Appendix E: EAG 21.1a model implementation in Gmacs

Gmacs working session:

A working session on AIGKC model implementation in Gmacs was conducted by Andre Punt during 1−3 December 2021 in Juneau. Andre Punt, Shareef Siddeek, Katie Palof, and Cody Szuwalski participated actively in person or via google virtual. William Stockhauson, Martin Dorn, and Michael Martinez also participated occasionally via google virtual.

Focus:

The focus was to modify eastern Aleutian Islands golden king status quo assessment model EAG21.1a to model EAG21.6 and implement it in Gmacs.

Results:

Differences between EAG21.1a and EAG21.6 are highlighted yellow in Table 1.

Table 1. Status quo and modified EAG models' differences.

EAG21.6 (Modification of EAG21.1a)	EAG21.1a (Original model)
Data: 1981−2020 retained, 1990−2020 total, 1989−2020 groundfish discard, 1985−1998 Fish Ticket CPUE, 1995−2020 Observer CPUE, Tag release-recaptures (6 years' returns)	Data: coequal
1) Equilibrium starts of simulation in 1960 with R_0= 1987−2017 mean of mfexp(log_mean_rec)*rec_len(l)	1) Equilibrium starts of simulation in 1960 with R_0=1987−2017 mean of mfexp(log_mean_rec+rec_dev(t))*rec_len(l)
2) Recruit distribution to first five bins by gamma, using size at lower limit of the bin 3) For reference points, mean R is estimated as in 1) of EAG21.1a Original model	2) Recruit distribution to first five bins by gamma, using size at mid point of the bin 3) For reference points, mean R is estimated as in 1).
4) Retained size composition likelihood is multinomial without offset for size bins 1 to 17 for 1985−2020. Francis final ESS values are used	4) Retained size composition likelihood is robust normal for size bins 6 to 17 for 1985−2020. Francis final ESS values are used
5) Total size composition likelihood is multinomial without offset for size bins 1 to 17 for 1990 to 2020. Francis final ESS values are used	5) Total size composition is robust normal for size bins 1 to 17 for 1990−2020. Francis final ESS values are used
6) No groundfish size composition likelihood is used	6) No groundfish size composition likelihood is used

7) Observer CPUE likelihood uses log CPUE difference residuals for 1995−2020 and reformatted as like1 = log(stddev) + 0.5*square(residual/stddev), where stddev = CV of CPUE+model estimated additional CV	7) Observer CPUE likelihood uses log CPUE difference residuals for 1995−2020 with CPUE variance + model estimated constant variance
8) Fish Ticket CPUE likelihood uses log CPUE difference residuals for 1985-1998 and reformatted as like1 = log(stddev) + 0.5*square(residual/stddev), where stddev = CV of CPUE+model estimated additional CV	8) Fish Ticket CPUE likelihood uses log CPUE difference residuals for 1985−1998 with CPUE variance + model estimated constant variance
9) Retained catch likelihood uses 1981−1984 catches in number of crabs and 1985−2020 catches in biomass, all transformed into log form, and dnorm(observed catch, expected catch, gmacs CV (0.032) converted to STD) function applied with the emphasis factor 4 (as weight) considered in gmacs	9) Retained catch likelihood uses 1981−1984 catches in number of crabs as normal likelihood with the weight of 500 and the 1985−2020 catch biomass as lognormal likelihood with the weight of 500
10) Total catch likelihood uses catch biomasses for 1990−2020 as in 9) with gmacs CV (0.045) converted to STD, and the gmacs emphasis factor 2 (as weight)	10) Total catch likelihood uses catch biomasses for 1990-2020 as lognormal with the graded weight going up to a maximum of 250. Grading of weights is by observer sampled number of pots
11) Groundfish bycatch likelihood uses groundfish bycatch biomasses for 1989−2020 as in 9) with gmacs CV (1.58) converted to STD, and the gmacs emphasis factor 1 (as weight)	11) Groundfish bycatch likelihood uses groundfish bycatch biomasses for 1989−2020 as lognormal with the weight of 0.2
12) likelihood for pot F	coequal
13) likelihood for groundfish bycatch F	coequal
14) likelihood for tagging data	coequal
15) Additional: a. like_rec_dev = dnorm(rec_dev+0.5*sigR*sigR, sigR) where sigR=0.3535 (for bias correction) b. At the end added a tst*tst to the total likelihood function?	15) like_rec_dev= 2*square(rec_dev(t))
16) Reference points: B_{35} = 6,606.73t; F_{35} = 0.57; OFL = 2,165.33t; B/B_{35}= 1.095; R_0= 2.17722 mill; B_0=17031t	16) Reference points: B_{35} = 6,767.93t; F_{35} = 0.61; OFL = 2,928.87t; B/B_{35}= 1.299; R_0= 2.28883 mill; B_0=19,376t

During the working session, a bridging analysis was done between models EAG21.6 and EAG21.1a. Comparison of reference points between models EAG21.6 and EAG21.1a are listed in Table 2. The comparison of MMB trends are shown in Figure1.

Table 2. Estimates of reference points for various changes of the May 2021 accepted model EAG21.1a.

Model Changes	EAG21.1a Base model (May 2021 accepted model)	EAG21.6 Modification of base model for gmacs	EAG21.1aSid1 EAG21.1a+ Retained, Total, and GF (by) catch likelihoods changed to EAG21.6 form	EAG21.1aSid2 EAG21.1aSid1+ Retained and Total size comps likelihoods changed to EAG21.6 form	EAG21.1aSid3 EAG21.1aSid2+ Rec_dev bias correction factor introduced as in EAG21.6	EAG21.1aSid4 EAG21.1aSid3+ CPUE likelihoods changed to EAG21.6 form
M	0.21	0.21	0.21	0.21	0.21	0.21
R_0 (millions)	2.55756	2.17147	2.44195	2.46983	2.43102	2.43102
B_0 (t)	19,376	17,031	18,581	18,845	18,577	18,577
B_{35} (t)	6,767.93	6,606.73	6,490.46	6,553.45	6,448.36	6,448.36
Bcurrent/B_{35}	1.299	1.095	1.222	1.233	1.067	1.067
F_{35}	0.61	0.57	0.55	0.55	0.55	0.55
F_{ofl}	0.61	0.57	0.55	0.55	0.55	0.55
Mean Trawl Byc F	0.00021	0.00023	0.00022	0.00022	0.00023	0.00023
Total catch OFL (t)	2,928.87	2,165.33	2,390.62	2,431.11	2,007.42	2,007.42

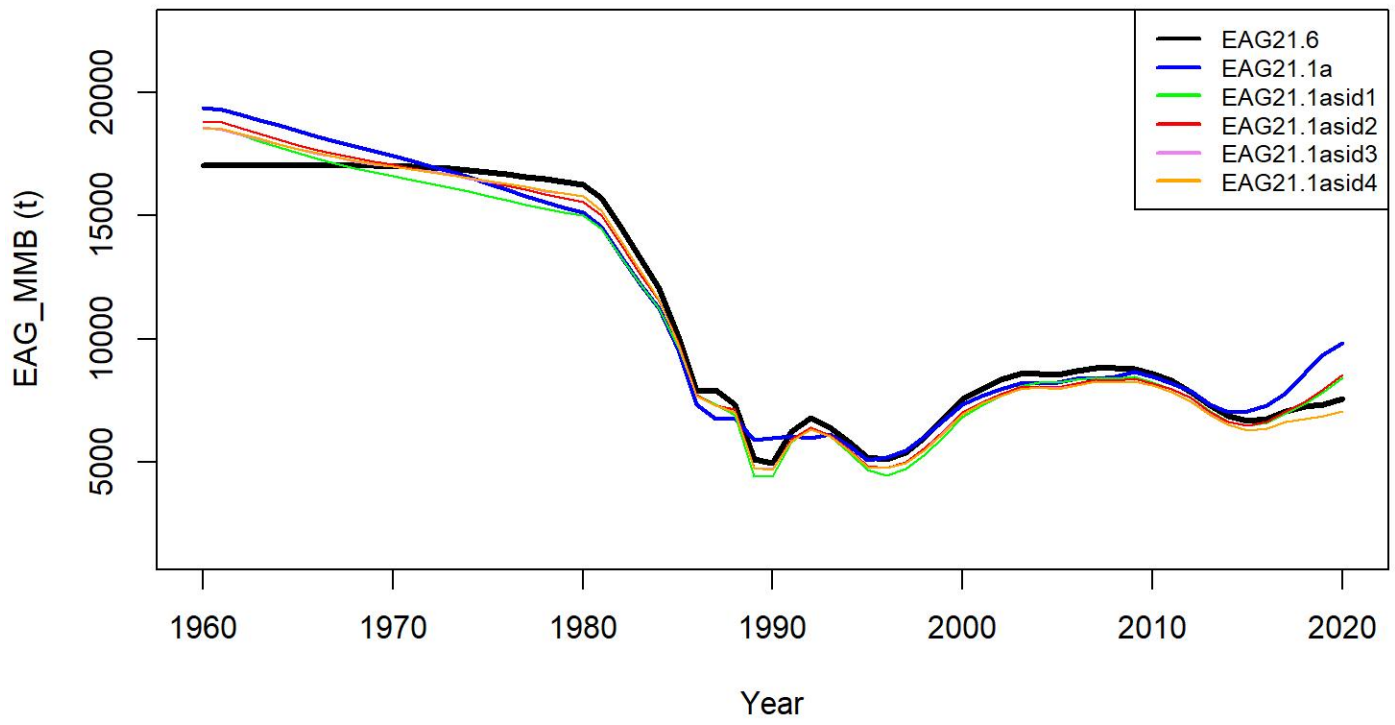

Figure 1. Comparison of MMB trends for various modifications of model EAG21.1a.

After the working session, a bridging analysis was done to assess the progress of model EAG21.6 toward model EAG 21.7. The model EAG21.7 made a few improvements to EAG21.6, one-step-at a time: SigmaR was changed from 0.3535 to 0.5, growth parameters were estimated in the model, and observer CPUE indices were updated following May/June 2021 CPT and SSC suggestions. Furthermore, these progressions were implemented in Gmacs models. The reference points among models EAG21.1aUpdate, EAG21.6, EAG21.7, EAG21.7b, Gmacs6 (implementation of EAG21_6 in Gmacs), Gmacs7, and Gmacs7b are listed in Table 3. The comparison of MMB trends are shown in Figure2, comparison of CPUE index trends in Figure 3, and comparison of abundance by size (N matrix) trends in Figures 4−9.

Table 3. Progression of model EAG21.6 (developed during the December 2021 working session in Juneau) toward EAG21.7 and comparison of reference points among base, modified, and Gmacs models.

	EAG21.1a Update	EAG21.6	EAG21.7	EAG21.7b	Gmacs6	Gmacs7	Gmacs7b
Model Changes	Base model EAG21.1a data with updated observer CPUE indices [Gmacs version of R0 and CPUE, and CPUE likelihood]	Modification of EAG21.1a for Gmacs, EAG21.1a data with status quo observer CPUE indices [Gmacs version of R0, size comp, catch, CPUE, and bycatch likelihoods]	EAG21.6+ Use EAG21.1a data with status quo CPUE indices	EAG21.7+ Use EAG21.1a data with updated observer CPUE indices	Convert EAG21.6 estimated par. values for input to Gmacs6.ctl, use Gmacs6.dat	Convert EAG21.7 estimated par. values for input to Gmacs7.ctl, use Gmacs6.dat	Gmacs7+ convert EAG21.7b par. values for input to Gmacs7b.ctl, update observer CPUE in Gmacs6.dat
Additional Changes	SigmaR= 0.5 bias correction	sigmaR=0.3535, Growth parameters fixed to previously estimated values	sigmaR=0.5, Growth parameters estimated				
M	0.21	0.21	0.21	0.21	0.21	0.21	0.21
R_0 (millions)	2.83536	2.17147	2.12642	2.15601	2.56546	2.63074	2.67558
B_0 (t)	25,937	20,166	19,871	20,135	19,634	20,160	20,586
B_{35} (t)	9,297.68	6,606.73	6,600.20	6,708.63	6,871.88	7,055.85	7,205.20
Bcurrent/ B_{35}	1.187	1.095	1.317	1.428	1.286	1.302	1.359
F_{35}	0.640	0.570	0.530	0.520	0.613	0.600	0.587
F_{ofl}	0.640	0.570	0.530	0.520	0.613	0.600	0.587
Mean Trawl Byc F	0.000181	0.000226	0.000217	0.000208	0.000215	0.000208	0.000198
Total catch OFL (t)	3,795.01	2,165.33	2,714.19	3,056.69	2,835.64	3,060.24	3,358.88

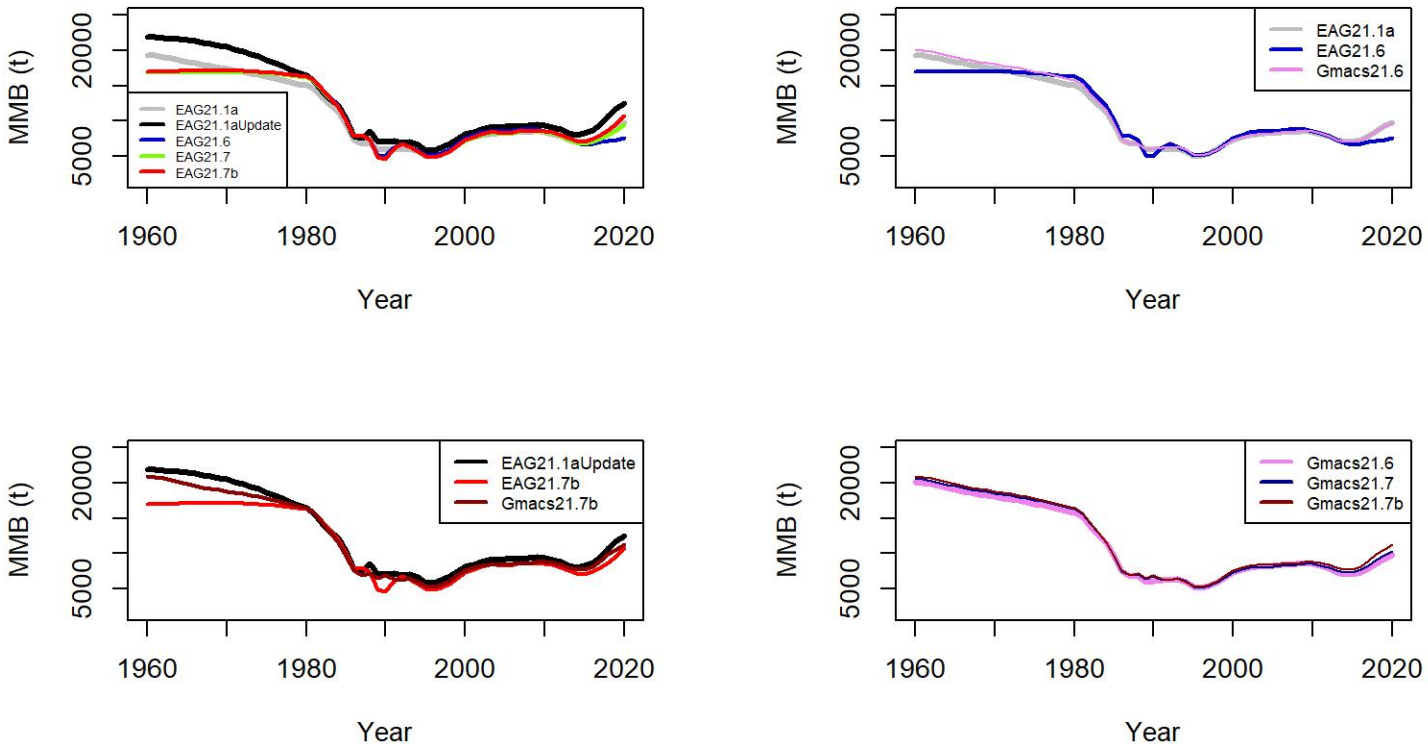

Figure 2. Comparison of MMB trends for various modifications of EAG golden king crab model and parallel Gmacs runs. EAG21.1a refers to the model accepted at the May/June 2021 CPT/SSC meeting whereas EAG21.1aUpdate refers to the updated model following CPT/SSC suggestions (observer CPUE updated).

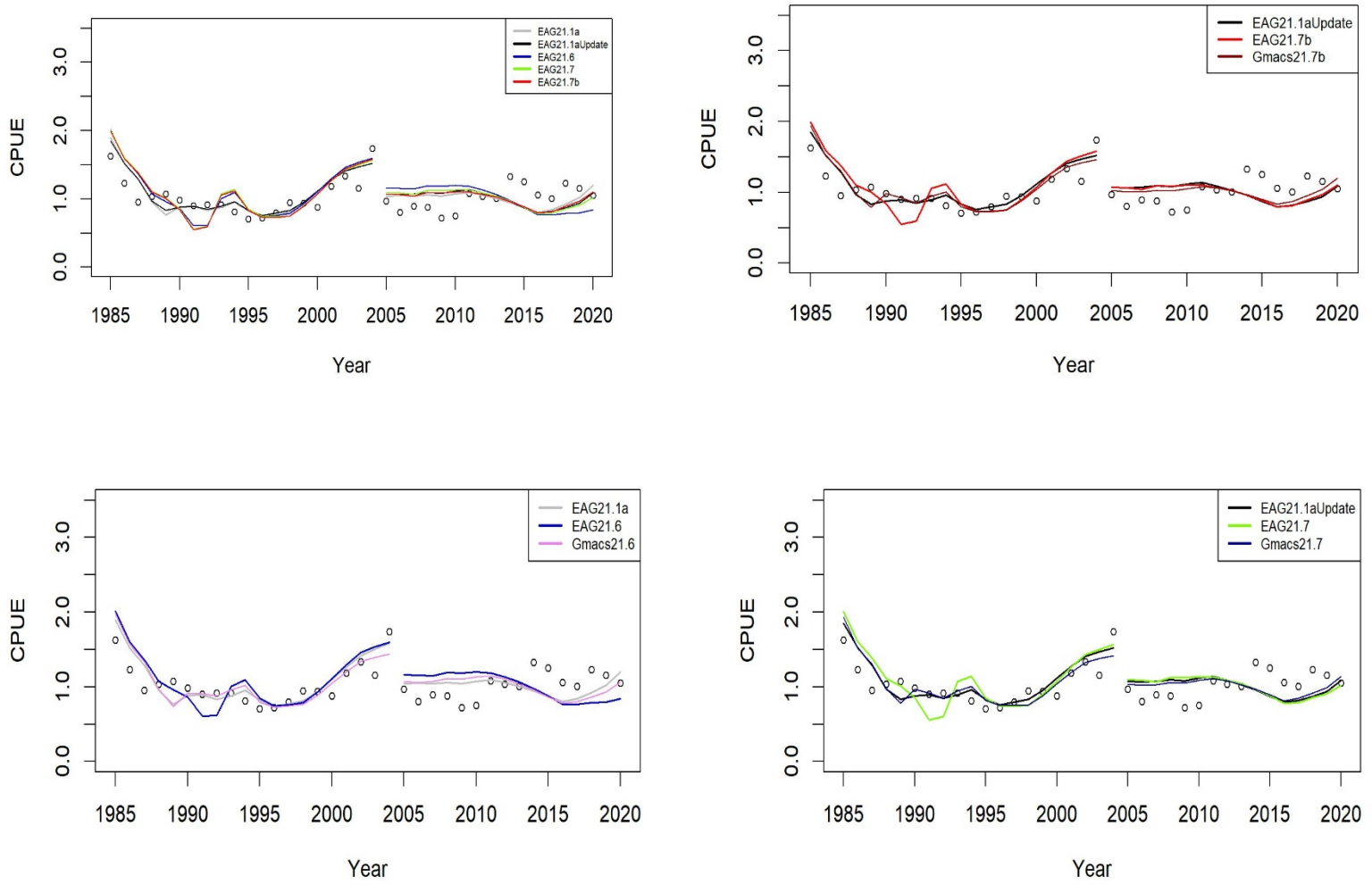

Figure 3. Comparison of CPUE index trends for various modifications of EAG golden king crab model and parallel Gmacs runs. EAG21.1a refers to the model accepted at the May/June 2021 CPT/SSC meeting whereas EAG21.1aUpdate refers to the updated model following CPT/SSC suggestions (observer CPUE updated).

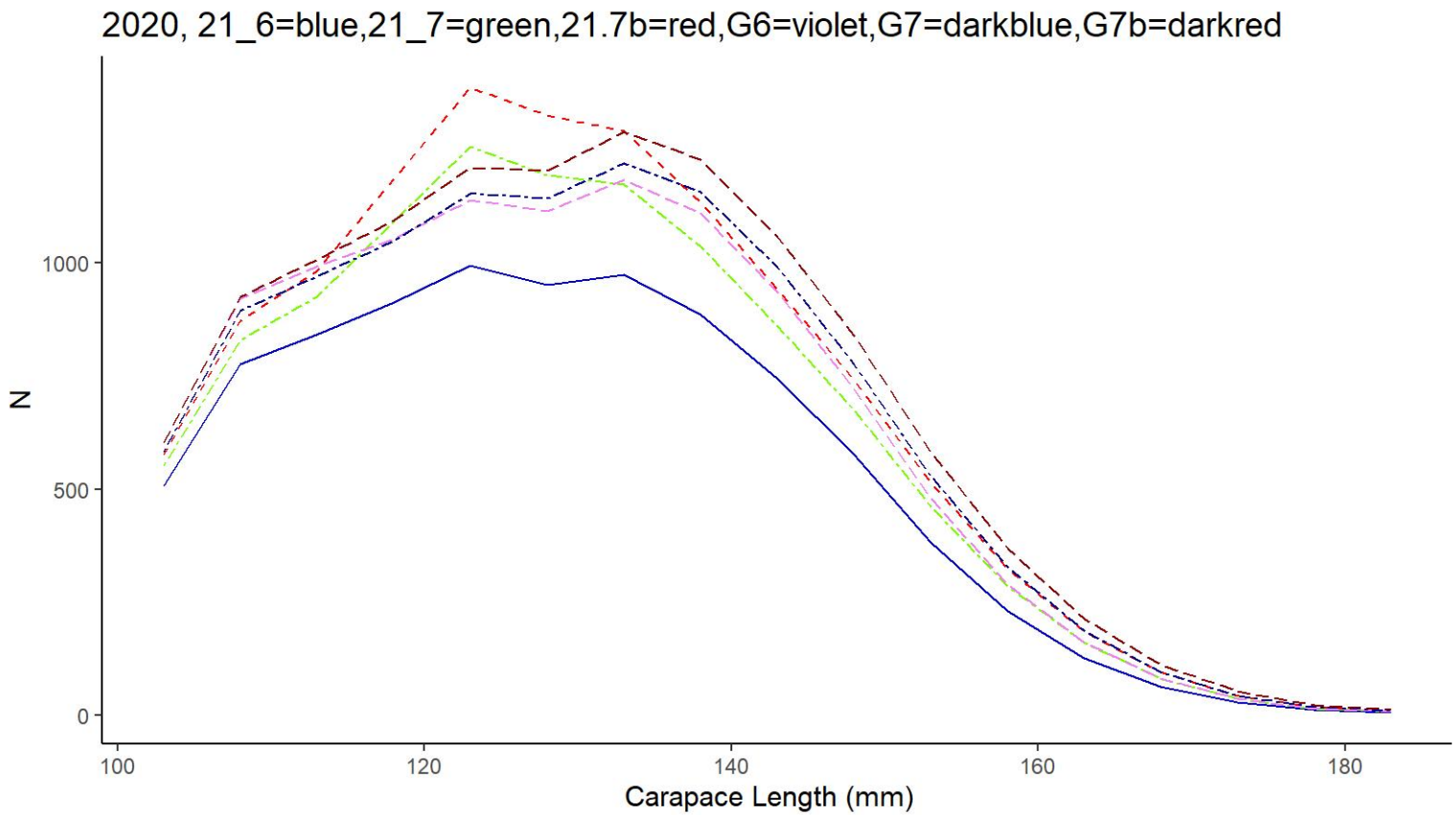

Figure 4. Model predicted abundance by size. N matrix: 2020. Keys: G6 stands for Gmacs6. Color key for this and subsequent plots is provided.

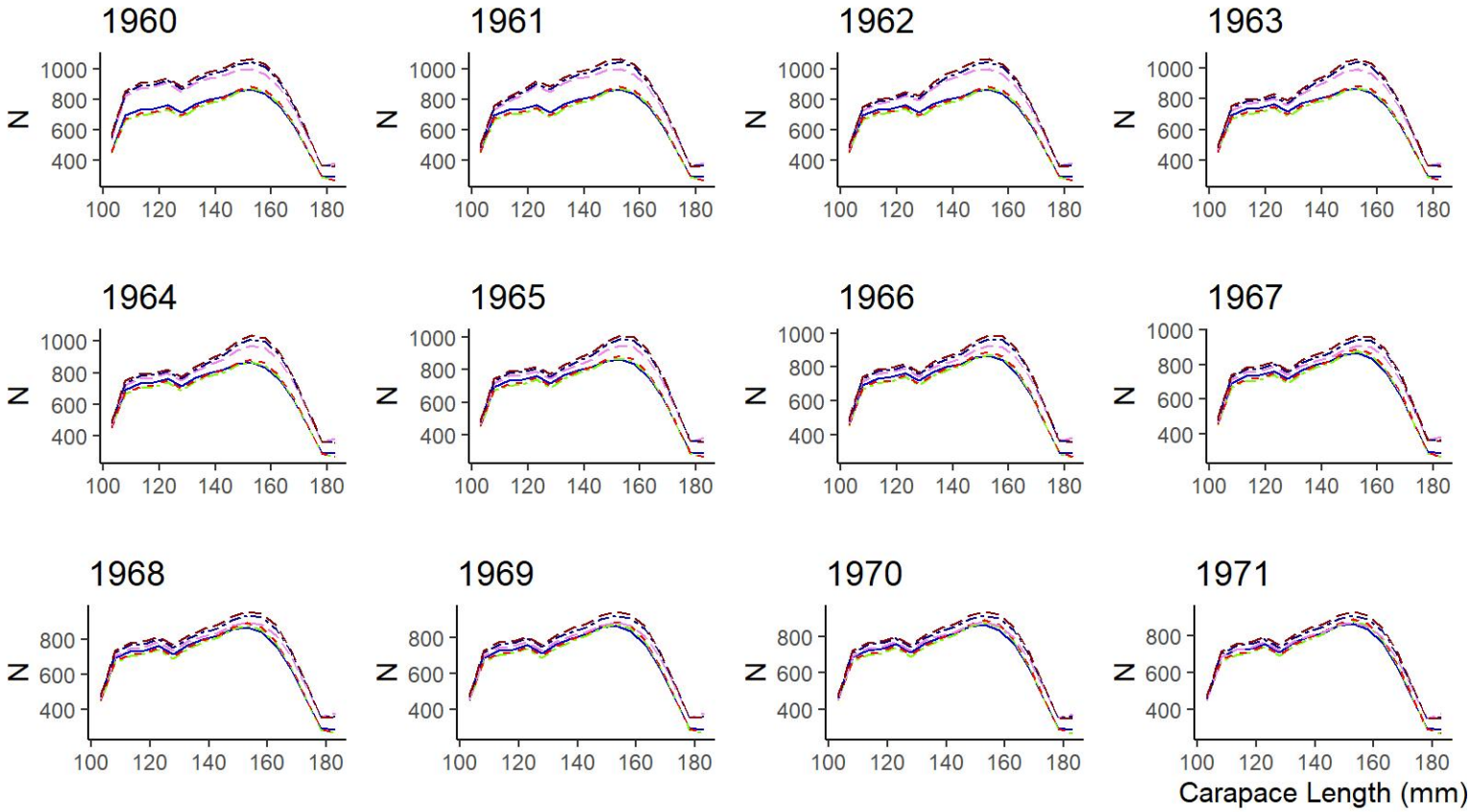

Figure 5. Model predicted abundance by size. N matrix: 1960−1971.

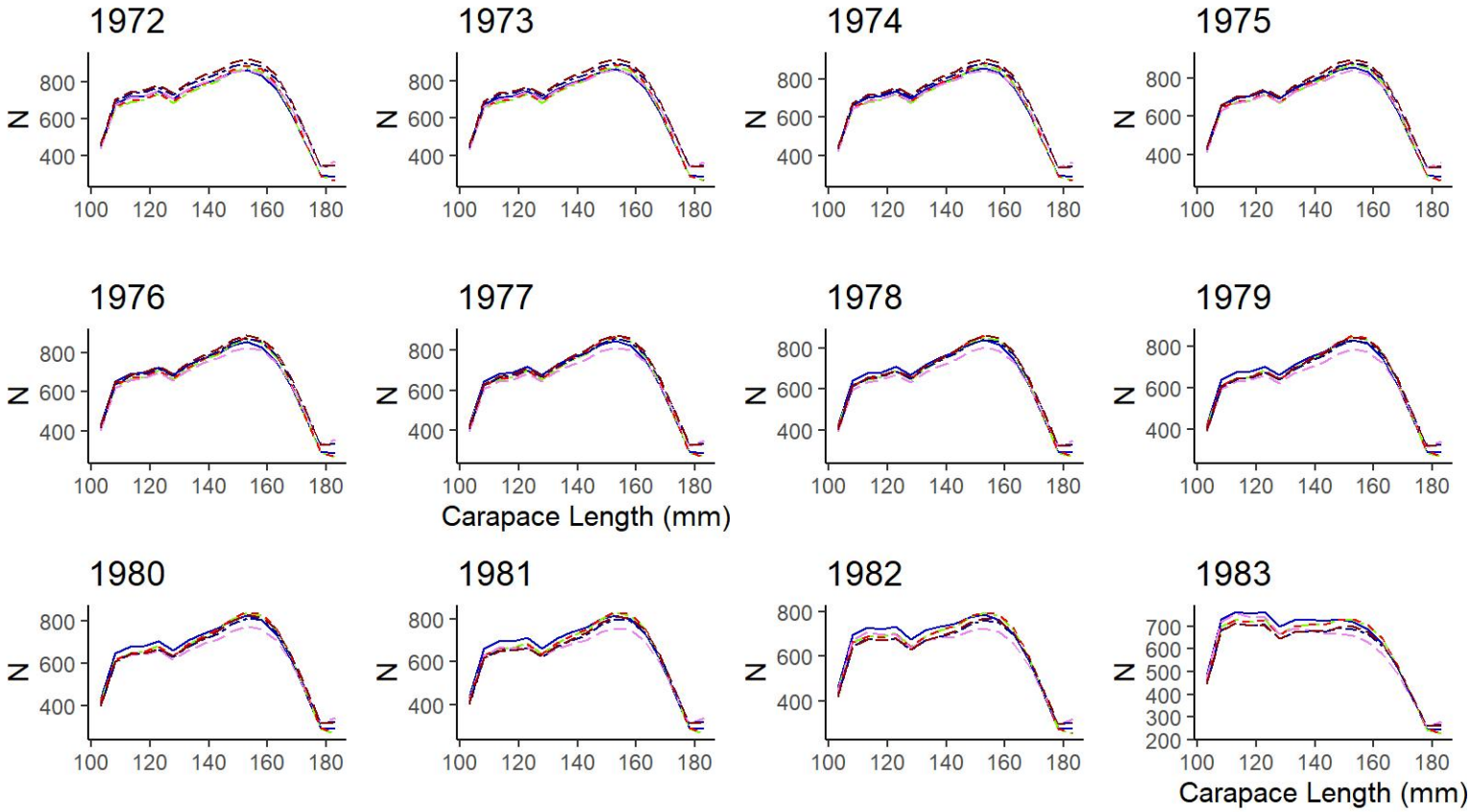

Figure 6. Model predicted abundance by size. N matrix: 1972−1983.

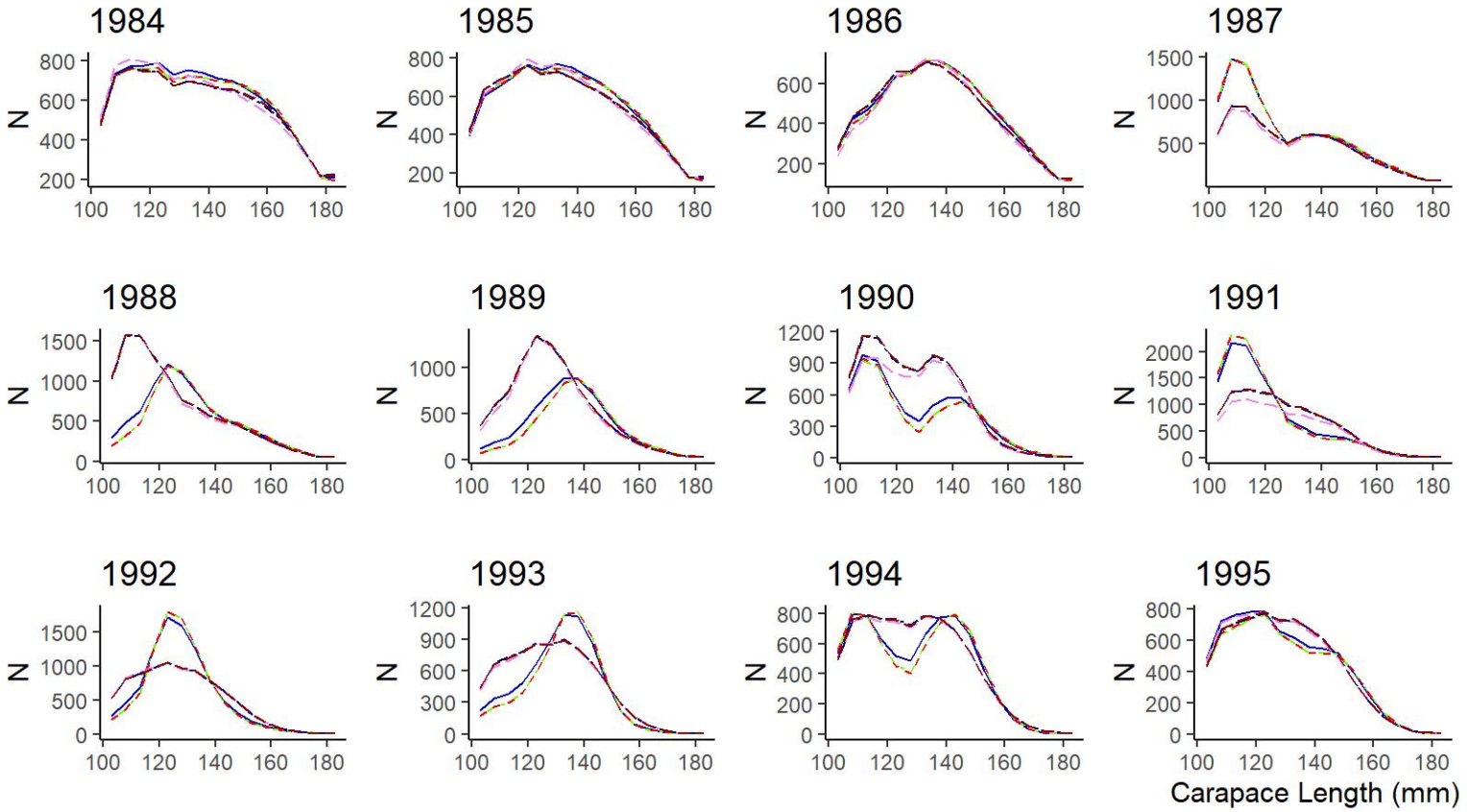

Figure 7. Model predicted abundance by size. N matrix: 1984−1995.

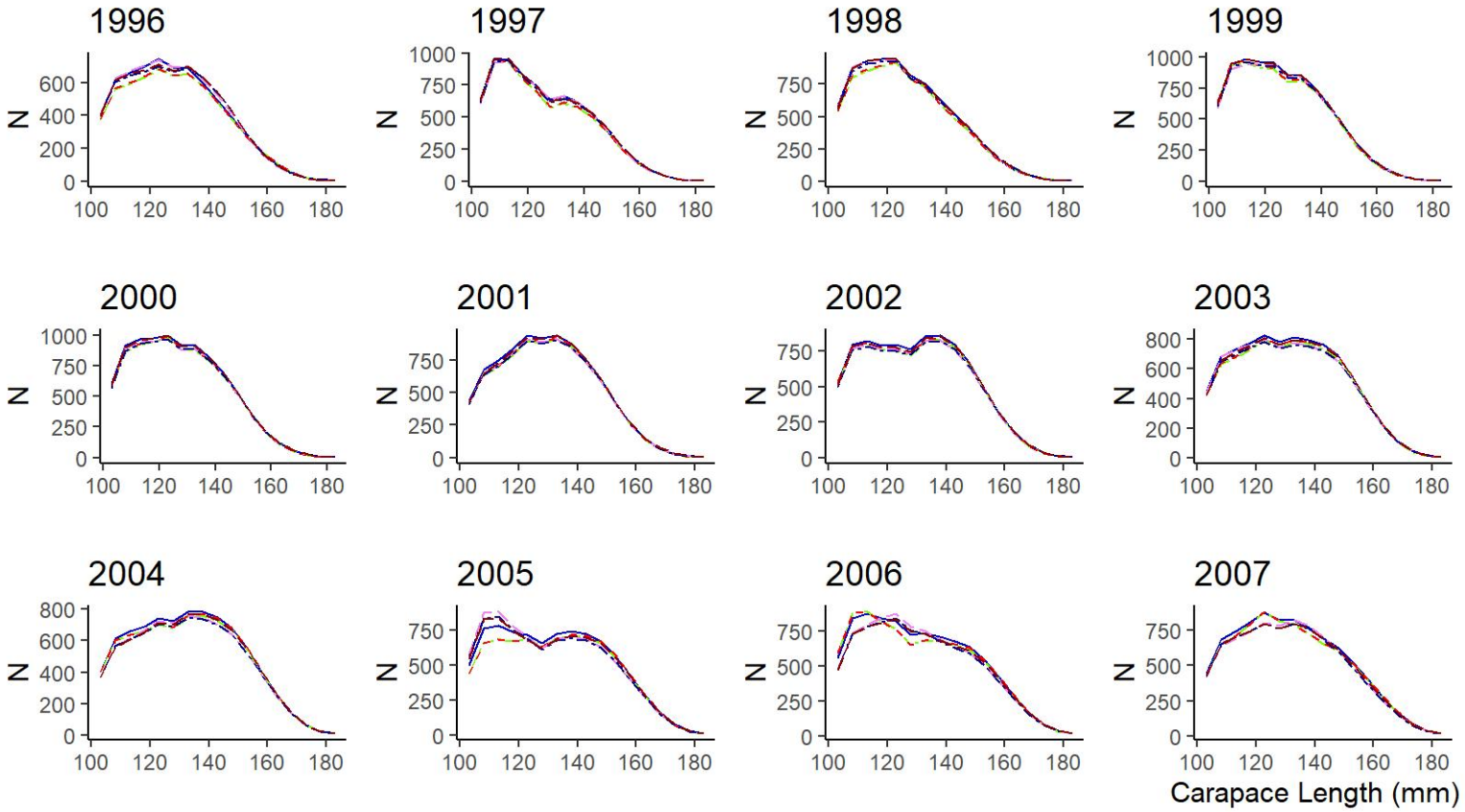

Figure 8. Model predicted abundance by size. N matrix: 1996−2007.

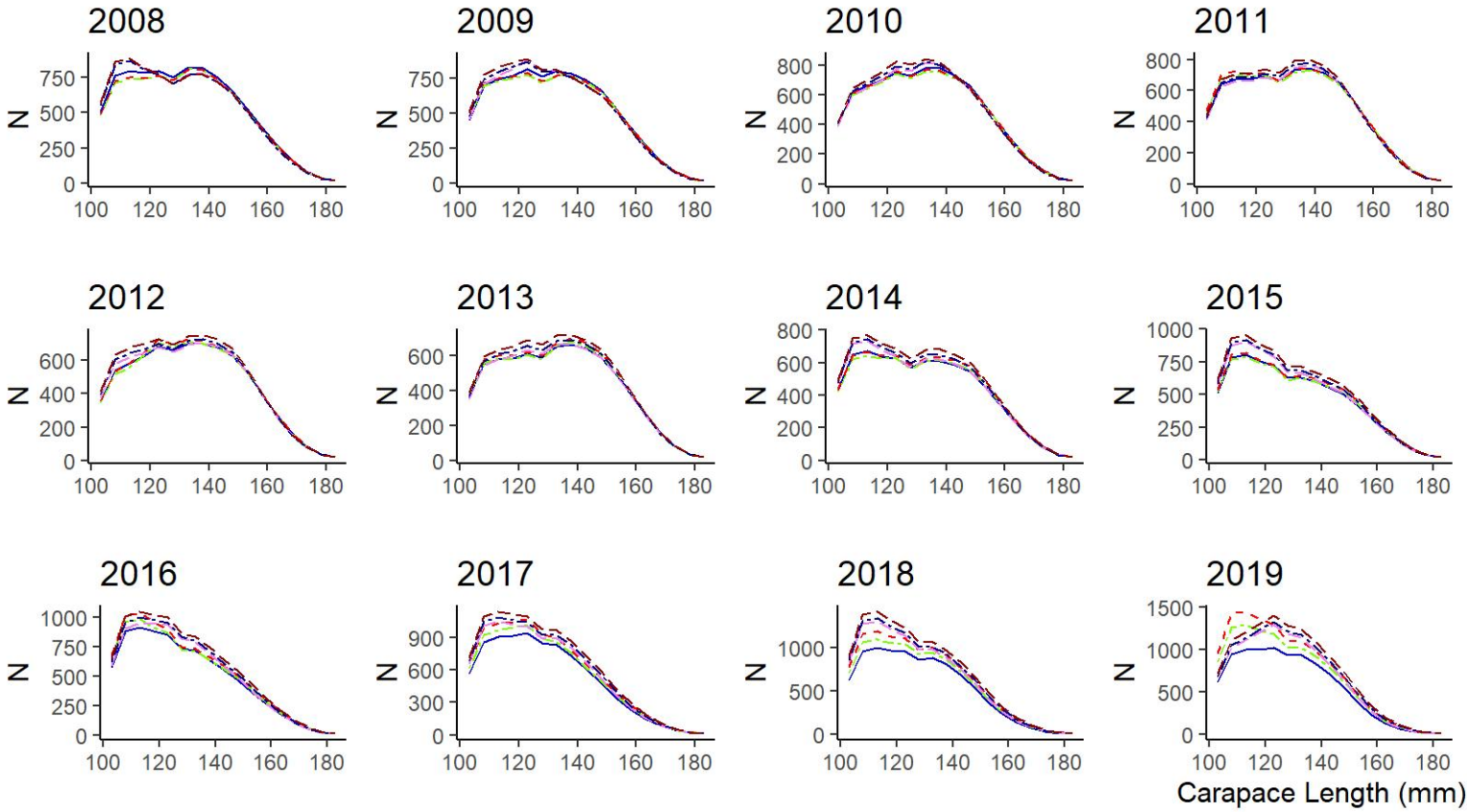

Figure 9. Model predicted abundance by size. N matrix: 2008-2019.