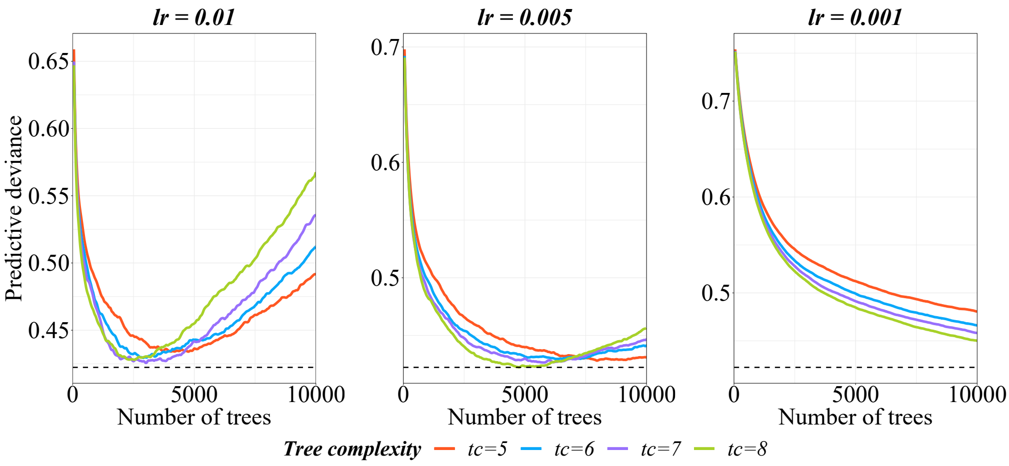
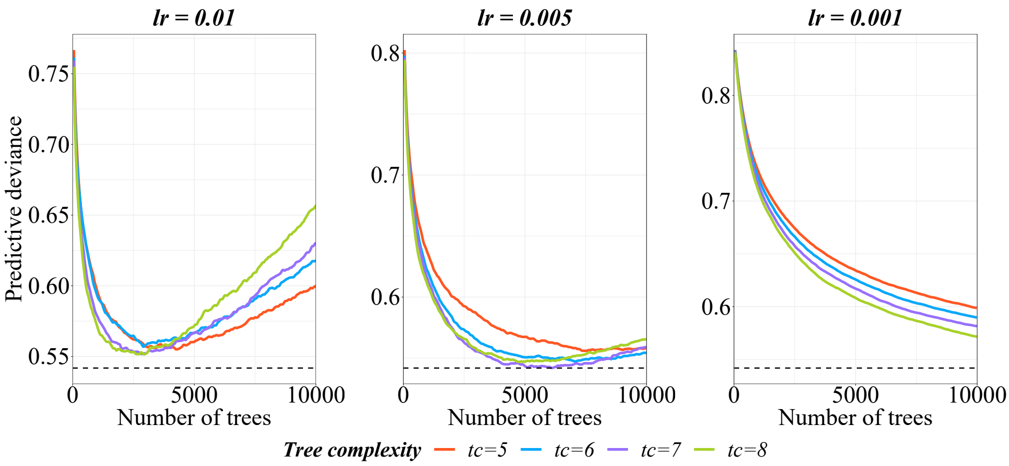
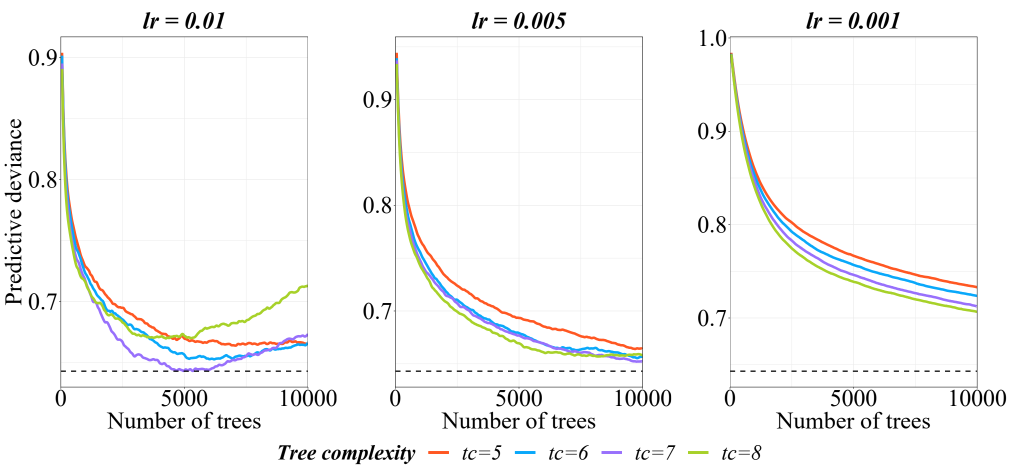


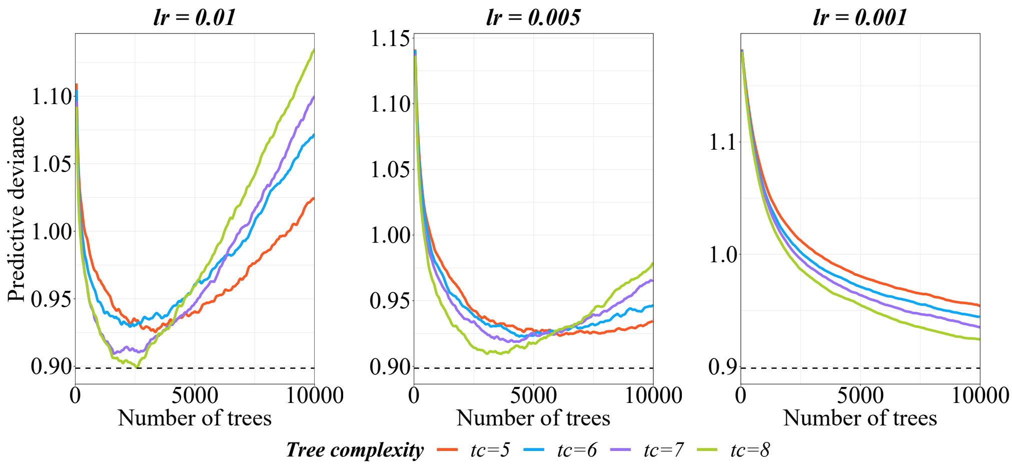
(a) June



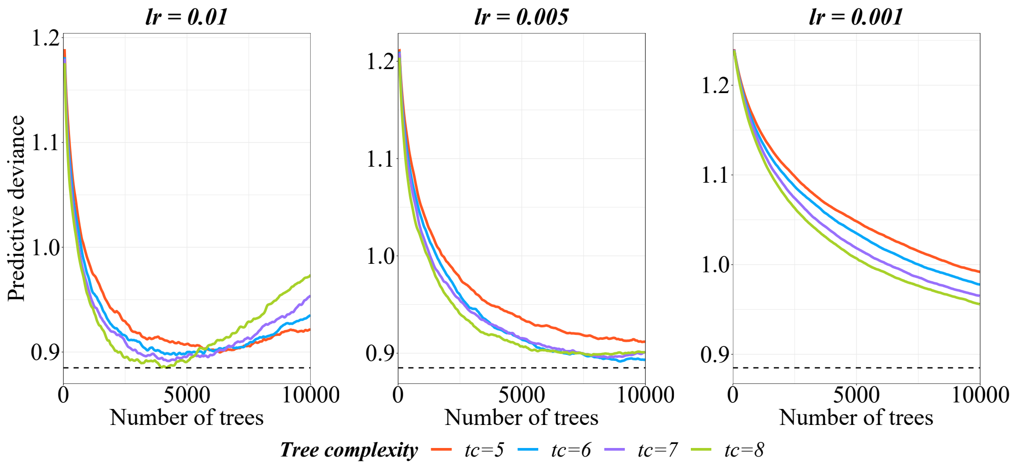
(b) July



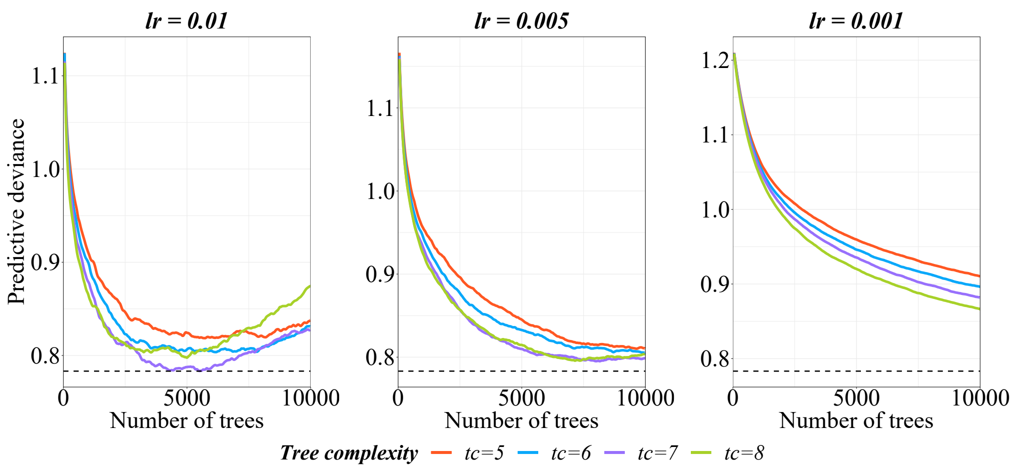
(c) August



(d) September

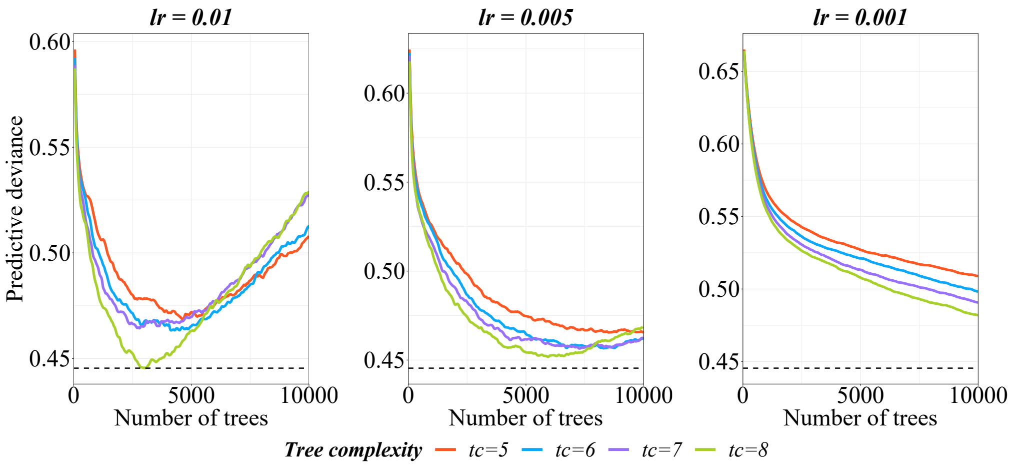


(e) October

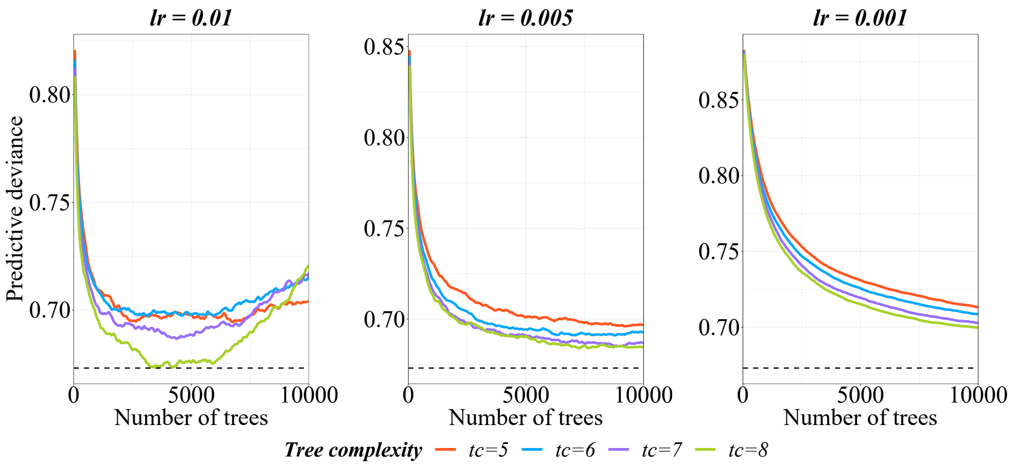


(f) November

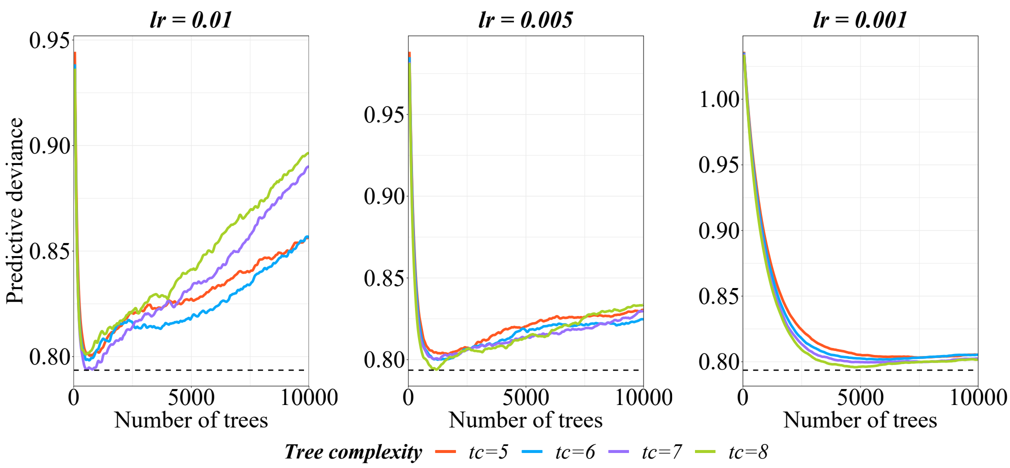
Figure S1: Predictive deviance under different learning rates and complexities for each month when the BRT model was first developed.



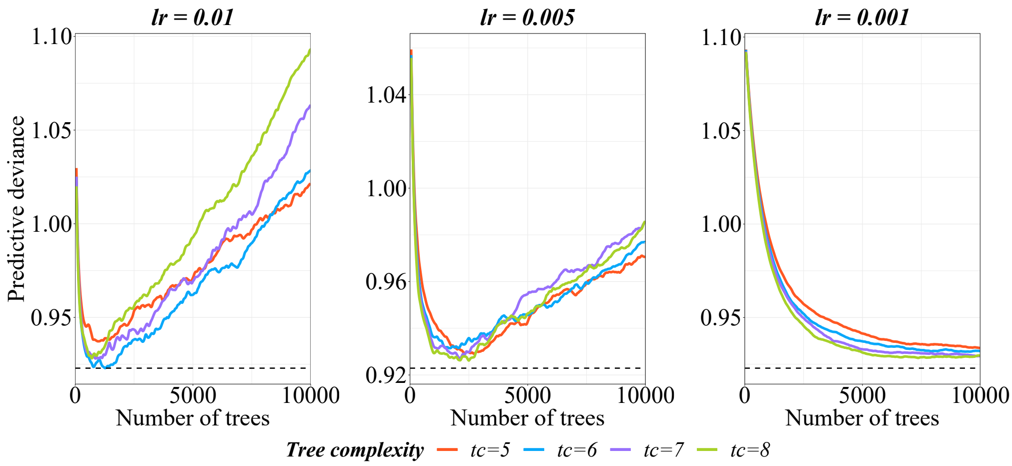
(a) June



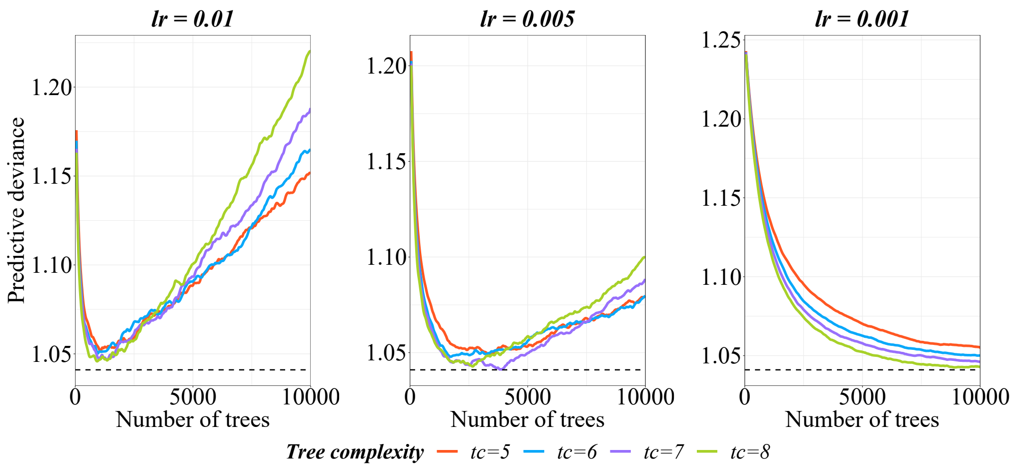
(b) July



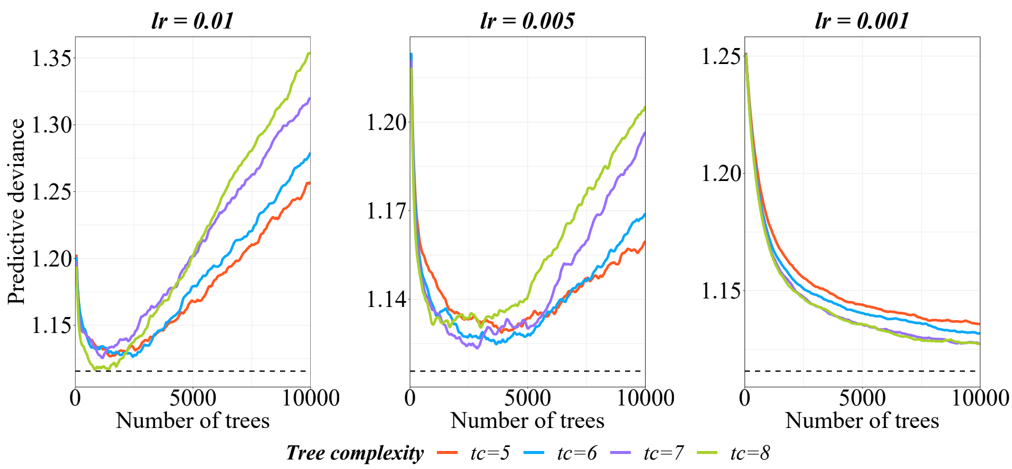
(c) August



(d) September

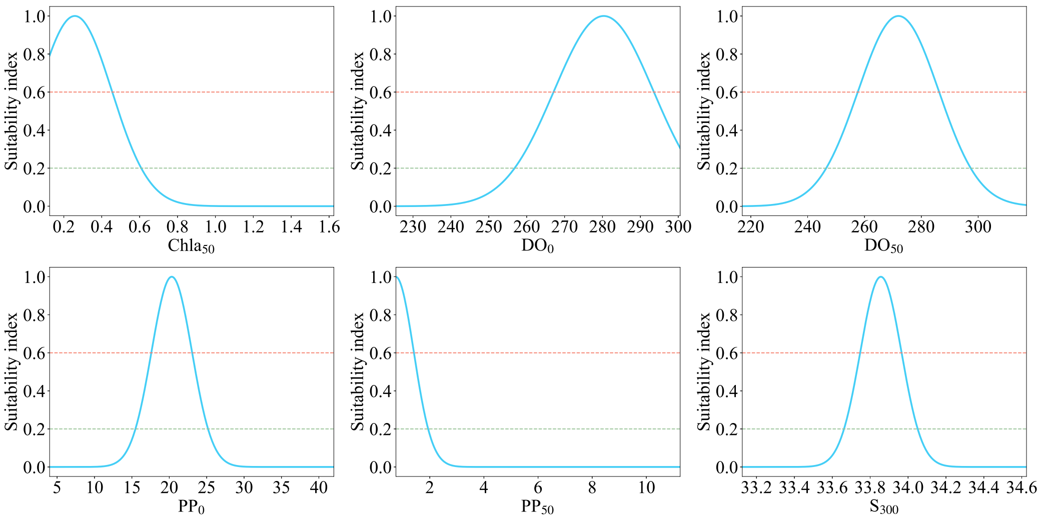


(e) October

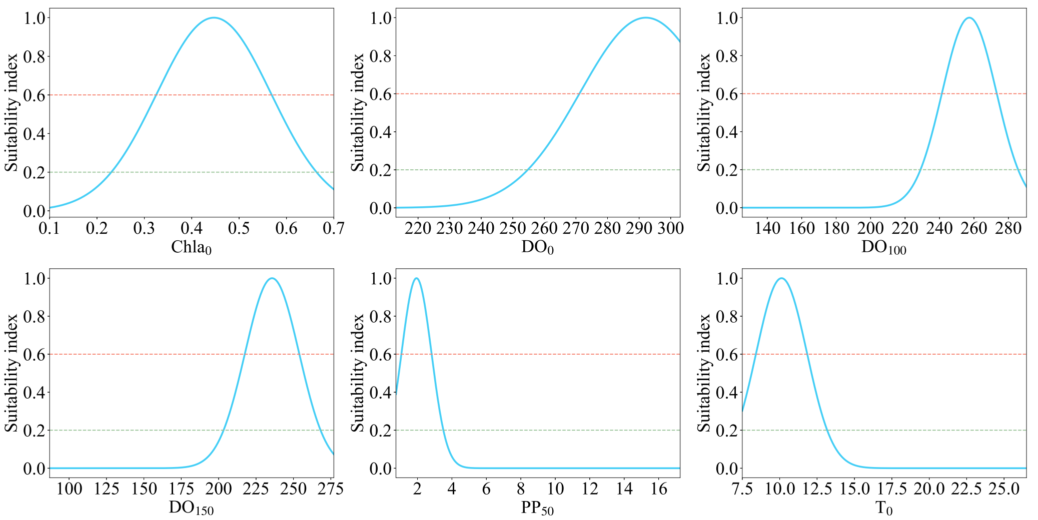


(f) November

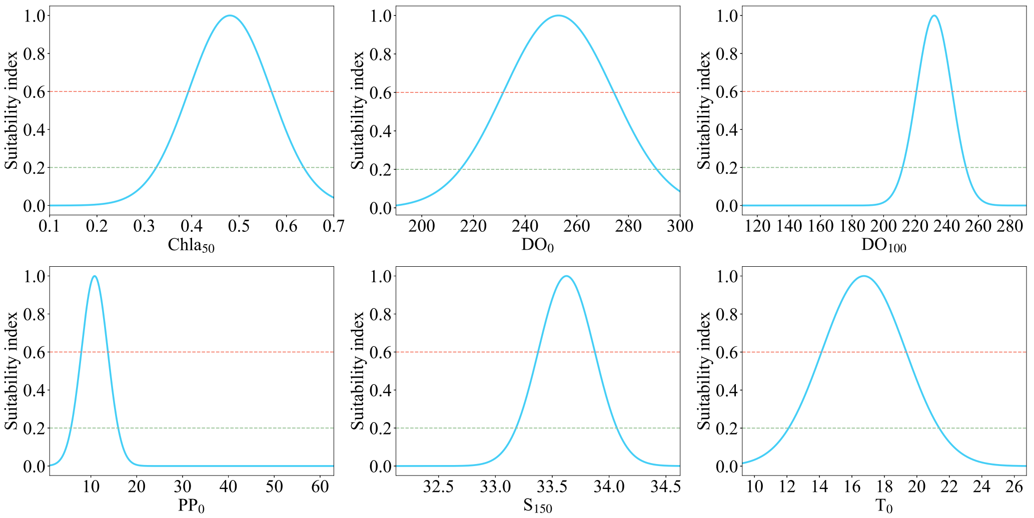
Figure S2: Predictive deviance under different learning rates and complexities for each month when the BRT model was second developed.


Suitability index
Chla$_{50}$
DO$_0$
DO$_{50}$
PP$_0$
PP$_{50}$
S$_{300}$

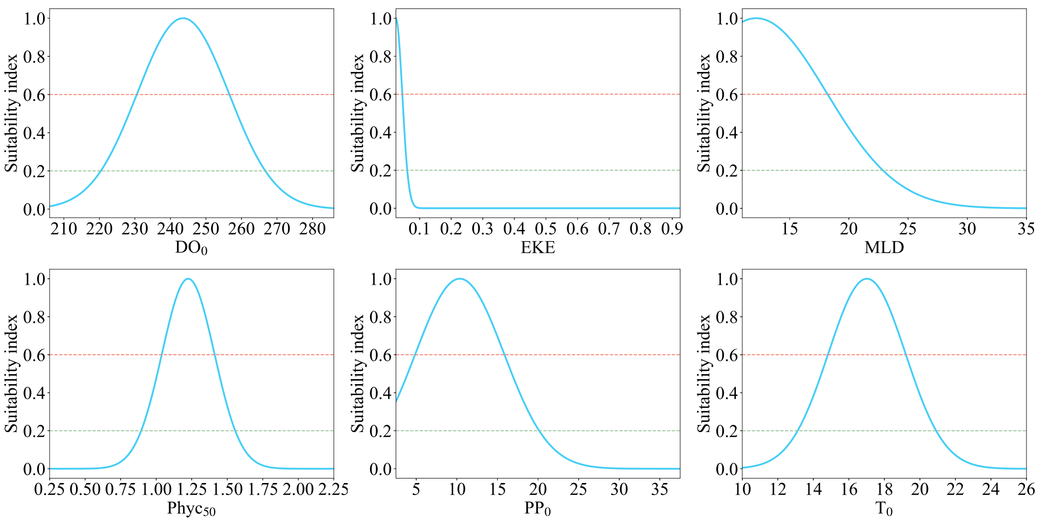
(a) June


Suitability index
Chla$_0$
DO$_0$
DO$_{100}$
DO$_{150}$
PP$_{50}$
T$_0$

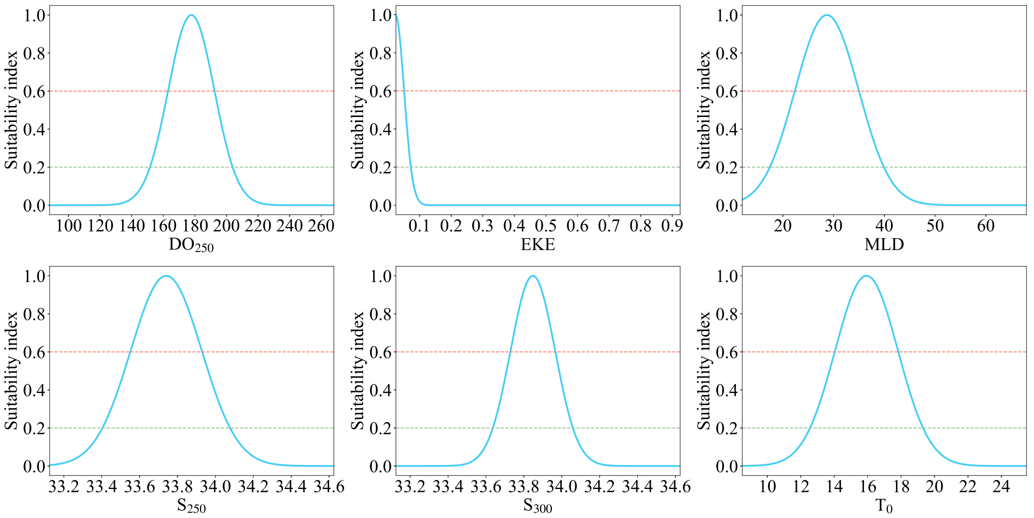
(b) July



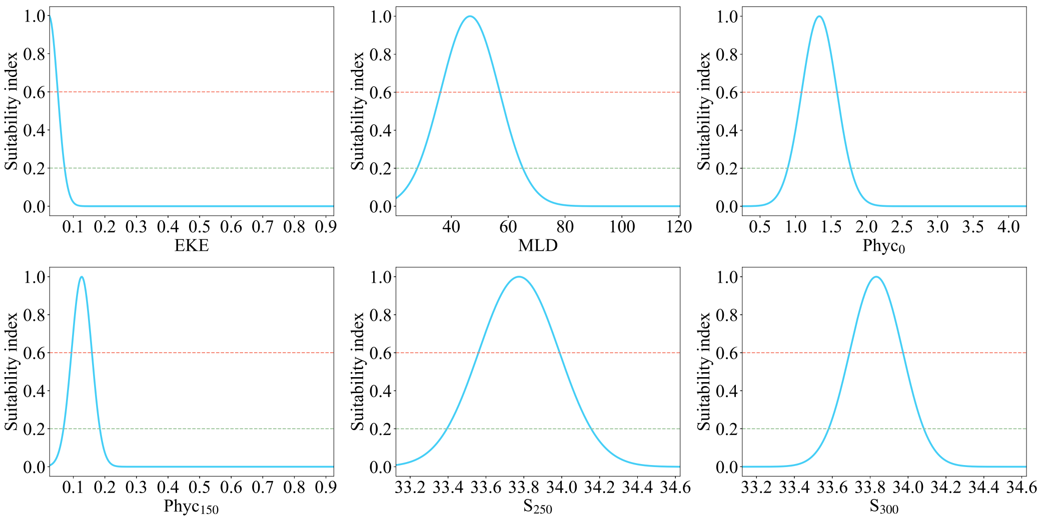
(c) August



(d) September



(e) October



(f) November

Figure S3: Predictive deviance under different learning rates and complexities for each month when the BRT model was second developed.

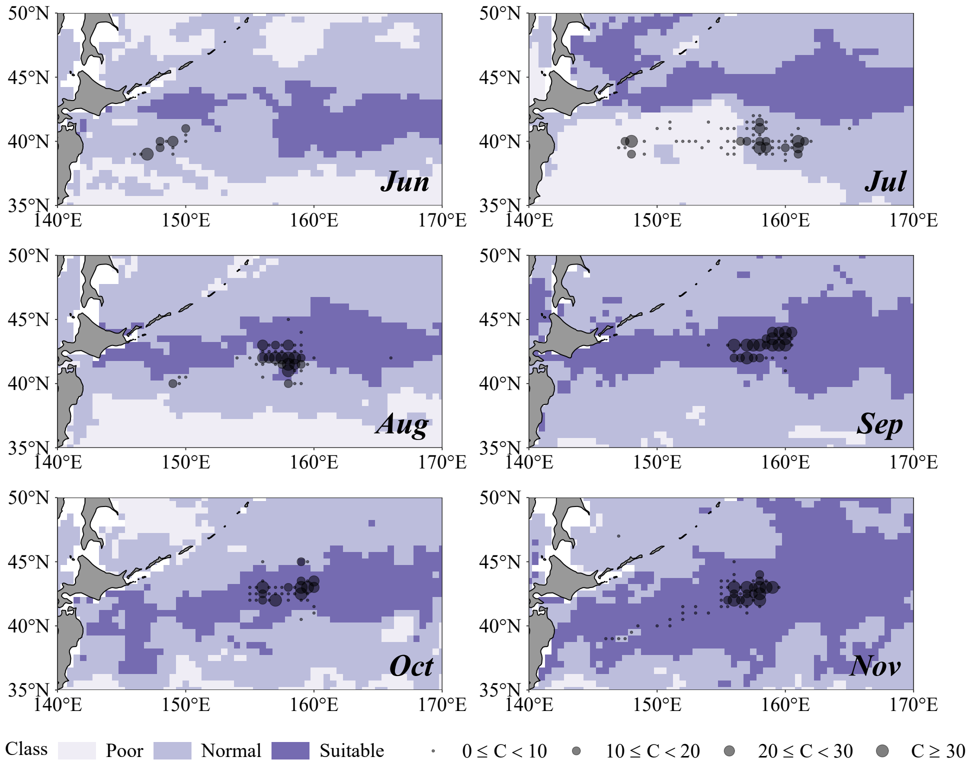


Figure S4: Monthly distribution for *O. bartramii* in the Northwest Pacific Ocean in 2018, overlaid on the habitat class map which was predicted by using weighted-AMM based on environmental data from 2018.

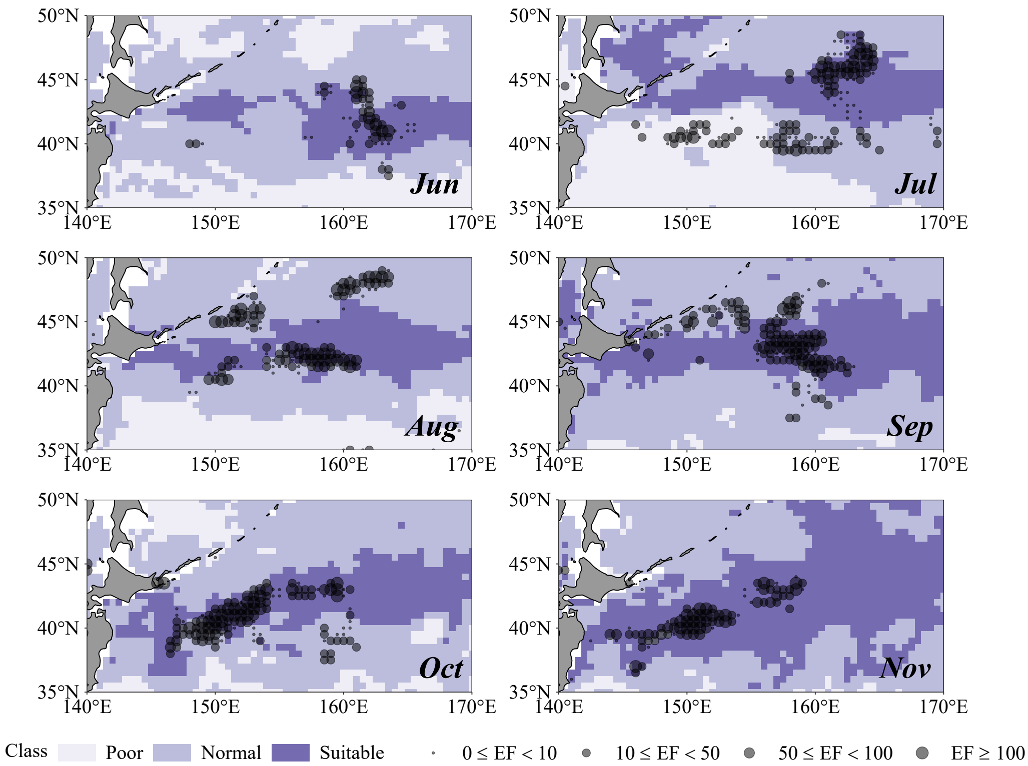


Figure S5: Monthly distribution of fishing effort for squid-jigging vessel in the Northwest Pacific Ocean in 2018, overlaid on the habitat class map which was predicted by using weighted-AMM based on environmental data from 2018.

Table S1: Optimal parameters for the first and second construction of the BRT model.

Month	*lr* in the first	*tc* in the first	*lr* in the second	*tc* in the second
Jun	0.005	8	0.01	8
Jul	0.005	7	0.01	8
Aug	0.01	7	0.005	8
Sep	0.01	8	0.01	6
Oct	0.01	8	0.005	7
Nov	0.01	7	0.01	8

Table S2: Statistical parameters for each SI model.

Month	Variable	Formula	RMSE	MAE	R^2
Jun	$Chla_{50}$	$y = \exp[-13.10971(x - 0.25817)^2]$	0.08	0.05	0.96
	DO_0	$y = \exp[-0.00291(x - 280.32583)^2]$	0.05	0.04	0.98
	DO_{50}	$y = \exp[-0.00249(x - 271.95491)^2]$	0.09	0.05	0.94
	PP_0	$y = \exp[-0.06841(x - 20.32789)^2]$	0.07	0.04	0.95
	PP_{50}	$y = \exp[-1.11789(x - 0.73938)^2]$	0.006	0.004	0.99
	S_{300}	$y = \exp[-42.62051(x - 33.85641)^2]$	0.007	0.005	0.99
Jul	$Chla_0$	$y = \exp[-34.29807(x - 0.44688)^2]$	0.07	0.06	0.97
	DO_0	$y = \exp[-0.00115(x - 292.15273)^2]$	0.13	0.10	0.84
	DO_{100}	$y = \exp[-0.002(x - 257.31089)^2]$	0.07	0.04	0.95
	DO_{150}	$y = \exp[-0.00153(x - 235.71015)^2]$	0.13	0.10	0.80
	PP_{50}	$y = \exp[-0.66148(x - 1.94346)^2]$	0.04	0.03	0.98
	T_0	$y = \exp[-0.17326(x - 10.12766)^2]$	0.18	0.12	0.62
Aug	$Chla_{50}$	$y = \exp[-66.43419(x - 0.48073)^2]$	0.02	0.02	0.99
	DO_0	$y = \exp[-0.00111(x - 252.91975)^2]$	0.13	0.10	0.84
	DO_{100}	$y = \exp[-0.00399(x - 232.09859)^2]$	0.06	0.03	0.94
	PP_0	$y = \exp[-0.06048(x - 10.8125)^2]$	0.10	0.05	0.83
	S_{150}	$y = \exp[-8.18109(x - 33.62496)^2]$	0.03	0.02	0.99
	T_0	$y = \exp[-0.07487(x - 16.74113)^2]$	0.18	0.11	0.73
Sep	DO_0	$y = \exp[-0.003(x - 243.56353)^2]$	0.08	0.07	0.95
	EKE	$y = \exp[-1247.44167(x - 0.02488)^2]$	0.001	0.0003	0.99
	MLD	$y = \exp[-0.01409(x - 12.18304)^2]$	0.10	0.07	0.94
	$Phyc_{50}$	$y = \exp[-14.69514(x - 1.22521)^2]$	0.007	0.006	0.99
	PP_0	$y = \exp[-0.01683(x - 10.35844)^2]$	0.07	0.05	0.97
	T_0	$y = \exp[-0.10581(x - 17.01536)^2]$	0.09	0.06	0.94
Oct	DO_{250}	$y = \exp[-0.00234(x - 177.73152)^2]$	0.07	0.03	0.95
	EKE	$y = \exp[-672.08638(x - 0.02334)^2]$	0.008	0.003	0.99
	MLD	$y = \exp[-0.01274(x - 28.66835)^2]$	0.11	0.05	0.90
	S_{250}	$y = \exp[-14.18482(x - 33.74047)^2]$	0.09	0.07	0.94
	S_{300}	$y = \exp[-36.09697(x - 33.84755)^2]$	0.01	0.009	0.99
	T_0	$y = \exp[-0.14085(x - 15.93163)^2]$	0.13	0.09	0.77
Nov	EKE	$y = \exp[-646.18689(x - 0.0227)^2]$	0.02	0.006	0.99
	MLD	$y = \exp[-0.00467(x - 46.57797)^2]$	0.08	0.05	0.94
	$Phyc_0$	$y = \exp[-8.1503(x - 1.3343)^2]$	0.03	0.02	0.99
	$Phyc_{150}$	$y = \exp[-484.09479(x - 0.12656)^2]$	0.005	0.002	0.99
	S_{250}	$y = \exp[-11.10656(x - 33.77468)^2]$	0.01	0.07	0.94
	S_{300}	$y = \exp[-25.51537(x - 33.8321)^2]$	0.02	0.02	0.99

Table S3: The favorable range of different variables for fishing effort.

Month	Variable	Range
Jun	$Chla_{50}$	$0.1 \sim 0.5$ mg · m^{-3}
	DO_0	$265 \sim 288$ mmol · m^{-3}
	DO_{50}	$255 \sim 290$ mmol · m^{-3}
	PP_0	$17 \sim 23$ mg · m^{-3} · day^{-1}
	PP_{50}	$1.0 \sim 1.5$ mg · m^{-3} · day^{-1}
	S_{300}	$33.8 \sim 34$
Jul	$Chla_0$	$0.3 \sim 0.55$ mg · m^{-3}
	DO_0	$270 \sim 300$ mmol · m^{-3}
	DO_{100}	$240 \sim 275$ mmol · m^{-3}
	DO_{150}	$213 \sim 260$ mmol · m^{-3}
	PP_{50}	$1.2 \sim 3$ mg · m^{-3} · day^{-1}
	T_0	$9 \sim 12$ °C
Aug	$Chla_{50}$	$0.4 \sim 0.58$ mg · m^{-3}
	DO_0	$230 \sim 270$ mmol · m^{-3}
	DO_{100}	$220 \sim 243$ mmol · m^{-3}
	PP_0	$9 \sim 15$ mg · m^{-3} · day^{-1}
	S_{150}	$33.3 \sim 33.8$
	T_0	$14 \sim 20$ °C
Sep	DO_0	$230 \sim 258$ mmol · m^{-3}
	EKE	$0 \sim 0.04$ m^2 · s^{-2}
	MLD	$10 \sim 18$ m
	$Phyc_{50}$	$1 \sim 1.4$ mg · m^{-3} · day^{-1}
	PP_0	$5 \sim 16$ mg · m^{-3} · day^{-1}
	T_0	$15 \sim 19.5$ °C
Oct	DO_{250}	$160 \sim 200$ mmol · m^{-3}
	EKE	$0 \sim 0.05$ m^2 · s^{-2}
	MLD	$22 \sim 36$ m
	S_{250}	$33.5 \sim 33.9$
	S_{300}	$33.7 \sim 34$
	T_0	$14 \sim 18$°C
Nov	EKE	$0 \sim 0.05$ m^2 · s^{-2}
	MLD	$38 \sim 60$ m
	$Phyc_0$	$1.2 \sim 1.6$ mg · m^{-3} · day^{-1}
	$Phyc_{150}$	$0.1 \sim 0.18$ mg · m^{-3} · day^{-1}
	S_{250}	$33.6 \sim 34$
	S_{300}	$33.7 \sim 34$