Year-round habitat use of black-footed albatrosses from western North Pacific, and their distribution overlap with fisheries

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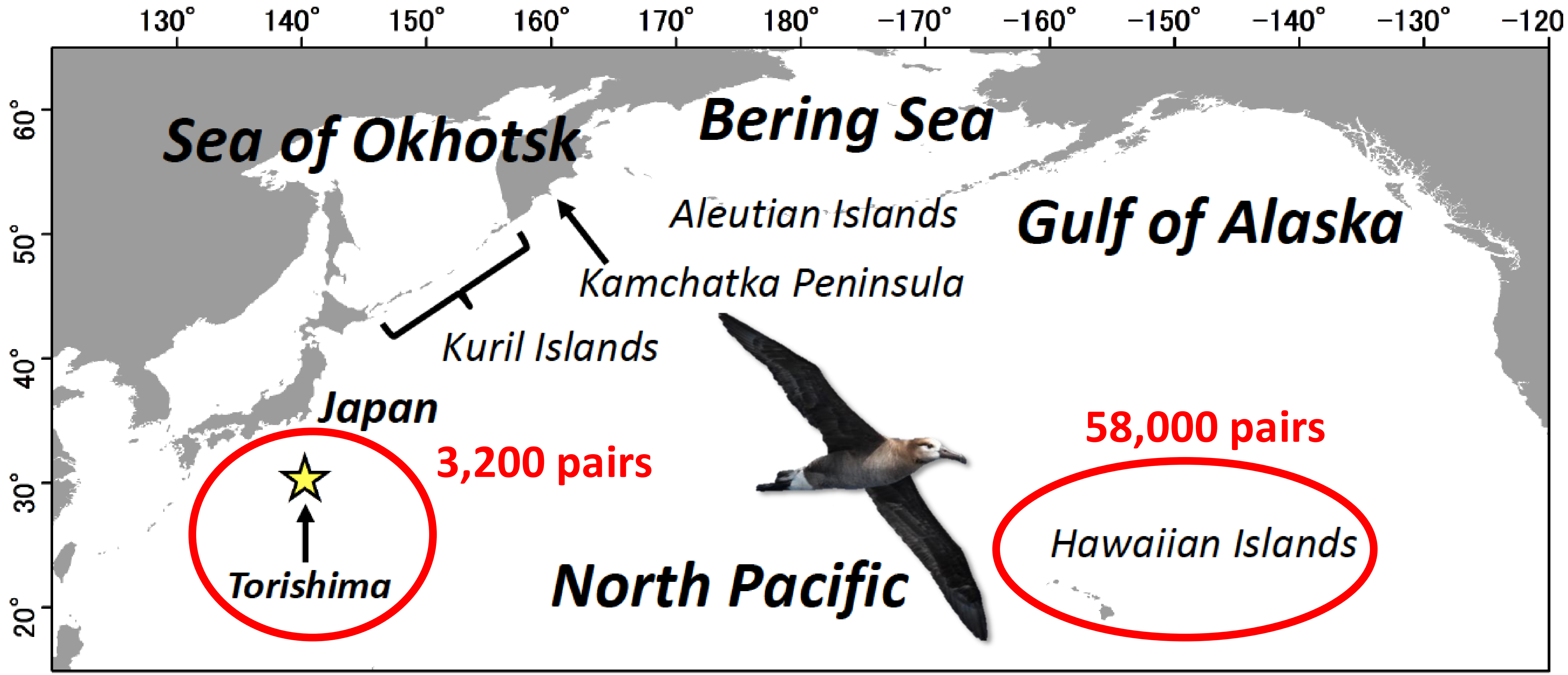
(Nishizawa et al. MEPS in press)

The black-footed albatross breeds in two distinct regions of the North Pacific



- No subspecies, but Japanese and Hawaiian populations are genetically distinctive (Walsh & Edwards 2005, Eda et al. 2008, Ando et al. 2014, Dierickx et al. 2015, Beck et al. 2025)

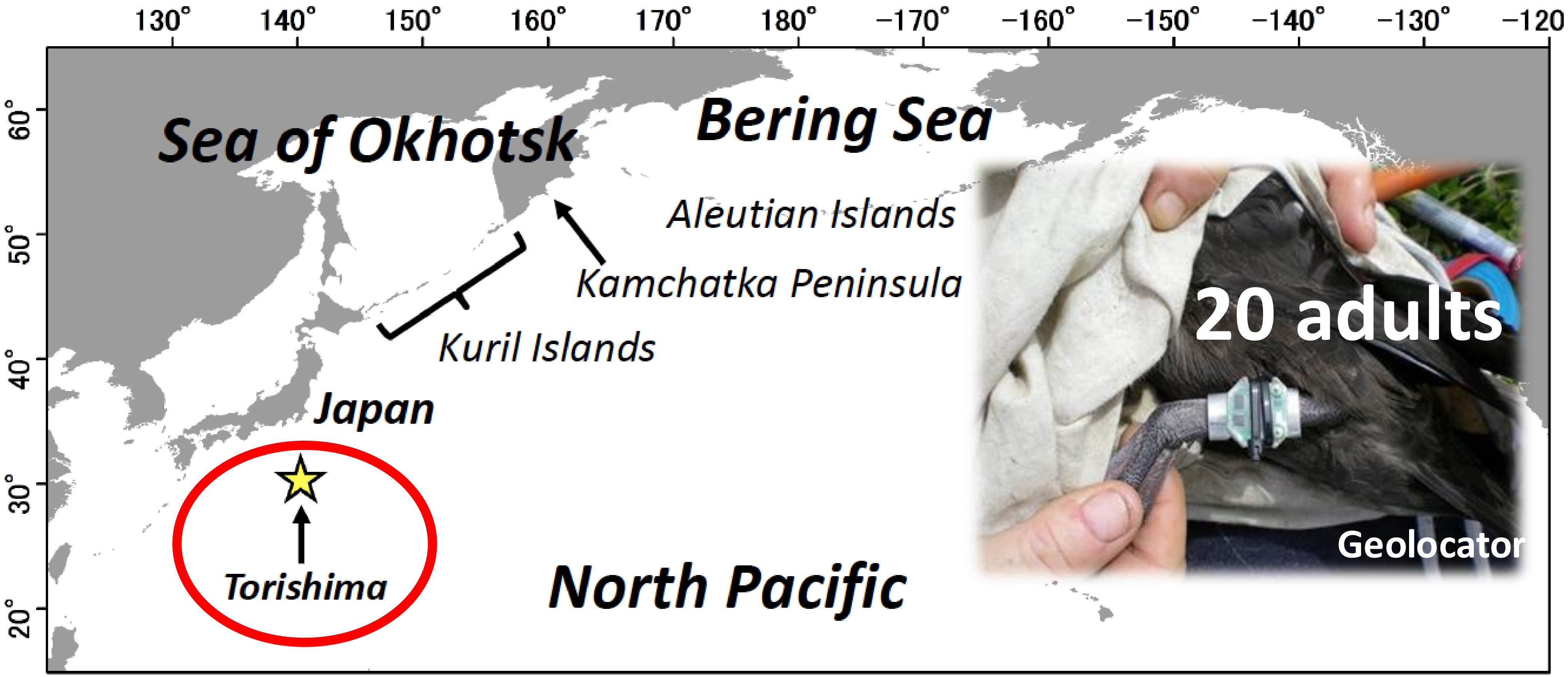
- Numbers in the Hawaiian populations are stable, whereas the Japanese population is increasing (Arata et al. 2009, Suzuki et al. 2019, Sato 2022)

- Large uncertainty remains around the future population trends due to interactions with fisheries (including bycatch) and losses of breeding colonies from effects linked to climate change, as well as from marine pollution (Arata et al. 2009, Bakker et al. 2018). The conservation status has been listed as "Near Threatened" (IUCN 2020)

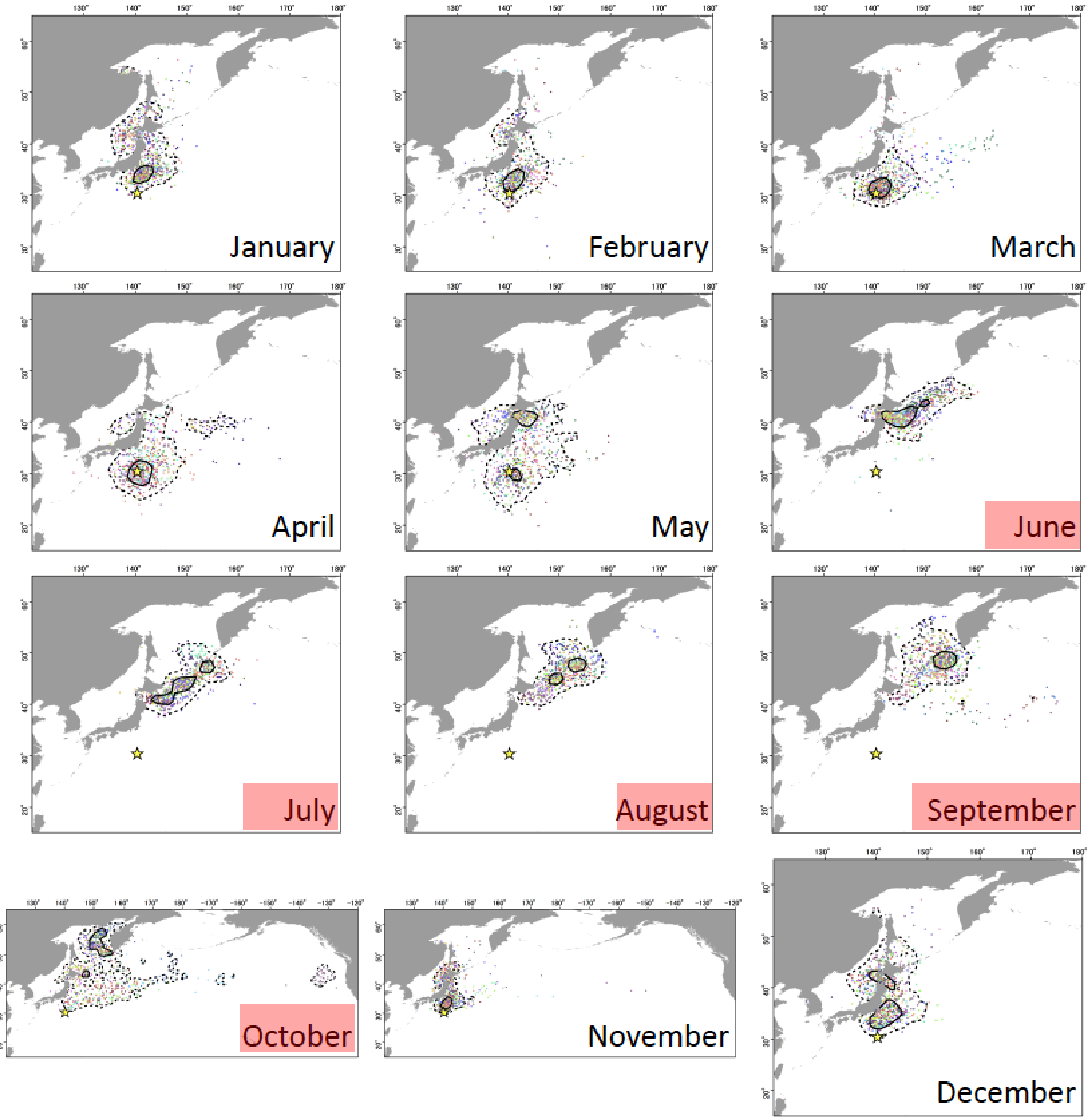
- In the Hawaiian population, at-sea distribution and habitat use during both breeding and nonbreeding periods are well described (Hyrenbach et al. 2002, Kappes et al. 2015, Conners et al. 2015, Antolos et al. 2017, Fischer et al. 2009, Žydelis et al. 2011, Gutowsky et al. 2014, Jordan et al. 2022). Relatively few studies are available on the Japanese population

We studied black-footed albatrosses from the Japanese population and aimed at characterizing

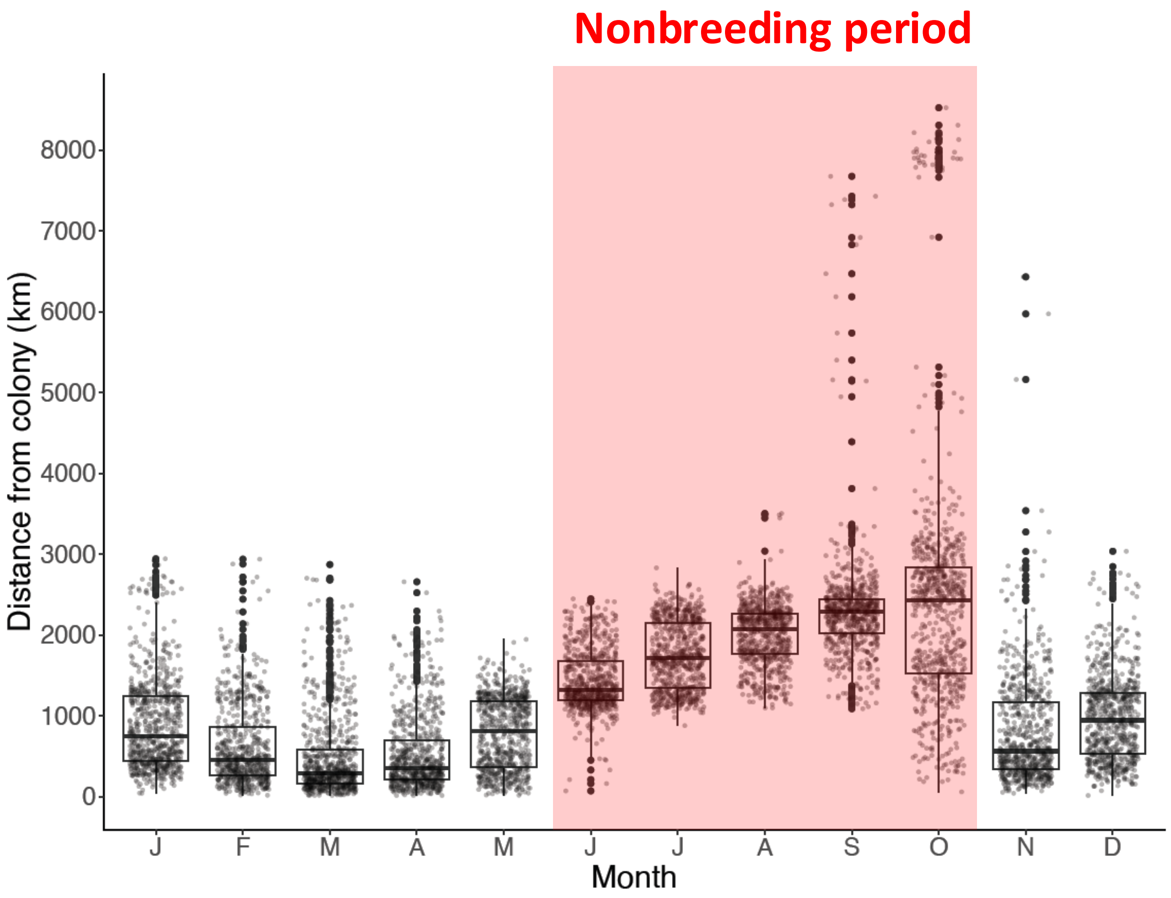
1) the birds' year-round movements, including their nonbreeding distribution areas
2) the marine habitats used during breeding vs. nonbreeding periods
3) the distribution overlap between fisheries and the core areas throughout the annual cycle



Monthly kernel density contours (50% and 95%)

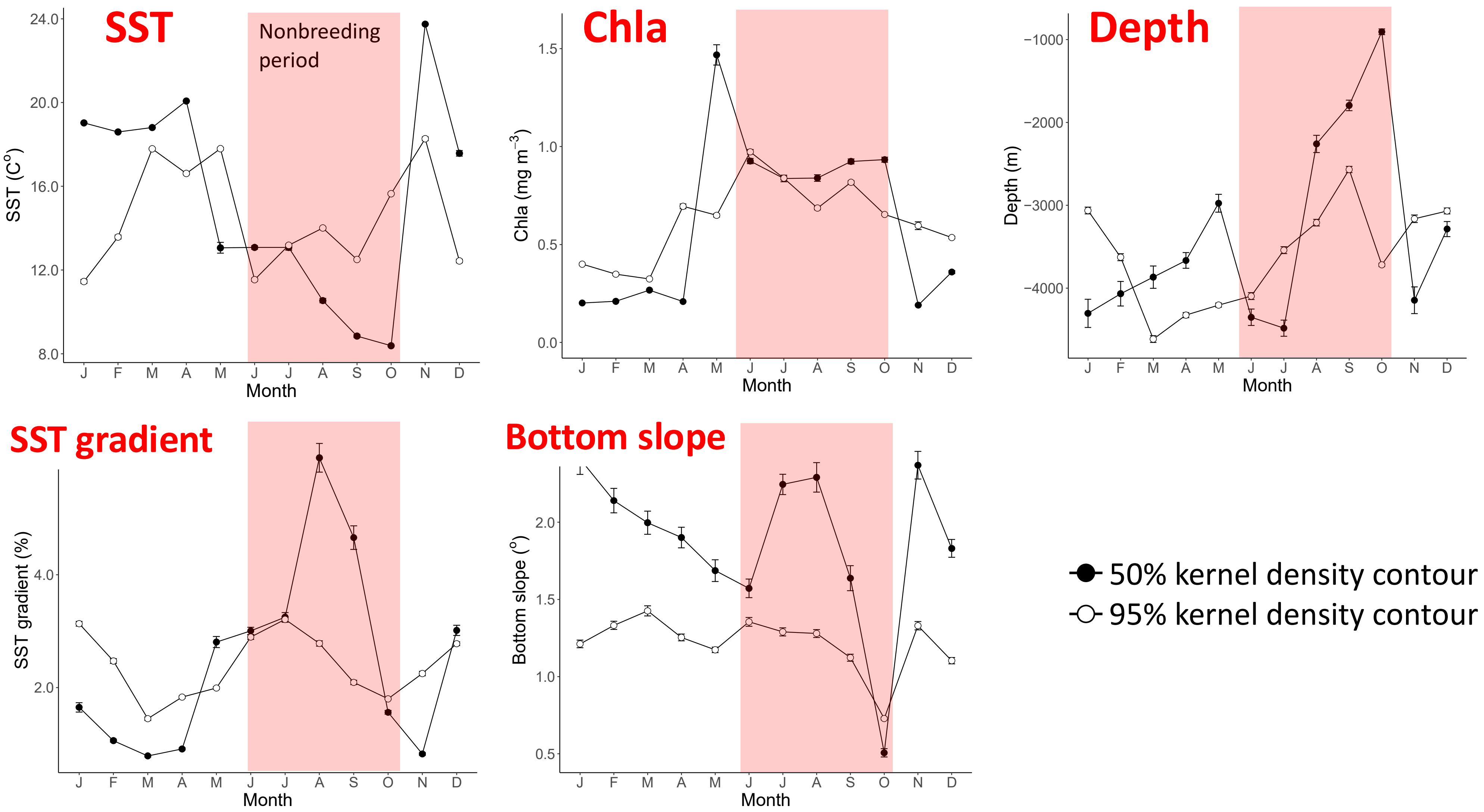


Distance from breeding colony



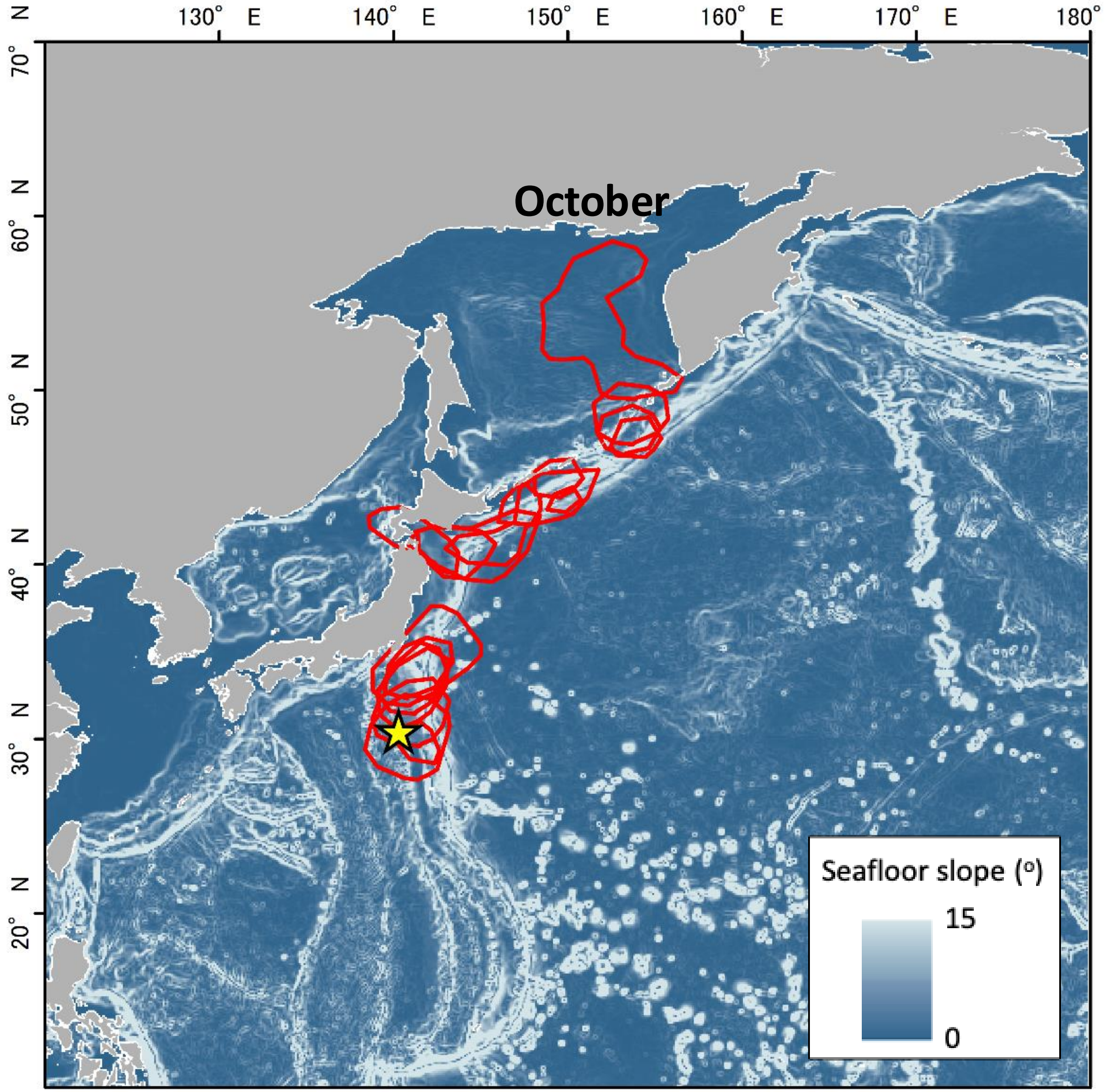
- ✓ Incubation period (Nov-Jan): 888 km
- ✓ Chick-rearing period (Feb-May): 597 km
- ✓ Nonbreeding period: 1980 km

Oceanographic conditions experienced by birds



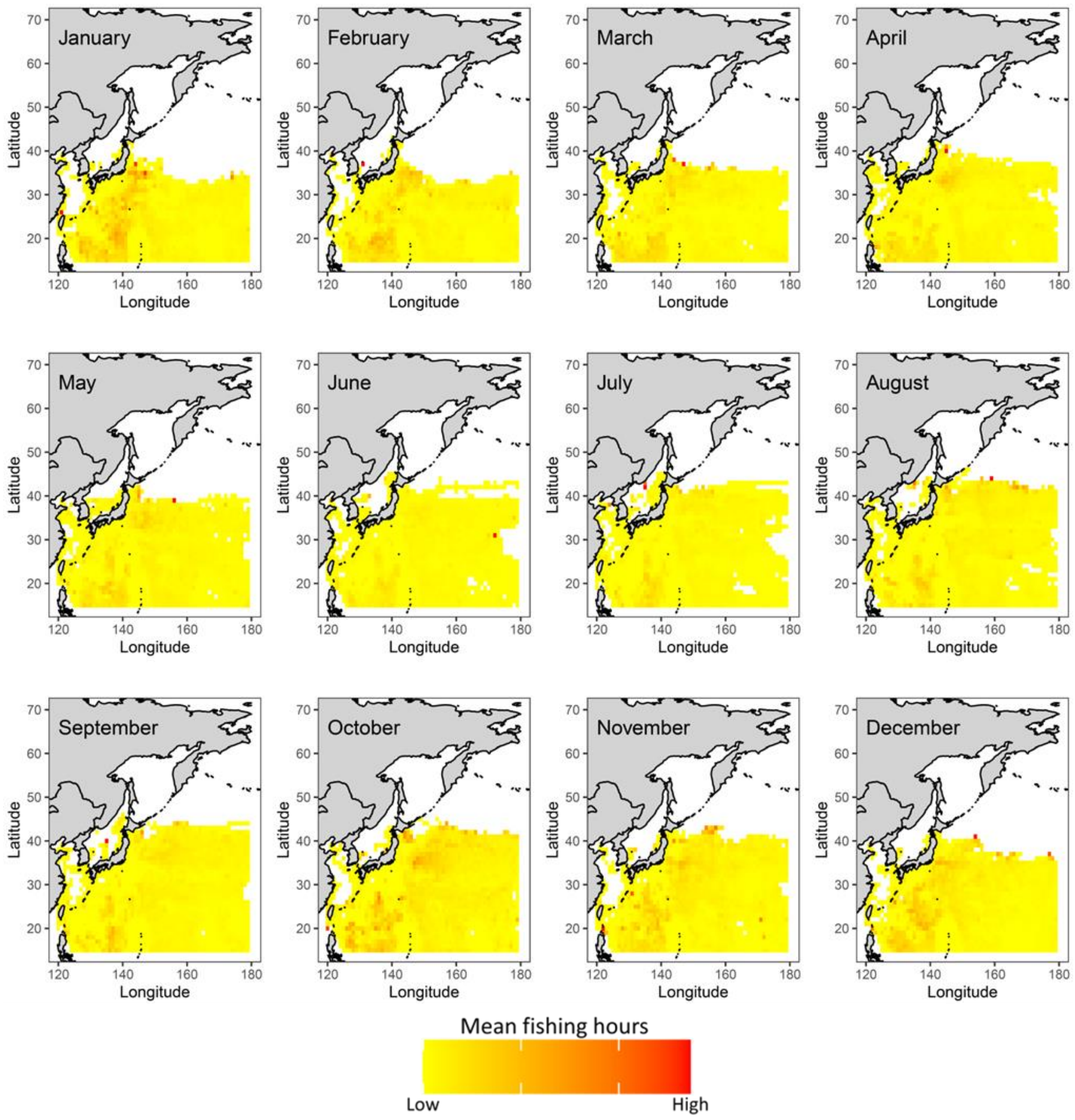
- ✓ During the nonbreeding season, marine habitat was characterized by a **lower SST**, a **higher Chla**, a shallower seafloor depth with a weaker slope, and a **higher SST gradient** than during the breeding season
- ✓ In every month except October, bottom slope the core areas (50% kernel) were significantly steeper than in wider home ranges (95% kernel)

Spatial association between the monthly core areas (50% kernel) and bottom slope

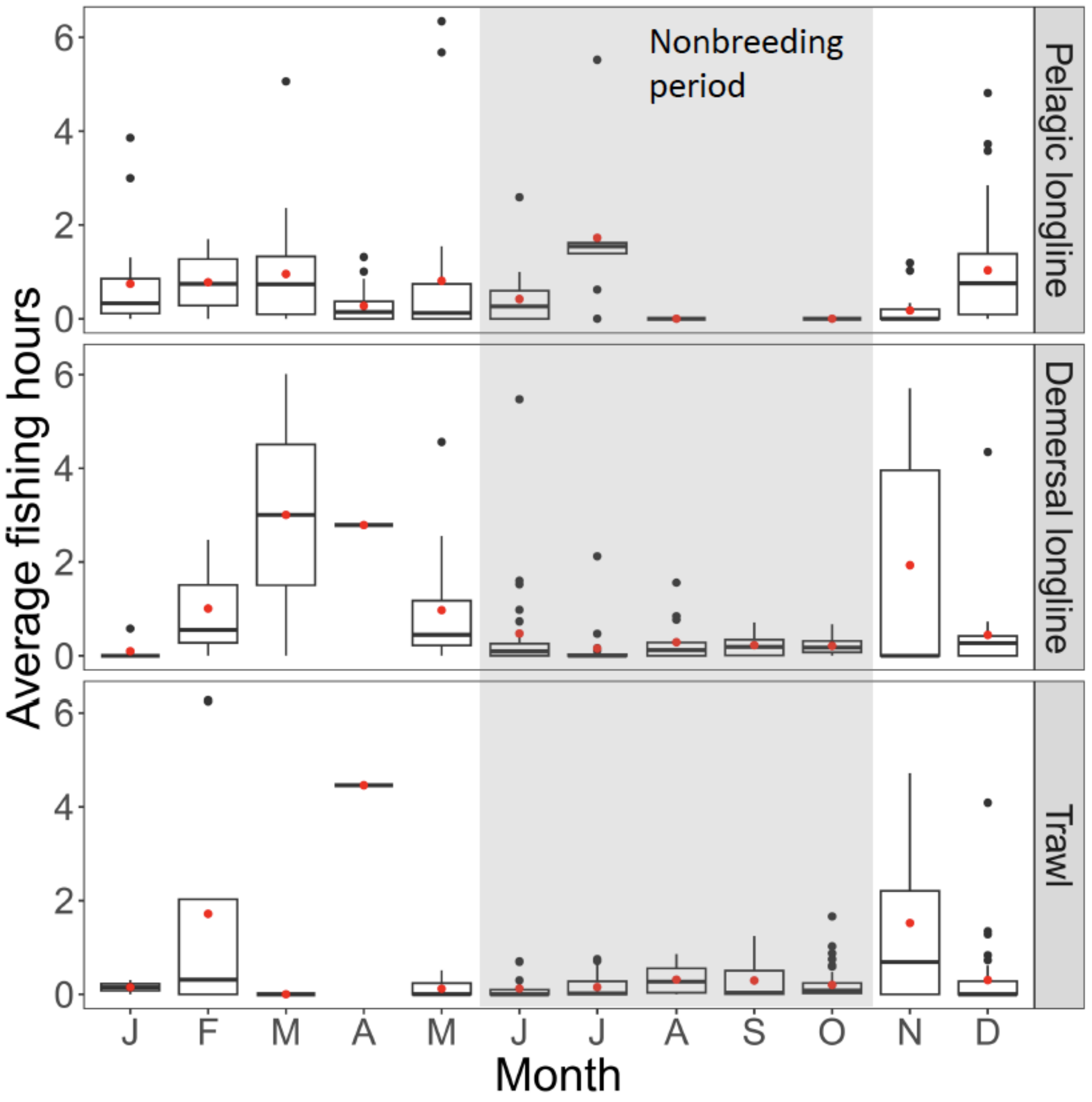


Birds were generally concentrating their distribution in areas with steeper bottom slope

Monthly fishing hours of pelagic longliners during our study period from GFW



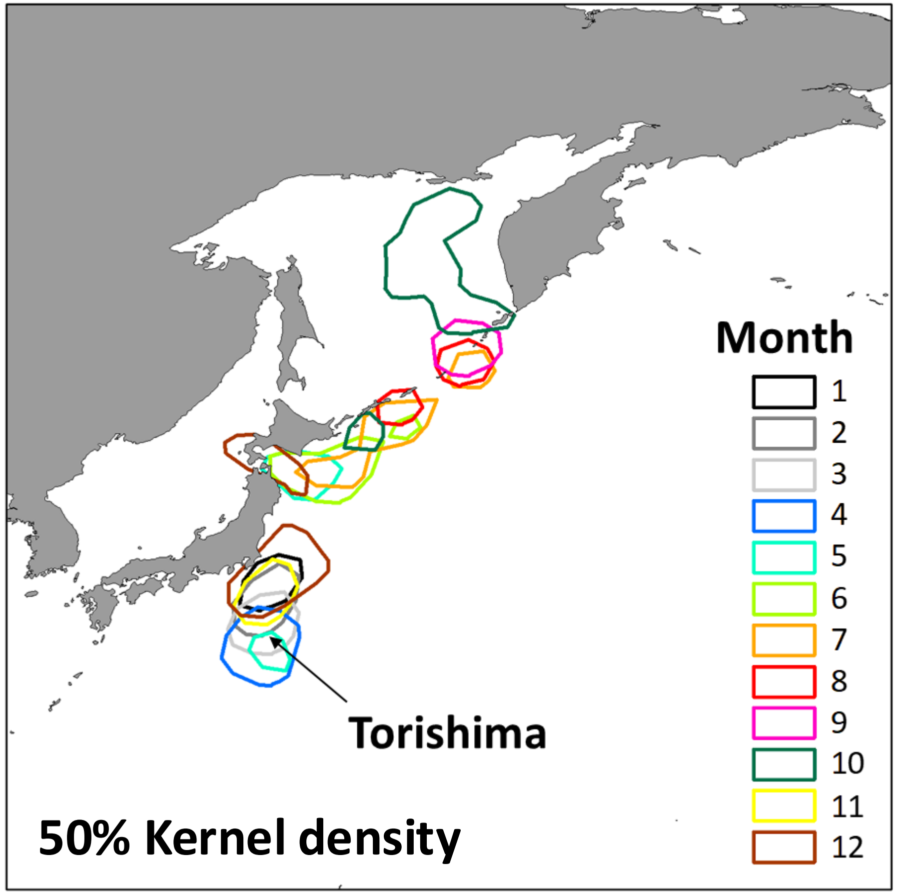
Monthly changes in fishing hours of three geartypes within core areas (50% kernel)



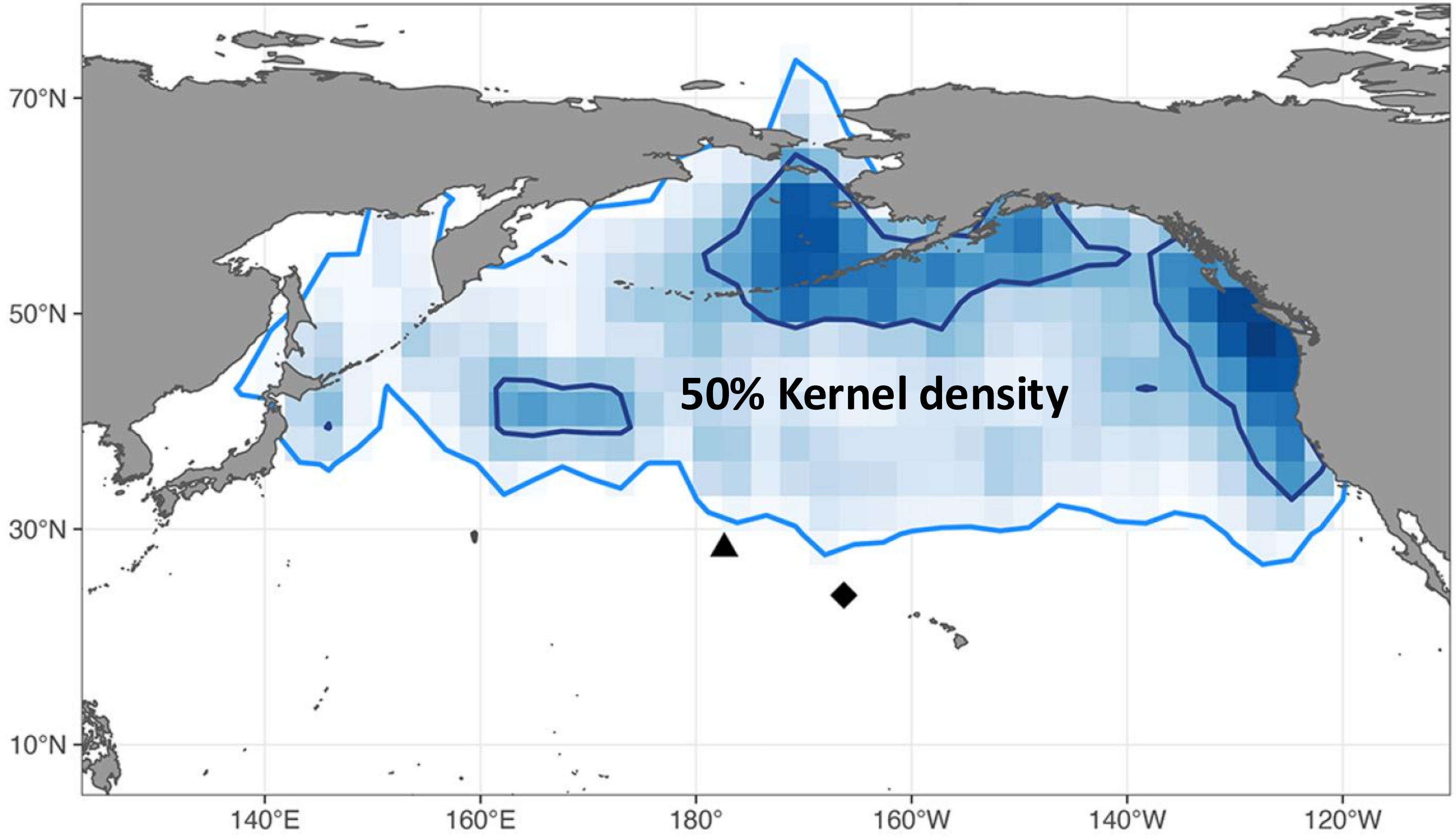
- ✓ **Higher overlap during breeding season**
- ✓ **Pelagic longliners had a higher overlap**

Nonbreeding areas between Japanese vs. Hawaiian populations

Japanese population (This study)



Nonbreeding areas of Hawaiian populations (Jordan et al. 2022)



Throughout the nonbreeding period, our birds did not use the Aleutian Islands, the Gulf of Alaska, and the Bering Sea, which are core nonbreeding areas for the Hawaiian population

Summary

- We provide year-round movements and nonbreeding destinations of black-footed albatrosses from a western North Pacific colony. We also quantified the habitat use and their spatial overlap with fishing activities throughout the annual cycle.

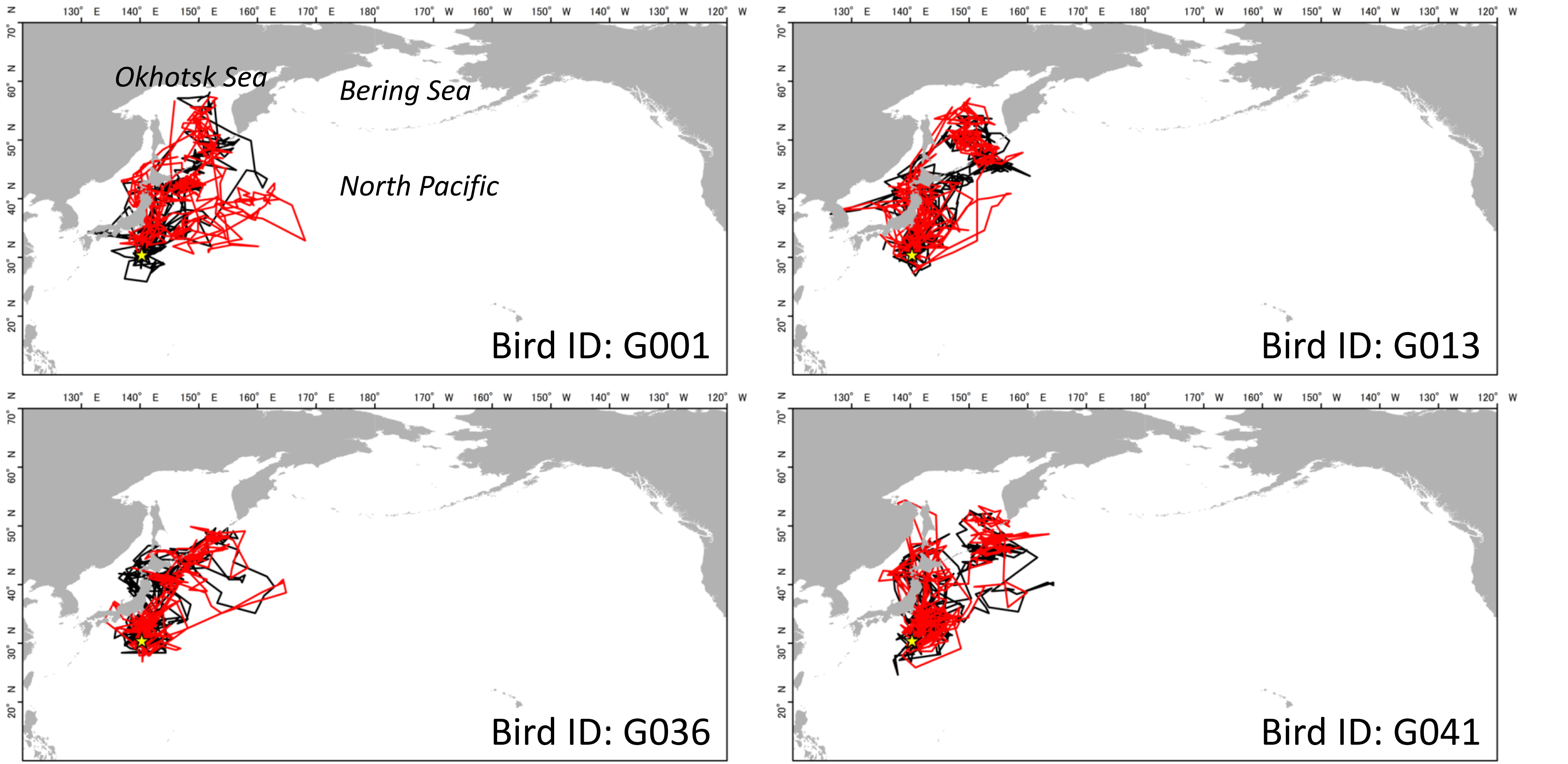
- During the breeding period, the birds were distributed in neritic waters off the Pacific coast of central Japan, while during the post-breeding period, they used neritic waters around the Pacific coast of northern Japan, Kuril Islands, and the Sea of Okhotsk.

- Birds during the nonbreeding period might concentrate their foraging activity at more profitable and predictable bathymetric and hydrographic features.

- The birds' at-sea distribution overlapped more intensively with industrial fishing fleets, especially pelagic longliners, during the breeding period than during the nonbreeding period.

- Currently 15 of the 22 albatross species are threatened with extinction due mainly to bycatch mortality associated with fishing activities (Anderson et al. 2011, Phillips et al. 2016, Dias et al. 2019). Our study highlight the importance of assessing the population-specific dynamic patterns of bycatch risk to develop adequate conservation strategies for such wide-ranging marine organisms.

Repeat migration of four birds, which were tracked for two consecutive years, between their breeding colony and nonbreeding areas



Similar movement patterns and destinations, indicating individual consistency in migratory patterns over years

List of 20 black-footed albatrosses tracked with geolocators between 2015 and 2019 from breeding colony of Torishima, Japan. Four birds (G001, G013, G036, and G041) were tracked for two consecutive years.

Bird ID	GLS model	First year tracked	Second year tracked
G001	MK3006	March 2015 - February 2016	February 2016 - February 2017
G002	MK3006	February 2015 - February 2016	NA
G003	MK3006	March 2015 - February 2016	NA
G006	MK3006	March 2015 - February 2016	NA
G008	MK3006	February 2015 - February 2016	NA
G009	MK3006	March 2015 - February 2016	NA
G010	MK3006	March 2015 - February 2016	NA
G011	MK3006	March 2015 - February 2016	NA
G012	MK3006	March 2015 - March 2016	NA
G013	MK3006	February 2015 - February 2016	February 2016 - February 2017
G014	MK3006	March 2015 - March 2016	NA
G018	MK3005	February 2016 - February 2017	NA
G023	MK3005	February 2016 - February 2017	NA
G034	MK3006	February 2017 - March 2018	NA
G035	MK3006	February 2017 - February 2018	NA
G036	MK3006	February 2017 - February 2018	February 2018 - February 2019
G037	MK3006	February 2017 - February 2018	NA
G038	MK3006	February 2017 - February 2018	NA
G041	MK3006	February 2017 - February 2018	Febeuary 2018 - February 2019
G044	MK3006	February 2017 - February 2018	NA

Environmental variables within 50% (core area) and 95 % (home range) kernel density contours between breeding (November to May) and nonbreeding (June to October) periods. Values are represented as mean±SD. Results of Mann-Whitney U test are also shown

Variables	50% kernel			95% kernel		
	Breeding	Nonbreeding	p	Breeding	Nonbreeding	p
SST (^{o}C)	18.38±4.24	10.55±3.19	<0.001	15.52±6.23	14.29±5.47	<0.001
Chla (mg m^{-3})	0.42±0.62	0.90±0.44	<0.001	0.54±0.76	0.74±0.70	<0.001
Depth (m)	-3643±2457	-2560±2359	<0.001	-3761±2217	-3519±2279	<0.001
SST gradient (%)	1.81±2.13	3.02±3.09	<0.001	2.26±2.28	2.24±2.44	0.518
Bottom slope (^{o})	1.99±1.48	1.39±1.49	<0.001	1.24±1.39	0.98±1.26	<0.001