



```

41 lambda[1] ~ dunif(0, 1)
42 lambda[2] <- 1 - lambda[1]
43 b[1] ~ dcat(lambda[])          # assign b for t=1
44
45 # scaling parameter for estimation error, accounts for diffs. among tags
46 logpsi ~ dunif(-10, 10)
47 psi <- exp(logpsi)
48
49 # Priors for first state estimate
50 for(k in 1:2){
51   x[1,k] ~ dt(y[1,k], itau2[1,k], nu[1,k])
52 }
53
54 # Assume simple random walk to estimate 2nd state estimate
55 x[2,1:2] ~ dmnorm(x[1,], iSigma[,])
56
57 # Process model
58 for(t in 2:(RegN-1)){
59
60   phi[t,1] <- alpha[b[t-1]]
61   phi[t,2] <- 1 - alpha[b[t-1]]
62   b[t] ~ dcat(phi[t,])
63
64   Tdx[t,1] <- cos(theta[b[t]]) * (x[t,1] - x[t-1,1]) +
65               sin(theta[b[t]]) * (x[t,2] - x[t-1,2])
66   x.mn[t,1] <- x[t,1] + Tdx[t,1] * gamma[b[t]]
67
68   Tdx[t,2] <- -sin(theta[b[t]]) * (x[t,1] - x[t-1,1]) +
69               cos(theta[b[t]]) * (x[t,2] - x[t-1,2])
70   x.mn[t,2] <- x[t,2] + Tdx[t,2] * gamma[b[t]]
71
72   # predict next state estimate w process error
73   x[t+1,1:2] ~ dmnorm(x.mn[t,], iSigma[,])
74 }
75
76 # Observation model
77 for (t in 2:RegN) {                                # loop over regular time intervals (t)
78   for(i in idx[t-1]:(idx[t]-1)){                  # loop over observed locations within interval t
79     for(k in 1:2){                                  # loop over lon & lat
80
81       # re-scale obs. error
82       itau2.psi[i,k] <- itau2[i,k] * psi
83
84       # reconcile irregular obs. with states
85       zhat[i,k] <- (1-j[i]) * x[t-1,k] + j[i] * x[t,k]
86
87       # update state predictions with observations
88       y[i,k] ~ dt(zhat[i,k], itau2.psi[i,k], nu[i,k])
89     }
90   }
91 }
92 }
93
94

```

## Appendix 2. Additional results

**Table A2-1.** Quantiles of the marginal posterior distributions for the movement parameters  $\theta_k$  and  $\gamma_k$  estimated from each of the nine turtle tracks. The subscripts 1 and 2 index the transiting and foraging behavioural modes, respectively.

Track	$\theta_1$			$\theta_2$			$\gamma_1$			$\gamma_2$		
	0.025	0.5	0.975	0.025	0.5	0.975	0.025	0.5	0.975	0.025	0.5	0.975
A	-0.28	-0.03	0.24	2.76	3.29	3.77	0.62	0.73	0.82	0.22	0.32	0.43
B.1	-0.19	-0.06	0.06	3.10	3.79	4.43	0.61	0.69	0.76	0.19	0.29	0.41
B.2	-0.26	-0.07	0.12	2.68	3.59	4.61	0.64	0.74	0.83	0.18	0.32	0.51
C.1	-0.20	0.05	0.33	1.42	3.21	4.80	0.48	0.57	0.70	0.21	0.42	0.66
C.2	-0.12	-0.04	0.06	2.64	4.11	5.15	0.68	0.75	0.81	0.16	0.28	0.43
D.1	-0.21	-0.01	0.17	2.20	3.02	3.96	0.56	0.65	0.74	0.20	0.33	0.48
D.2	-0.13	-0.02	0.09	3.28	4.53	5.23	0.63	0.70	0.77	0.14	0.24	0.35
E.1	-0.11	0.01	0.13	2.37	3.30	4.16	0.69	0.77	0.85	0.17	0.28	0.41
E.2	-0.19	-0.01	0.18	2.35	2.97	3.62	0.62	0.72	0.81	0.18	0.30	0.44

$\theta_k$ 's are measured in radians.

1 **Figure A2-1.** State estimates ( $\mathbf{x}_t$ 's, filled circles) with associated behavioural mode estimates (blue  
2 = transiting, red = foraging, black = uncertain) obtained from the SSSM for a leatherback turtle  
3 (A) tagged in coastal waters off Nova Scotia, Canada. The full path is shown inset. The underlying  
4 grey line indicates the observed Argos positions. The time interval between the  $\mathbf{x}_t$ 's is 6 h. The  
5 1000 m isobath is displayed as a dashed black line.

6  
7 **Figure A2-2.** Marginal posterior distributions for the movement parameters  $\theta$  (mean turn angle),  
8 and  $\gamma$  (combined turn and speed autocorrelation), in transiting and foraging modes estimated for  
9 turtles A and B (see Fig. 1). The circular histograms are binned MCMC samples from the marginal  
10 posterior distributions of  $\theta_1$  and  $\theta_2$ . Note on the circular histograms that the transiting mode es-  
11 timates are displayed in black and the foraging mode estimates are displayed in grey.

12  
13 **Figure A2-3.** Distributions for travel rates of turtles A and B (see Fig. 1) in transiting and foraging  
14 modes. Note that the travel rates were calculated *a posteriori* from the state estimates. Notches  
15 in the travel rate boxplots show the 95 % confidence limits around the median value.

16  
17 **Figure A2-4.** Temporal histograms of time at depth, dive duration, water temperature, and max-  
18 imum dive depth for turtle A (see Fig. 1). The bins presented on the left vertical axis are the 14  
19 user-defined ranges for each variable. The coloured shingle in each bin indicates percentage of time  
20 or dives observed in that range over a 6-hour period. The time periods are: 2100 - 0300; 0300 -  
21 0900; 0900 - 1500; 1500 - 2100 hours. The labels indicate the mid-point of each bin. Bins shaded  
22 grey indicate no dives were observed in that range for that 6-hr time period. Estimated behavioural  
23 mode  $b_t$  for each 6-hr period is overlaid (solid black line). Estimates less than 1.25 (lower dashed  
24 line) represent transiting (black circles in Fig. 1), estimates greater than 1.75 (upper dashed line)  
25 represent foraging (red circles in Fig. 1), and estimates between the dashed lines are not assigned  
26 to either behavioural mode (the behavioural mode for these time steps could not be estimated with  
27 reasonable certainty, ie.  $1.25 < b_t < 1.75$ ). These uncertain estimates of  $b_t$  correspond with the  
28 black circles in Fig. 1.

29  
30 **Figure A2-5.** Stacked barplots of the proportion of observations within each depth, temperature  
31 or time bin obtained while turtle A was transiting (black) or foraging (grey). The proportion of  
32 observations associated with behavioural modes that could not be estimated with reasonable cer-

33 tainty (see caption Fig. A2-4) are displayed in white. The width of each bin is proportional to the  
34 total number of observations (all behavioural modes) within that range. The labels indicate the  
35 mid-point of each bin. Empty bins indicate no dives were observed in that range for any behavioural  
36 state over the duration of the movement pathway. Proportion of observations in each bin while  
37 foraging can be read from the top down on the right vertical axis. Labels on the colour scale are  
38 mid-points of the bins.

39

40 **Figure A2-6.** Temporal histograms of time at depth, dive duration, water temperature, and maxi-  
41 mum dive depth for turtle E.1 (duty-cycled tag). The bins presented on the left vertical axis are the  
42 14 user-defined ranges for each variable. The coloured shingle in each bin indicates percentage of  
43 time or dives observed in that range over a 6-hour period. The time periods are: 2100 - 0300; 0300  
44 - 0900; 0900 - 1500; 1500 - 2100 hours. The labels indicate the mid-point of each bin. Bins shaded  
45 grey indicate no dives were observed in that range for that 6-hr time period. Estimated behavioural  
46 mode  $b_t$  for each 6-hr period is overlaid (solid black line). Estimates less than 1.25 (lower dashed  
47 line) represent transiting (black circles in Fig. 1), estimates greater than 1.75 (upper dashed line)  
48 represent foraging (red circles in Fig. 1), and estimates between the dashed lines are not assigned  
49 to either behavioural mode (the behavioural mode for these time steps could not be estimated with  
50 reasonable certainty, ie.  $1.25 < b_t < 1.75$ ). These uncertain estimates of  $b_t$  correspond with the  
51 black circles in Fig. 1.

52

53 **Figure A2-7.** Stacked barplots of the proportion of observations within each depth, temperature  
54 or time bin obtained while turtle E.1 was transiting (black) or foraging (grey). The proportion  
55 of observations associated with behavioural modes that could not be estimated with reasonable  
56 certainty (see caption Fig. A2-6) are displayed in white. The width of each bin is proportional to  
57 the total number of observations (all behavioural modes) within that range. The labels indicate the  
58 mid-point of each bin. Empty bins indicate no dives were observed in that range for any behavioural  
59 state over the duration of the movement pathway. Proportion of observations in each bin while  
60 foraging can be read from the top down on the right vertical axis. Labels on the colour scale are  
61 mid-points of the bins.

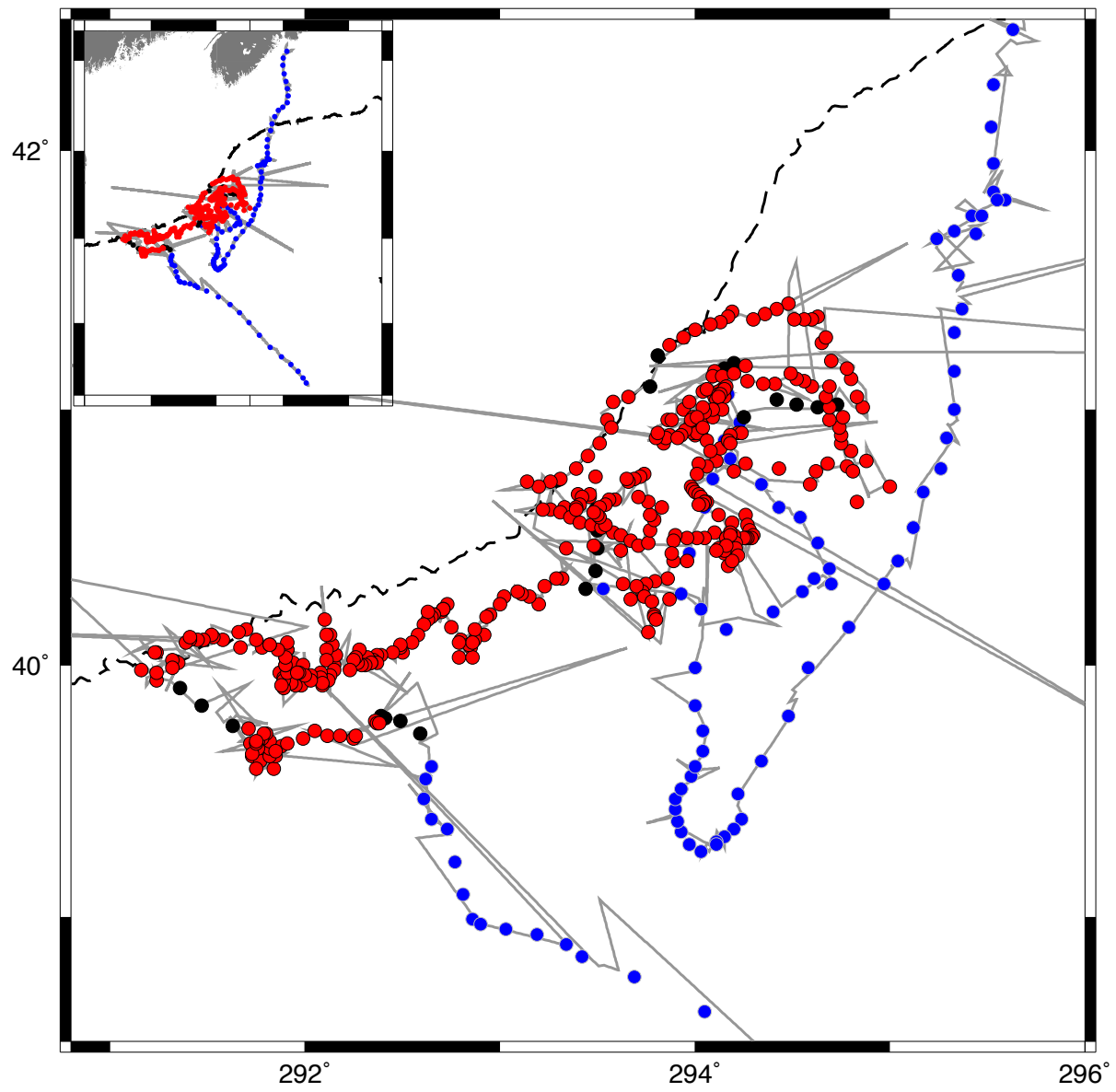


Figure A2-1

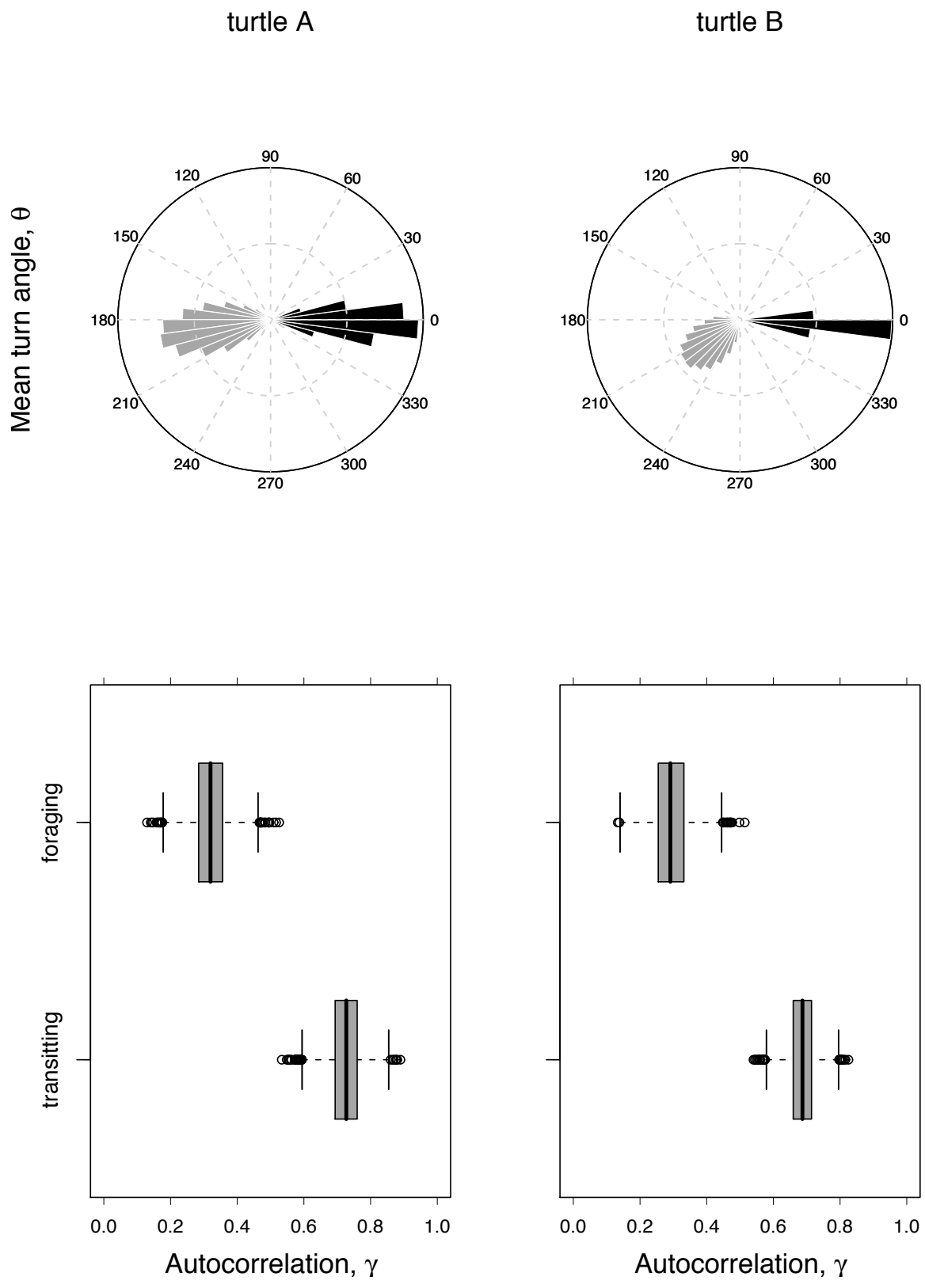


Figure A2-2

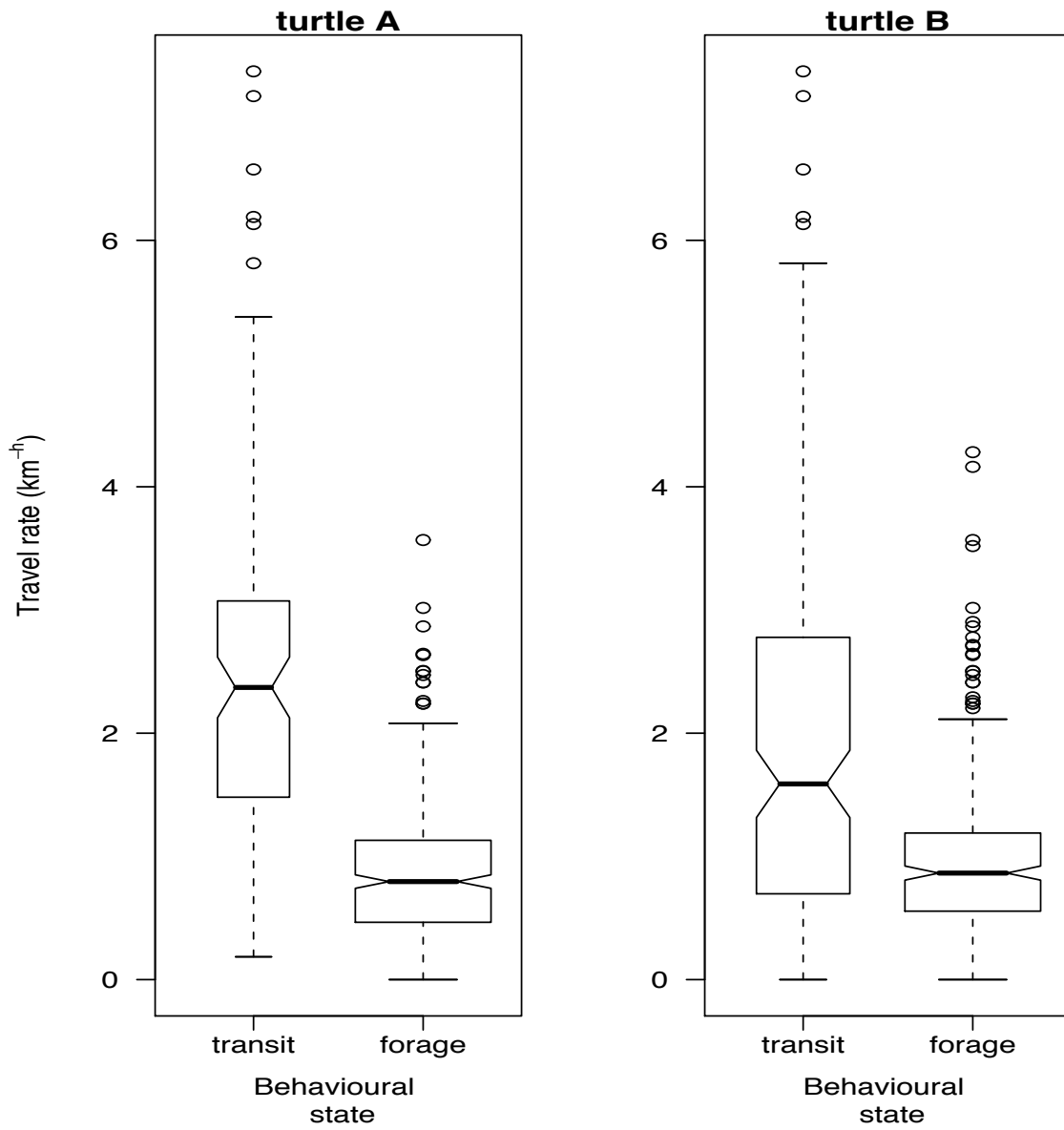


Figure A2-3



# turtle A

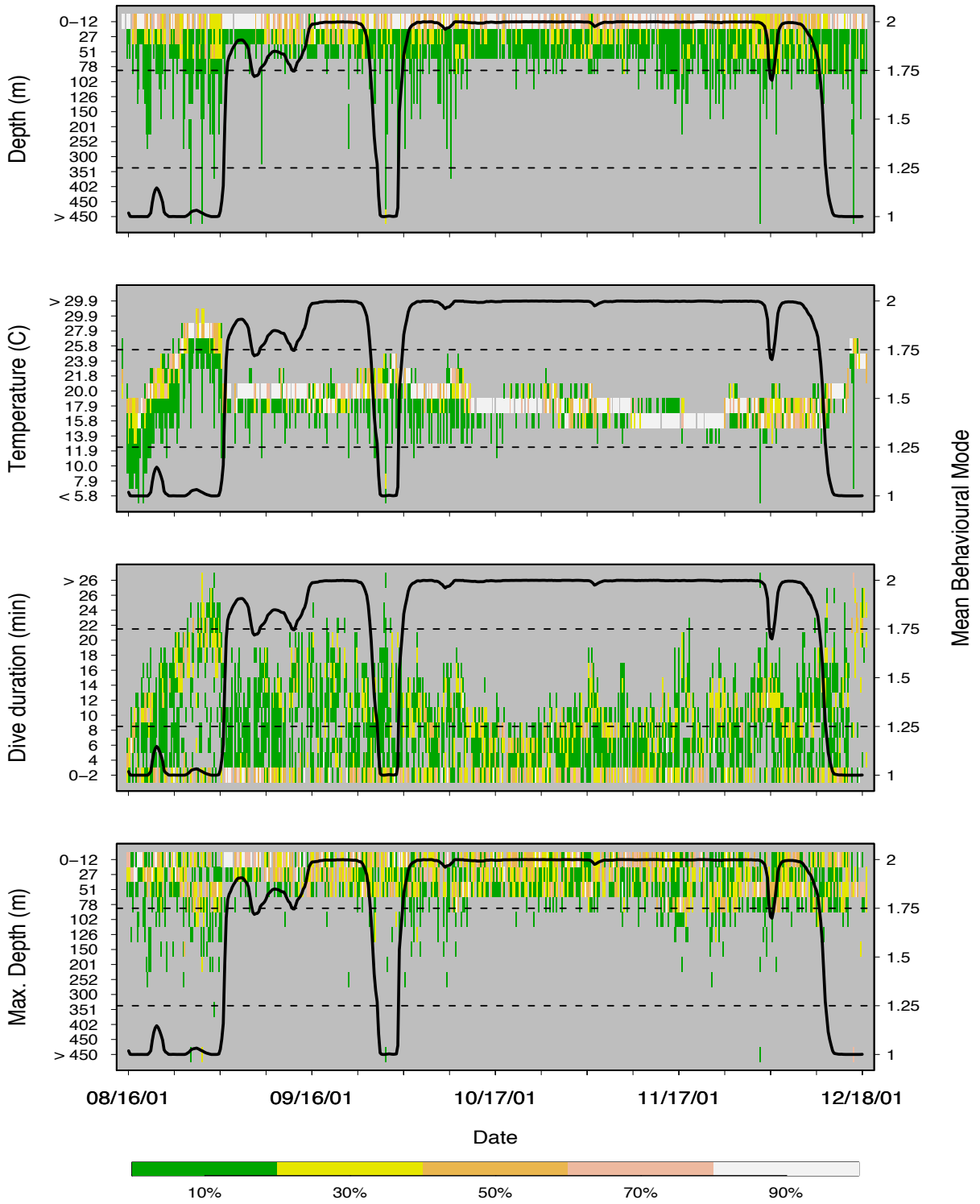
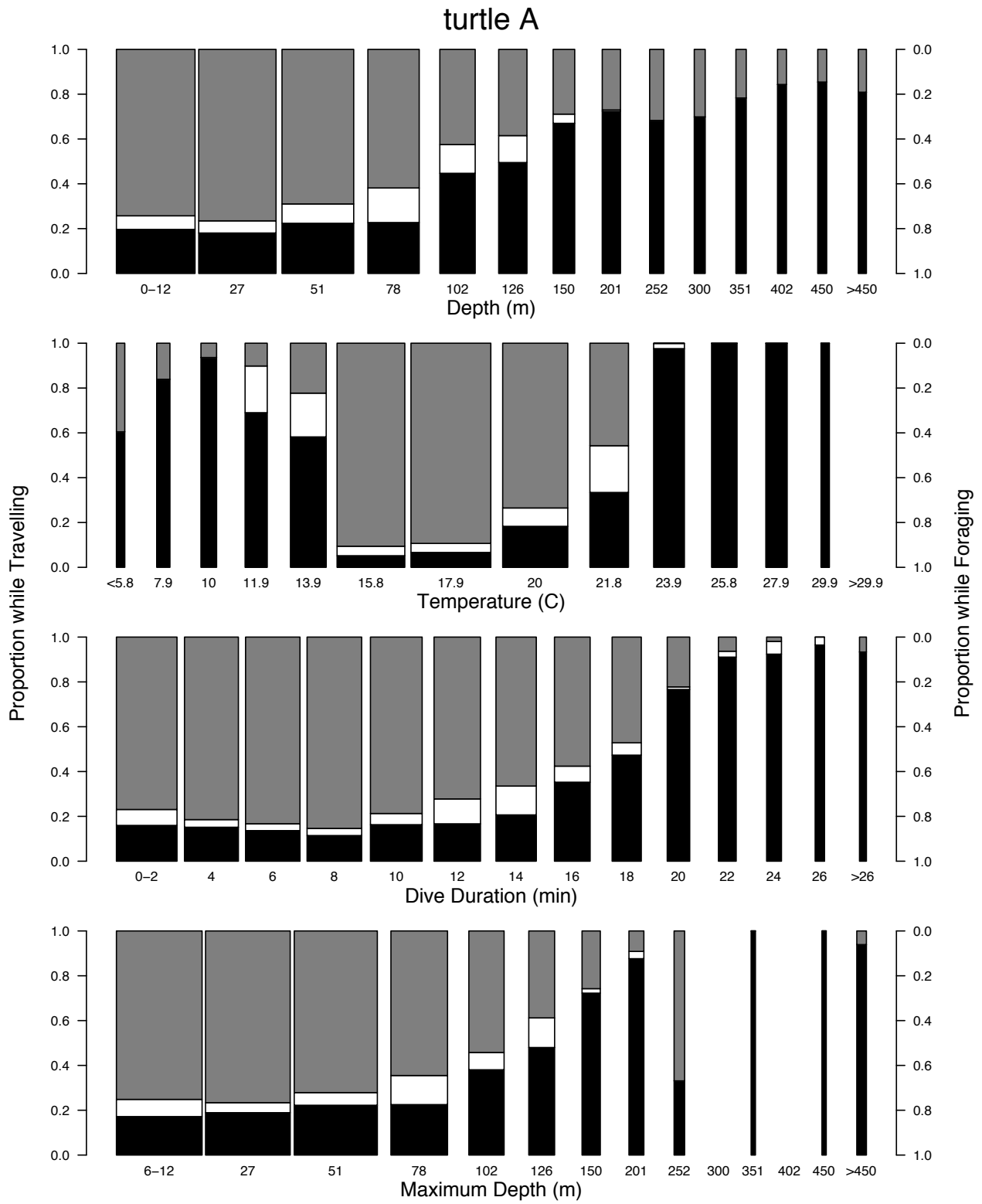


Figure A2-4



**Figure A2-5**

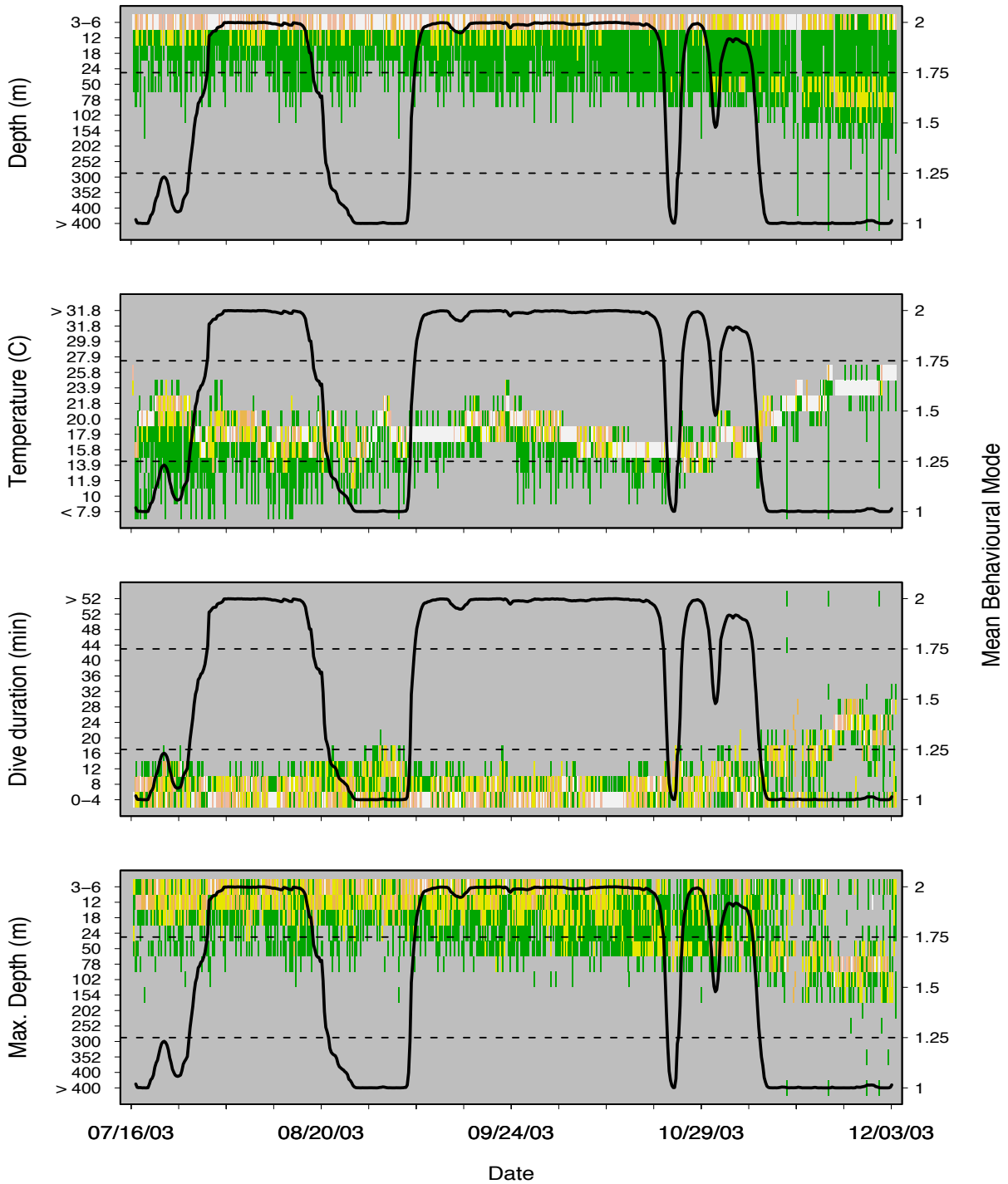


Figure A2-6

turtle E.1

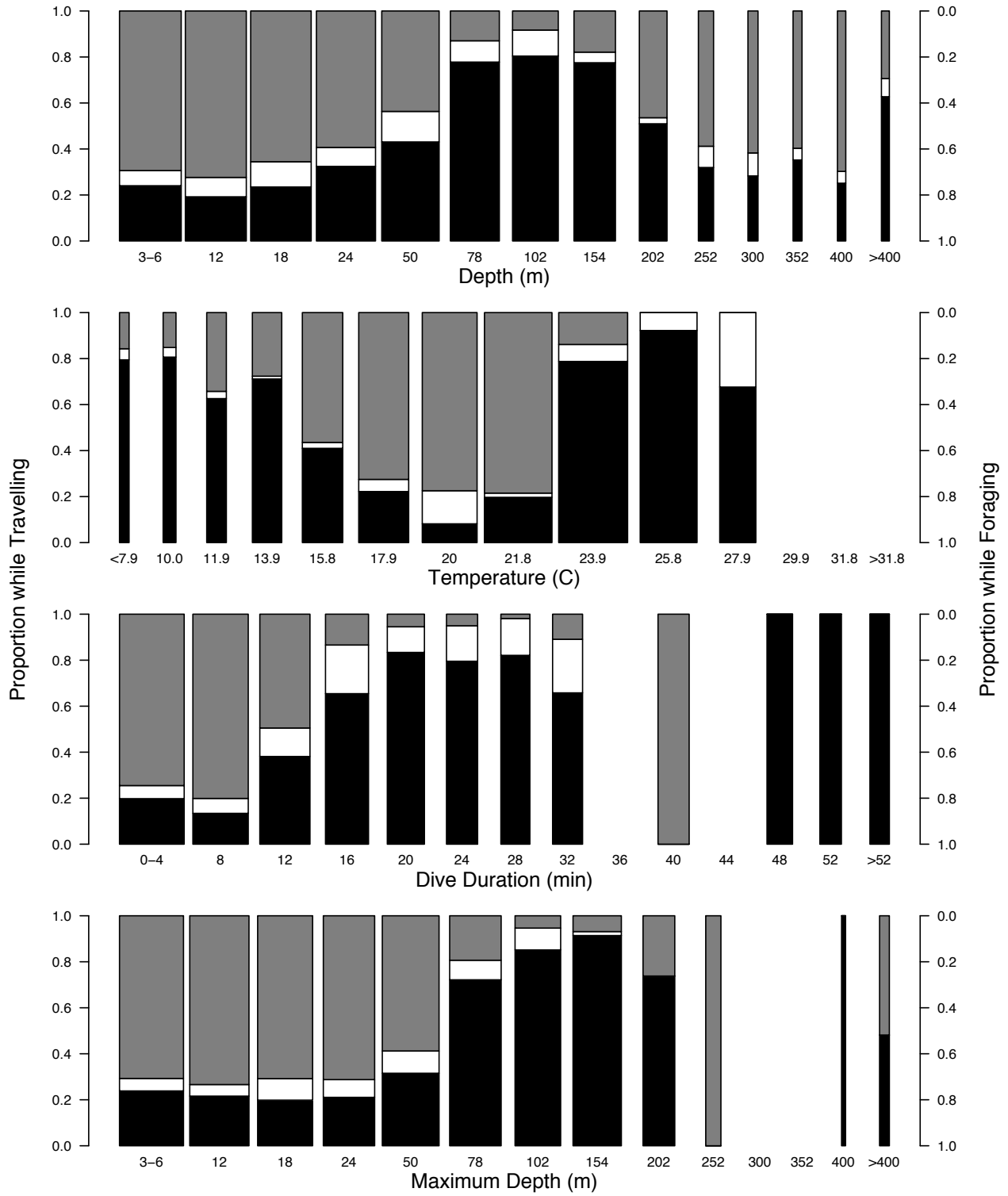


Figure A2-7