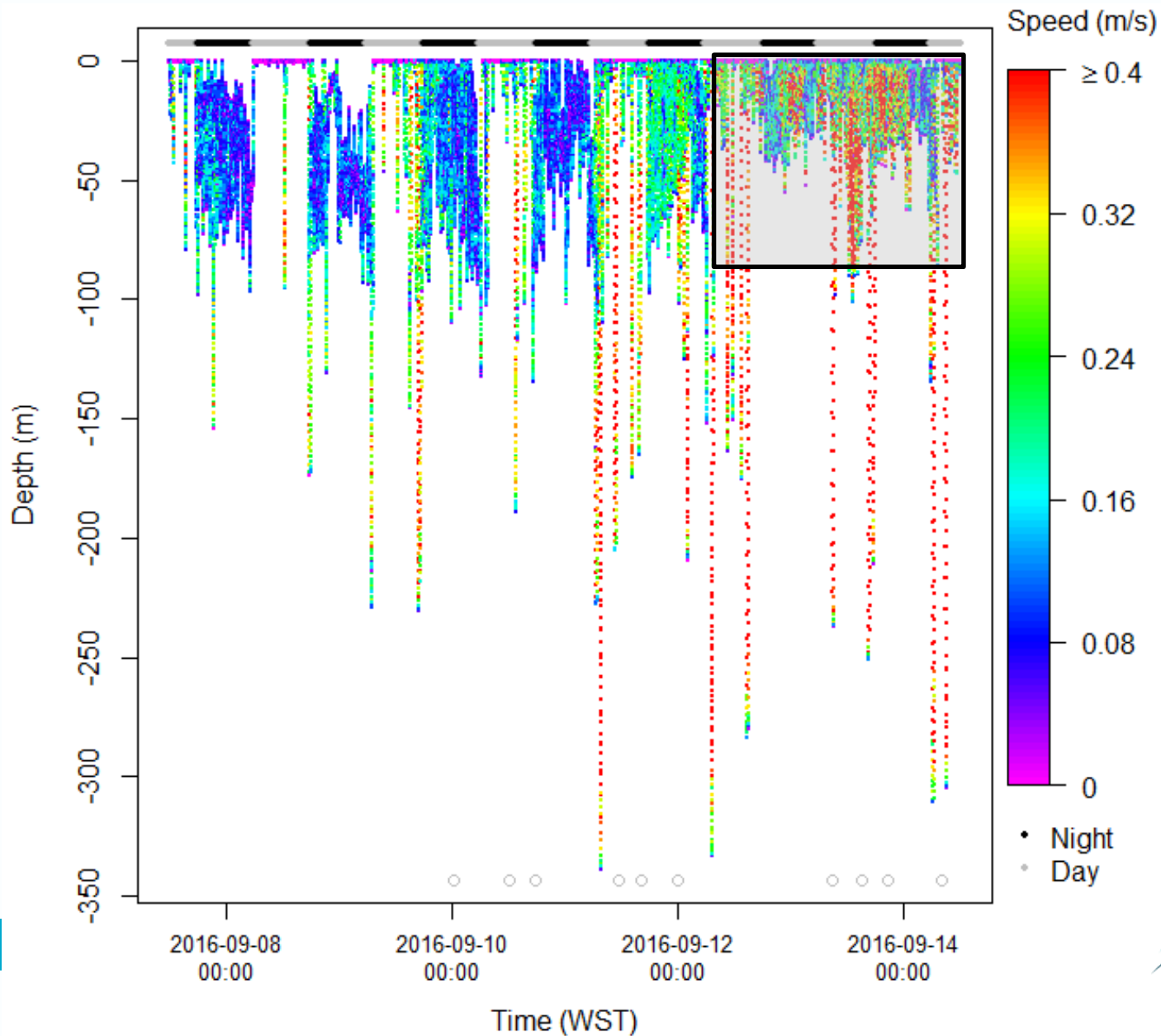
In transit between Ningaloo and Indonesia



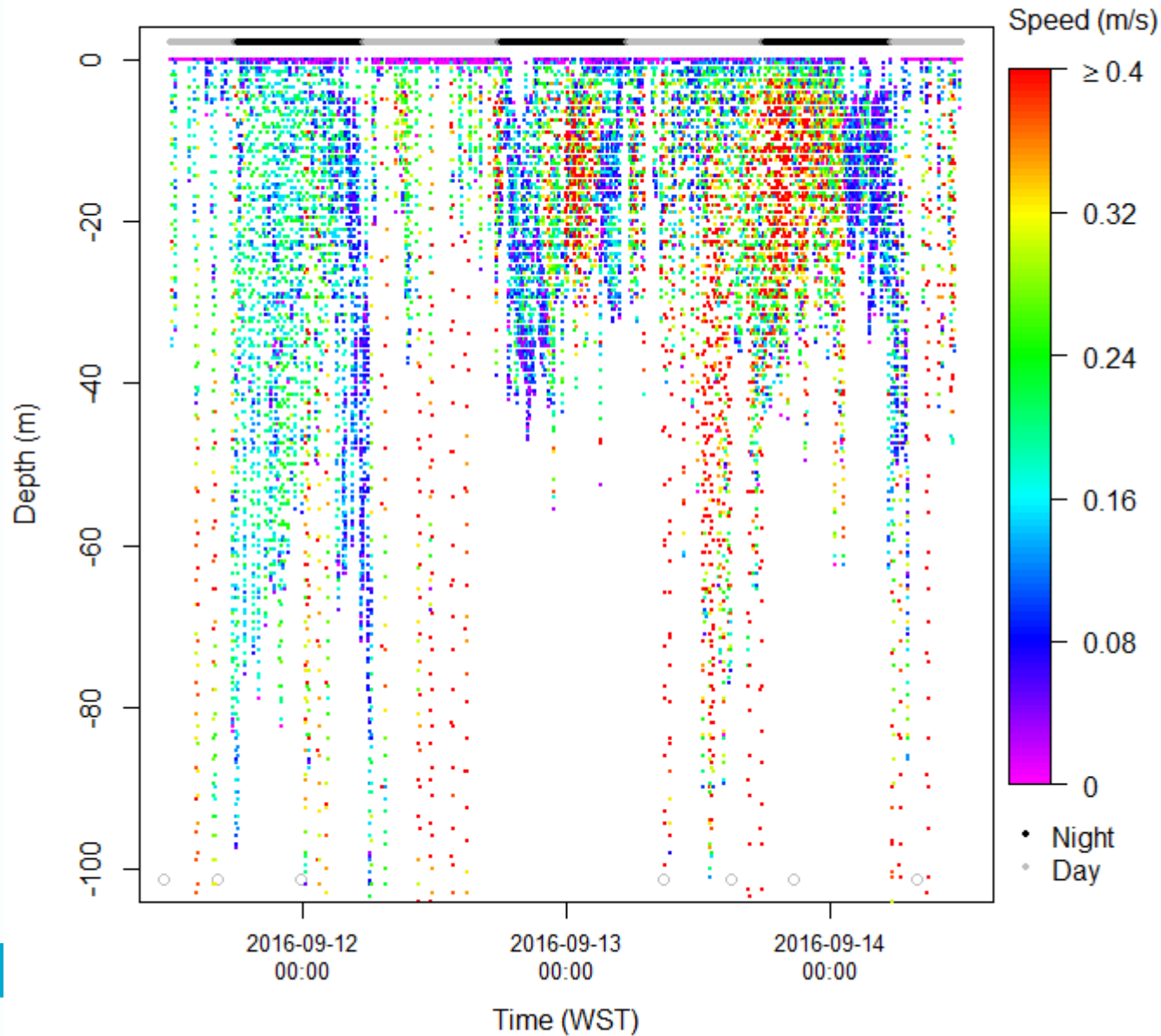
Variation in dive behaviour



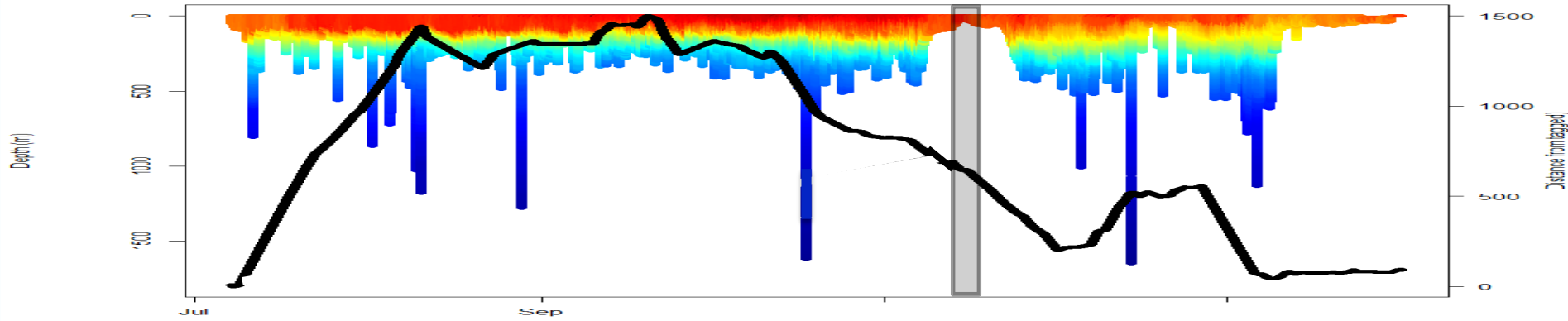
SW of Roti – resident for 2 months



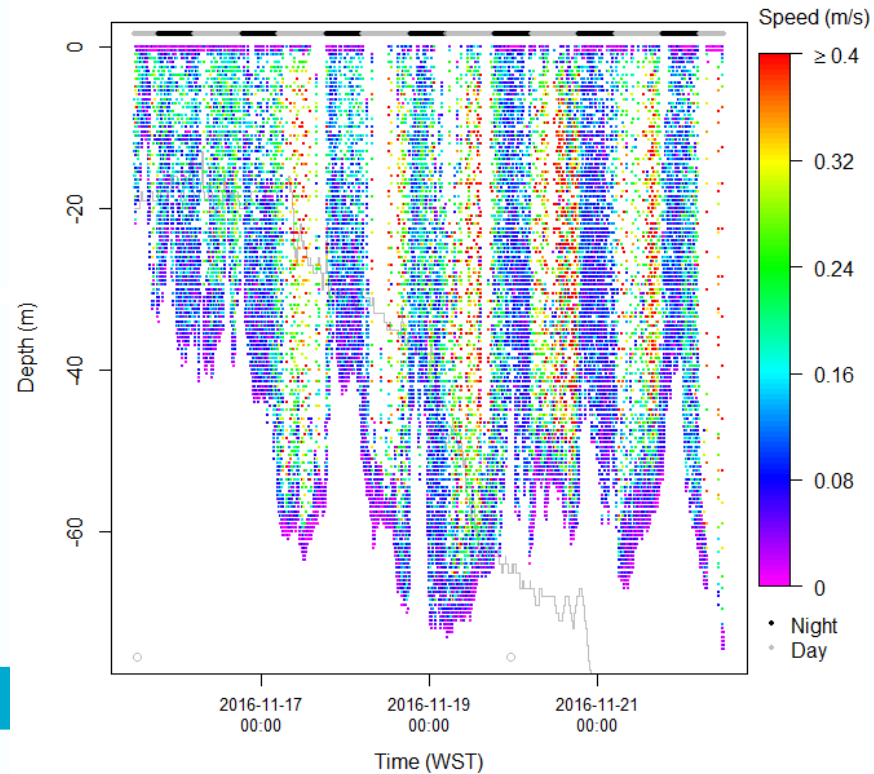
SW of Roti – resident for 2 months



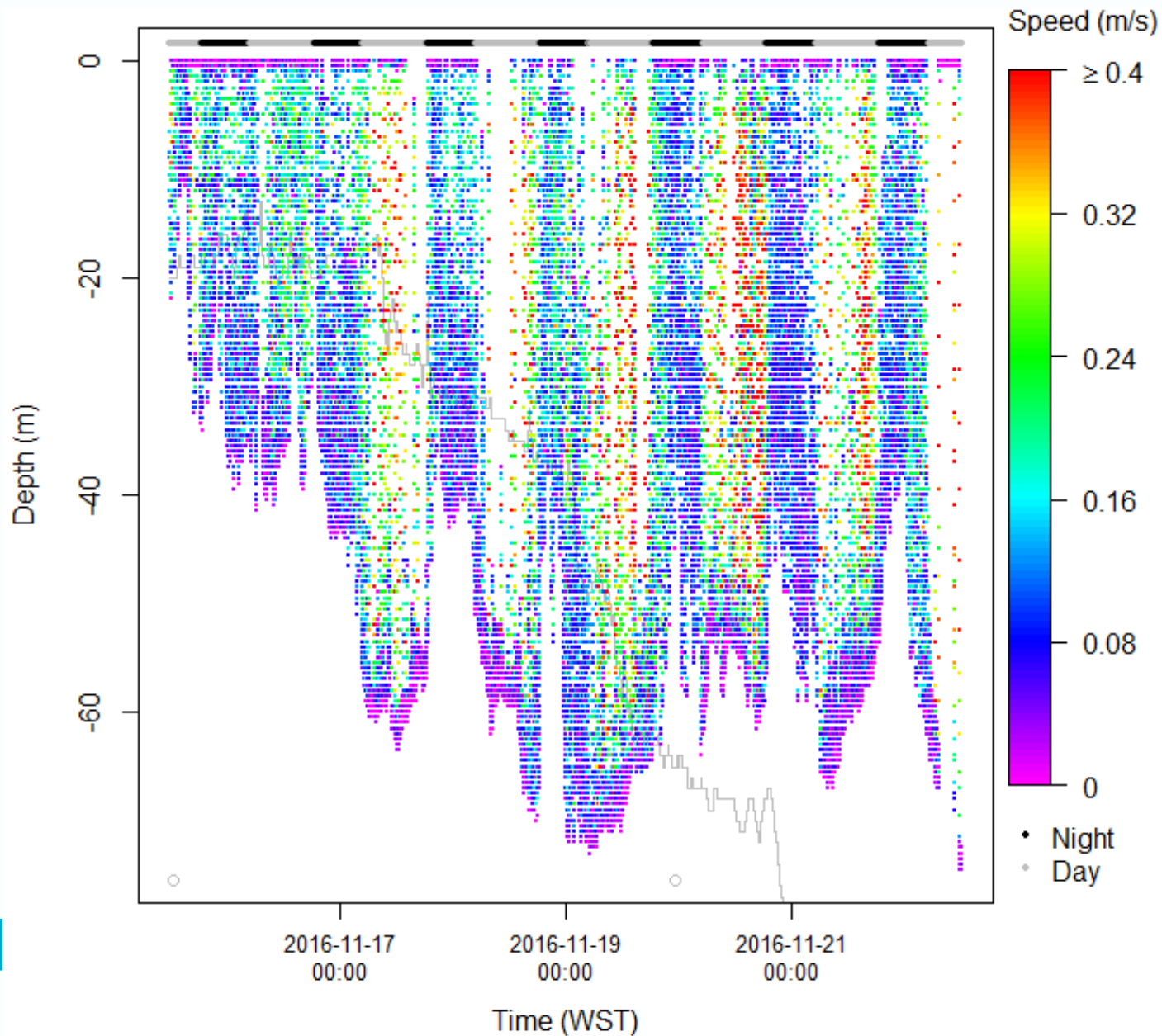
Variation in behaviour



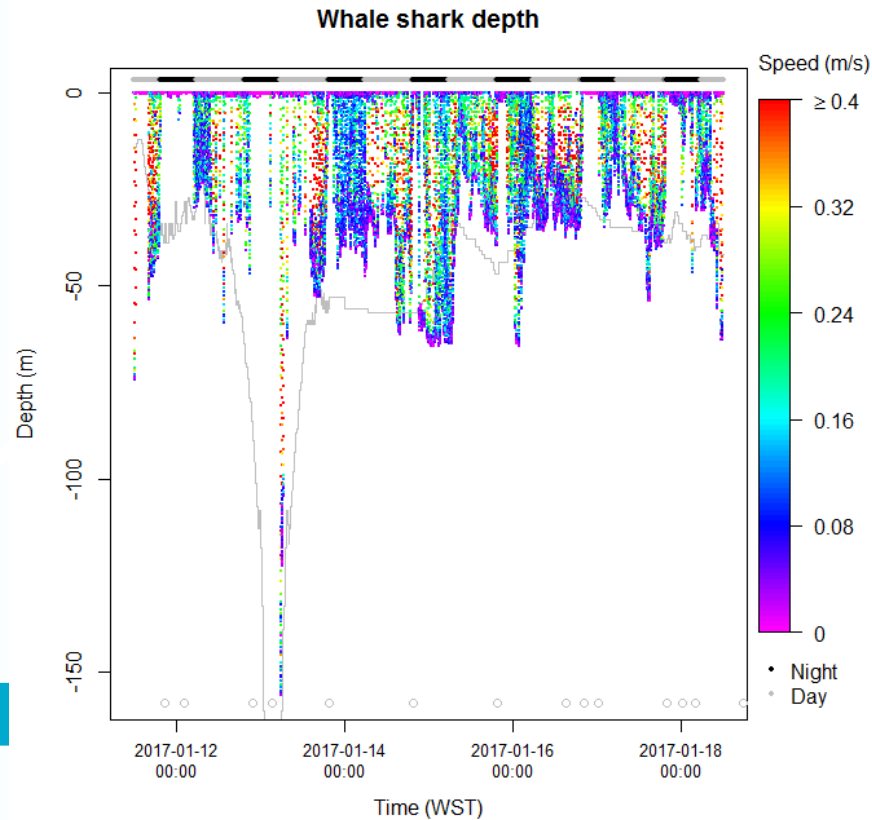
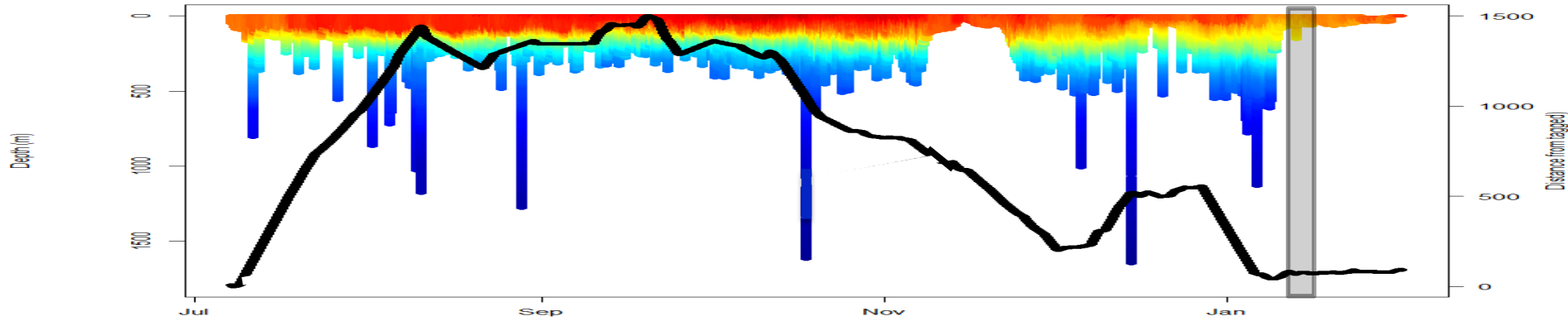
Whale shark depth



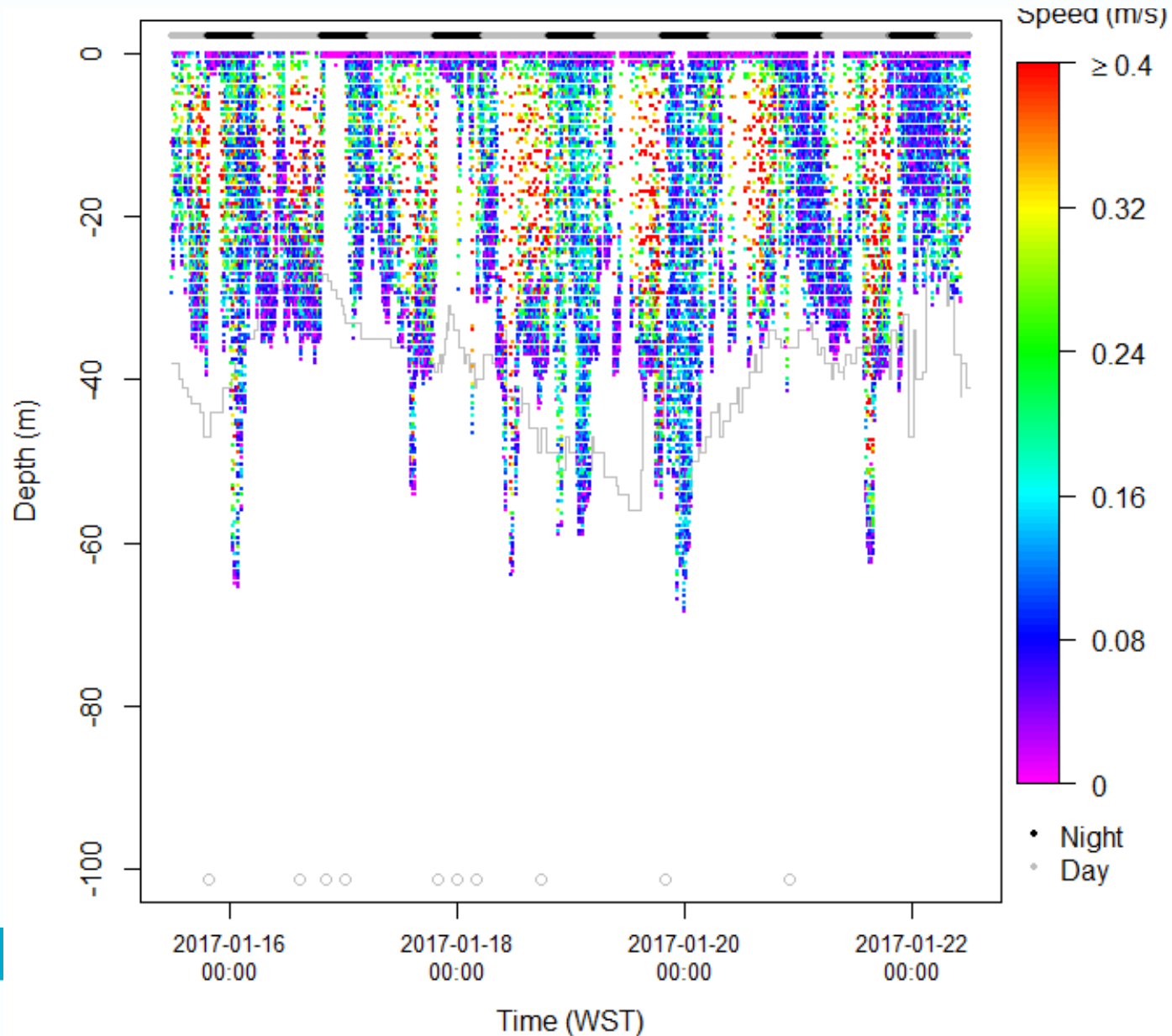
East - west movement off Pilbara coast



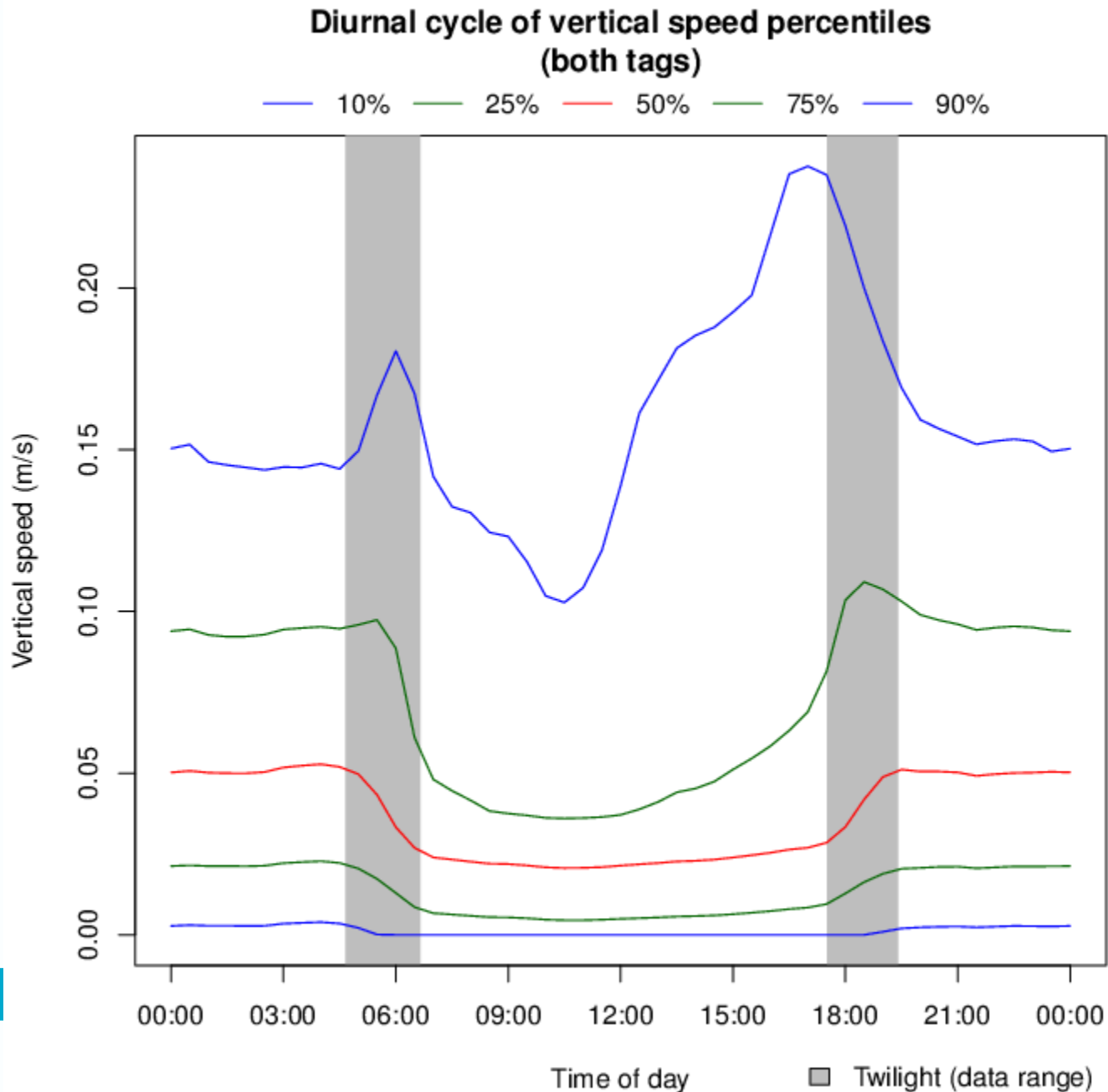
Variation in behaviour



Off Ningaloo Reef



Diel vertical movement



Relevance and future directions

- Timing, distance and routes of Whale Shark movement and migration as well as dive behaviour relevant to Whale Shark management
- Demonstrated the first recorded movement of a whale shark tagged at Ningaloo into the Gulf of Carpentaria (QLD)
- Long term data on diving behaviour of Whale Sharks reveals multiple feeding strategies and provides an insight into feeding strategies in different habitats
- Focus on obtaining data required for robust estimates of Whale Shark population size and status over the next two years

Acknowledgements

- BHP-CSIRO Ningaloo Outlook Marine Research Partnership
- DPAW Exmouth Office - Dani Rob, Joe Morgan & Peter Barnes
- AIMS Whale Shark team
- Ningaloo Aviation
- Exmouth District High School
- Exmouth community volunteers too numerous to mention
- IMOS Animal tracking node
- Tim Cooper, Belinda Fox & Claire Hall