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Supplementary Materials for

Diving into the vertical dimension of elasmobranch movement ecology

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The PDF file includes:

Figs. S1 to S3
Tables S1 and S2, S4 and S5
References

Other Supplementary Material for this manuscript includes the following:

Table S3

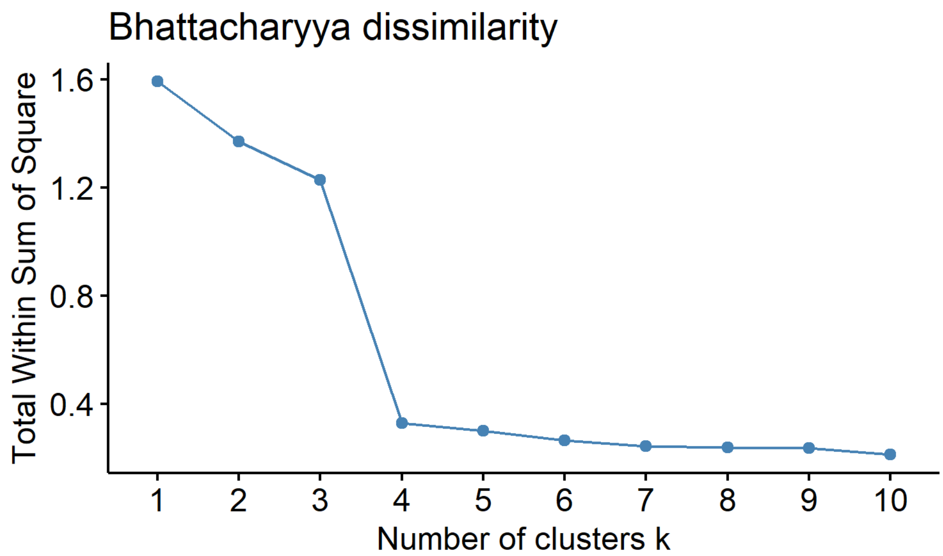


Fig. S1. Elbow plot used to determine the optimum number of clusters (n = 4) for the hierarchical cluster analysis performed on measures of vertical overlap between elasmobranch species. The plot displays the within-cluster sum of squares against the number of clusters.

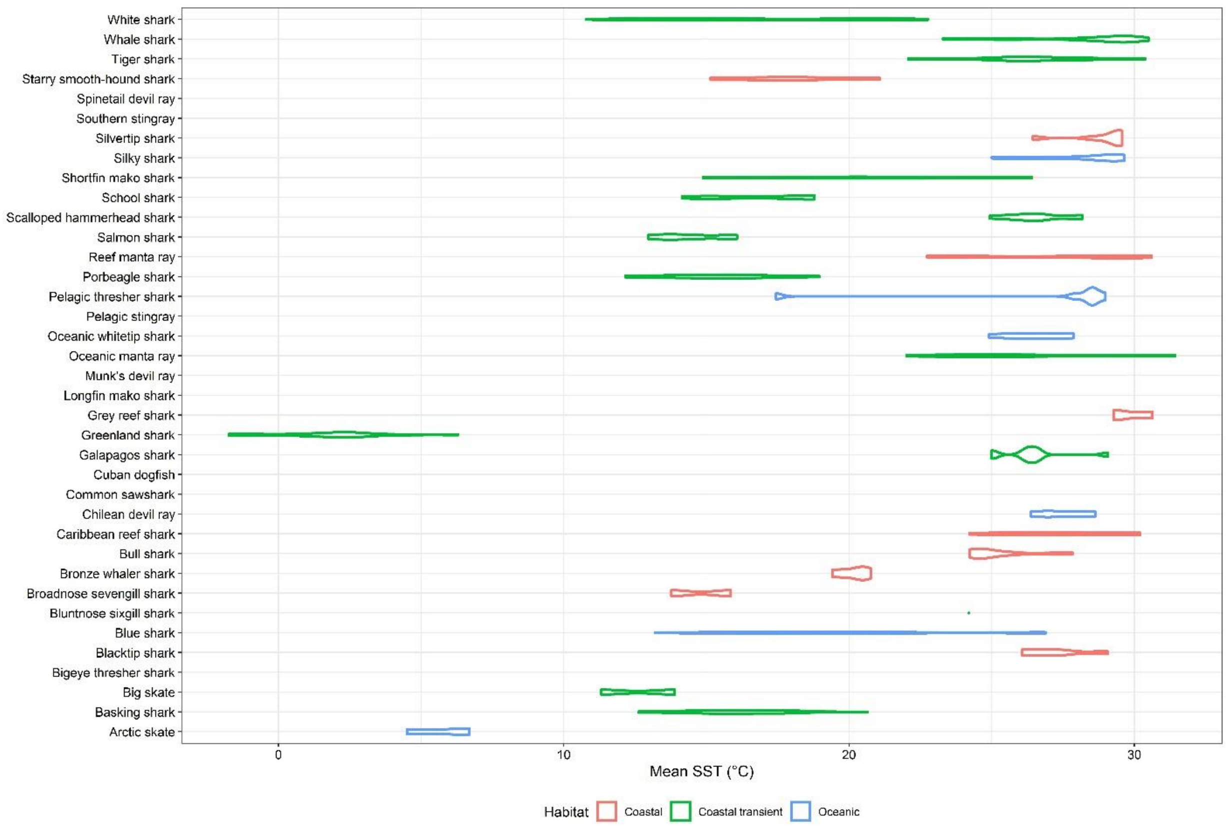


Fig. S2. Mean sea surface temperature (SST; °C) at the location of tag deployment for each species. SST was the National Oceanic and Atmospheric Administration's Multi-scale Ultra-High Resolution (NOAA MUR) level 4 analysis on a 0.01 degree spatial resolution and averaged across the seven days following deployment to correspond with INLA models.

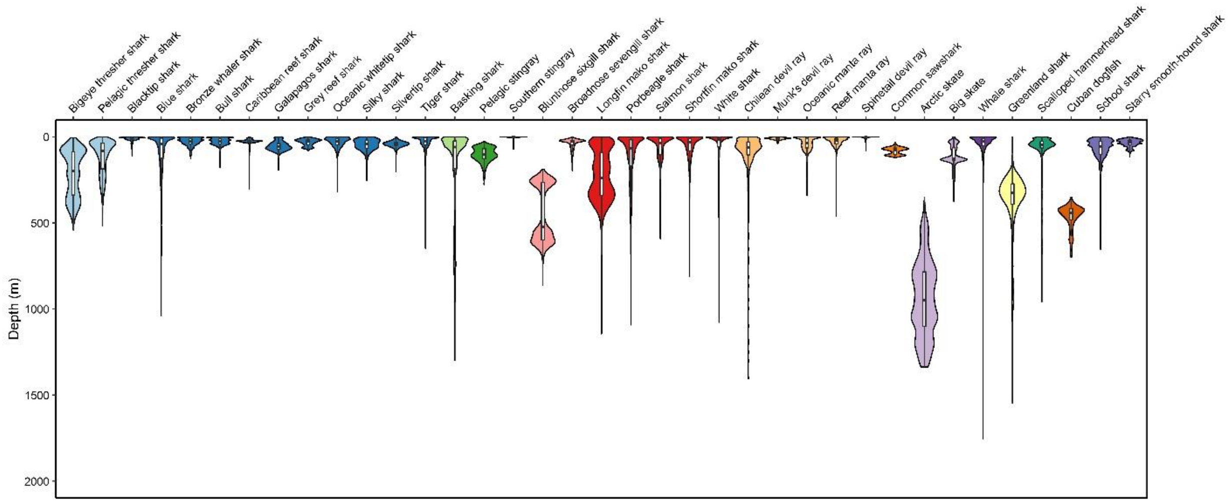


Fig. S3. The hourly median depth distributions of all elasmobranch species with time-series, determined from median hourly depths from each satellite-tagged individual within each species. Violin plots represent the full distribution of the data, with colours relating to family. Boxplots depict the lower quartile, upper quartile (and thus the interquartile range) and median within the data, with whiskers extending from the shallowest to the deepest depth observed within each species.

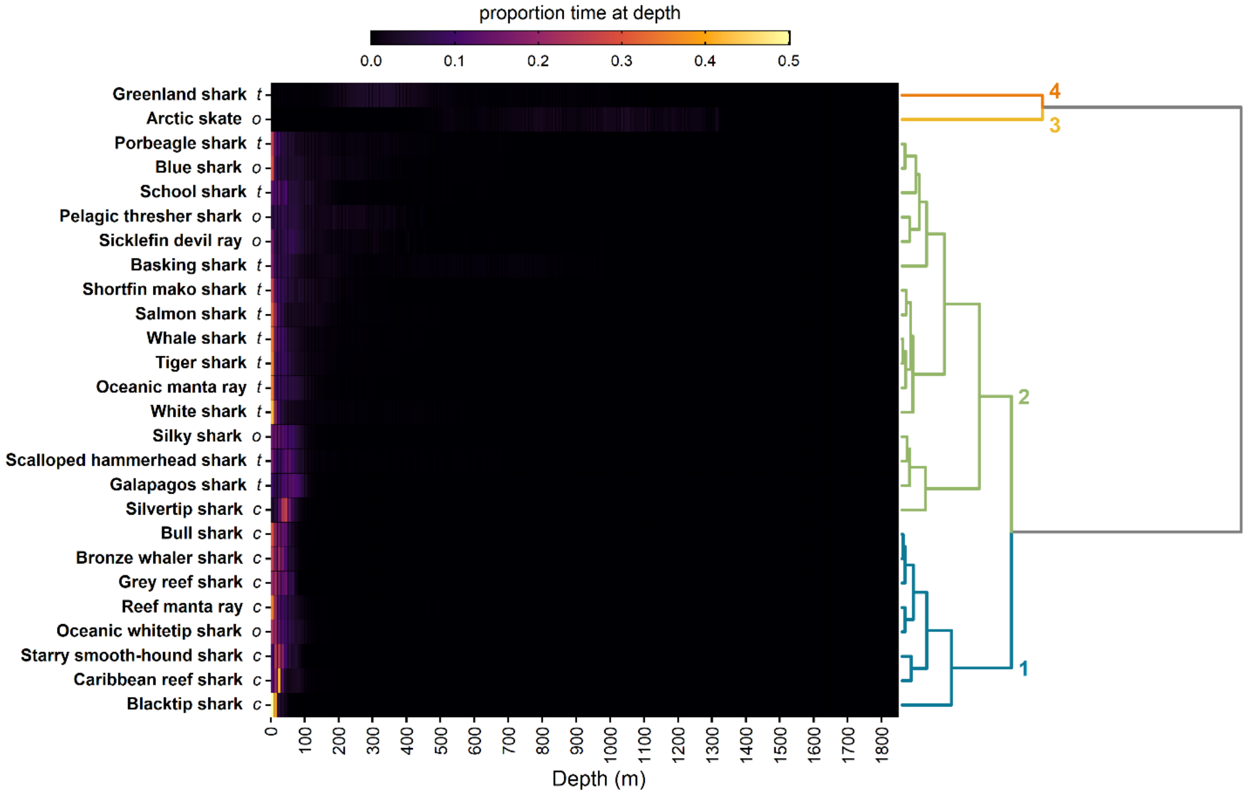


Fig. S4. Depth distributions for 26 elasmobranch species binned at 10 m intervals. Italicized lettering next to each species name indicates the habitat type of each species (*c* = coastal, *t* = transient, *o* = oceanic). The dendrogram and clusters on the right side of the figure resulted from hierarchical cluster analysis performed on dissimilarity of Bhattacharyya's coefficient. Numbered clusters represent species grouped according to similarity in vertical habitat use.

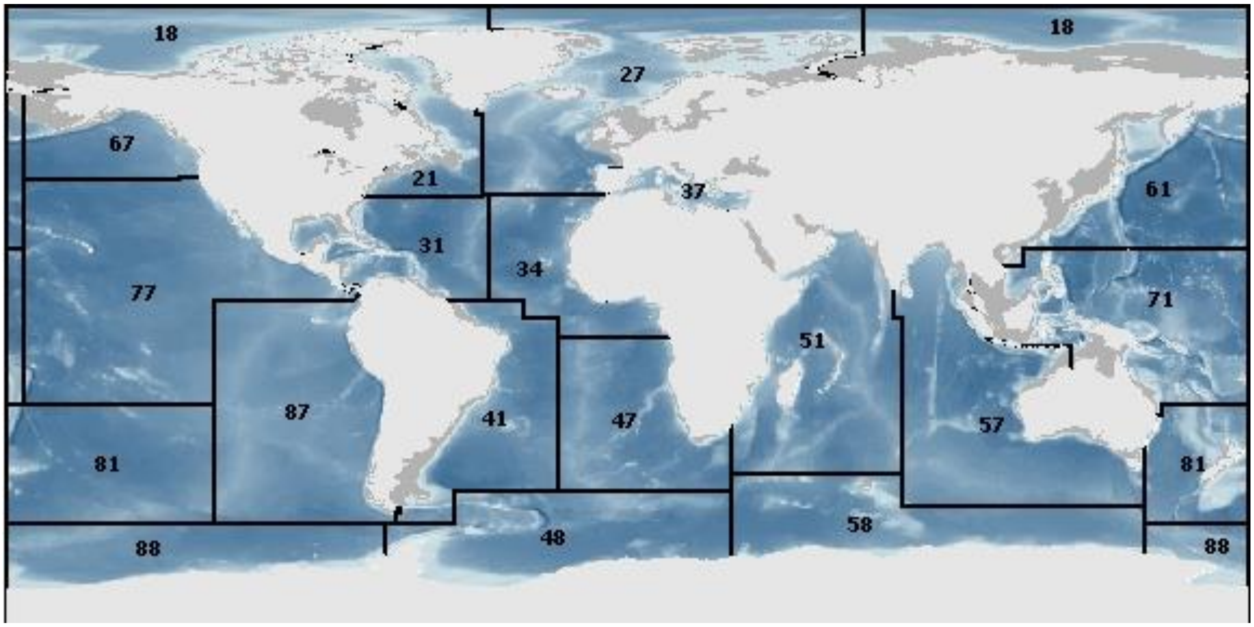
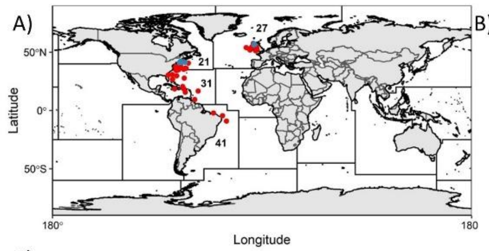


Fig. S5. Food and Agriculture Organization (FAO) Major Fishing Area sourced from https://www.fao.org/fishery/en/area/search. Areas by numbered box are: 18 Arctic Sea; 21 Atlantic, Northwest; 27 Atlantic, Northeast; 31 Atlantic, Western Central; 34 Atlantic, Eastern Central; 37 Mediterranean and Black Sea; 41 Atlantic, Southwest; 47 Atlantic, Southeast; 48 Atlantic, Antarctic; 51 Indian Ocean, Western; 57 Indian Ocean, Eastern; 58 Indian Ocean, Antarctic and Southern; 61 Pacific, Northwest; 67 Pacific, Northeast; 71 Pacific, Western Central; 77 Pacific, Eastern Central; 81 Pacific, Southwest; 87 Pacific, Southeast and; 88 Pacific, Antarctic.

Basking shark (*n = 66*)

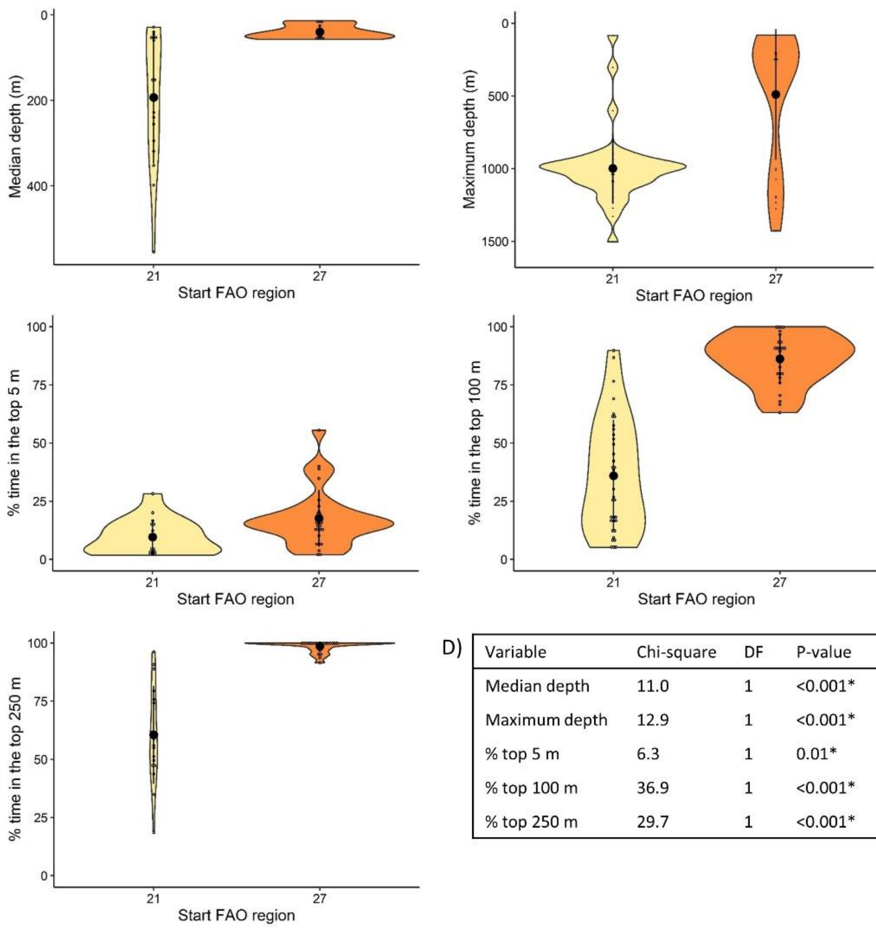
A)



B)

FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
21	38	17	126.2 ± 66.3
27	28	14	115.4 ± 92.4

C)



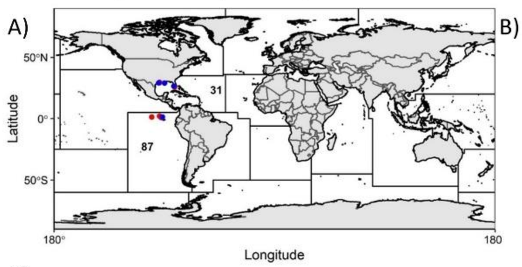
D)

Variable	Chi-square	DF	P-value
Median depth	11.0	1	<0.001*
Maximum depth	12.9	1	<0.001*
% top 5 m	6.3	1	0.01*
% top 100 m	36.9	1	<0.001*
% top 250 m	29.7	1	<0.001*

Fig. S6. Region-specific vertical metrics for basking sharks *Cetorhinus maximus* (n = 66). (A) Deployment (black) and pop-up (red) locations of tagged basking sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions where >4 tags were deployed. *indicates a significant difference ($p<0.05$). [a]Start FAO regions (i.e. FAO region where tag(s) were deployed) for basking sharks: 21: Atlantic, Northwest; 27: Atlantic, Northeast.

Blacktip shark (*n = 10*)

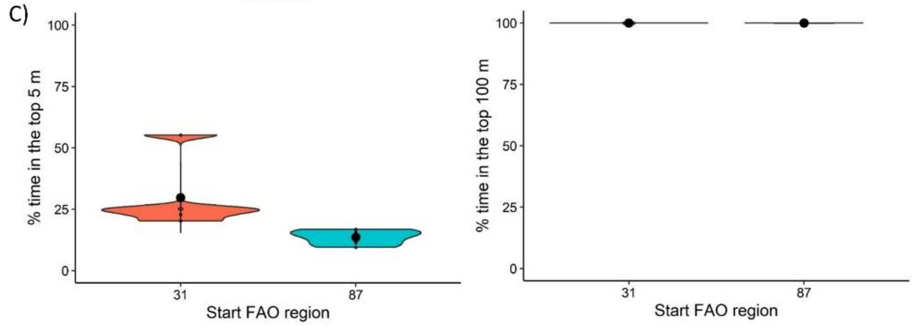
A)

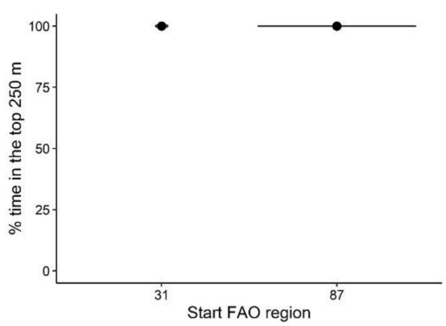


B)

FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
31	5	5	91.4 ± 58.1
87	5	0	35.4 ± 17.5

C)





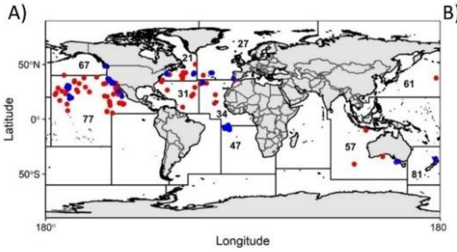
D)

Variable	Chi-square	Df	P-value
% top 5 m	6.8	1	0.009*
% top 100 m	0.01	1	0.91
% top 250 m	0	1	1

Fig. S7. Region-specific vertical metrics for blacktip sharks *Carcharhinus limbatus* (n = 10). (A) Deployment (black) and pop-up (red) locations of tagged blacktip sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >4 tags. *indicates a significant difference ($p<0.05$). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for blacktip sharks: 31: Atlantic, Western Central; 87: Pacific, Southeast.

Blue shark (*n = 101*)

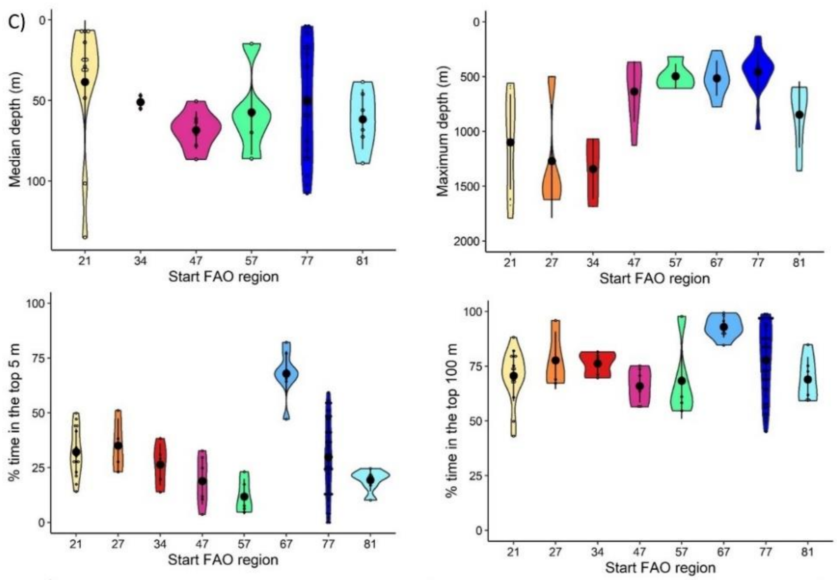
A)

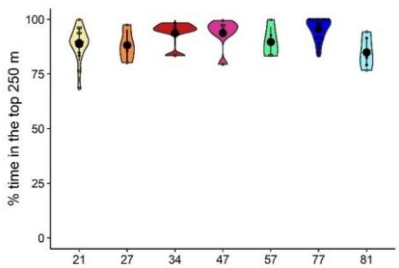


B)

FAO region (start)[a]	Sample size		Mean data days
	All	Time-series	
21	16	13	115.6 ± 44.4
27	4	0	74.0 ± 11.2
34	5	2	73.0 ± 26.6
47	7	7	51.1 ± 34.6
57	5	5	144.0 ± 55.3
67	8	0	144.5 ± 36.6
77	46	19	59.4 ± 42.0
81	6	6	39.5 ± 11.3

C)

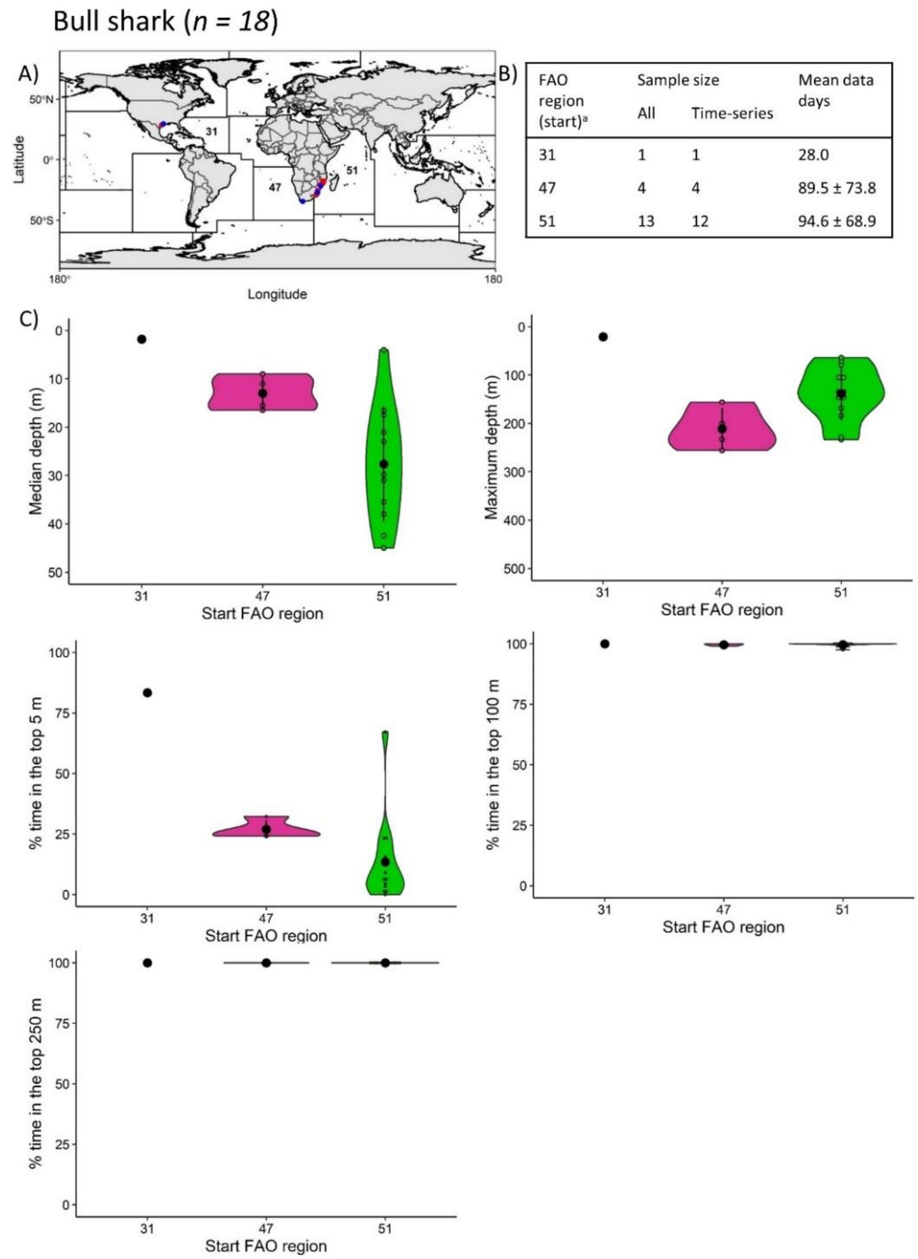




D)

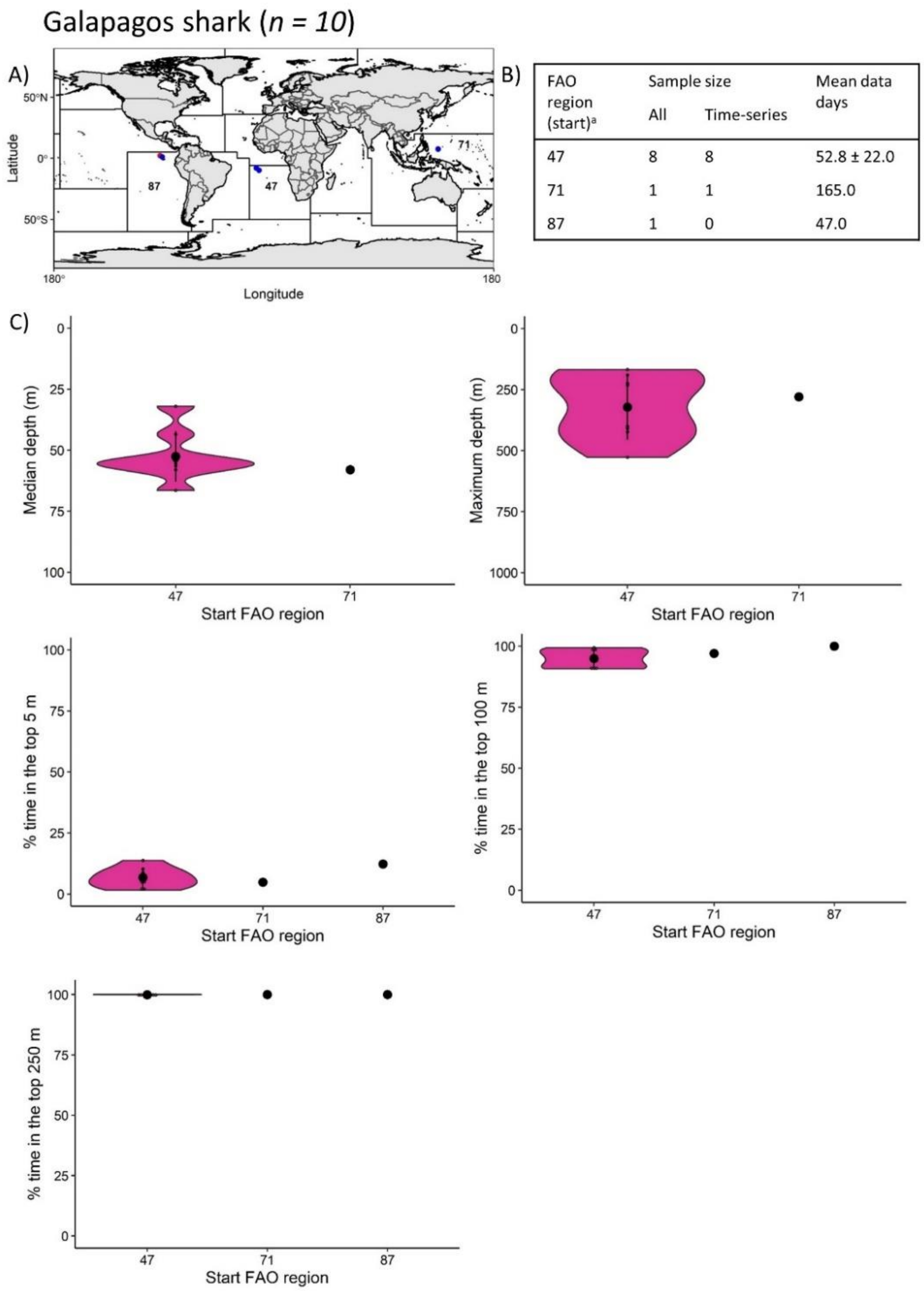
Variable	Chi-square	Df	P-value
Median depth	6.6	4	0.16
Maximum depth	45.25	6	<0.001*
% top 5 m	31.6	6	<0.001*
% top 100 m	19.8	6	0.003*
% top 250 m	20.2	5	0.001*

Fig. S8. Region-specific vertical metrics for blue sharks *Prionace glauca* (n = 101). (A) Deployment (black) and pop-up (red) locations of tagged blue sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >4 tags. *indicates a significant difference (p<0.05). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for blue sharks: 21: Atlantic, Northwest; 27: Atlantic, Northeast; 34: Atlantic, Eastern Central; 47: Atlantic, Southeast; 57: Indian Ocean, Eastern; 67: Pacific, Northeast; 77: Pacific, Eastern Central; 81: Pacific, Southwest.



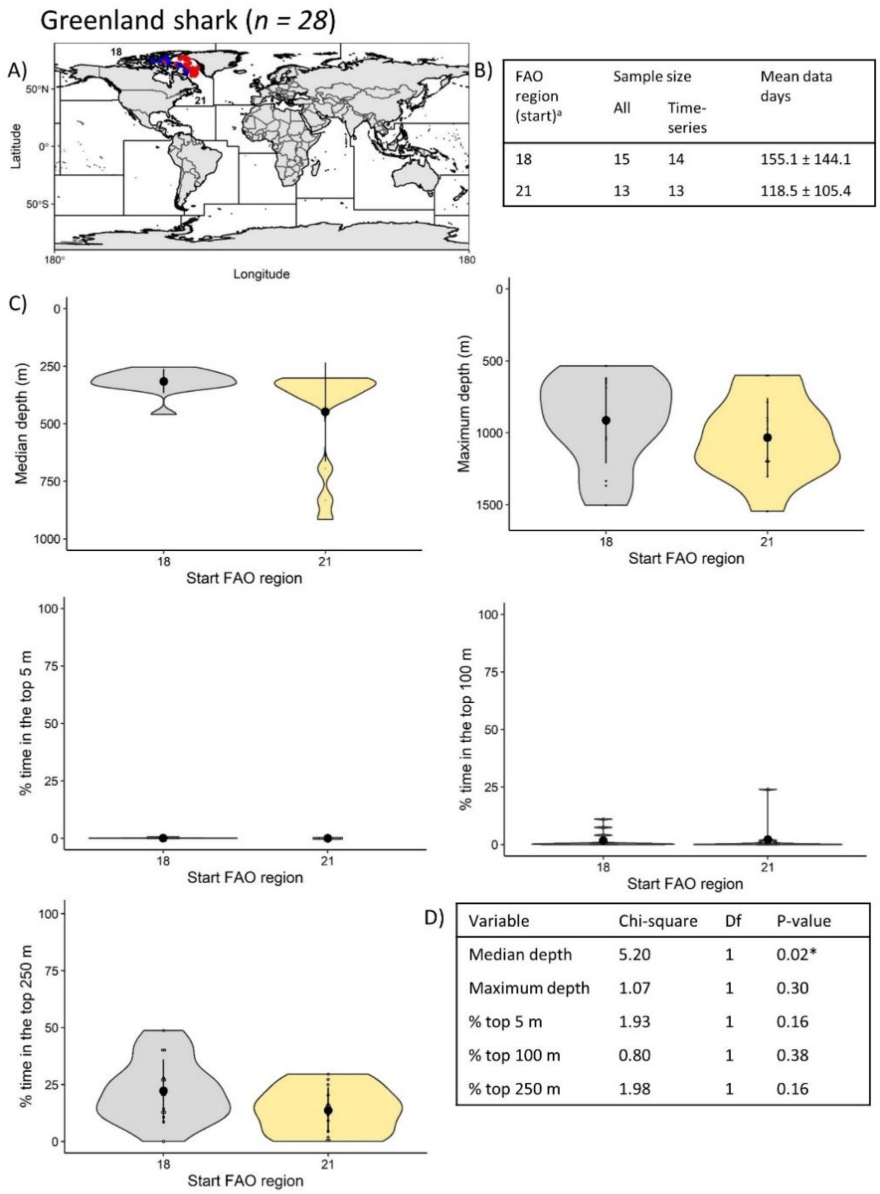
FAO region (start)[a]	Sample size: All	Sample size: Time-series	Mean data days
31	1	1	28.0
47	4	4	89.5 ± 73.8
51	13	12	94.6 ± 68.9

Fig. S9. Region-specific vertical metrics for bull sharks *Carcharhinus leucas* (n = 11). (A) Deployment (black) and pop-up (red) locations of tagged bull sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. [a]Start FAO regions (i.e. FAO region where tag(s) were deployed) for bull sharks: 31: Atlantic, Western Central; 47: Atlantic, Southeast; 51: Indian Ocean, Western.



FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
47	8	8	52.8 ± 22.0
71	1	1	165.0
87	1	0	47.0

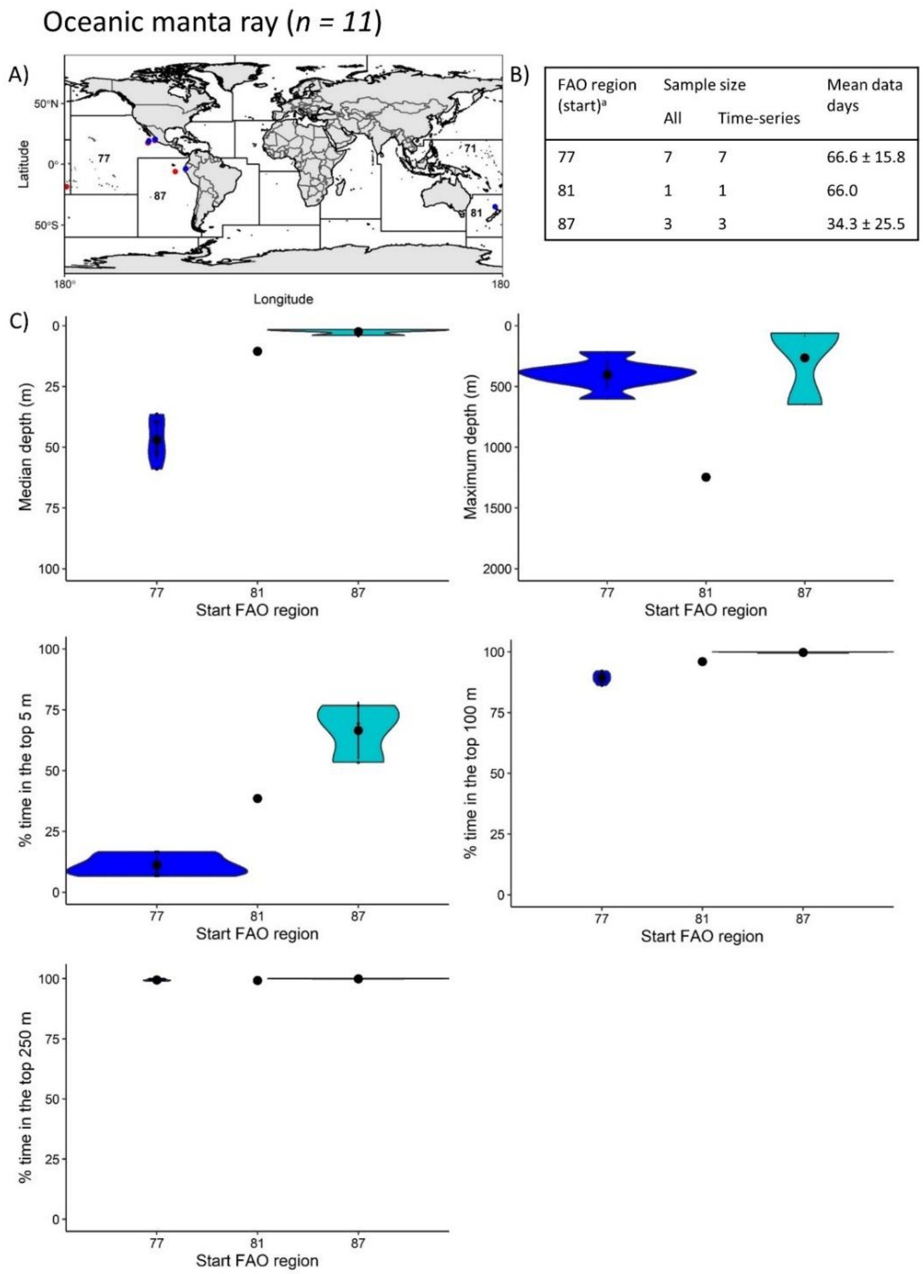
Fig. S10. Region-specific vertical metrics for Galapagos sharks *Carcharhinus galapagensis* (n = 10). (A) Deployment (black) and pop-up (red) locations of tagged Galapagos sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. [a]Start FAO regions (i.e. FAO region where tag(s) were deployed) for Galapagos sharks: 47: Atlantic, Southeast; 71: Pacific, Western Central; 87: Pacific, Southeast.



FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
18	15	14	155.1 ± 144.1
21	13	13	118.5 ± 105.4

Variable	Chi-square	Df	P-value
Median depth	5.20	1	0.02*
Maximum depth	1.07	1	0.30
% top 5 m	1.93	1	0.16
% top 100 m	0.80	1	0.38
% top 250 m	1.98	1	0.16

Fig. S11. Region-specific vertical metrics for Greenland sharks *Somniosus microcephalus* (n = 28). (A) Deployment (black) and pop-up (red) locations of tagged Greenland sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >4 tags. *indicates a significant difference (p<0.05). [a]Start FAO regions (i.e. FAO region where tag(s) were deployed) for Greenland sharks: 18: Arctic Sea; 21: Atlantic, Northwest.

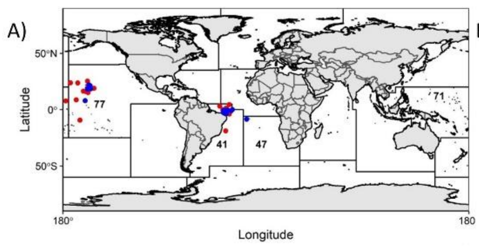


FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
77	7	7	66.6 ± 15.8
81	1	1	66.0
87	3	3	34.3 ± 25.5

Fig. S12. Region-specific vertical metrics for oceanic manta rays *Mobula birostris* (n = 11). (A) Deployment (black) and pop-up (red) locations of tagged oceanic manta rays. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for oceanic manta rays: 77: Pacific, Western Central; 81: Pacific, Southwest; 87: Pacific, Southeast.

Oceanic whitetip shark (*n = 22*)

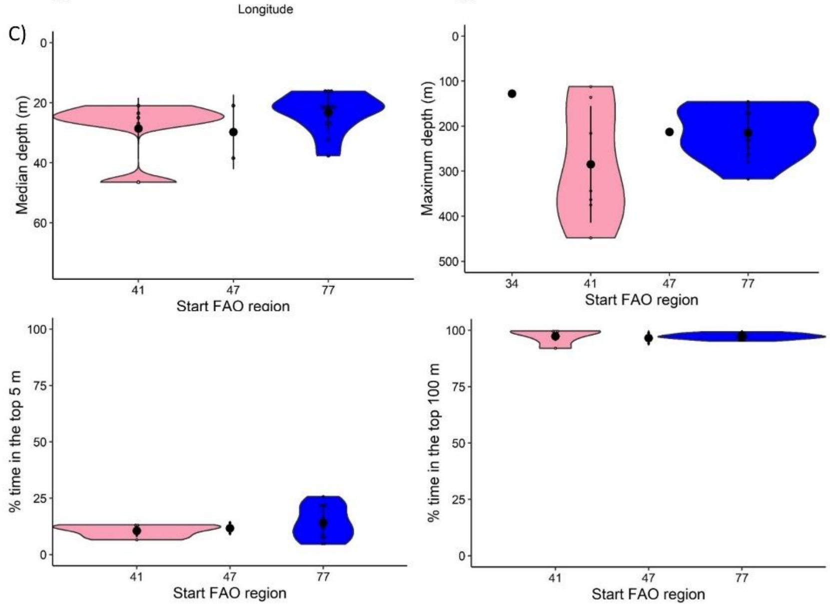
A)

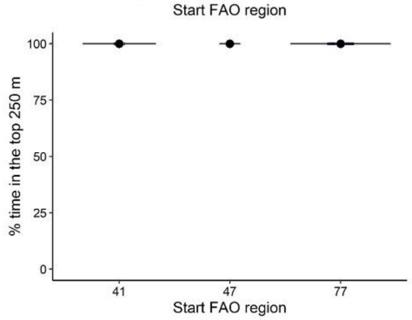


B)

FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
34	1	0	78.0
41	7	5	92.0 ± 43.4
47	2	2	53.0 ± 1.4
77	12	12	93.5 ± 44.4

C)

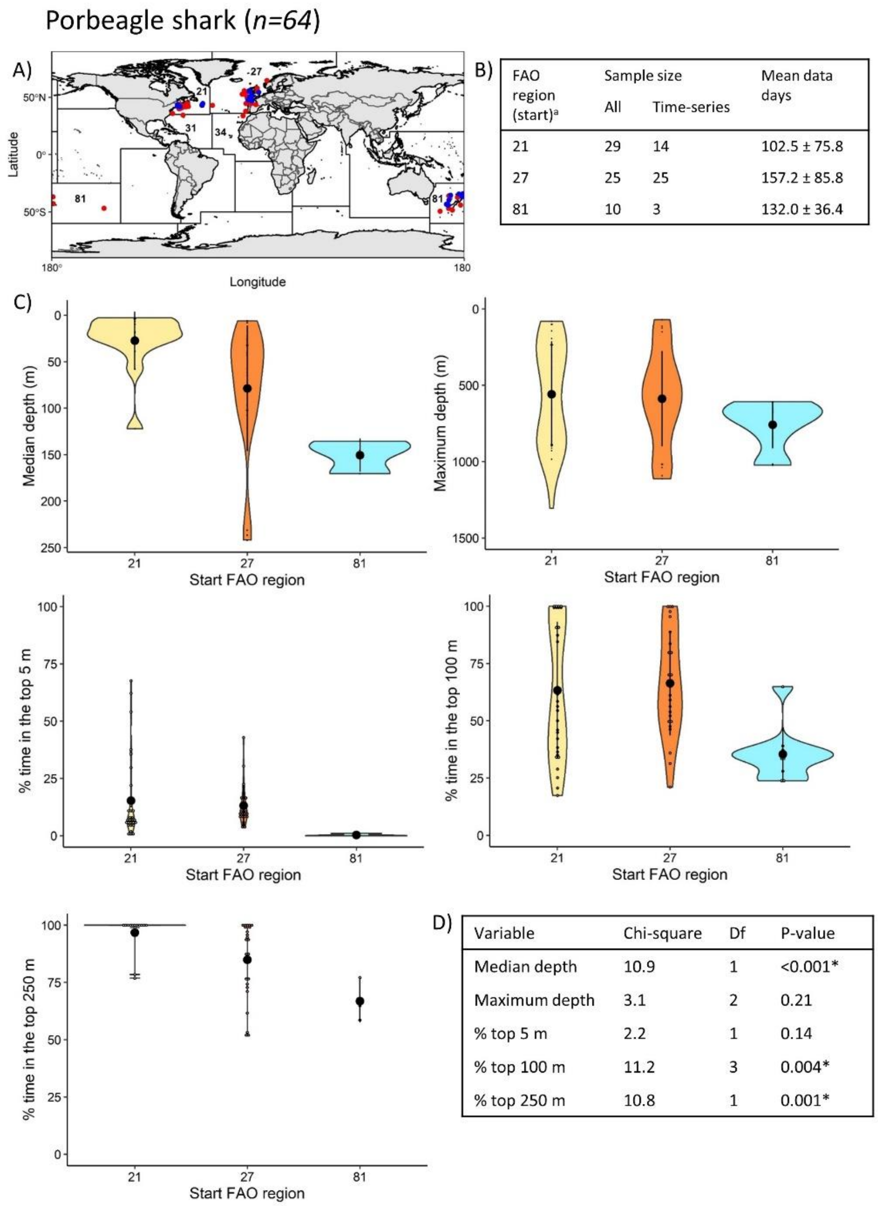




D)

Variable	Chi-square	Df	P-value
Median depth	1.4	1	0.24
Maximum depth	1.03	1	0.31
% top 5 m	0.71	1	0.40
% top 100 m	0.71	1	0.40
% top 250 m	0.75	1	0.39

Fig. S13. Region-specific vertical metrics for oceanic whitetip sharks *Carcharhinus longimanus* (n = 22). (A) Deployment (black) and pop-up (red) locations of tagged oceanic whitetip sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference ($p<0.05$). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for oceanic whitetip sharks: 34: Atlantic, Eastern Central; 41: Atlantic, Southwest; 47: Atlantic, Southeast; 77: Pacific, Eastern Central.



B)

FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
21	29	14	102.5 ± 75.8
27	25	25	157.2 ± 85.8
81	10	3	132.0 ± 36.4

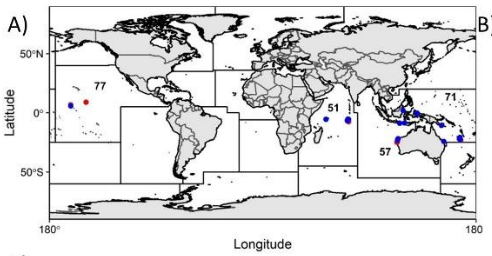
D)

Variable	Chi-square	Df	P-value
Median depth	10.9	1	<0.001*
Maximum depth	3.1	2	0.21
% top 5 m	2.2	1	0.14
% top 100 m	11.2	3	0.004*
% top 250 m	10.8	1	0.001*

Fig. S14. Region-specific vertical metrics for porbeagle sharks *Lamna nasus* (n = 64). (A) Deployment (black) and pop-up (red) locations of tagged porbeagle sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference (p<0.05). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for porbeagle sharks: 21: Atlantic, Northwest; 27: Atlantic, Northeast; 81: Pacific, Southwest.

Reef manta ray (*n = 64*)

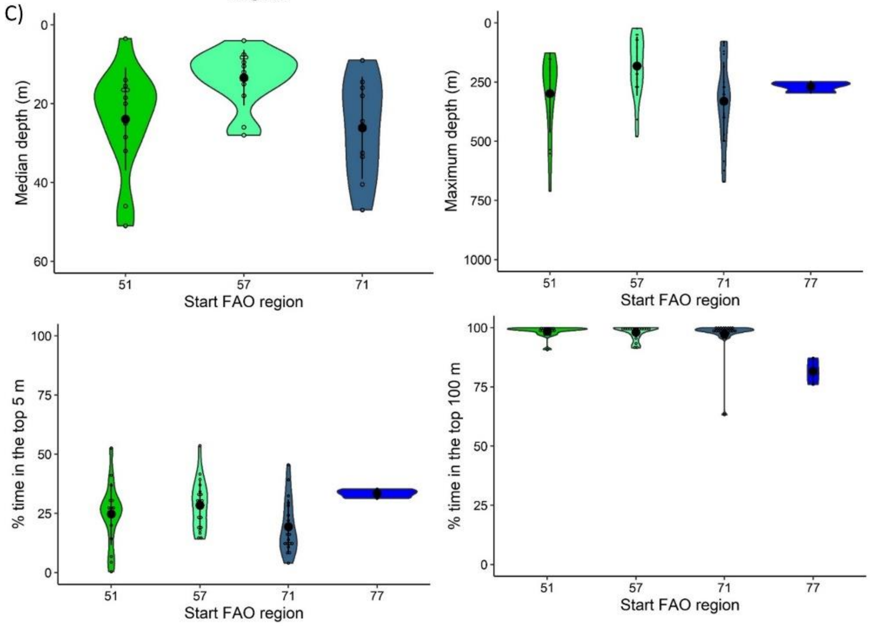
A)

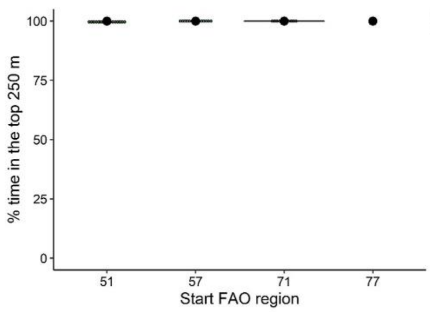


B)

FAO region (start)[a]	Sample size		Mean data days
	All	Time-series	
51	17	13	89.1 ± 73.6
57	19	13	45.8 ± 28.2
71	25	9	82.6 ± 33.1
77	3	0	157.3 ± 32.5

C)



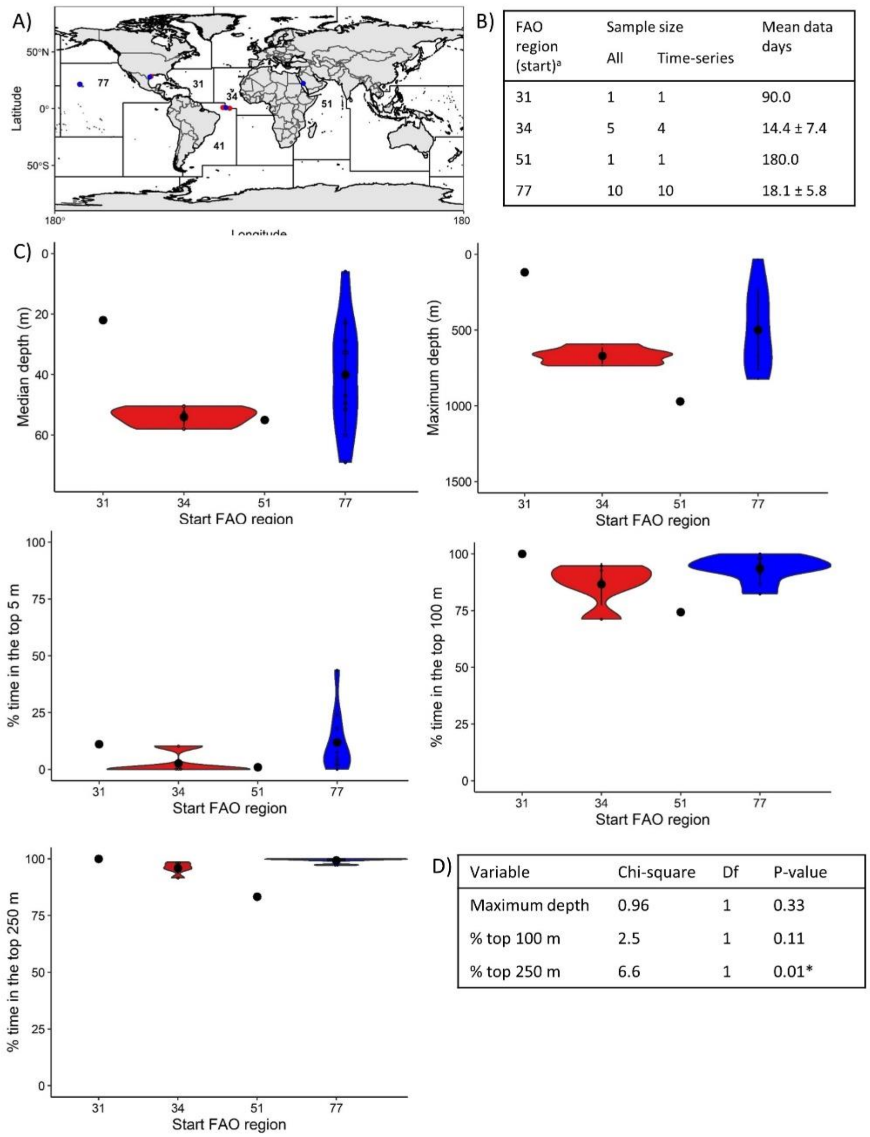


D)

Variable	Chi-square	Df	P-value
Median depth	9.1	2	0.01*
Maximum depth	10.9	2	0.004*
% top 5 m	6.8	2	0.03*
% top 100 m	2.3	2	0.32
% top 250 m	7.1	2	0.03*

Fig. S15. Region-specific vertical metrics for reef manta rays *Mobula alfredi* (n = 64). (A) Deployment (black) and pop-up (red) locations of tagged reef manta rays. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference ($p<0.05$). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for reef manta rays: 51: Indian Ocean, Western; 57: Indian Ocean, Eastern; 71: Pacific, Western Central; 77: Pacific, Eastern Central.

Scalloped hammerhead shark (*n = 17*)



B)

FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
31	1	1	90.0
34	5	4	14.4 ± 7.4
51	1	1	180.0
77	10	10	18.1 ± 5.8

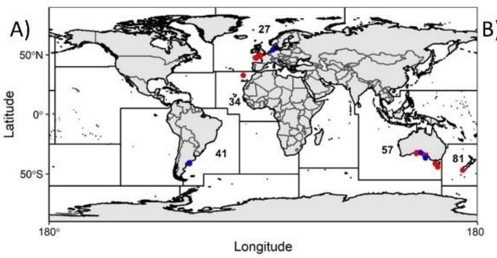
D)

Variable	Chi-square	Df	P-value
Maximum depth	0.96	1	0.33
% top 100 m	2.5	1	0.11
% top 250 m	6.6	1	0.01*

Fig. S16. Region-specific vertical metrics for scalloped hammerhead sharks *Sphyrna lewini* (n = 17). (A) Deployment (black) and pop-up (red) locations of tagged scalloped hammerhead sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference ($p<0.05$). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for scalloped hammerhead sharks: 31: Atlantic, Western Central; 34: Atlantic, Eastern Central; 51: Indian Ocean, Western; 77: Pacific, Eastern Central.

School shark (*n = 17*)

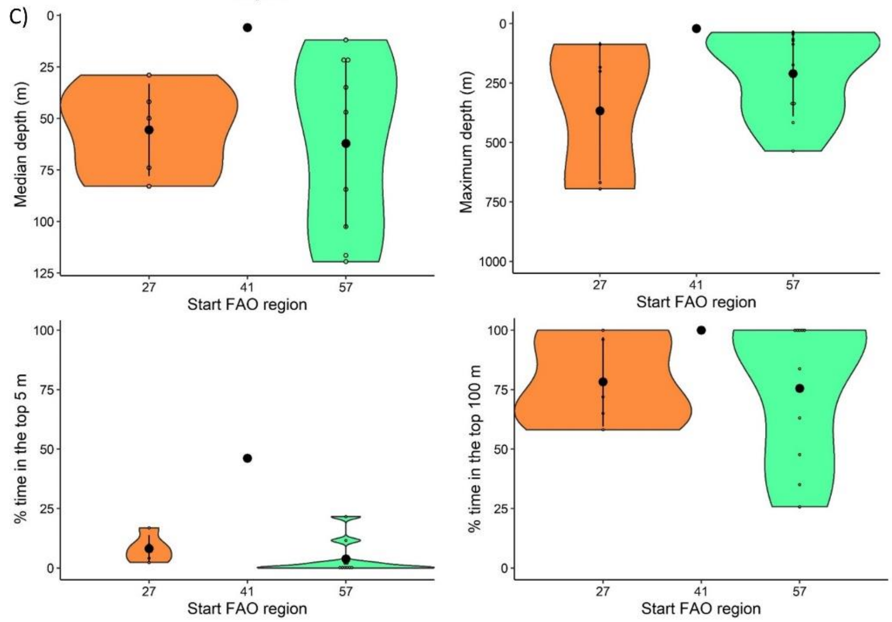
A)

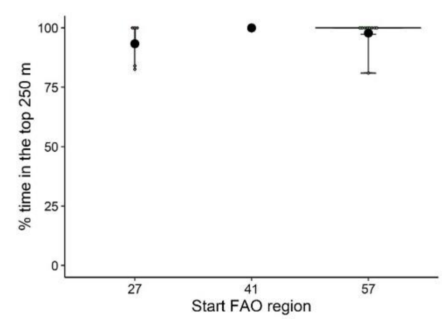


B)

FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
27	5	5	104.8 ± 56.4
41	2	1	14.0 ± 4.2
57	10	10	78.0 ± 35.3

C)

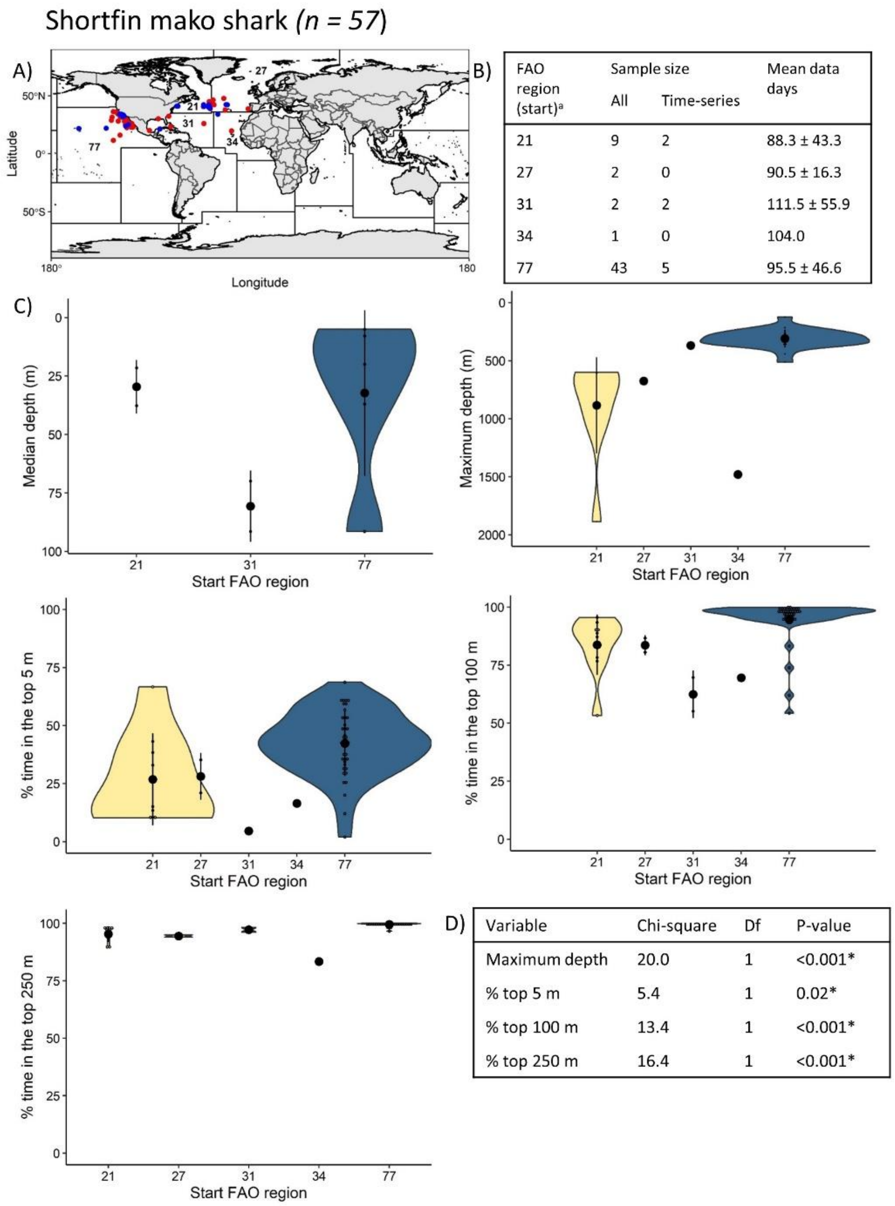




D)

Variable	Chi-square	Df	P-value
Median depth	0.02	1	0.90
Maximum depth	2.2	1	0.14
% top 5 m	3.8	1	0.05
% top 100 m	0.04	1	0.85
% top 250 m	0.26	1	0.61

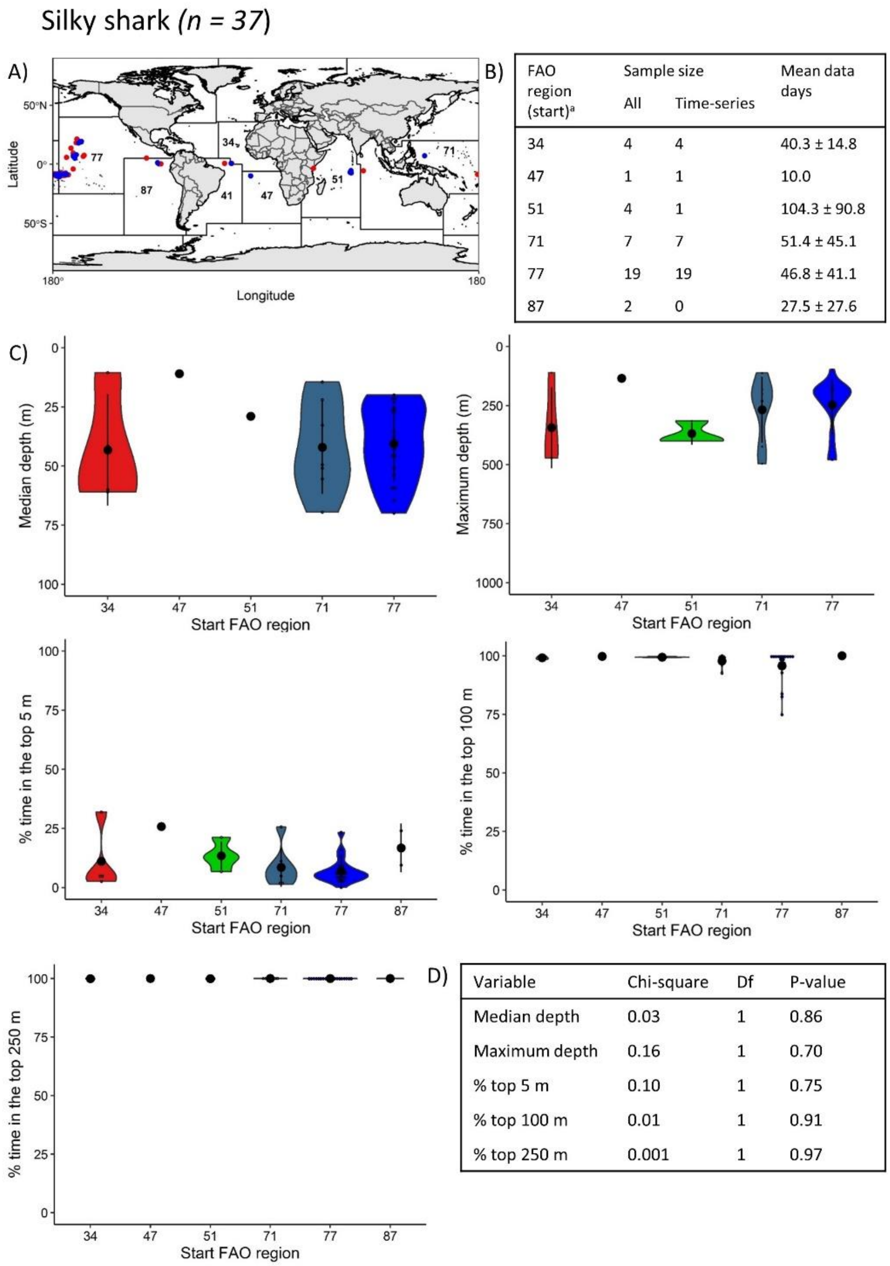
Fig. S17. Region-specific vertical metrics for school sharks *Galeorhinus galeus* (n = 17). (A) Deployment (black) and pop-up (red) locations of tagged school sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference (p<0.05). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for school sharks: 27: Atlantic, Northeast; 41: Atlantic, Southwest; 57: Indian Ocean, Eastern.



FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
21	9	2	88.3 ± 43.3
27	2	0	90.5 ± 16.3
31	2	2	111.5 ± 55.9
34	1	0	104.0
77	43	5	95.5 ± 46.6

Variable	Chi-square	Df	P-value
Maximum depth	20.0	1	<0.001*
% top 5 m	5.4	1	0.02*
% top 100 m	13.4	1	<0.001*
% top 250 m	16.4	1	<0.001*

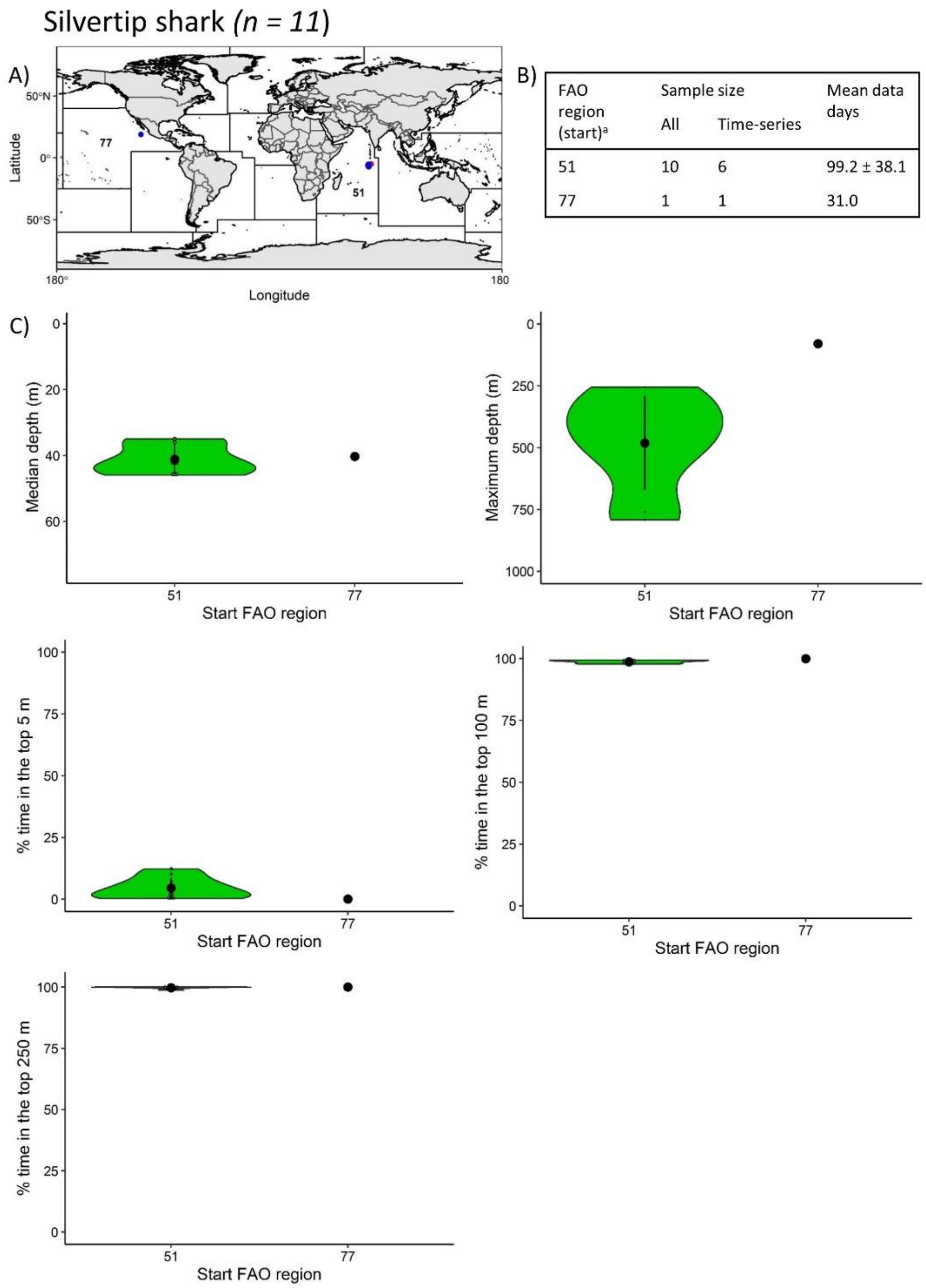
Fig. S18. Region-specific vertical metrics for shortfin mako sharks *Isurus oxyrinchus* (n = 57). (A) Deployment (black) and pop-up (red) locations of tagged shortfin mako. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference (p<0.05). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for shortfin mako sharks: 21: Atlantic, Northwest; 27: Atlantic, Northeast; 31: Atlantic, Western Central; 34: Atlantic, Eastern Central; 77: Pacific, Eastern Central.



FAO region (start)[a]	Sample size		Mean data days
	All	Time-series	
34	4	4	40.3 ± 14.8
47	1	1	10.0
51	4	1	104.3 ± 90.8
71	7	7	51.4 ± 45.1
77	19	19	46.8 ± 41.1
87	2	0	27.5 ± 27.6

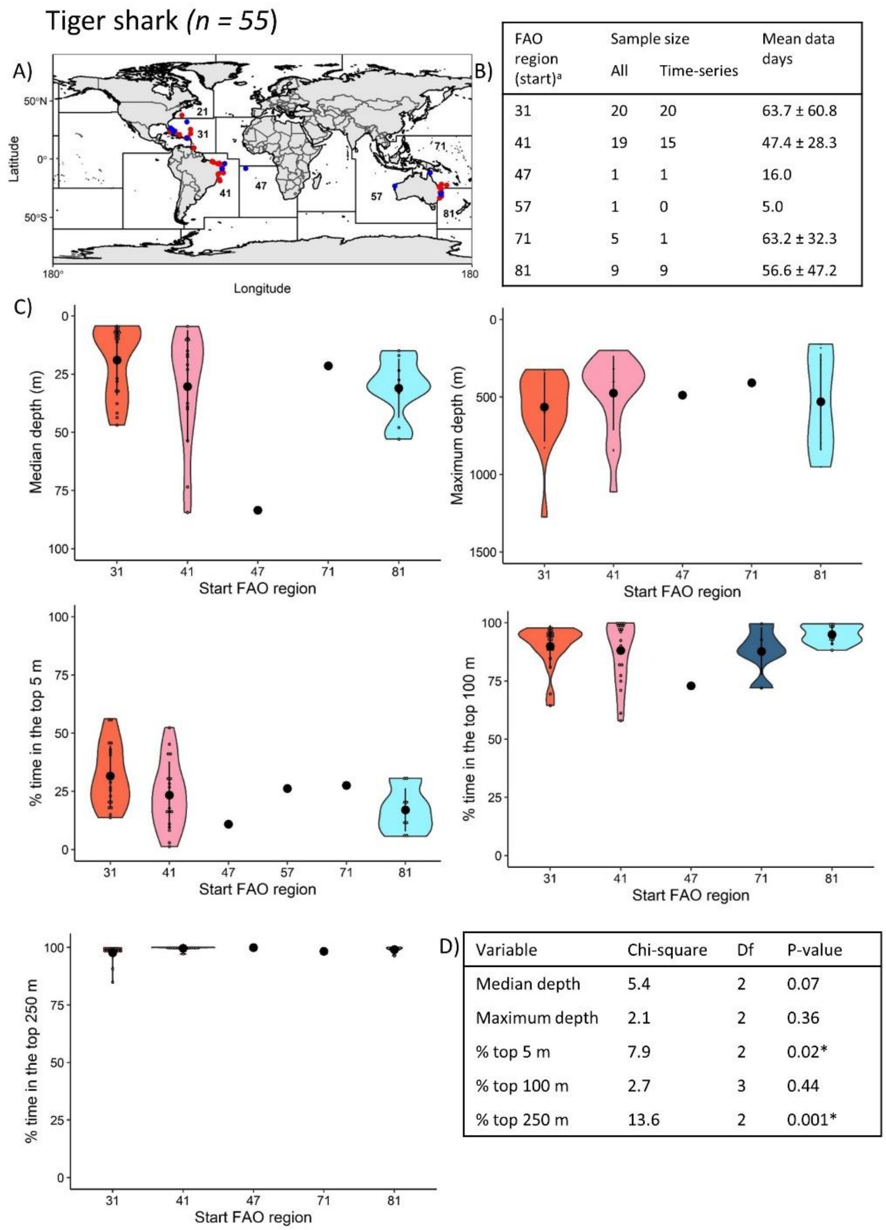
Variable	Chi-square	Df	P-value
Median depth	0.03	1	0.86
Maximum depth	0.16	1	0.70
% top 5 m	0.10	1	0.75
% top 100 m	0.01	1	0.91
% top 250 m	0.001	1	0.97

Fig. S19. Region-specific vertical metrics for silky sharks *Carcharhinus falciformis* (n = 37). (A) Deployment (black) and pop-up (red) locations of tagged silky sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference (p<0.05). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for silky sharks: 34: Atlantic, Eastern Central; 47: Atlantic, Southeast; 51: Indian Ocean, Western; 71: Pacific, Western Central; 77: Pacific, Eastern Central; 87: Pacific, Southeast.



FAO region (start)[a]	Sample size: All	Sample size: Time-series	Mean data days
51	10	6	99.2 ± 38.1
77	1	1	31.0

Fig. S20. Region-specific vertical metrics for silvertip sharks *Carcharhinus albimarginatus* (n = 11). (A) Deployment (black) and pop-up (red) locations of tagged silvertip sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for silvertip sharks: 51: Indian Ocean, Western; 77: Pacific, Eastern Central.



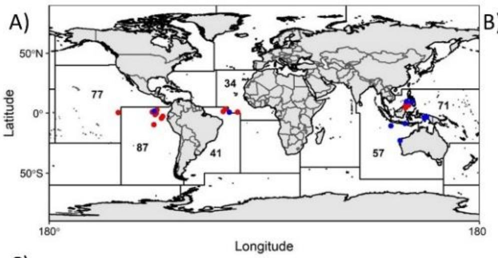
FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
31	20	20	63.7 ± 60.8
41	19	15	47.4 ± 28.3
47	1	1	16.0
57	1	0	5.0
71	5	1	63.2 ± 32.3
81	9	9	56.6 ± 47.2

Variable	Chi-square	Df	P-value
Median depth	5.4	2	0.07
Maximum depth	2.1	2	0.36
% top 5 m	7.9	2	0.02*
% top 100 m	2.7	3	0.44
% top 250 m	13.6	2	0.001*

Fig. S21. Region-specific vertical metrics for tiger sharks *Galeocerdo cuvier* (n = 55). (A) Deployment (black) and pop-up (red) locations of tagged tiger sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference ($p<0.05$). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for tiger sharks: 31: Atlantic, Western Central; 41: Atlantic, Southwest; 47: Atlantic, Southeast; 71: Pacific, Western Central; 81: Pacific, Southwest.

Whale shark *(n = 61)*

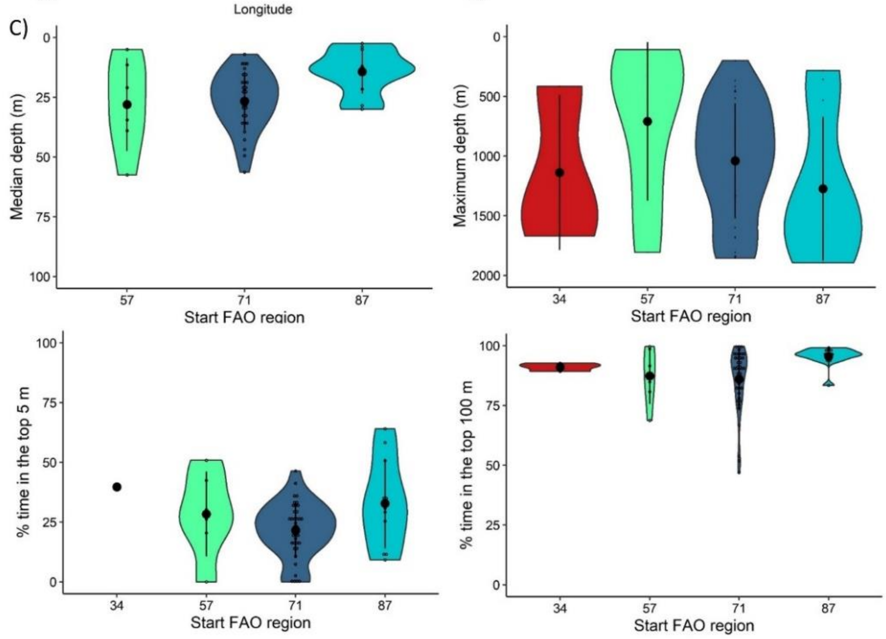
A)

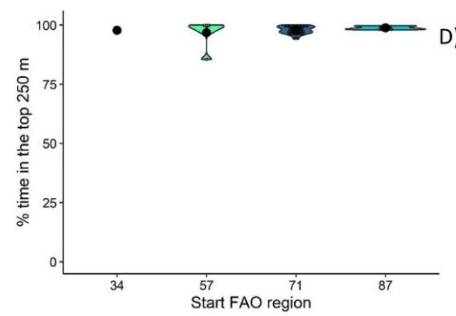


B)

FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
34	3	0	13.3 ± 1.5
57	6	6	98.3 ± 157.1
71	39	31	198.9 ± 170.7
87	13	11	46.8 ± 41.3

C)





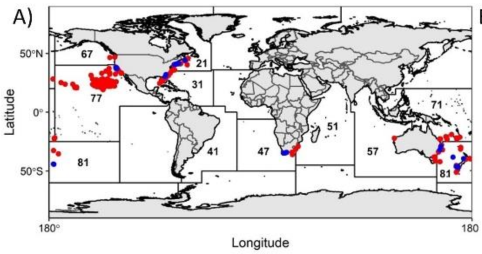
D)

Variable	Chi-square	Df	P-value
Median depth	7.2	2	0.03*
Maximum depth	4.7	2	0.10
% top 5 m	3.6	2	0.16
% top 100 m	7.8	2	0.02*
% top 250 m	2.4	2	0.30

Fig. S22. Region-specific vertical metrics for whale sharks *Rhincodon typus* (n = 61). (A) Deployment (black) and pop-up (red) locations of tagged whale sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference (p<0.05). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for whale sharks: 34: Atlantic, Eastern Central; 57: Indian Ocean, Eastern; 71: Pacific, Western Central; 87: Pacific, Southeast.

White shark *(n = 187)*

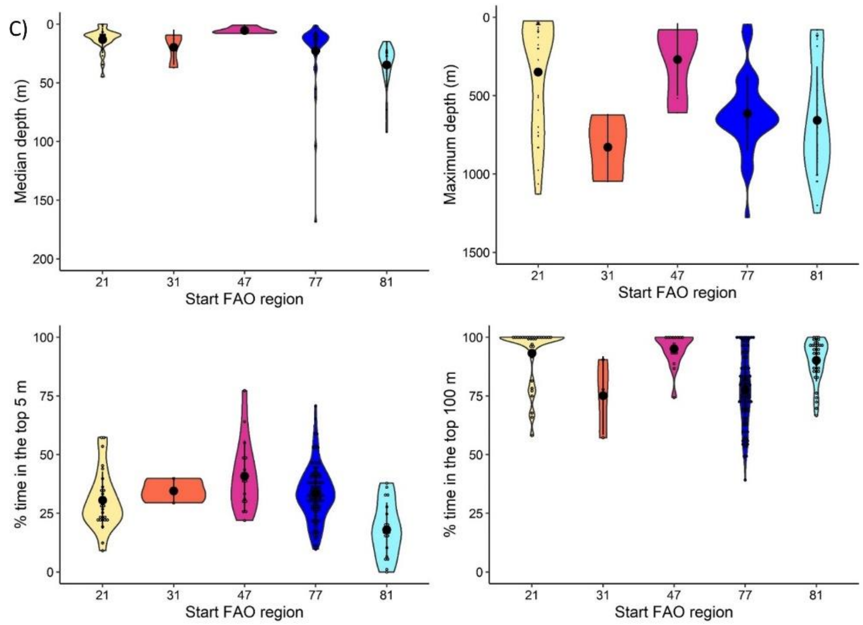
A)

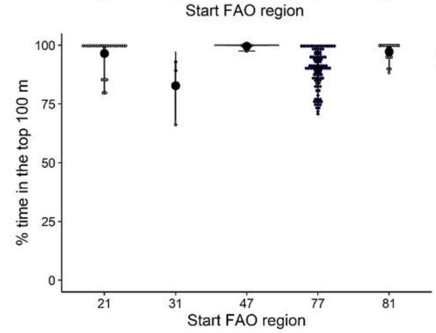


B)

FAO region (start)[a]	Sample size All	Sample size Time-series	Mean data days
21	33	26	83.2 ± 86.1
31	3	3	120.7 ± 77.5
47	16	6	61.8 ± 49.7
77	97	39	131.6 ± 78.6
81	35	17	118.5 ± 76.0

C)





D)

Variable	Chi-square	Df	P-value
Median depth	35.1	3	<0.001*
Maximum depth	20.3	3	<0.001*
% top 5 m	25.8	3	<0.001*
% top 100 m	47.1	3	<0.001*
% top 250 m	38.3	3	<0.001*

Fig. S23. Region-specific vertical metrics for white sharks *Carcharodon carcharias* (n = 187). (A) Deployment (black) and pop-up (red) locations of tagged white sharks. (B) Sample size and mean deployment duration for each FAO region. Sample size for all represents total number of tags in the database, sample size for time-series represents the number of tags with time-series data available. (C) Violin plots of vertical metrics for each FAO region. Dot-and-whisker plot display mean and standard deviation for each FAO region. Note that not all metrics are available from all tags. (D) Results of Kruskal-Wallis tests comparing vertical metrics between FAO regions. Note that tests were only applied for FAO regions with >5 tags. *indicates a significant difference (p<0.05). [a]Start FAO region (i.e. FAO region where tag(s) were deployed) for white sharks: 21: Atlantic, Northwest; 31: Atlantic, Western Central; 47: Atlantic, Southeast; 77: Pacific, Eastern Central; 81: Pacific, Southwest.

Species (common)	Trophic level	Source	Max species body size (kg)	Source	Female size at maturity	Source	Male size at maturity	Source	Primary habitat	Source
Pelagic thresher shark	4.2	(*81*)	62	(*82*)	272	(*83*)	245.6	(*83*)	Oceanic	(*84*)
Bigeye thresher shark	4.2	(*81*)	363.8	(*85*)	140	(*86*)	120	(*86*)	Coastal transient	(*84*)
Common thresher shark	4.2	(*81*)	348	(*85*)	226	(*87*)	184	(*87*)	Coastal transient	(*84*)
Arctic skate	4.3	(*85*)	5.2	(*88*)	70.5	(*89*)	66.8	(*89*)	Oceanic	(*90*)
Big skate	3.9	(*85*)	91	(*85*)	126	(*91*)	124	(*91*)	Coastal transient	(*90*)
Silvertip shark	4.2	(*81*)	162.2	(*85*)	208.9	(*92*)	174.7	(*92*)	Coastal	(*84*)
Grey reef shark	4.1	(*81*)	33.7	(*85*)	195	(*93*)	170	(*93*)	Coastal	(*68*)
Bronze whaler shark	4.2	(*81*)	304.6	(*85*)	270	(*94*)	224	(*94*)	Coastal	(*84*)
Silky shark	4.2	(*81*)	346	(*85*)	210	(*95*)	175	(*95*)	Oceanic	(*26*)
Galapagos shark	4.2	(*81*)	85.5	(*85*)	215	(*96*)	205	(*96*)	Coastal transient	(*68*)
Bull shark	4.3	(*81*)	316.5	(*85*)	225	(*97*)	210	(*97*)	Coastal	(*68*)
Blacktip shark	4.2	(*81*)	122.8	(*85*)	150	(*97*)	130	(*97*)	Coastal	(*68*)
Oceanic whitetip shark	4.2	(*81*)	167.4	(*85*)	190	(*98*)	172	(*98*)	Oceanic	(*84*)
Caribbean reef shark	4.5	(*85*)	69.9	(*85*)	182.6	(*99*)	180.8	(*99*)	Coastal	(*68*)
White shark	4.5	(*81*)	2530	(*100*)	454	(*101*)	332	(*87*)	Coastal transient	(*68*)
Basking shark	3.2	(*81*)	4000	(*85*)	810	(*102*)	500	(*102*)	Coastal transient	(*68*)

Tiger shark	4.1	(*81*)	807.4	*(85)*	330	(*103)*	292	(*103)*	Coastal transient	*(68)*
School shark	4.2	(*81*)	44.7	*(85)*	125	(*104)*	108	(*104)*	Coastal transient	*(68)*
Bluntnose sixgill shark	4.3	(*81*)	590	*(85)*	394	(*105)*	300	(*105)*	Coastal transient	*(68)*
Lutz's stingray*	3.5	*(85)*	135.6	*(85)*	70	(*106)*	58	(*106)*	Coastal	(*107)*
Shortfin mako shark	4.3	(*81*)	505.8	*(85)*	258	(*108)*	179	(*108)*	Coastal transient	(*109)*
Longfin mako shark	4.3	(*81*)	566	(*110)*	230	(*111)*	215	(*111)*	Oceanic	(*112)*
Salmon shark	4.5	*(85)*	175	*(85)*	205	(*113)*	158	(*113)*	Coastal transient	(*84*)
Porbeagle shark	4.2	(*81*)	230	*(85)*	170	(*114)*	140	(*114)*	Coastal transient	(*84*)
Reef manta ray	3.6	*(85)*	1200	Manta Trust, pers comms	351*	(*115)* (mean)	283*	(*115)* (mean)	Coastal	(*116)*
Oceanic manta ray	3.5	*(85)*	2000	Manta Trust, pers comms	431*	(*115)* (mean)	365*	(*115)* (mean)	Coastal transient	(*116)*
Spinetail devil ray	3.4	*(85)*	300	(*117)*	216*	(*115)* (mean)	210*	(*115)* (mean)	Coastal transient	*(90)*
Munk's pygmy devil ray	3.8	*(85)*	25	(*118)*	94*	(*115)* (mean)	90*	(*115)* (mean)	Coastal	*(90)*
Sicklefin devil ray	3.8	*(85)*	400	Manta Trust, pers comms	259*	(*115)* (mean)	225*	(*115)* (mean)	Oceanic	(*17)*
Starry smooth-hound	3.7	(*81*)	4.8	*(85)*	87	(*119)*	78	(*119)*	Coastal	(*84*)
Broadnose sevengill shark	4.7	(*81*)	107	*(85)*	210	(*120)*	190	(*120)*	Coastal	(*121)*

Blue shark	4.1	(*81*)	205.9	*(85)*	172	(*122)*	170	(*122)*	Oceanic	(*112)*
Common sawshark	4.2	*(85)*	1.9	(*123)*	90	(93*)*	80	(*123)*	Coastal transient	(*41)*
Pelagic stingray	4.4	*(85)*	49	(*124)* (captive though)	48	(*125)*	41	(*125)*	Oceanic	*(90)*
Whale shark	3.5	(*81*)	34000	*(85)*	900	(*126)*	800	(*126)*	Coastal transient	(*68)*
Greenland shark	4.2	(*81*)	775	*(85)*	419	(*127)*	284	(*127)*	Coastal transient	(*68)*
Scalloped hammerhead	4.1	(*81*)	152.4	*(85)*	155	(*128)*	136	(*128)*	Coastal transient	(*129)*
Cuban dogfish	4.2	(*81*)	6.1	(*130)*	44.5	(*131)*	42.7	(*131)*	Oceanic	(*132)*

Table S1. Biological and ecological traits for each species included in the study compiled from the published literature. Traits include trophic level, maximum species body size, female size at maturity, male size at maturity and primary habitat type (i.e. oceanic, coastal transient or coastal), and are listed alongside respective references.

Species	Measurement	TL Conversion	Reference
Blacktip shark	CPL	PCL = (0.74493)TL-23.13766	(*133)*
Blue shark	FL	TL = 1.631+1.201*FL	(*134)*
Blue shark	PCL	TL = 3.549+1.313*PCL	(*134)*
Common thresher	FL	FL = (0.5474)TL+7.0262	(*87)*
Cuban dogfish	FL	FL = −1.94 + 0.88 STL	(*135)*
Porbeagle shark	FL	TL = 0.742+1.147*FL	(*134)*
Shortfin mako shark	FL	TL = 0.000+1.127*FL	(*134)*
Silky shark	FL	FL = (0.8388)TL-2.6510	(*87)*
Silky shark	FL	FL = (0.8761)TL-13.3535	(*87)*
Whale shark	FL	TL = 1.063 FL + 26.491	(*136)*
White shark	FL	FL = (0.9442)TL-5.7441	(*87)*
Salmon shark	FL	FL = 1.0813 * PCL + 6.9137 & TL = 1.1529 * PCL + 15.186	(*137)*
Oceanic whitetip	FL	FL = (0.8602)TL - 7.2885	(*138)*
Longfin mako	CPL	PCL = 0 + 0.918*FL & FL = 0 + 0.888 * TL	(*102)*
Longfin mako	FL	FL = 0 + 0.888 * TL	(*101)*
Galapagos shark	FL	TL = 0 + 1.237 * FL	(*105)*

Table S2. Length-length conversions and associated references used to convert body length to total length (TL) for species where alternate measurements were taken.

See auxillary csv file for Table S3.

Table S3. The individual count of each species across marine biogeographic realms (as defined by (*46)*). Counts are broken up by starting realm (i.e. deployment location) and track end realm (i.e. tag detachment location). Note that tag detachment locations were not available for all individuals.

Species_common	Species_latin	Top2m	Top2m_SD	Top5m	Top5m_SD	Top10m	Top10m_SD	Top50m	Top50m_SD	Top100m	Top100m_SD	Top250m	Top250m_SD
Arctic skate	*Amblyraja hyperborea*	0	0	0	0	0	0	0	0	0	0	0	0
Basking shark	*Cetorhinus maximus*	10.7	8.5	14.6	11.3	17.3	12.3	43.3	24.4	58.2	31.8	84	22.9
Big skate	*Beringraja binoculata*	1.7	2.4	3.2	4.5	6.5	9.1	39.4	36.4	59.6	34.3	97.8	3.1
Bigeye thresher shark	*Alopias superciliosus*	0	0	0	0	0	0.1	10.5	6.4	30.1	5.4	59	12
Blacktip shark	*Carcharhinus limbatus*	13.3	2.3	21.6	13	40.4	19.4	99.1	1.1	100	0	100	0
Blue shark	*Prionace glauca*	16.6	11.6	31.2	18.6	37.8	19.2	61.3	21	76.2	14.7	92.3	7
Bluntnose sixgill shark	*Hexanchus griseus*	0	0	0	0	0	0	0	0	0	0	13.8	9.7
Broadnose sevengill shark	*Notorynchus cepedianus*	4.4	5.1	0.5	0.7	22.9	21.6	74	7.4	95.1	4.2	100	0
Bronze whaler shark	*Carcharhinus brachyurus*	8.8	8	16.6	13.9	27.2	19	88.7	15.3	99.2	1.8	100	0
Bull shark	*Carcharhinus leucas*	10.2	14.3	20.3	22.6	30.1	27.1	89.4	10.9	99.6	0.6	100	0
Caribbean reef shark	*Carcharhinus perezi*	1	1.4	3.2	4.4	10.8	15.8	87.8	18.1	98.3	1.8	100	0
Chilean devil ray	*Mobula tarapacana*	9	6.1	12.4	4.2	15.1	4.1	41.7	8.2	68.9	10.4	91	4.9
Common sawshark	*Pristophorus cirratus*	0	0	0	0	0	0	6.1	9.3	71.1	25.1	100	0
Common thresher shark	*Alopias vulpinus*	NA	NA	30.1	3.9	51.9	16.1	90.3	7.3	97.2	4.8	100	0
Cuban dogfish	*Squalus cubensis*	0	0	0	0	0	0	0	0	0	0	0	0
Galapagos shark	*Carcharhinus galapagensis*	2.8	1.9	7.1	4.1	11.6	7	51	20.5	95.6	3.6	100	0.1
Greenland shark	*Somniosus microcephalus*	0	0.1	0	0.1	0.1	0.2	1.1	3.6	1.9	5	18.1	12.7
Grey reef shark	*Carcharhinus amblyrhynchos*	2	1.8	6.6	3.2	22.5	13.7	85.1	10.1	100	0	100	0
Longfin mako shark	*Isurus paucus*	1.1	0	6.7	4.6	6.6	4.8	24.8	5.3	41.4	14.3	60.9	12.9

Munk's devil ray	*Mobula munkiana*	7.7	0	24.8	0	55.4	0	98.7	0	100	0	100	0
Oceanic manta ray	*Mobula birostris*	22.4	22.4	28.7	26.3	35.2	28.6	68.2	22.6	92.8	5.2	99.6	0.4
Oceanic whitetip shark	*Carcharhinus longimanus*	10.5	7.4	12.9	6.1	23.8	9.6	77.3	8.9	97.2	2	100	0
Pelagic stingray	*Pteroplatytrygon violacea*	0	0	0.2	0	0.3	0	10.1	0	49.6	0	99.3	0
Pelagic thresher shark	*Alopias pelagicus*	1.8	3.1	2.9	2.9	6	4.4	34.1	20.3	59.5	16.4	86.3	8.3
Porbeagle shark	*Lamna nasus*	10.3	9	13.6	14.7	19.4	18.8	44.6	28.7	60.1	27	87.5	15.8
Reef manta ray	*Mobula alfredi*	15.1	9.2	24.7	11.9	38.4	15.7	84.8	13.9	97.1	6.1	100	0.1
Salmon shark	*Lamna ditropis*	9.5	7.7	24.9	10.3	35.9	11.9	68.6	16.4	82.6	11.5	95.9	6.5
Scalloped hammerhead	*Sphyrna lewini*	4.2	6.5	8.8	11.7	16.7	21.5	54.8	20.5	90.7	8.4	97.4	4.3
School shark	*Galeorhinus galeus*	3.9	6.8	7.8	12.2	17.6	24.5	57.8	36.8	79.2	25.6	96.7	6.9
Shortfin mako shark	*Isurus oxyrinchus*	15.3	14.3	37.5	17	46.8	20	80	20.4	90.8	12.3	97.7	3.6
Silky shark	*Carcharhinus falciformis*	5.9	5.9	9.4	8	16.3	12.1	68.6	22.8	97.2	5.5	100	0
Silvertip shark	*Carcharhinus albimarginatus*	0.7	1	4.1	4.2	7.3	6.4	76.2	10.5	98.8	0.7	99.8	0.4
Southern stingray	*Hypanus americanus*	62.1	16.1	93.8	0	82.2	16.8	99.6	0.6	100	0	100	0
Spinetail devil ray	*Mobula mobula*	56.8	0	55.9	22.8	82.4	16.6	92.4	8.1	96.5	4.8	99.9	0
Starry smooth-hound	*Mustelus asterias*	0.3	0.5	2	1.7	9.3	6.6	85.4	14.6	99.9	0.2	100	0
Tiger shark	*Galeocerdo cuvier*	15.1	10.9	25.3	13.7	37.1	18.3	72.8	17.9	89.6	10.8	98.7	2.5
Whale shark	*Rhincodon typus*	15	12	24.8	14.3	35.3	13.9	72.9	17.8	88.4	11.8	98	2.3
White shark	*Carcharodon carcharias*	21.5	14.5	31.8	13.2	43.7	15.4	76.5	19.7	84.5	15	92.1	8.3

Table S4. Mean (and SD) percentage of time at liberty spent by each tagged elasmobranch species within the top 5 m, top 10 m, top 100 m and top 250 m.

Name	Response variable	Fixed effects	Hierarchical effect (iid)						WAIC	ΔWAIC	Effective parameters
m8		Intercept, habitat, maturity, max size, sst, trophic level		spatial term	species	species*realm		species*sst	211.23	0.00	82.74
m8b		Intercept, habitat, maturity, max size, sst, trophic level	phylogeny	spatial term	species	species*realm		species*sst	211.80	0.57	82.78
m9		Intercept, habitat, maturity, max size, sst, trophic level		spatial term	species	species*realm	species*maturity	species*sst	212.54	1.31	85.84
m7	log(meddepth+1)	Intercept, habitat, maturity, max size, sst, trophic level	phylogeny	spatial term	species	species*realm	species*maturity		212.96	1.73	84.35
m9b		Intercept, habitat, maturity, max size, sst, trophic level	phylogeny	spatial term	species	species*realm	species*maturity	species*sst	213.09	1.86	85.80
m1		Intercept, habitat, maturity, max size, sst, trophic level	phylogeny	spatial term	species	species*realm			213.17	1.94	81.76
m3*		**Intercept, habitat, maturity, max size, sst, trophic level**		**spatial term**	**species**	**species*realm**			**213.20**	**1.97**	**81.41**

m7b		Intercept, habitat, maturity, max size, sst, trophic level		spatial term	species	species*realm	species*maturity		213.31	2.08	84.62
m3c		Intercept, habitat, maturity, max size, sst, trophic level		spatial term		species*realm			218.24	7.01	84.18
m3e		Intercept, max size, sst, trophic level		spatial term	species	species*realm			222.01	10.78	83.18
m6		Intercept	phylogeny	spatial term	species	species*realm			228.53	17.30	84.26
m4		Intercept, habitat, maturity, max size, sst, trophic level	phylogeny	spatial term	species				241.95	30.72	77.68
m4b		Intercept, habitat, maturity, max size, sst, trophic level		spatial term	species				242.01	30.78	78.03
m2		Intercept, habitat, maturity, max size, sst, trophic level	phylogeny		species	species*realm			284.06	72.83	58.66
m3b		Intercept, habitat, maturity, max size, sst, trophic level			species	species*realm			284.17	72.94	58.61
m5		Intercept, habitat, maturity	phylogeny		species				468.63	257.40	28.74

Table S5. Model selection table for Bayesian regression models examining the median depths of tagged elasmobranchs from 38 species within the first seven days of tracking (excluding the first day of deployment) using Integrated Nested Laplace Approximation (INLA). Models compared using Watanabe Akaike Information Criteria (WAIC; (*139)*). Asterisk denotes the best model.

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