Migration Behavior Changes of Juvenile North Pacific Albacore linking to Environmental Variability

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About us

NOAA FISHERIES

Southwest Fisheries Science Center

La Jolla, California, USA

We generate science necessary for the conservation and management of living marine resources in the California Current, Pacific Ocean and in Antarctica.

About the Species

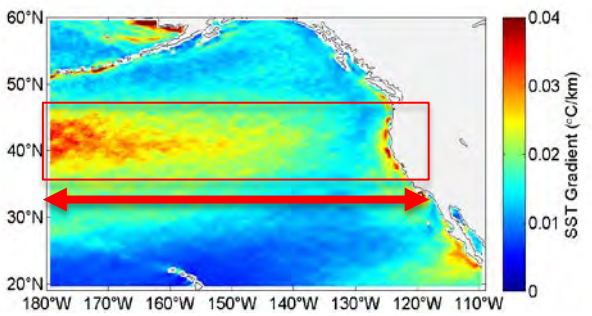
- Highly migratory
- Juvenile age2-5, size 57-110cm
- Good omega-3 sources
- Sushi/sashimi
- Canning
- Currently healthy stock status

WILD PACIFIC ALBACORE®
U.S. CAUGHT

Background & Objectives

- The albacore surface fishery (troll and pole-and-line) is the most important commercial tuna fishery on the US and Canada West Coast.
- Previous research study showed that albacore distribution is associated with sea surface temperature gradient and SST front over large spatial (northeast Pacific) and temporal scales (30 years, 1982-2011). Higher CPUE were observed at places with greater SST gradient longitudinally. (Xu et al., 2015, Progress in Oceanography, In Press)

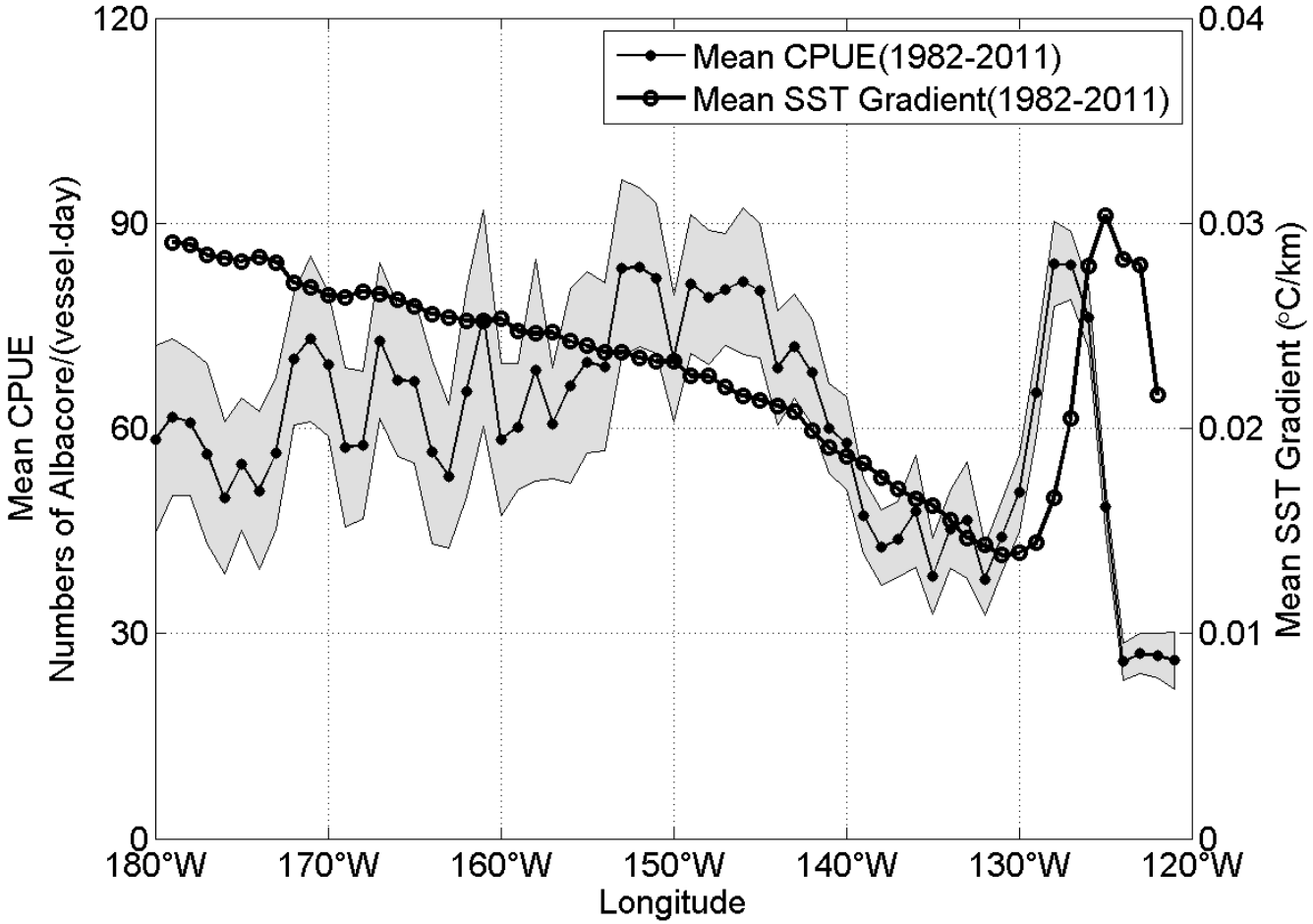
- Our objective is to study albacore behavior changes (movement, diving, ambient water and body temperature changes, etc) in different study areas identified by SST gradients and fronts, using archival tagging data.



Longitudinal changes in mean SST gradient & CPUE

SST gradient decrease from west to east, reaching min@130W, before rapidly increase near the coast.

Albacore CPUE generally has higher value in the transition zone, and reaching min@132-135W, and rapidly increase near the coast.



Data

- Archival tags (manufactured by Wildlife Computers, USA and Lotek Wireless, Canada)
- 920 tags were deployed in 2004-2014 (123 tags in 2015)
- 29 recoveries (recover rate 3.2%)
- 13 albacore crossed all interested regions
- Time, light level, depth, body temperature, and water temperature were measured and recorded from the tags.

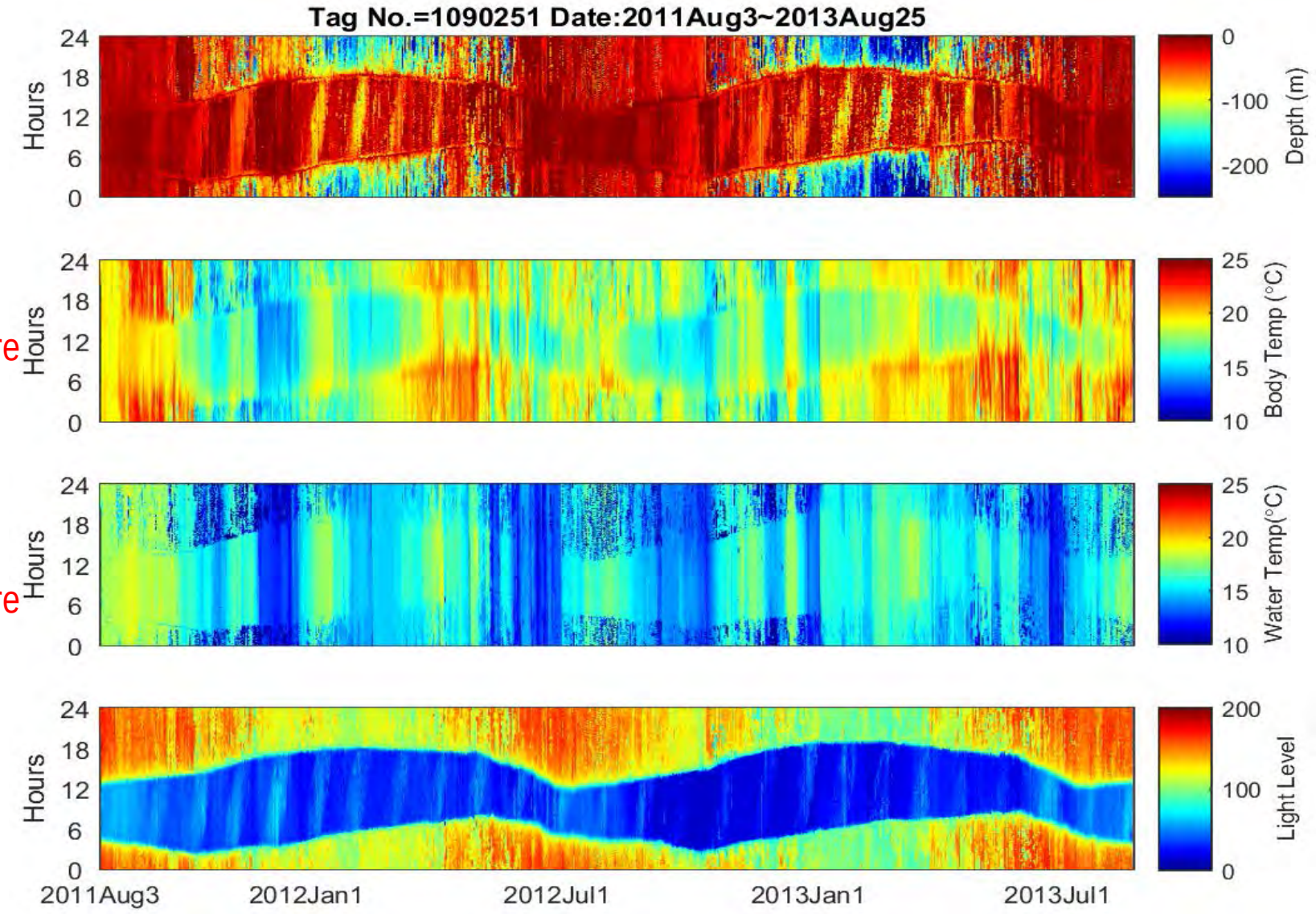
Raw Data

Depth

Body Temperature

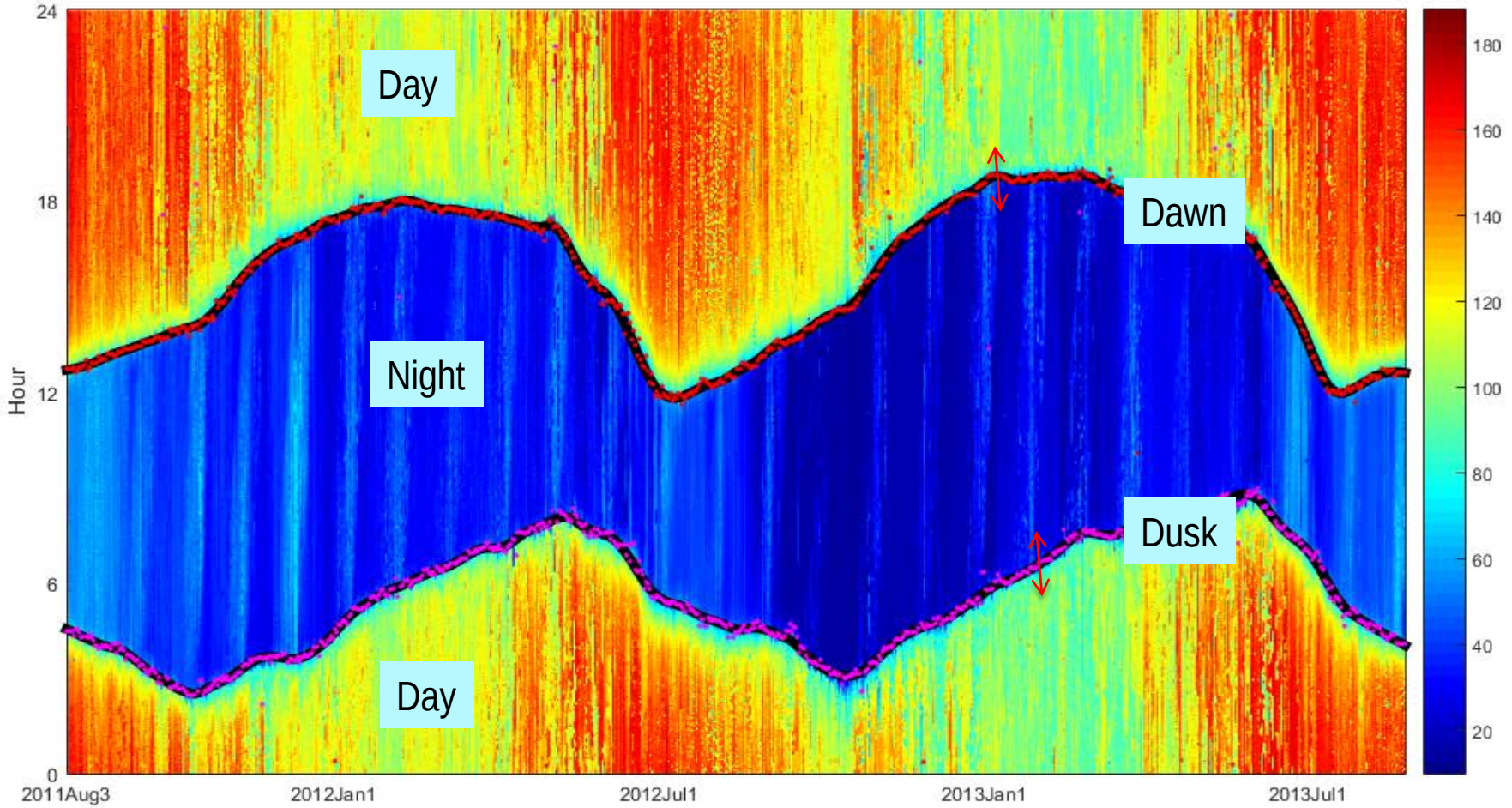
Water Temperature

Light Level



Estimate Sunrise/Sunset from Light level

$$sunrise: \max\left(\frac{dLightLevel}{Dt}\right) \quad sunset: \min\left(\frac{dLightLevel}{Dt}\right)$$

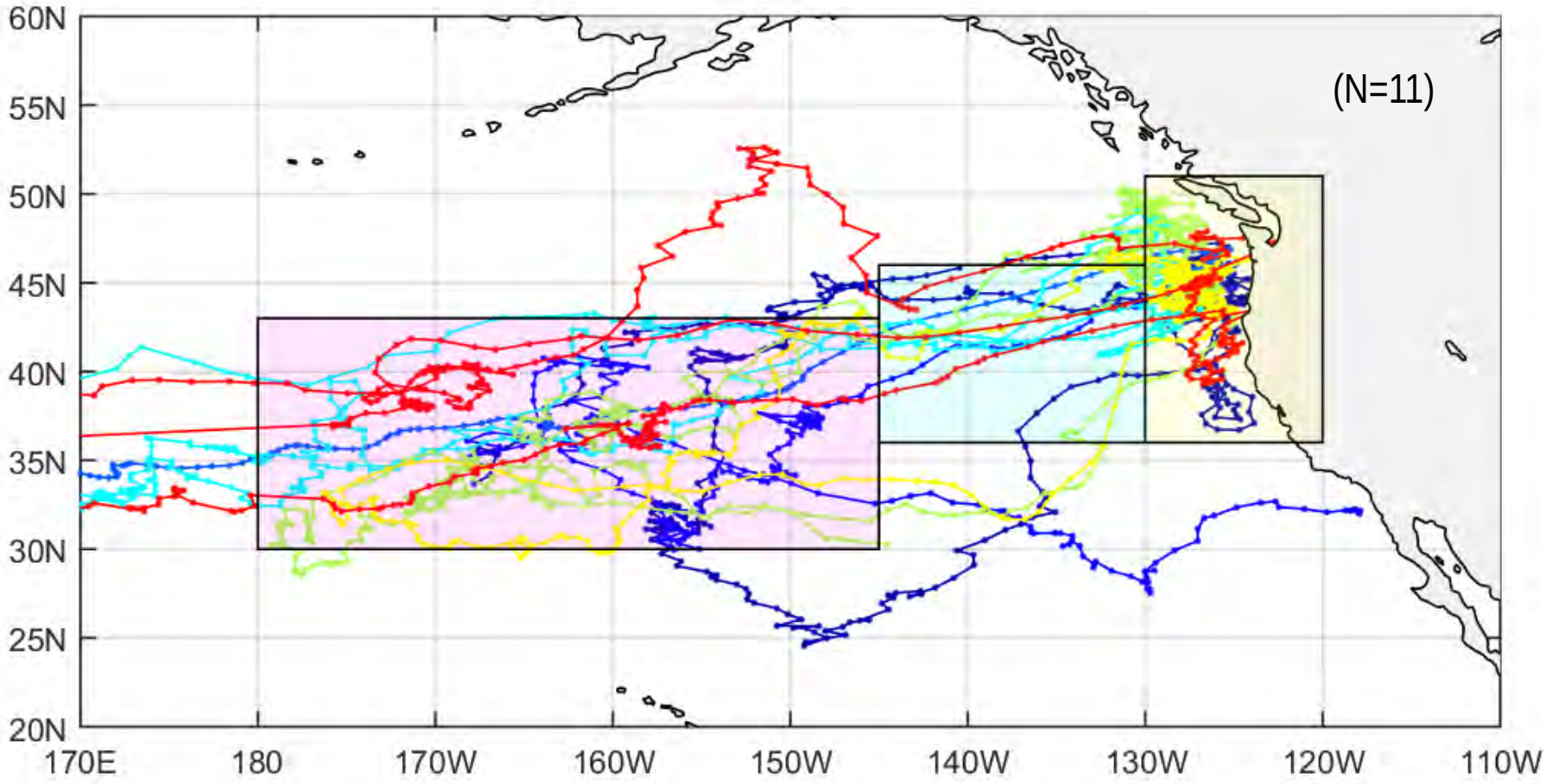


Summary of tags

Tag number	Type	Release			Recover			Days at liberty
		Date	Latitude	Longitude	Date	Latitude	Longitude	
B2381	Lotek	2004/07/01	44.53	-125.63	2005/09/01	45.53	-125.97	428
B2398	Lotek	2004/07/01	44.52	125.62	2005/09/19	45.85	-126.50	446
B2393	Lotek	2004/06/30	44.71	-125.76	2006/05/27	30.30	-144.58	697
0490306	Wildlife	2004/09/13	45.03	-125.28	2005/12/06	33.70	-167.83	450
0690063	Wildlife	2006/08/07	46.10	-124.87	2007/06/29	32.00	-117.92	327
0690065	Wildlife	2006/08/07	46.07	-124.87	2007/05/27	32.5*	-140.1*	294
0690078	Wildlife	2006/10/06	46.11	-125.14	2008/06/26	13	-172	630
D1045	Lotek	2006/08/06	46.02	-124.95	2008/06/16	31.21	-139.34	681
A0394	Lotek	2011/08/03	44.82	-126.35	2012/08/15	46.77	-125.22	379
1090269	Wildlife	2011/08/04	44.85	-126.34	2013/06/26	35.23	143.68	693
A0396	Lotek	2011/08/03	44.89	-126.38	2013/06/16	35.25	145.25	684
1090251	Wildlife	2011/08/03	44.80	-126.35	2013/08/24	46.06	-126.41	753
1190241	Wildlife	2011/10/08	46.51	-124.99	2014/09/03	N/A	N/A	1061

(N=13)

Daily Estimated Geolocations

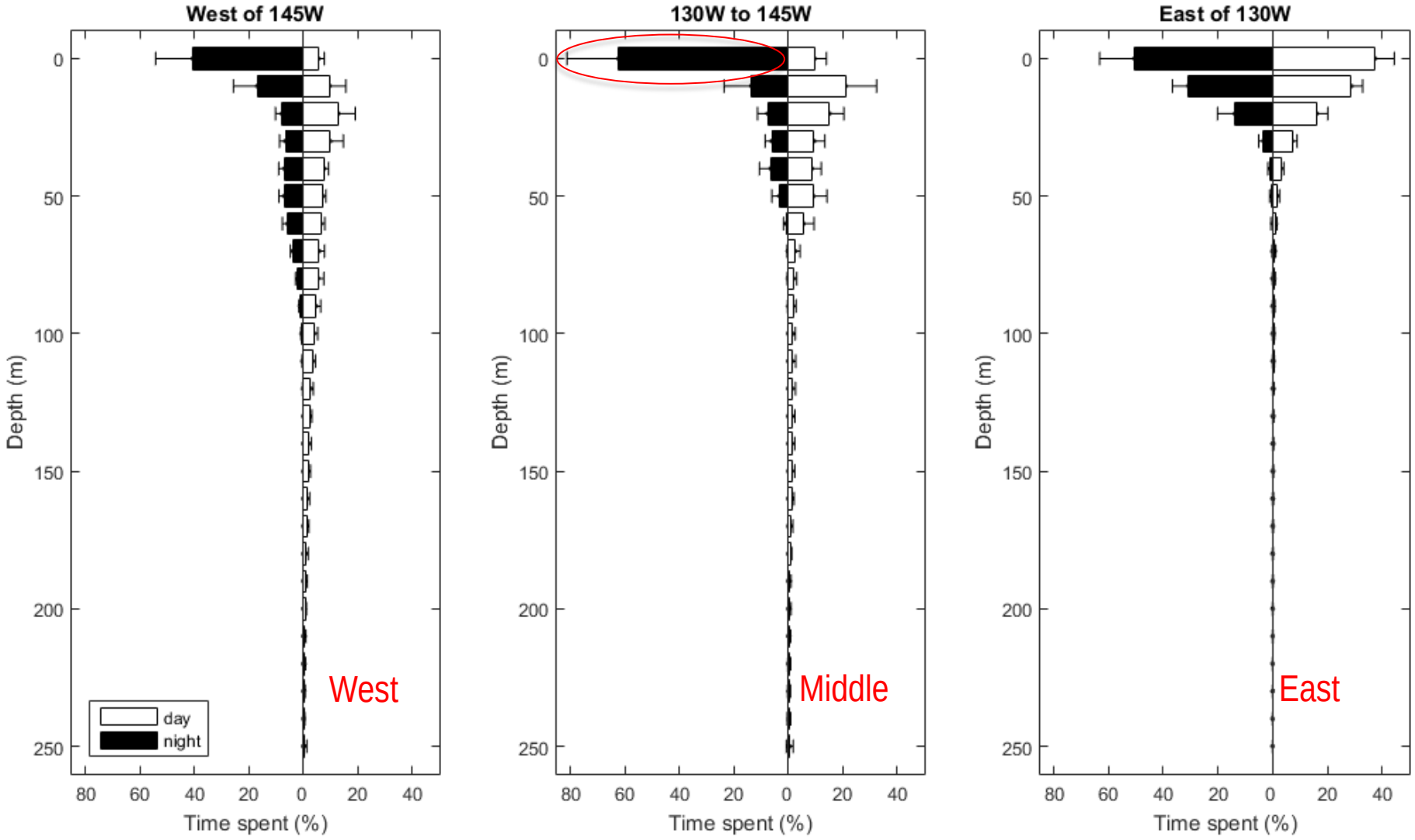


Results

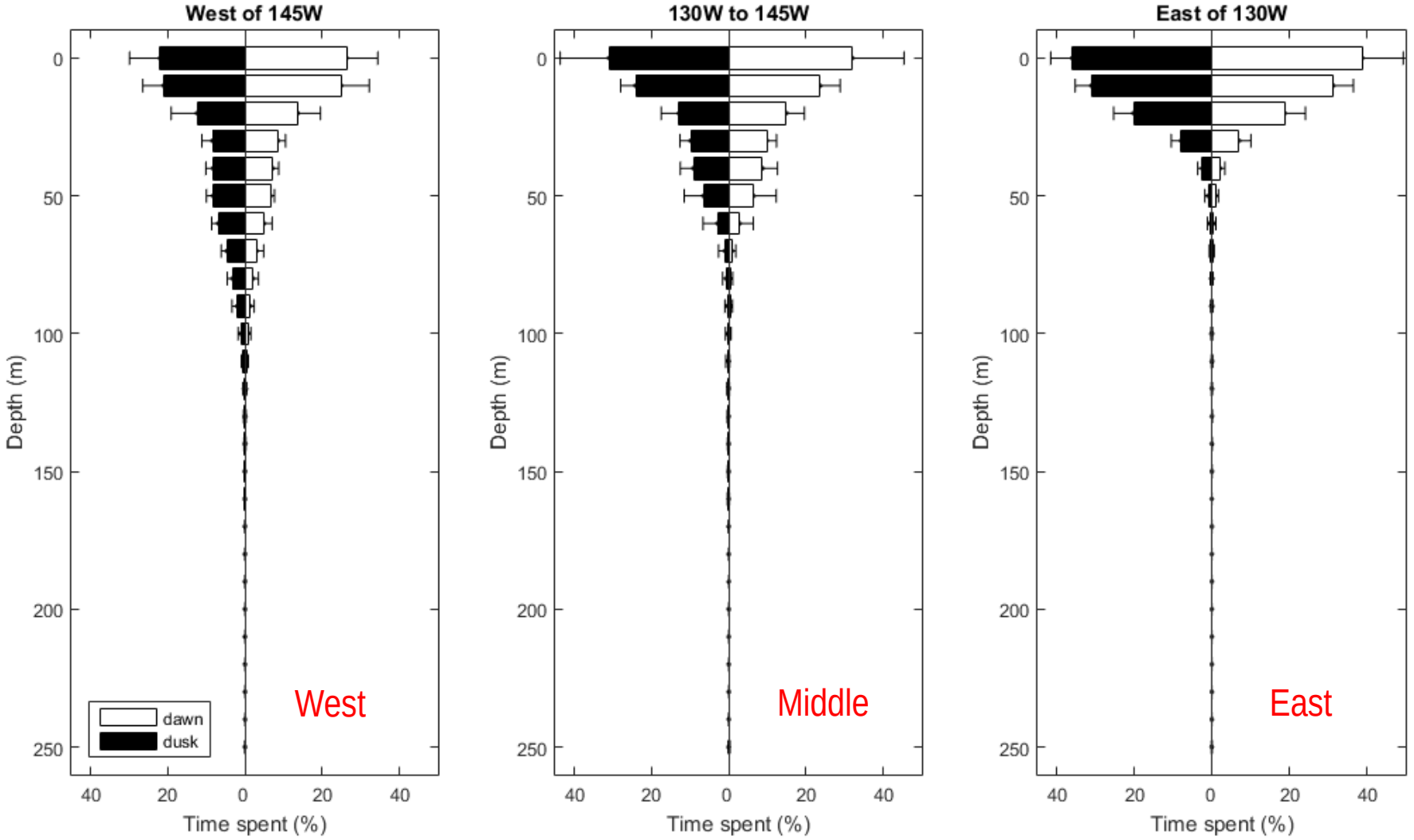
- Percentage of time in vertical water columns (day/night)
- Percentage of time in vertical water columns (dawn/dusk)
- Ambient Water Temperature
- Body Temperature
- Average Horizontal Daily Speed
- Average Cumulative Vertical Daily Speed

Mean Percentage of Time Spent at Depth during Day/Night

n=11

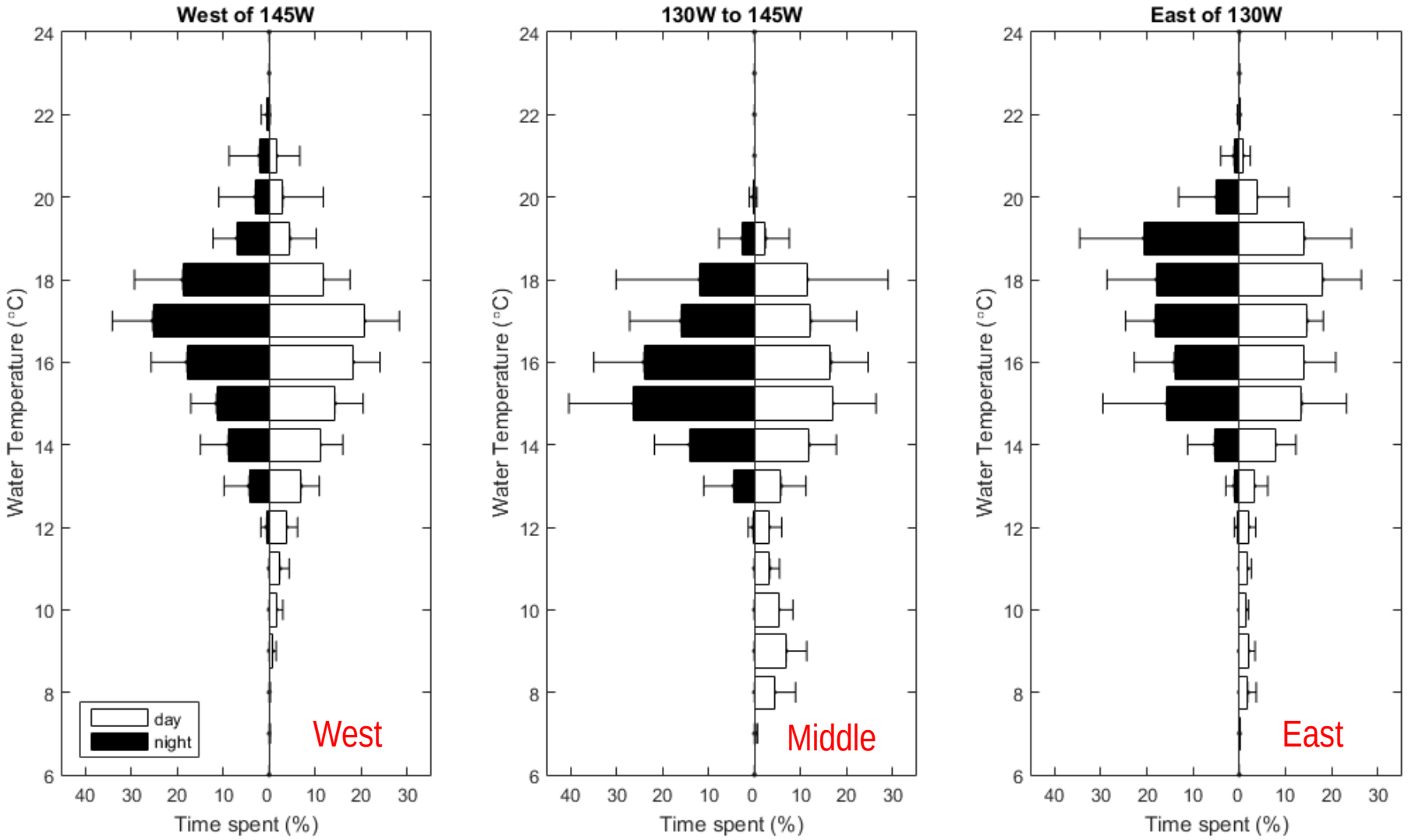


Mean Percentage of Time Spent at Depth during Dawn/Dusk

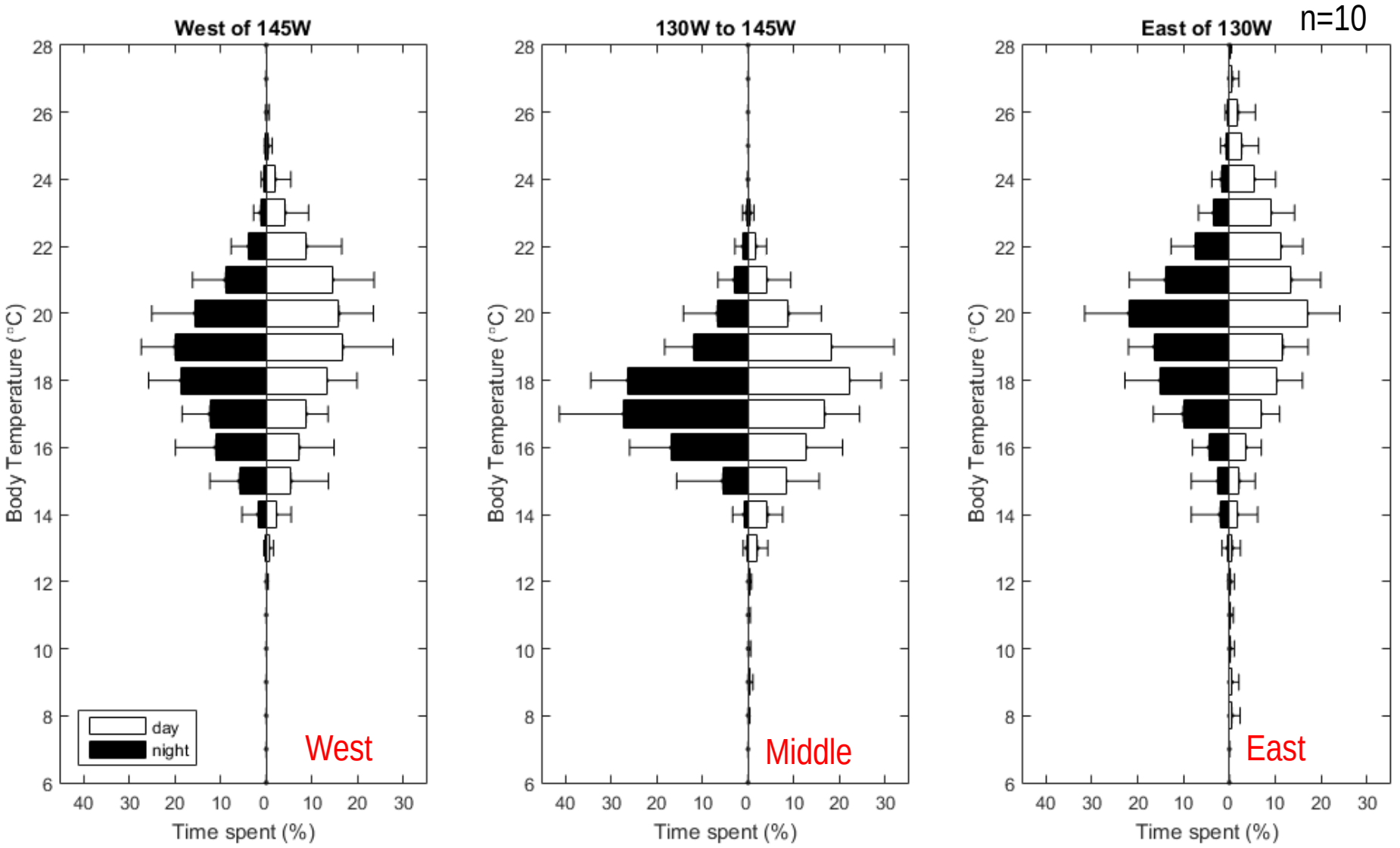


Ambient Water Temperature

n=10



Body Temperature



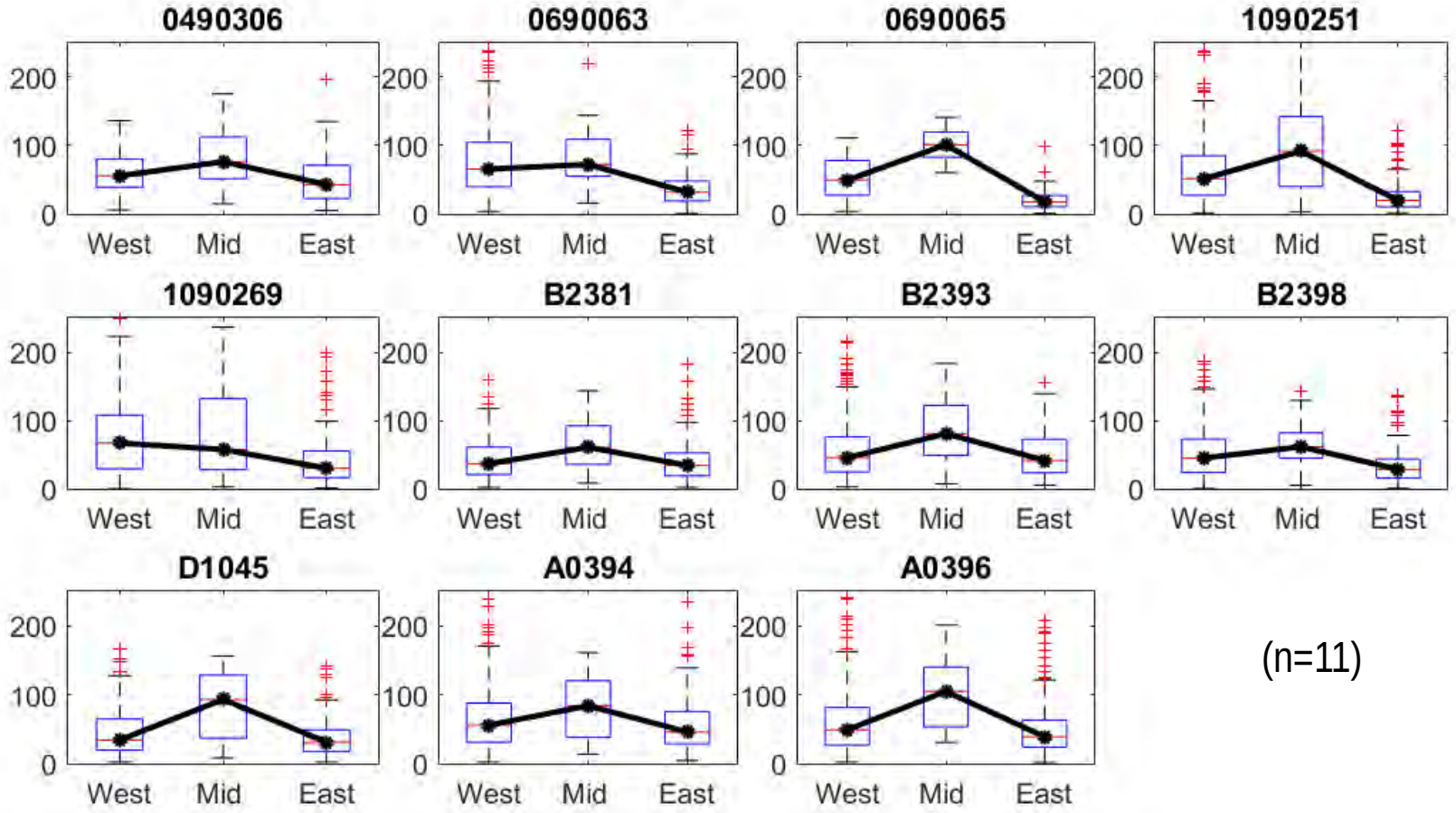
Average Water & Body Temperature

Temperature (°C) Mean±SD	West of 145W (West)	130W to 145W (Middle)	East of 130W (East)
Water (daytime)	**15.28±2.00**	**13.89±2.57**	**16.67±3.41**
Water (nighttime)	**16.14±1.57**	**15.29±1.20**	**17.41±2.55**
Body (daytime)	**18.61±1.83**	**17.05±1.75**	**19.52±2.30**
Body (nighttime)	**17.92±1.65**	**17.07±1.30**	**18.78±1.69**

- The average ambient water temperature is cooler in the middle region.
- The averaged body temperature in the middle region is cooler than western and eastern region.

Horizontal Daily Speed

Region	West of 145W (West)	130W to 145W(Middle)	East of 130W(East)
Average Horizontal Speed (km/day) Mean±SD	50.45±10.31	80.31±16.40	32.70±8.96



(n=11)

Data Analysis

Fit data to generalized linear mixed-effects model (GLME)

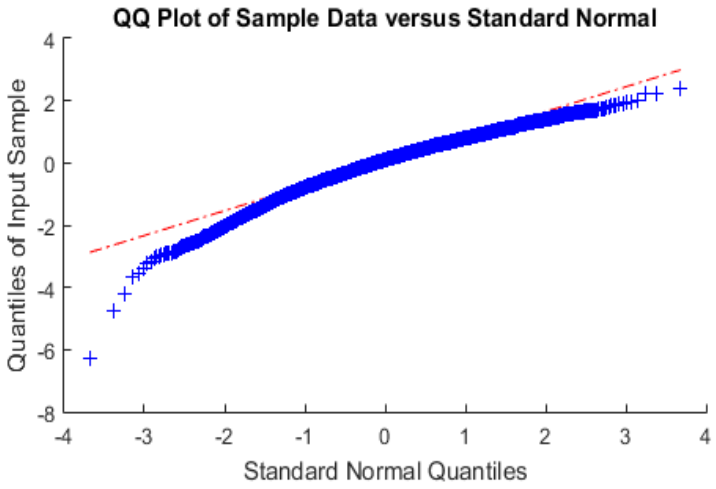
	Model Formula	Intercept	Area_ mid	Area_ east	AIC	BIC	Log Likelihood	Deviance	Dispersion
All Fish	log(speed)~1+area+fish	3.98	0.42	-0.35	10922	11011	-5446.9	10894	0.86
All Fish	log(speed)~ 1+area+fish+area:fish	3.99	0.28	-0.34	10811	11028	-5371.6	10743	0.85
All Fish	log(speed)~1+area+ (1|fish)	3.75	0.42	-0.35	10946	10977	-5467.8	10936	0.86
All Fish	log(speed)~1+area+ (area|fish)	3.78	0.40	-0.41	10857	10921	-5418.7	10837	0.85

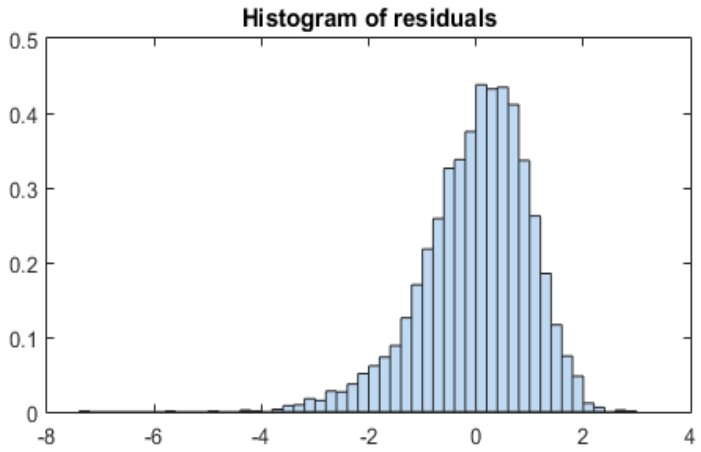
All the model showed similar results.

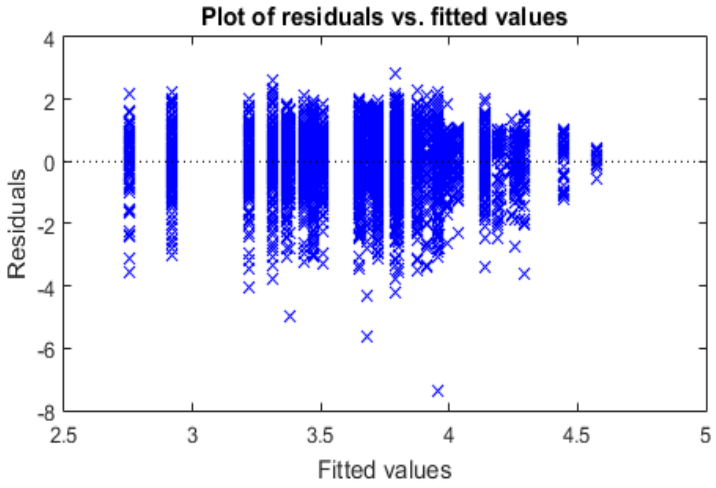
Model log(speed)~ 1+area+fish+area:fish shows the minimum AIC and maximum log-likelihood.

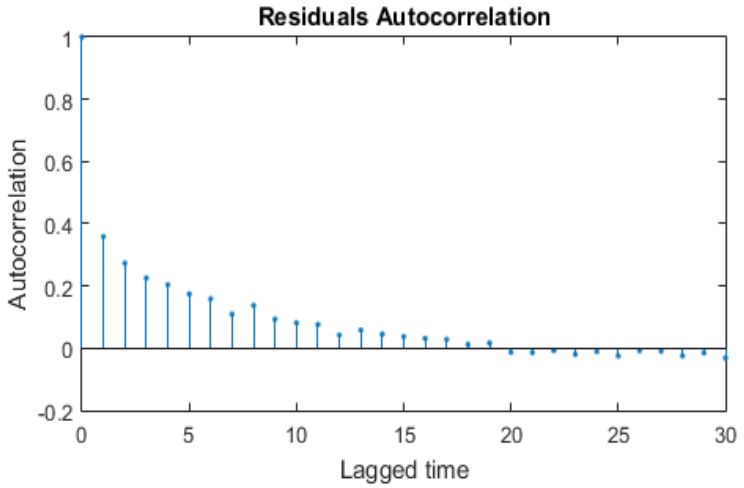
Model Diagnostics

log(speed)~1+area+fish+area:fish

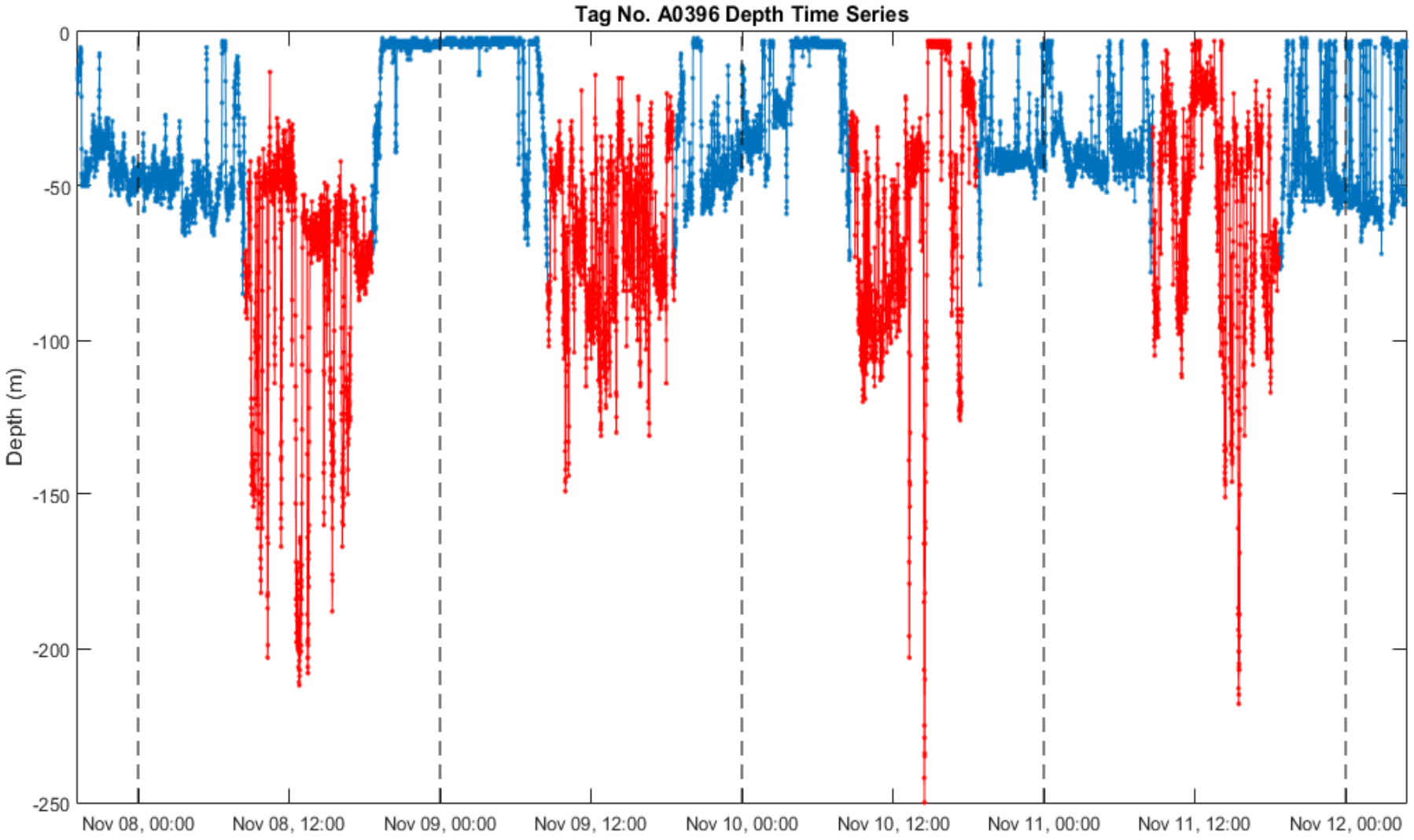








Cumulative Daily Vertical Speed



Average Cumulative Daily Vertical Speed

Average Speed (km/day) Mean±SD	West of 145W (West)	130W to 145W (Middle)	East of 130W (East)
Daytime	**10.08±3.18**	**9.88±3.99**	**7.03±3.20**
Nighttime	**4.29±1.99**	**2.72±1.56**	**3.08±1.25**

- The average cumulative vertical daily speed in the middle region during daytime is similar to west region and slightly higher than the east region.
- During nighttime, the average speed in the middle region is the slower than the west and east region.

Summary

Middle region characteristics:

- Albacore spent more time in surface waters during night. During daytime, albacore spend more time than the east region, and less time than the west region.
- Ambient water temperature is cooler at night. During daytime, bigger proportion in cold water may due to long distance diving.
- Body and water temperature is cooler both daytime and nighttime.
- The horizontal daily speed is faster than west and east region.
- Cumulative vertical speed during nighttime is slower.

Future work:

- Update geolocation information
- Statistical analyses
- Publication

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How does explicit treatment of spatial variability in environmental conditions affect simulated anchovy recruitment?

Will be presented

October 22nd, 2015