Table S1. Summary of tracked turtles and data periods.

ID	Post-nesting and foraging periods (yyyy/mm/dd)	Days tracked (d)	SCL (mm)	Nesting site	Destination
1	2017/7/9–2018/7/15	372	818	Okinoerabu	ECS
2	2016/6/28–2017/11/21	512	915	Okinoerabu	ECS
3	2018/7/6–2019/1/10	189	804	Okinoerabu	ECS
4	2017/7/16–2018/1/29	198	843	Okinoerabu	ECS
5	2017/7/4–2017/7/13	10	876	Okinoerabu	ECS
6	2016/7/13–2016/11/2	113	860	Okinoerabu	CMJ
7	2017/8/27–2017/12/20	116	870	Ichinomiya	CMJ
8	2016/7/1–2016/8/16	47	785	Okinoerabu	NPO
9	2016/6/22–2016/10/13	114	784	Ichinomiya	NPO
10	2016/7/8–2017/12/10	521	798	Okinoerabu	NPO

ECS, CMJ, and NPO represent the East China Sea, the coastal area of mainland Japan, and the North Pacific Ocean, respectively.

Table S2. Summary of dive types in the three migration types of loggerhead turtles. The recordable maximum dive depth limit of the abstracted SRDL data is 340 m; however, there was a 379.5-m dive from detailed dive data collected from ID 2. This table does not include the results of detailed ID 2 dives, see Fig. S1.

		Neritic		Oceanic
		ECS	CMJ	NPO
Type 1	n	912	762	66
	mean ± SE (m)	103.5 ± 0.9	36.0 ± 0.6	38.8 ± 3.1
	max–min (m)	180–3	120–3	80–3
Type 2	n	431	161	458
	mean ± SE (m)	29.0 ± 1.8	24.4 ± 1.7	24.3 ± 2.0
	max–min (m)	240–7	220–7	340–7
Type 3	n	1507	264	811
	mean ± SE (m)	23.9 ± 0.6	21.8 ± 0.9	21.3 ± 0.7
	max–min (m)	150–6	80–7	200–6
Type 4	n	2551	718	2742
	mean ± SE (m)	4.1 ± 0.0	4.2 ± 0.0	4.1 ± 0.0
	max–min (m)	18–3	6–3	6–3
Type 5	n	1299	183	2098
	mean ± SE (m)	24.8 ± 0.5	20.4 ± 0.9	23.8 ± 0.4
	max–min (m)	130–7	85–7	240–7

Table S3. Diel dive duration of dive types in the three migration types of loggerhead turtles.

		Neritic				Oceanic	
		ECS		CMJ		NPO	
		day	night	day	night	day	night
Type 1	n	702	210	450	312	46	20
	mean ± SD (min)	**42.9 ± 21.0**	38.2 ± 22.2	57.4 ± 49.7	**82.3 ± 48.7**	**42.7 ± 21.3**	23.5 ± 16.3
Type 2	N	325	106	88	73	259	199
	mean ± SD (min)	4.5 ± 6.1	**8.7 ± 8.5**	6.2 ± 5.8	7.2 ± 6.6	5.2 ± 8.0	4.1 ± 5.8
Type 3	N	387	1120	114	150	299	512
	mean ± SD (min)	33.3 ± 30.1	37.7 ± 29.7	28.7 ± 38.0	29.5 ± 28.8	26.6 ± 19.7	**43.4 ± 28.9**
Type 4	n	1051	1500	280	438	797	1945
	mean ± SD (min)	3.8 ± 6.9	**8.4 ± 10.0**	3.7 ± 5.9	**7.3 ± 6.9**	3.9 ± 6.7	**7.9 ± 15.0**
Type 5	N	1005	294	127	56	1537	561
	mean ± SD (min)	**22.1 ± 20.6**	19.2 ± 16.9	20.6 ± 20.9	21.9 ± 17.1	**26.3 ± 19.8**	19.1 ± 18.1

Bold values denote significantly longer results between daytime and nighttime.
Descriptions of the statistical analysis are in Text S3.

Text S1. Statement of the retrieved tag data from the turtle, ID 2

The satellite relay data logger deployed onto the ID 2 turtle in 2016 was physically retrieved when she came back to the same nesting beach in 2018. Thus, we obtained the continuous depth and water temperature data recorded at 4-s intervals, containing data for 26,964 dives during the period from July 9, 2016, to December 3, 2017. It was possible to measure the dive depth that exceeded the measurement limit of depth and transfer it to the Argos satellite system (>340 m).

This continuous depth profile data revealed that ID 2 dove to 379.5 m in depth with a V-shaped Type 2 dive when approaching Yakushima Island on May 25, 2017 (Figs. S1, S4). The dive to 379.5 m is the deepest dive recorded in loggerheads compared with previous studies (Sakamoto et al. 1990: 233 m, Narazaki et al. 2015: 340 m). The seafloor at this location was at approximately 2,400 m. The roles of such an extraordinarily deep dive are suggested as being for thermoregulation, predator avoidance, and prey detection (Houghton et al. 2008, Okuyama et al. 2021). However, further studies are needed to determine the roles of such extraordinary deep dives.

The ID 2 approached Yakushima and Tanegashima Islands, on which many loggerhead turtles nest, and returned to the ECS without a landing signal (haul-out) in April to May. Kume et al. 2017 reported that the period from April to May is known to be a mating season, in which both adult male and female loggerheads enter the water off Tanegashima Island. These facts suggest that ID 2 might have migrated to this water from her foraging habitat to explore the opportunity for mating but was unsuccessful.

Literature cited

Kume M, Ishihara T, Parker D, Balazs GH (2017) Habitat use of sea turtles in the coastal waters around Tanegashima Island, Kagoshima Prefecture. Umigame Newsletter of Japan 105:2–10

Houghton JDR, Doyle TK, Davenport J, Wilson RP, Hays GC (2008) The role of infrequent and extraordinary deep dives in leatherback turtles (*Dermochelys coriacea*). J Exp Biol 211:2566–2575 https://doi.org/10.1242/jeb.020065

Narazaki T, Sato K, Miyazaki N (2015) Summer migration to temperate foraging habitats and active winter diving of juvenile loggerhead turtles Caretta caretta in the western North Pacific. Mar Biol 162:1251–1263 https://doi.org/10.1007/s00227-015-2666-0

Okuyama J, Benson SR, Dutton PH, Seminoff JA (2021) Changes in dive patterns of leatherback turtles with sea surface temperature and potential foraging habitats. Ecosphere 12:e03365 https://doi.org/10.1002/ecs2.3365

Sakamoto W, Naito Y, Uchida I, Kureha K (1990) Circadian rhythm on diving motion of the loggerhead turtle *Caretta caretta* during inter-nesting and its fluctuations induced by the oceanic environmental events. Nippon Suisan Gakkaishi 56:263–272

Text S2. Correction of the definition of daytime and nighttime

Daytime and nighttime were corrected using each time zone. The time of data collection was corrected to fit each time zone before defining daytime and nighttime as per Okuyama et al. (2021). The times of sunrise and sunset at each data collection point were calculated based on the date and location (latitude and longitude) by following the computation method of Woolf (1968). Daytime was defined as the time duration from sunrise to sunset, while nighttime was from sunset to sunrise.

Literature cited

Okuyama J, Benson SR, Dutton PH, Seminoff JA (2021) Changes in dive patterns of leatherback turtles with sea surface temperature and potential foraging habitats. Ecosphere 12:e03365 https://doi.org/10.1002/ecs2.3365

Woolf HM (1968) On the computation of solar elevation angles and the determination of sunrise and sunset times. NASA Technical Memorandum X-1646. National Meteorological Center, Suitland, Maryland, USA.

Text S3. Seasonal migration and dive behaviors

Two ECS females (ID 2, 3) changed their dive types along with their seasonal migration. They engaged mostly in Type 5 dives at the northern part of the ECS before migrating to the southern ECS, where they increased the proportion of Type 1 dives (Figs. 6a, b). They increased the proportion of Type 5 dives again when they returned to the northern area the following summer (Fig. 6a). Similarly, the CMJ turtle (ID 7), which utilized the northern part of the coastal area of the mainland, showed a seasonal change in her dive behavior patterns (Fig. 6c). She mostly spent the time performing Type 1 and 4 dives during September and October in the northern part of the coastal area, while she engaged predominantly in Type 1 dives in the southern part during November.

Text S4. Depth utilization change and thermoclines

Depth utilization of dives to the water column (Type 5) changed chronologically in the individuals in the ECS and NPO. For instance, the monthly dive depth of Type 5 in ID 2 migrating to the ECS significantly changed throughout the tracking period (July 2016 to October 2017) (one-way ANOVA, $F_{15,\,665}$ = 16.7, P < 0.001). The mode depth of Type 5 of ID 2 ranged from 0 to 90 m (Fig. 7a). Temperature–depth profiles obtained from ID 2 showed strong thermoclines which occurred between 30 and 60 m in the regions where ID 2 stayed from June to October; however, there were no clear thermoclines observed during November to May (Fig. 7a). When the thermoclines clearly occurred (June to October), ID 2 deliberately utilized the narrow range of depth by Type 5 dives just above or in the thermoclines, with a wider range of depth when clear thermoclines were not observed (November to May) (Fig. 7a). In the NPO, the monthly dive depth of Type 5 by ID 10 significantly changed throughout the tracking period (July 2016 to November 2017) (one-way ANOVA, $F_{16,\,1734}$ = 26.8, P < 0.001). The mode depth of Type 5 in ID 10 ranged from 10 to 90 m (Fig. 7b). Temperature−depth profiles obtained from ID 10 showed gradual thermoclines that occurred at depths between 30 and 70 m in the regions where ID 10 stayed during June to November; however, there were almost no thermoclines observed during December to May (Fig. 7b). When the thermocline occurred (June to November), ID 10 utilized a wider range of depths above or in the thermoclines, while she utilized shallow waters (<30 m) when the thermoclines were not clearly observed during December to May (Fig. 7b). The mean water temperature experienced by the loggerhead turtles was 20.7 ± 4.0 (mean ± SD), 21.9 ± 3.0, and 20.3 ± 2.9 ℃ for ECS, CMJ, and NPO turtles, respectively.

Text S5. Statistical analysis of the mean dive duration of each dive type

The mean duration of Type 1 dives was significantly long during the daytime for the ECS and NPO turtles but was long at night for the CMJ turtles (likelihood ratio test, ECS: χ^2 = 4.9, P = 0.03, CMJ: χ^2 = 36.5, P < 0.001, NPO: χ^2 = 12.1, P < 0.001, Table S3). Type 3 dives were significantly long at night for the NPO turtles (ECS: χ^2 = 3.6, P = 0.06, CMJ: χ^2 = 0.0, P = 0.98, NPO: χ^2 = 70.1, P < 0.001). Type 5 dives were significantly long during the daytime for the ECS and NPO turtles (ECS: χ^2 = 6.3, P = 0.01, CMJ: χ^2 = 0.1, P = 0.70, NPO: χ^2 = 56.2, P < 0.001). Type 2 and 4 dives were shorter than other dives; however, Type 4 dives were long at night in all habitats (ECS: χ^2 = 147.7, P < 0.001, CMJ: χ^2 = 50.1, P < 0.001, NPO: χ^2 = 52.1, P < 0.001).

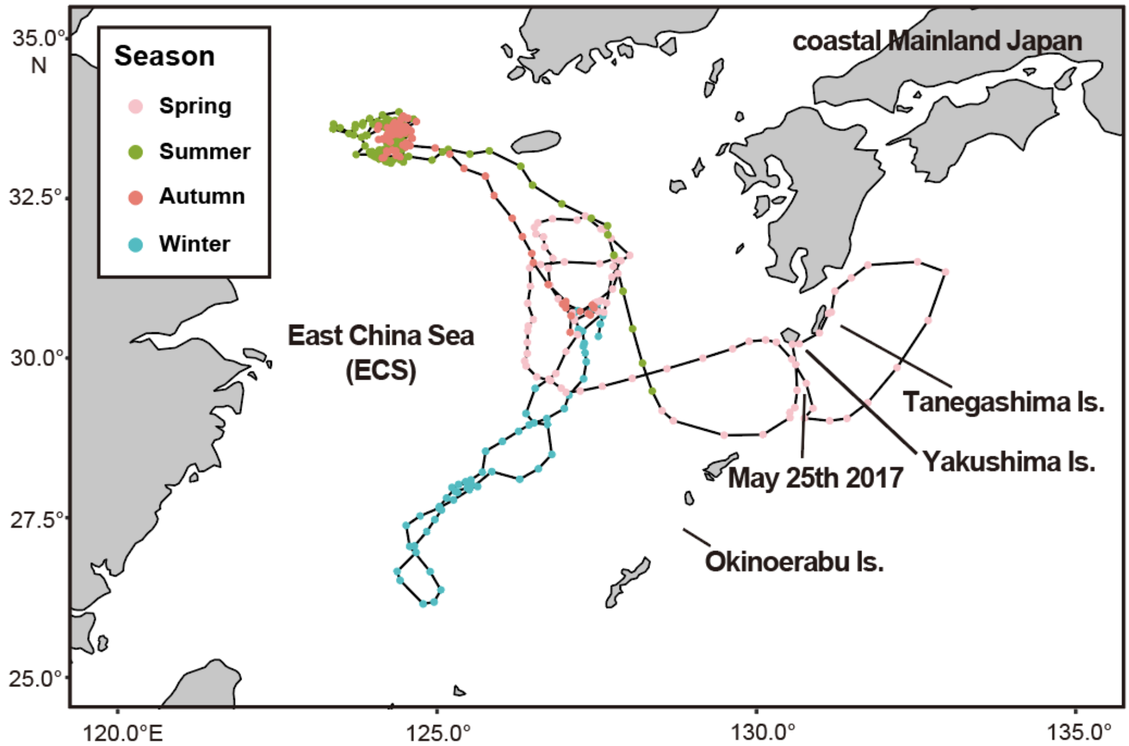

Fig. S1. Trajectory of the seasonal migration by a female utilizing the East China Sea in 2017 (ID 2). The colors represent the seasons during tracking periods. March–May, June–August, September–November, and December–February were defined as spring, summer, autumn, and winter, respectively.

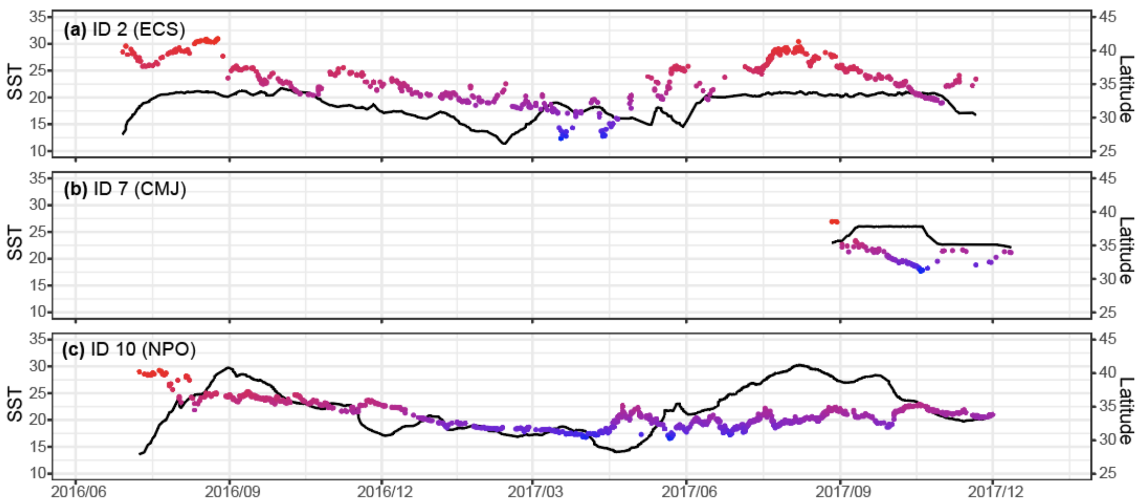

Fig. S2. Relationship between SST (°C) and latitude of the tracking path. The points colored from red to blue show SSTs, and the black solid lines show latitudes. The neritic females (ID 2, 7) undertook southward migration when the SST decreased to approximately 20 °C, while there was no clear association between the seasonal migration of the oceanic female (ID 10) and water temperature.

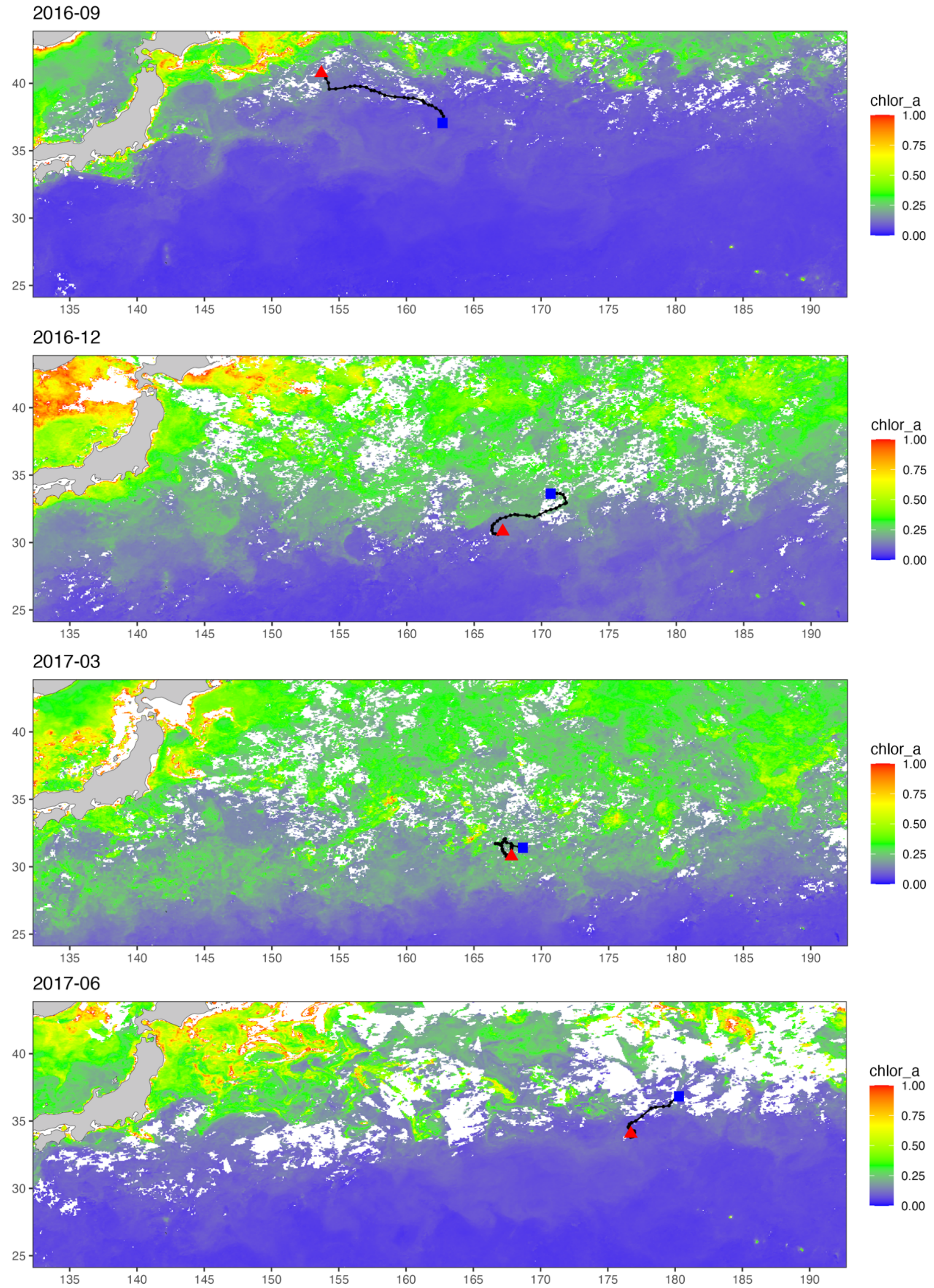

Fig. S3. Snapshots of monthly movement on the oceanic female (ID 10) with monthly average chlorophyll a (mg/m^3) from September 2016 to June 2017. Red triangles represent starting points on the first day of the subject month, and blue squares represent ending points on the last day

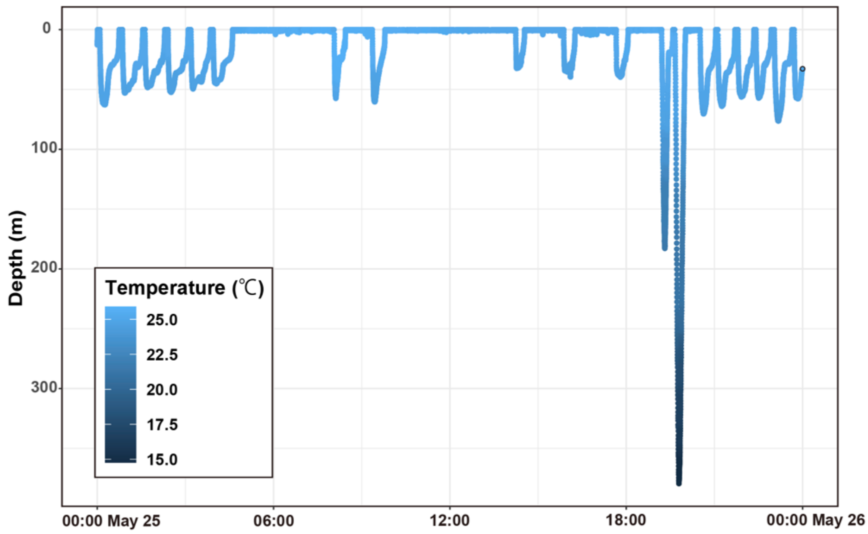

Fig. S4. Continuous depth profile of a female turtle (ID 2) when the maximum dive depth throughout the entire dive data in this study was recorded.