Preliminary assessment of Pacific cod in the Aleutian Islands

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Alaska Fisheries Science Center

Grant Thompson

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Responses to Team/SSC comments

SSC comments in general

- See Bering Sea assessment

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SSC comments on AI Pacific cod

- SSC5 (12/15 minutes): *"One additional recommendation from the SSC is to examine weights-at-age of Pacific cod by area."* This recommendation will be addressed in the final assessment

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Data

Data used in one or more models

- ## Model 13.4:

Source	Type	Years
AI bottom trawl survey	Biomass	1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014

- ## Models 16.1-16.5 (data not used last year shown in italics):

Source	Type	Years
Fishery	Catch biomass	1977-2015
Fishery	Size composition	1978-1979, 1982-1985, 1990-2015
AI bottom trawl survey	Numerical abundance	1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014
AI bottom trawl survey	Size composition	1991, 1994, 1997, 2000, 2002, 2004, 2006, 2010, 2012, 2014
AI bottom trawl survey	Age composition	2002, 2006, 2010, 2012, 2014
IPHC longline survey	*Relative abundance*	*1997-2014*
IPHC longline survey	*Size composition*	*2015*
NMFS longline survey	*Relative abundance*	*1996-2014 (even years only)*
NMFS longline survey	*Size composition*	*1996-2014 (even years only)*

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Model structures

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Requested models (1 of 3)

- Model 13.4: Final model from 2013-2015 (Tier 5 random effects model)

- Model 16.1: Like Model 15.7, but simplified as follows:
  - Weight abundance indices more heavily than sizecomps
  - Use the simplest selectivity form that gives a reasonable fit
  - Do not allow survey selectivity to vary with time
  - Do not allow survey catchability to vary with time
  - Do not allow strange selectivity patterns
  - Estimate trawl survey catchability internally with a fairly non-informative prior

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Requested models (2 of 3)

- Model 16.2: Like Model 15.7, but including the IPHC longline survey data and other features, specifically:
  - Do now allow strange selectivity patterns
  - Estimate trawl survey catchability internally with a fairly non-informative prior
  - Estimate catchability of new surveys internally with non-restrictive priors
  - Include additional data sets to increase confidence in model results
  - Include IPHC longline survey, with "extra SD"
- Model 16.3: Like Model 16.2 above, but including the NMFS longline survey instead of the IPHC longline survey

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Requested models (3 of 3)

- Model 16.4: Like Models 16.2 and 16.3 above, but including both the IPHC and NMFS longline survey data

- Model 16.5: Like AI Model 15.7, except:

  - Use the post-1994 AI time series (instead of the post-1986 time series)

  - Do not allow strange selectivity patterns

  - Estimate trawl survey catchability internally with a fairly non-informative prior

    - Interpreted to mean non-constraining uniform prior

AI Model 15.7: differences from BS model 15.6

- Natural mortality rate M fixed at 0.34 (vs. estimated internally)
- Standard deviation of log-scale age 0 recruitment (σ_R) was estimated internally instead of being estimated iteratively
- Log-scale Q was estimated using a normal prior distribution with μ=0.00 and σ=0.11, instead of a non-constraining uniform prior
- 10 age groups were estimated in the initial vector (vs. 20)
- Von Bertalanffy growth was assumed instead of Richards growth
- Catchability Q was constant rather than time-varying
- Input N was tuned to arithmetic mean rather than harmonic mean
- σ for **dev** vectors was tuned by method of Thompson and Lauth (2012) rather than method of Thompson (2015)
  - T&L method cumbersome, large potential for "false negatives"

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Results

Big picture

- Female spawning biomass (t), relative to $B_{100\%}$:

Quantity	Model 16.1		Model 16.2		Model 16.3		Model 16.4		Model 16.5	
	Value	CV	Value	CV	Value	CV	Value	CV	Value	CV
FSB 2016	84,234	0.12	451,880	0.45	85,869	0.19	198,934	0.23	172,307	0.25
Bratio 2016	0.46	0.09	0.62	0.15	0.29	0.13	0.47	0.10	0.47	0.13

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Objective function values

Obj. function component	Aggregated data components				
	M16.1	M16.2	M16.3	M16.4	M16.5
Catch	0.00	0.00	0.00	0.00	0.00
Equilibrium catch	0.00	0.00	0.00	0.00	0.00
Survey abundance index	-2.60	-16.33	6.93	-18.12	-4.21
Size composition	779.91	846.84	1678.53	1677.15	686.70
Age composition	151.86	113.24	110.19	72.12	108.99
Recruitment	18.78	9.23	21.43	18.22	15.04
Priors	97.63	95.08	489.83	492.93	70.66
"Softbounds"	0.00	0.00	0.00	0.00	0.00
Deviations	30.92	118.38	119.65	95.56	100.96
Total	1076.49	1166.44	2426.56	2337.88	978.15

Goodness of fit: survey indices

Model	Survey	σave	RMSE	MNR	SDNR	Corr.
16.1	Trawl	0.18	0.34	0.16	1.79	0.61
16.2	Trawl	0.18	0.20	0.07	1.22	0.91
16.3	Trawl	0.18	0.35	-0.10	2.34	0.85
16.4	Trawl	0.18	0.24	0.00	1.55	0.90
16.5	Trawl	0.18	0.25	-0.03	1.63	0.72
16.2	IPHC LL	0.42	0.44	-0.04	1.01	0.46
16.4	IPHC LL	0.41	0.42	-0.04	1.01	0.54
16.3	NMFS LL	0.44	0.49	0.03	1.04	0.50
16.4	NMFS LL	0.34	0.38	0.02	1.03	0.53

Fit to trawl survey biomass (Model 13.4)
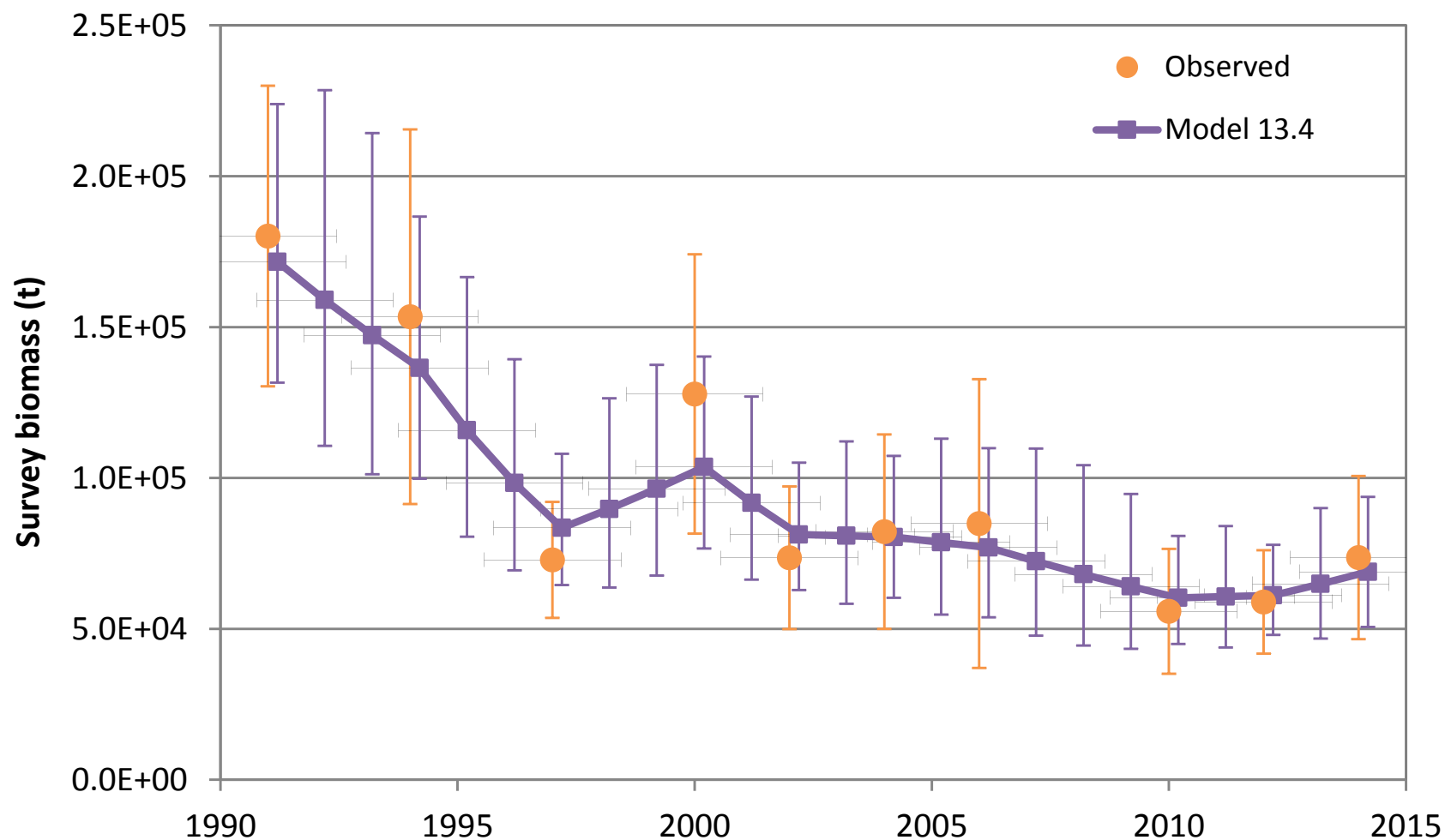
Fit to trawl survey index (Models 16.1-16.5)
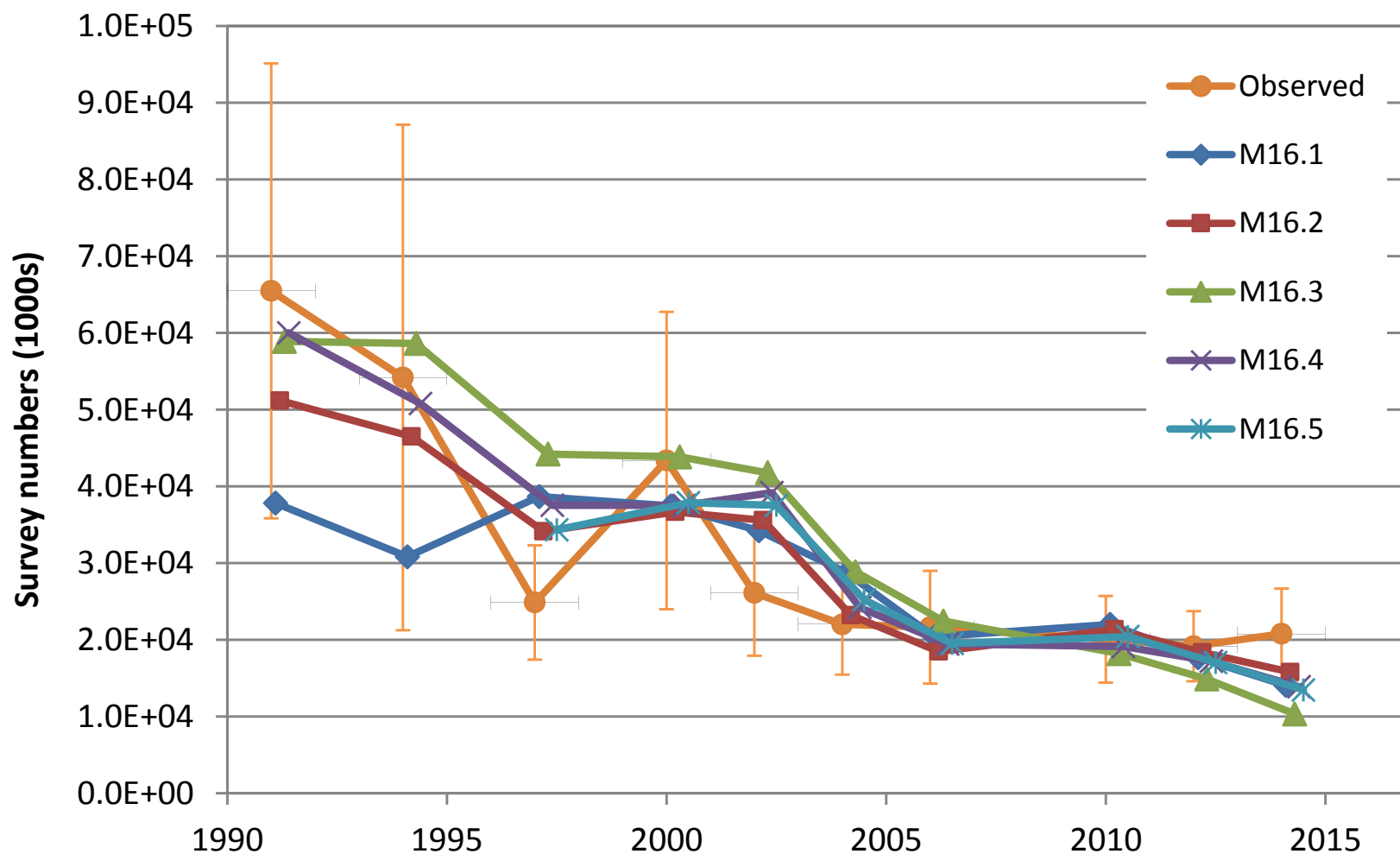
Fit to IPHC LL survey index (Model 16.2)
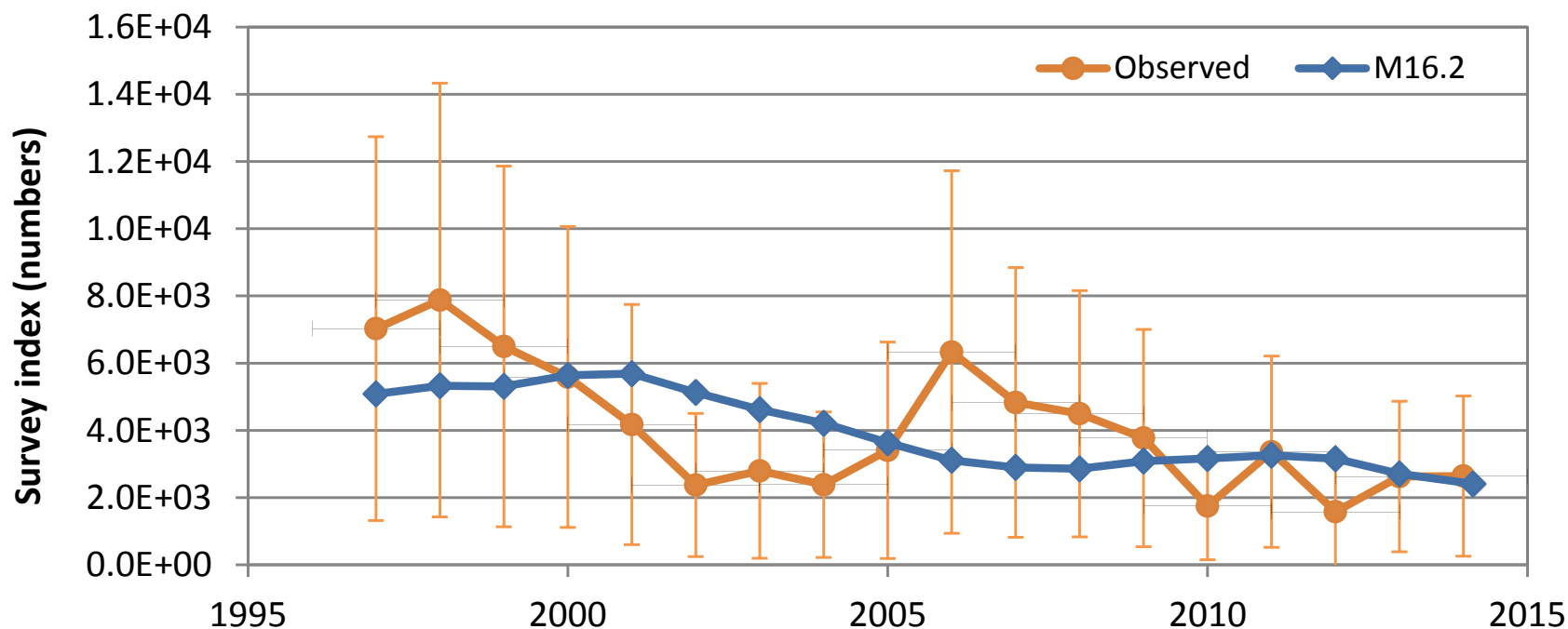
Fit to IPHC LL survey index (Model 16.4)

Fit to NMFS LL survey index (Model 16.3)

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It has not been formally disseminated by the National Marine Fisheries Service and should not be construed to represent any agency determination or policy.
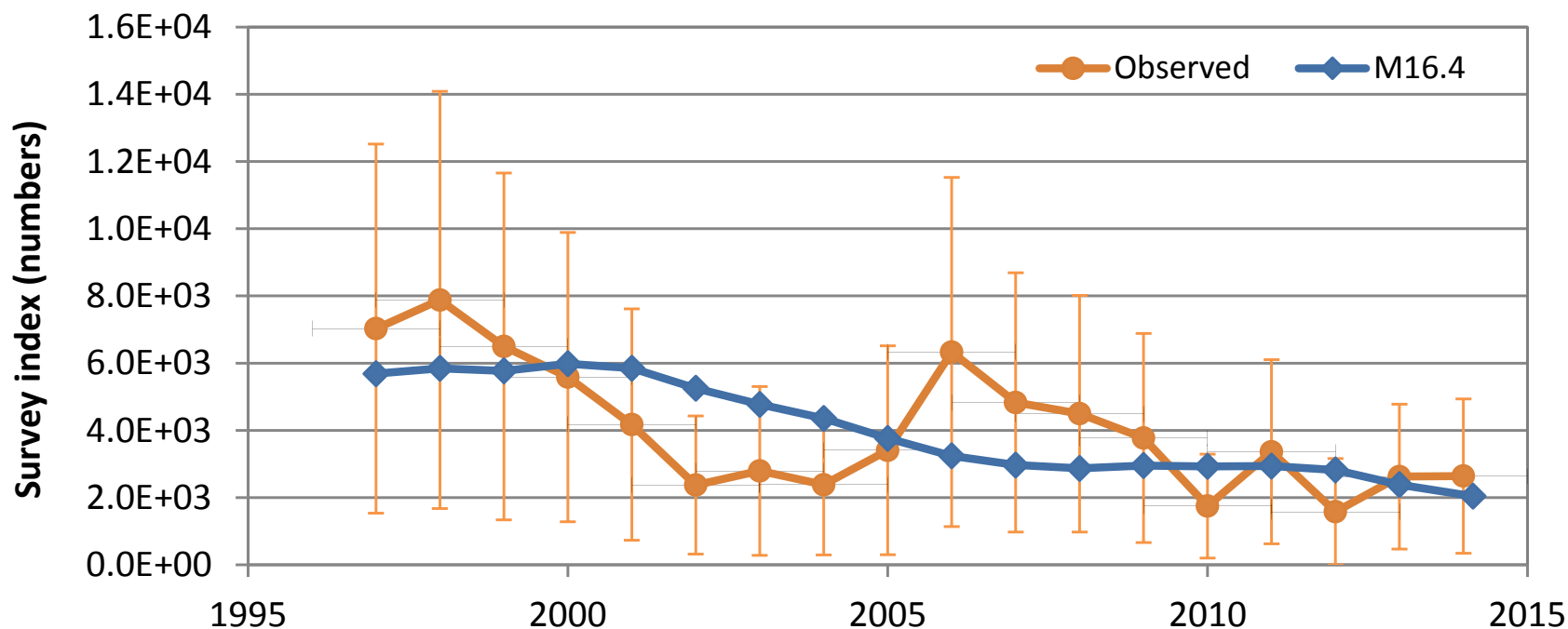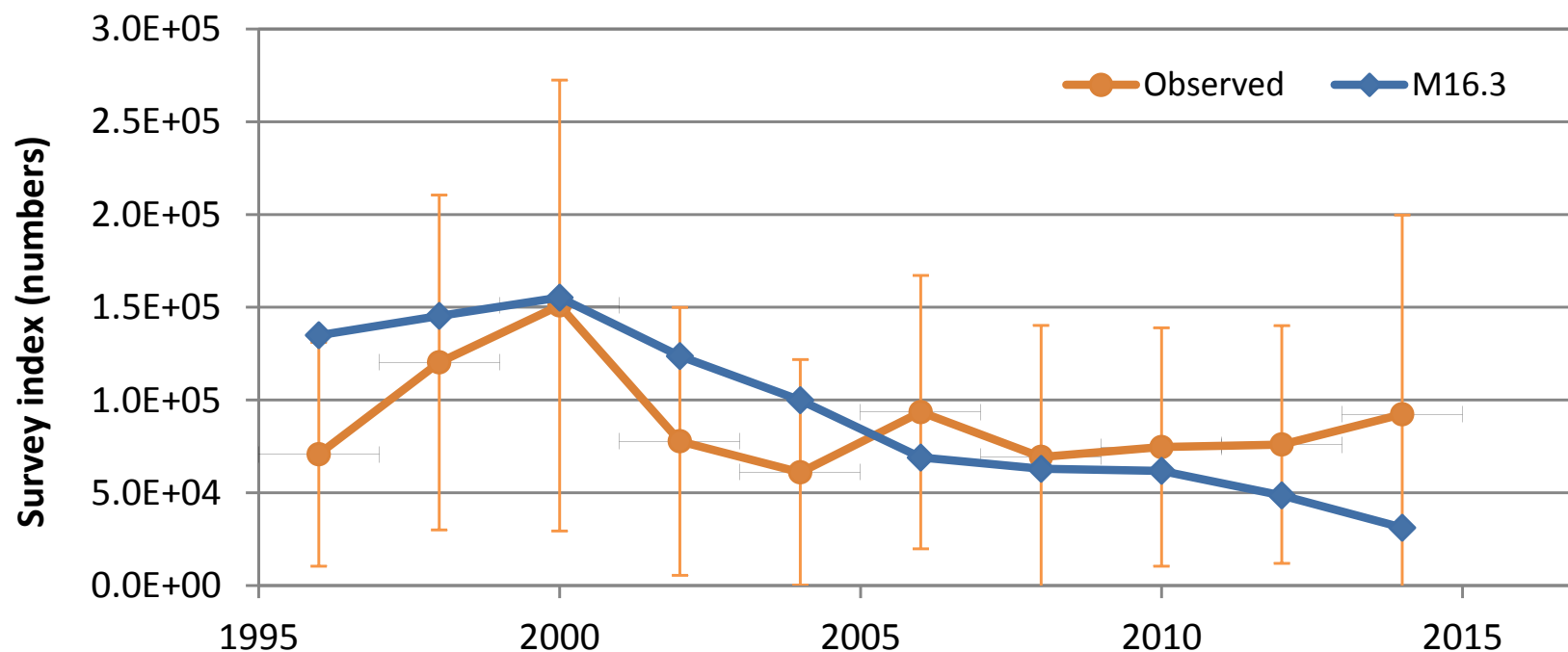
Fit to NMFS LL survey index (Model 16.4)
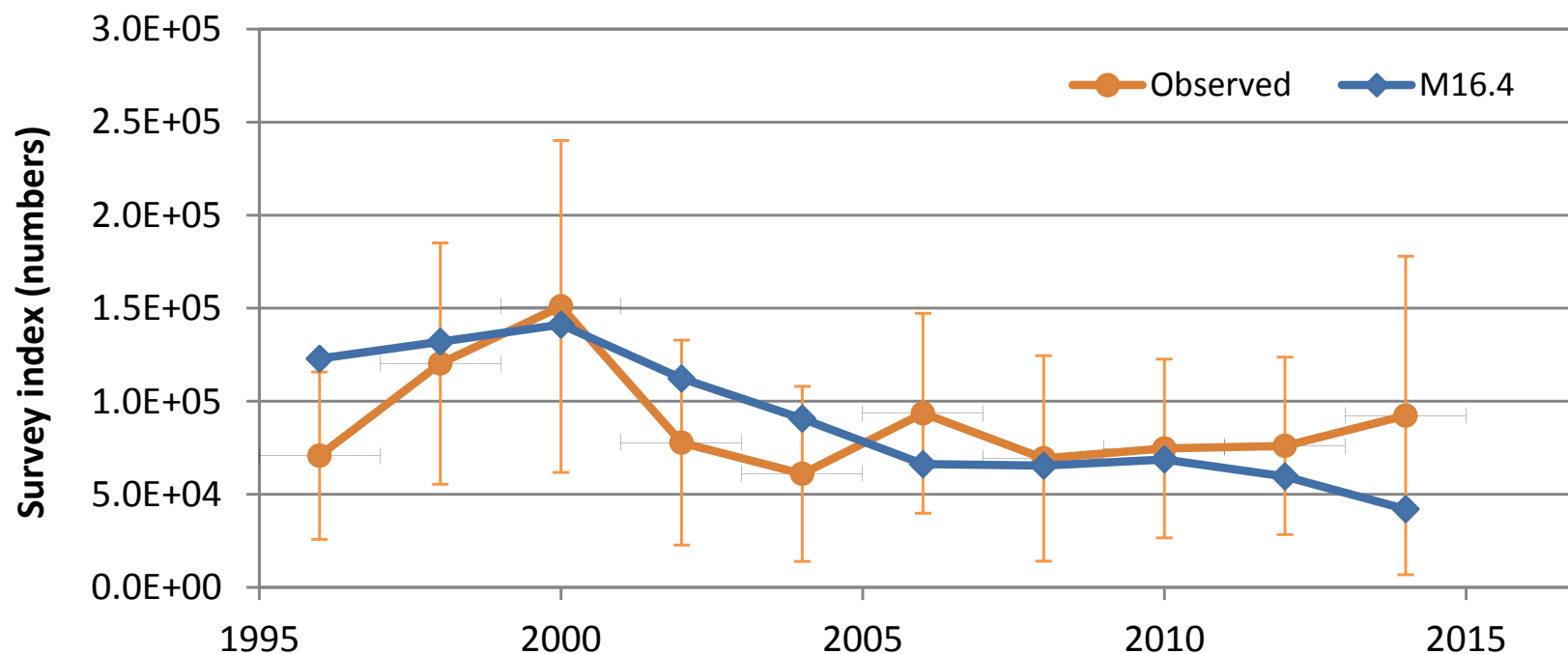
Goodness of fit: size composition

Model	Fleet	Nrec	A(Ninp)	A(Neff)/A(Ninp)	H(Neff)/A(Ninp)
16.1	Fishery	32	300	6.94	3.54
16.2	Fishery	32	1278	3.11	1.13
16.3	Fishery	32	1278	2.76	1.03
16.4	Fishery	32	1278	2.72	1.04
16.5	Fishery	32	1278	3.18	1.08
16.1	Trawl survey	10	300	1.99	1.50
16.2	Trawl survey	10	248	2.46	1.87
16.3	Trawl survey	10	248	2.23	1.61
16.4	Trawl survey	10	248	2.76	1.82
16.5	Trawl survey	8	212	2.86	2.66
16.2	IPHC longline survey	1	300	1.64	1.64
16.4	IPHC longline survey	1	300	1.79	1.79
16.3	NMFS longline survey	10	300	0.63	0.56
16.4	NMFS longline survey	10	300	0.64	0.58

Goodness of fit: survey age composition

Year	Model 16.1 In. N	Model 16.1 Eff. N	Model 16.2 In. N	Model 16.2 Eff. N	Model 16.3 In. N	Model 16.3 Eff. N	Model 16.4 In. N	Model 16.4 Eff. N	Model 16.5 In. N	Model 16.5 Eff. N
2002	168	70	168	190	168	157	168	179	168	234
2006	391	321	391	81	391	79	391	164	391	76
2010	345	40	345	31	345	23	345	33	345	30
2012	307	123	307	118	307	108	307	276	307	121
2014	289	82	289	64	289	121	289	102	289	82
Mean	300	127	300	97	300	97	300	151	300	109
Harm.		79		67		63		91		71
Ratio1		0.42		0.32		0.32		0.50		0.36
Ratio2		0.26		0.22		0.21		0.30		0.24

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Fit to survey sizecomps (Model 16.1)
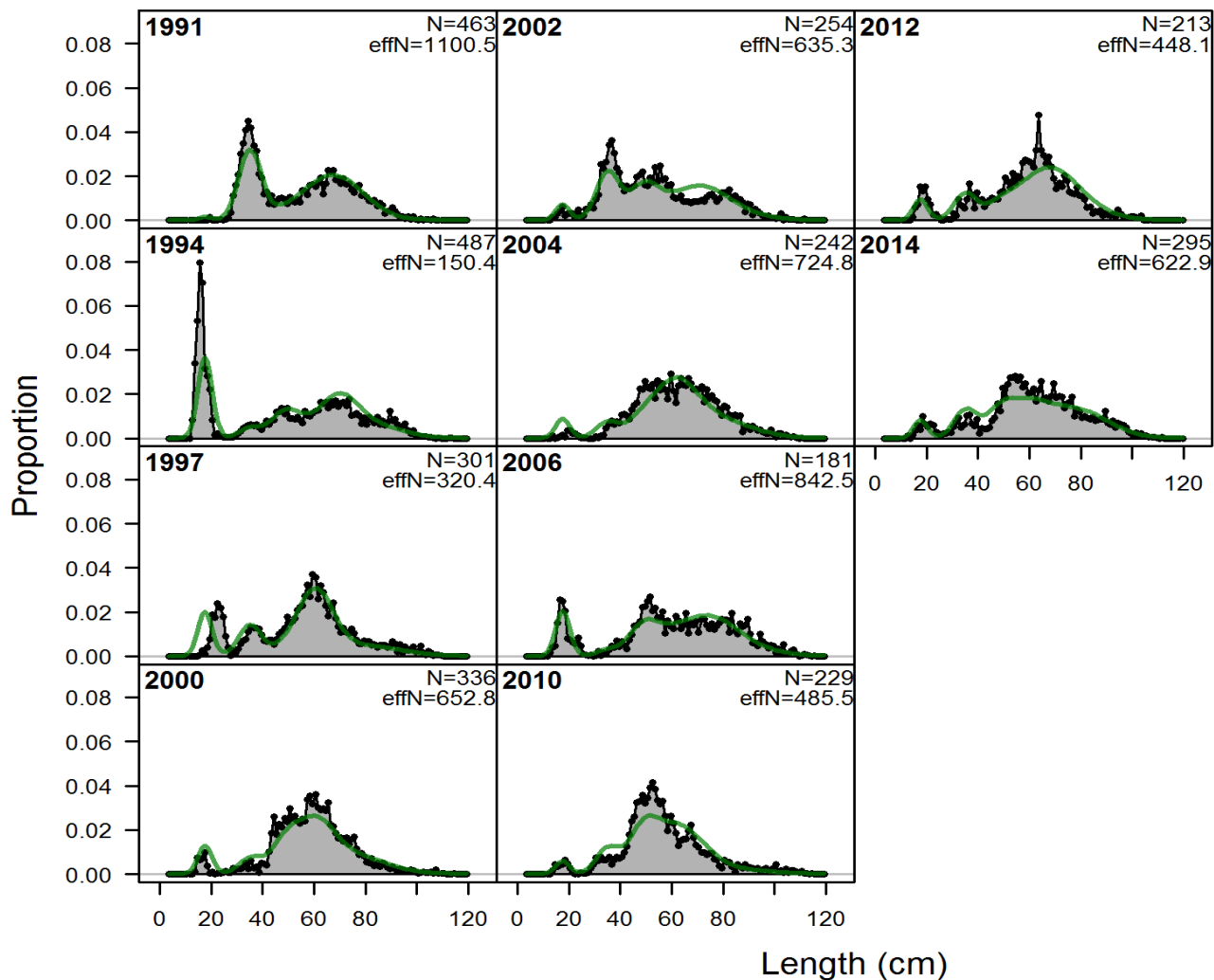
Fit to survey sizecomps (Model 16.2)
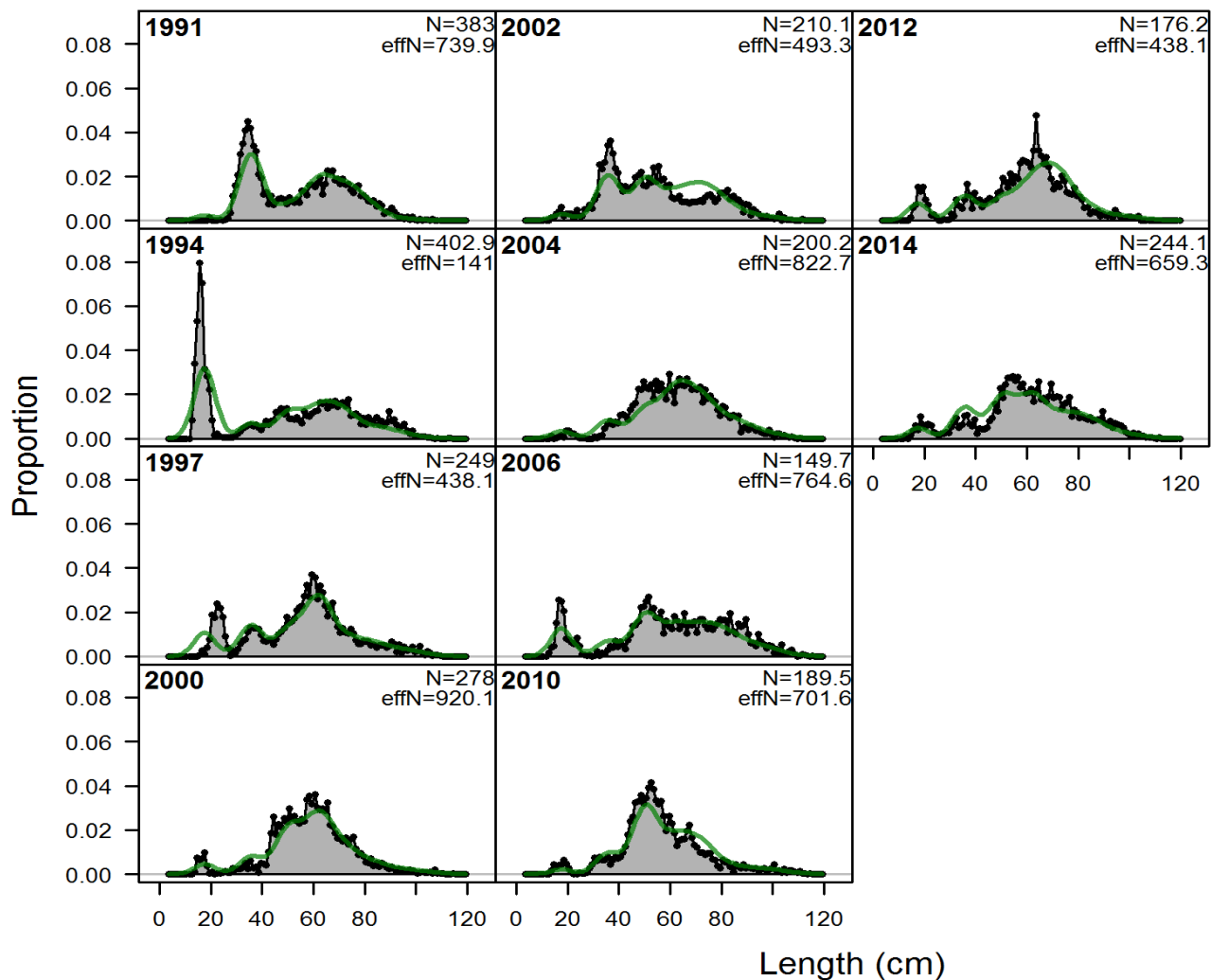
Fit to survey sizecomps (Model 16.3)
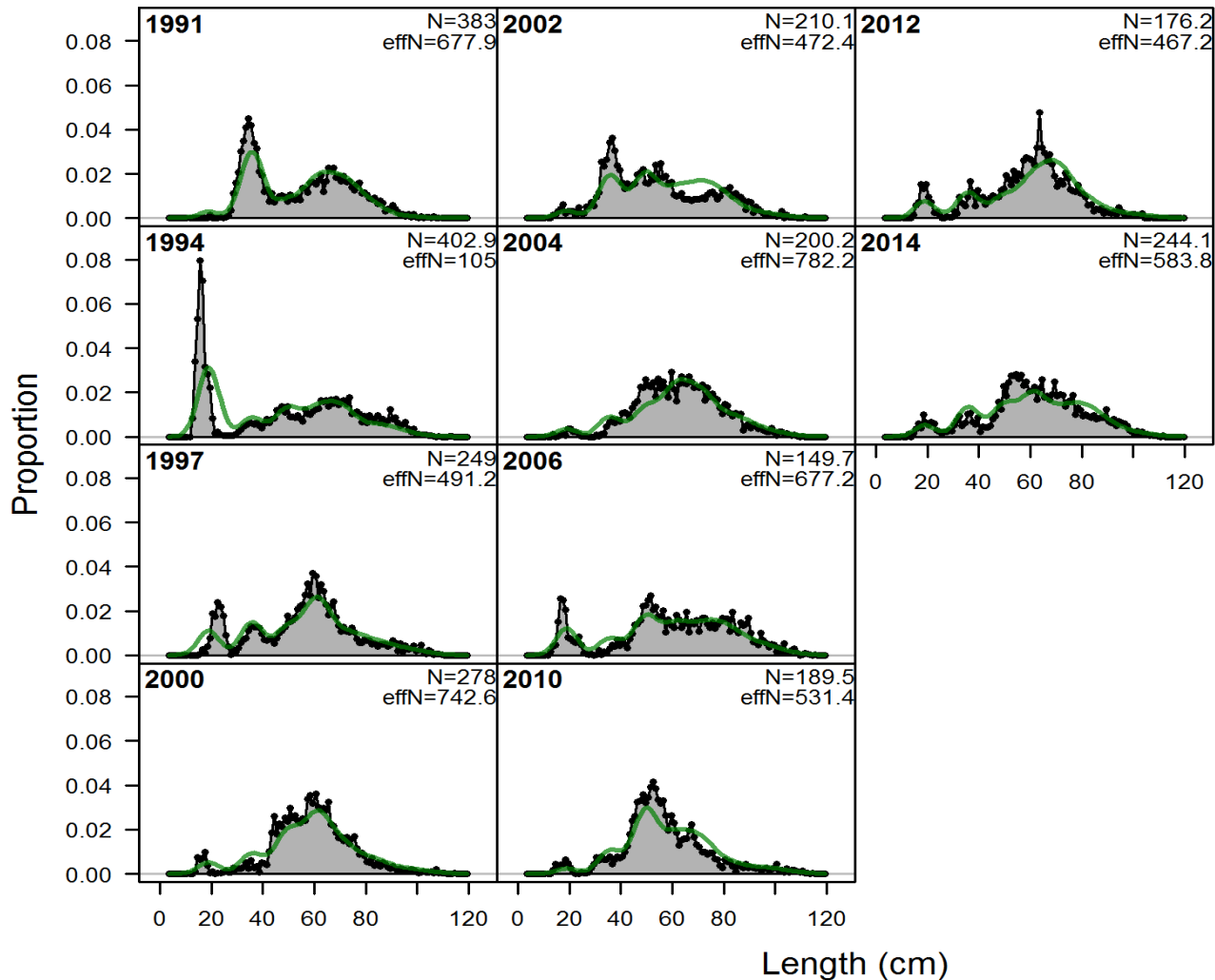
Fit to survey sizecomps (Model 16.4)
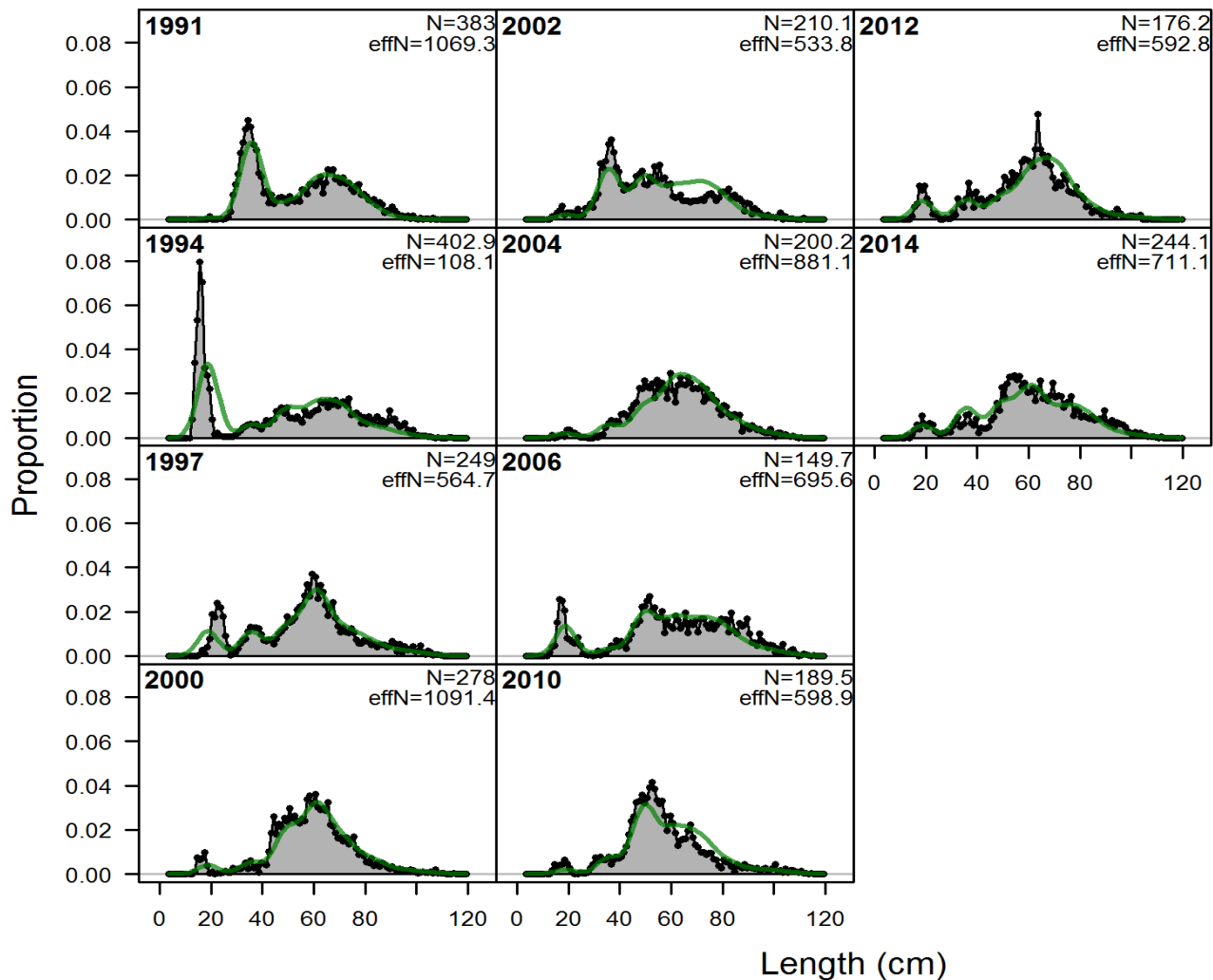
Fit to survey sizecomps (Model 16.5)
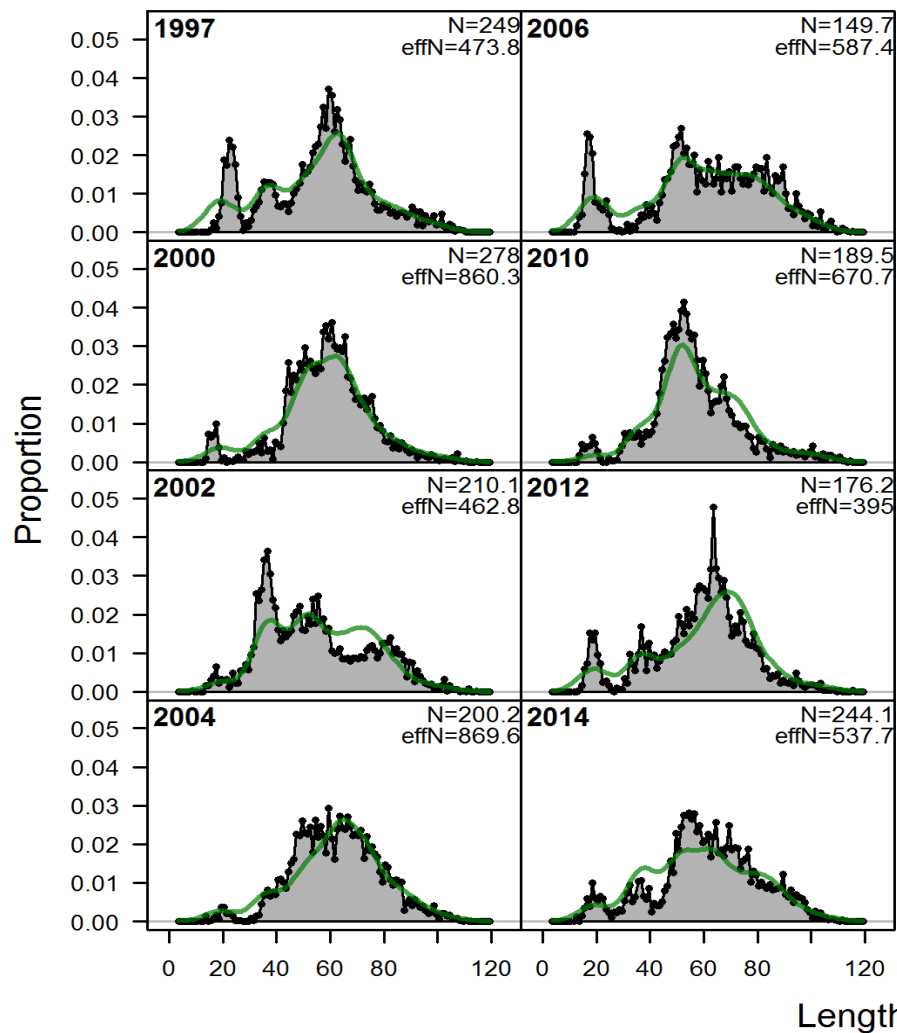
Fit to survey agecomps (Models 16.1 and 16.2)

Model 16.1
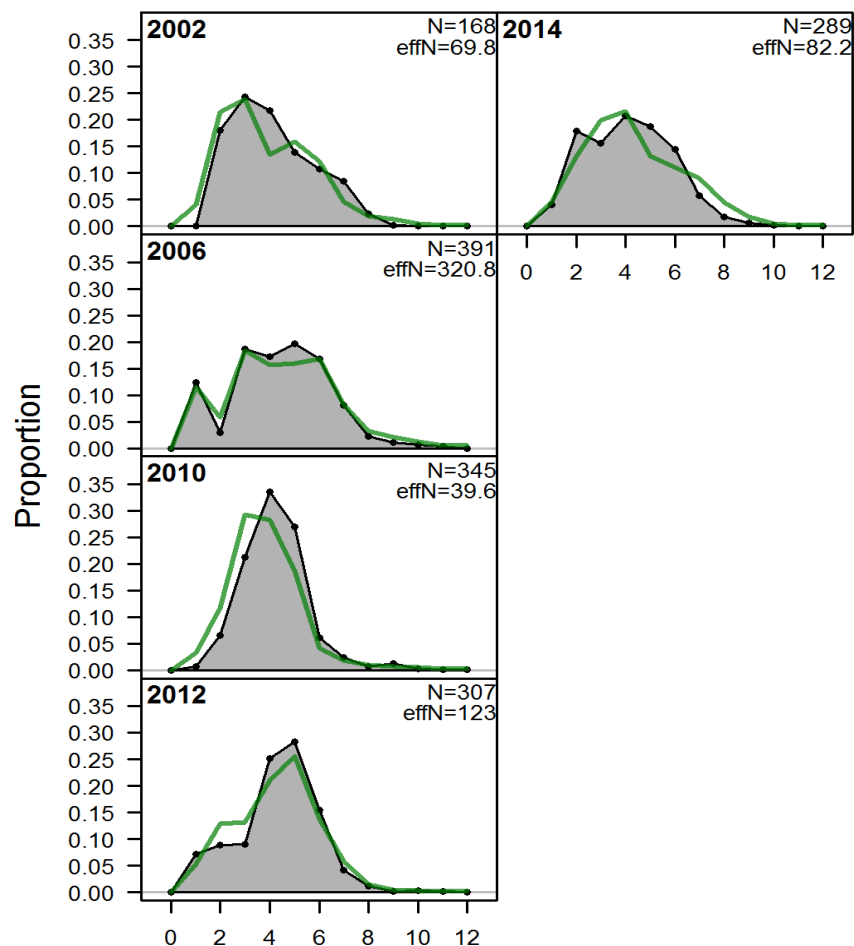
Model 16.2
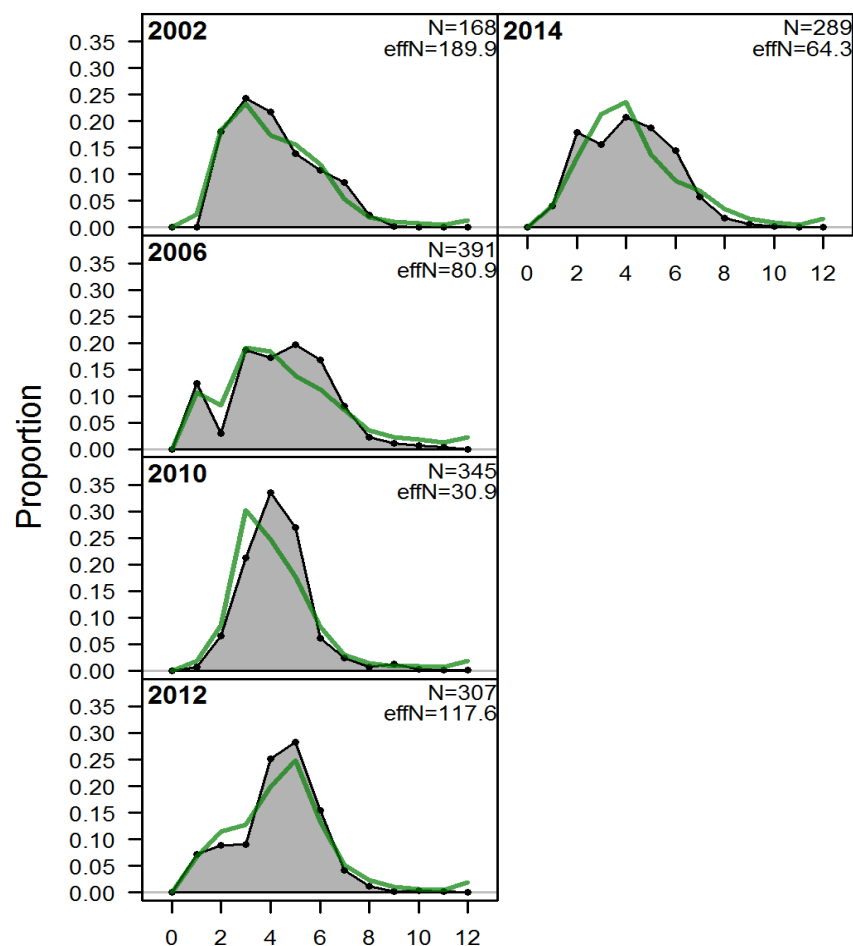
Fit to survey agecomps (Models 16.3 and 16.4)

Model 16.3

Model 16.4

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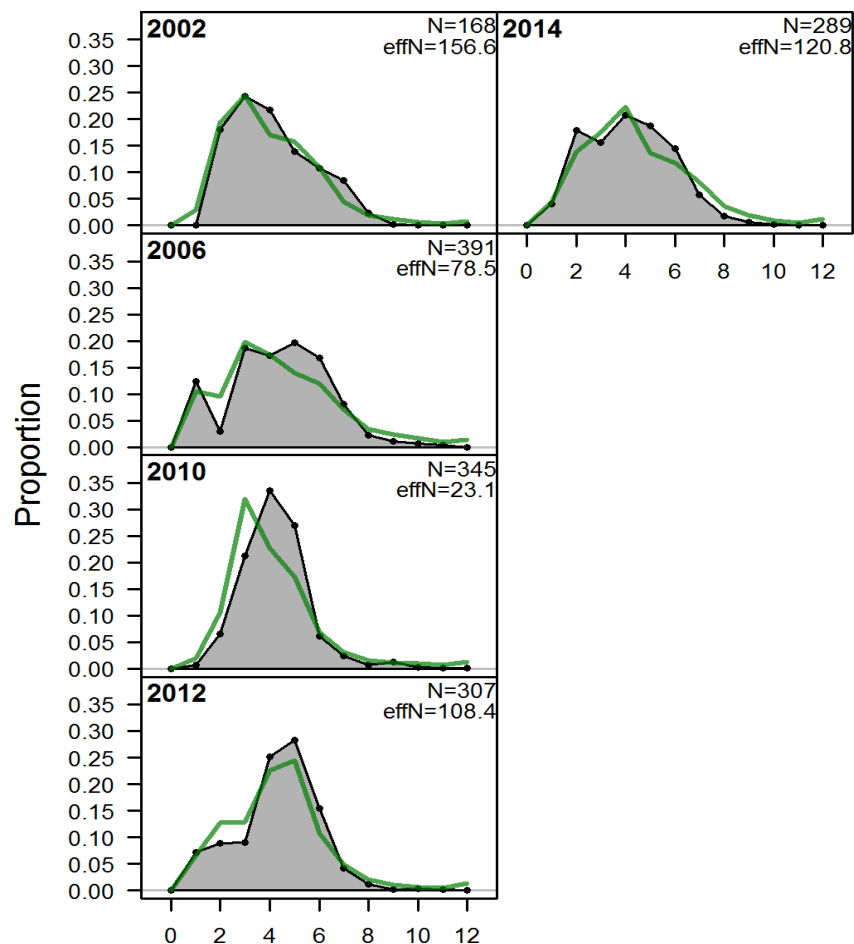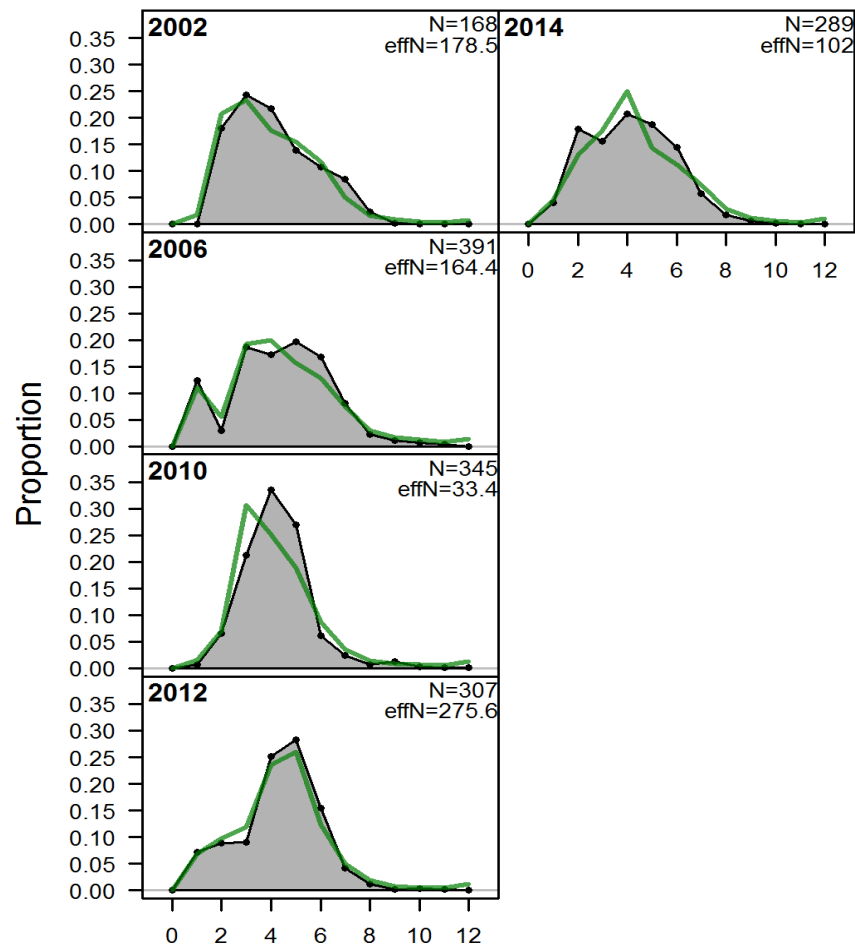
Fit to survey agecomps (Model 16.5)

Model 16.5
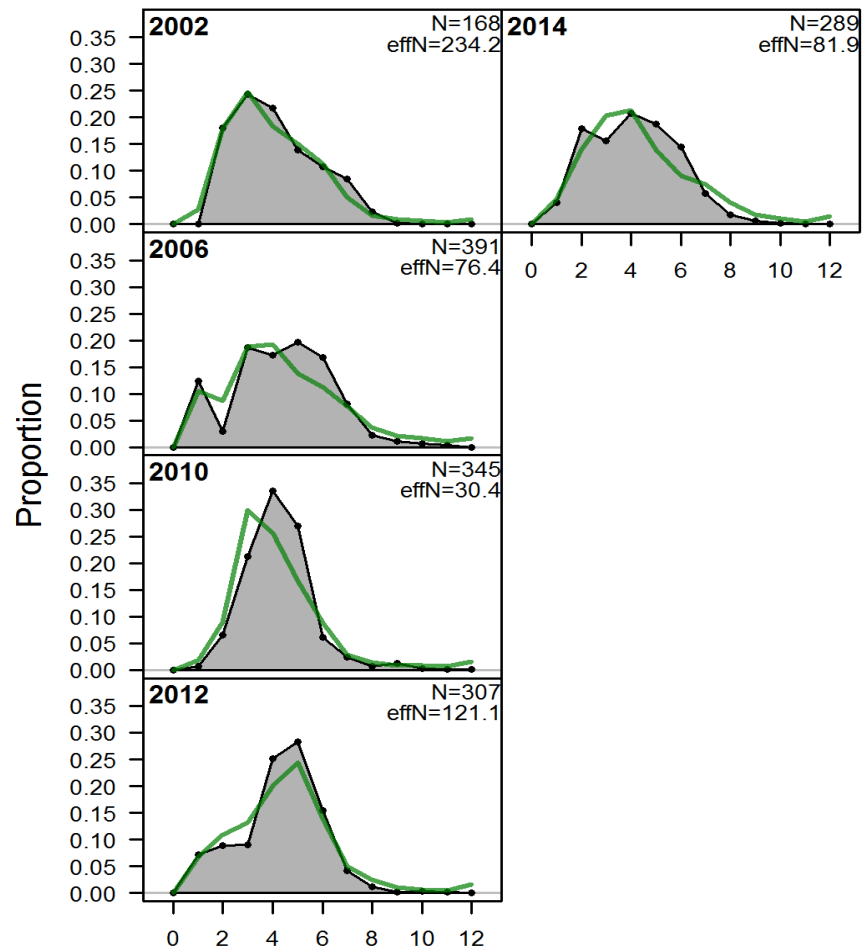
Key parameters (Table 2.1.7, p. 19)

Parameter	Model 16.1 Est.	Model 16.1 SD	Model 16.2 Est.	Model 16.2 SD	Model 16.3 Est.	Model 16.3 SD	Model 16.4 Est.	Model 16.4 SD	Model 16.5 Est.	Model 16.5 SD
Length at age 1 (cm)	18.050	0.129	18.003	0.254	19.368	0.275	19.228	0.262	19.450	0.474
Asymptotic length (cm)	107.795	1.315	107.507	0.652	111.453	0.796	109.874	0.699	110.692	0.909
Brody growth coefficient	0.217	0.005	0.227	0.003	0.203	0.003	0.207	0.003	0.219	0.004
SD of length at age 1 (cm)	2.815	0.088	4.157	0.194	4.125	0.192	4.037	0.182	5.807	0.306
SD of length at age 20 (cm)	11.318	0.375	6.679	0.226	6.170	0.262	6.165	0.241	5.493	0.270
Ageing bias at age 1 (years)	0.431	0.014	0.422	0.021	0.417	0.023	0.426	0.022	0.430	0.020
Ageing bias at age 20 (years)	-1.549	0.350	-0.275	0.431	-1.568	0.556	-0.990	0.443	0.210	0.378
ln(mean recruitment)	10.716	0.072	12.072	0.383	11.156	0.110	11.549	0.165	11.313	0.183
Sigma_R	0.731	0.065	0.647	0.071	0.795	0.072	0.715	0.066	0.740	0.083
Initial F	0.049	0.005	0.008	0.003	0.023	0.003	0.014	0.003	0.017	0.003
"Extra SD" for NMFS LL survey					0.260	0.107	0.160	0.080		
"Extra SD" for IPHC LL survey			0.280	0.072			0.266	0.069		
Base ln(Q) for trawl survey	-0.640	0.079	-1.827	0.393	-0.795	0.119	-1.205	0.179	-1.035	0.195
Base ln(Q) for NMFS LL survey					0.697	0.170	0.230	0.197		
Base ln(Q) for IPHC LL survey			-3.369	0.417			-2.798	0.212		

- Trawl survey catchability:

Model 16.1 Est.	Model 16.1 SD	Model 16.2 Est.	Model 16.2 SD	Model 16.3 Est.	Model 16.3 SD	Model 16.4 Est.	Model 16.4 SD	Model 16.5 Est.	Model 16.5 SD
0.527	0.079	0.161	0.409	0.452	0.119	0.300	0.180	0.355	0.197

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Fishery selectivity
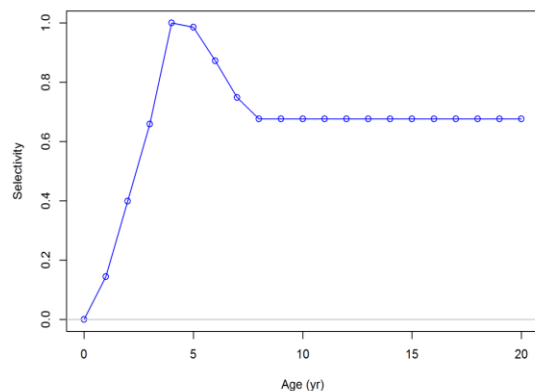

Model 16.1
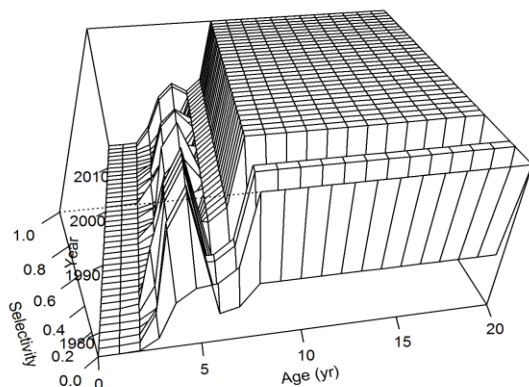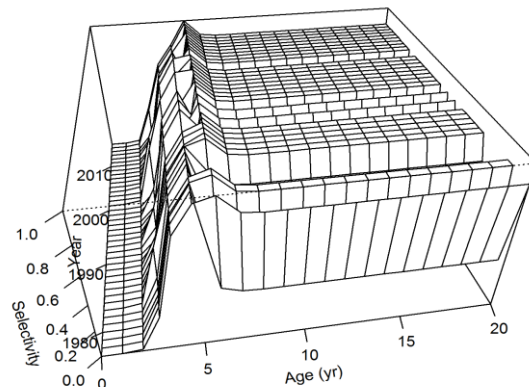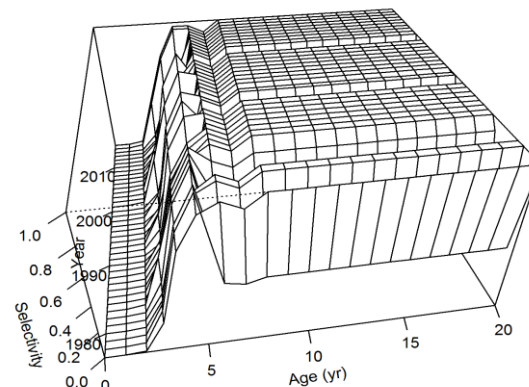
Model 16.2
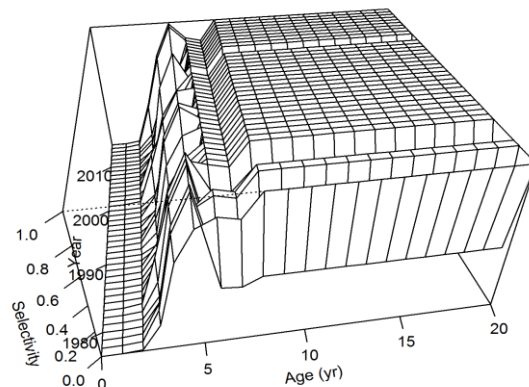
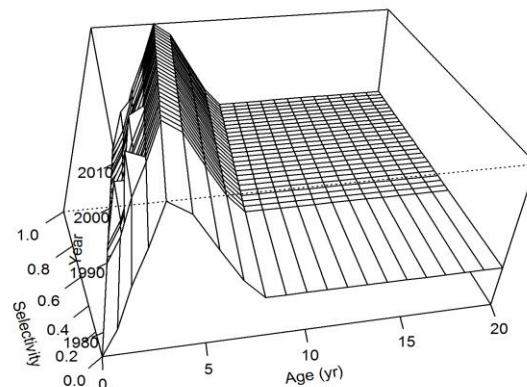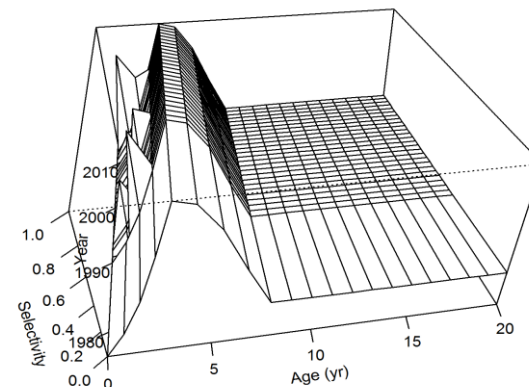Model 16.4
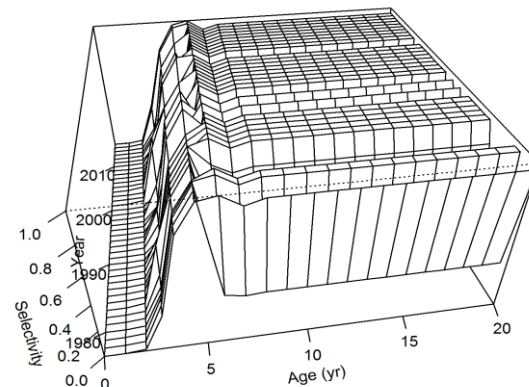
Model 16.3
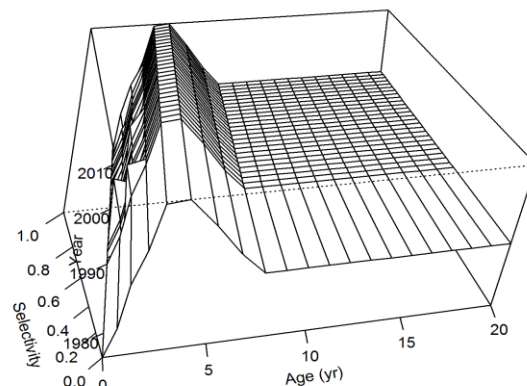

Model 16.5

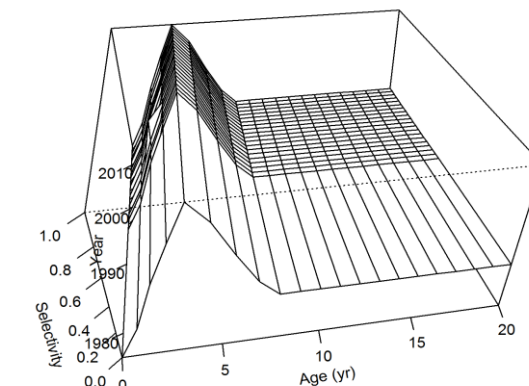# Trawl survey selectivity

Model 16.1

Model 16.2
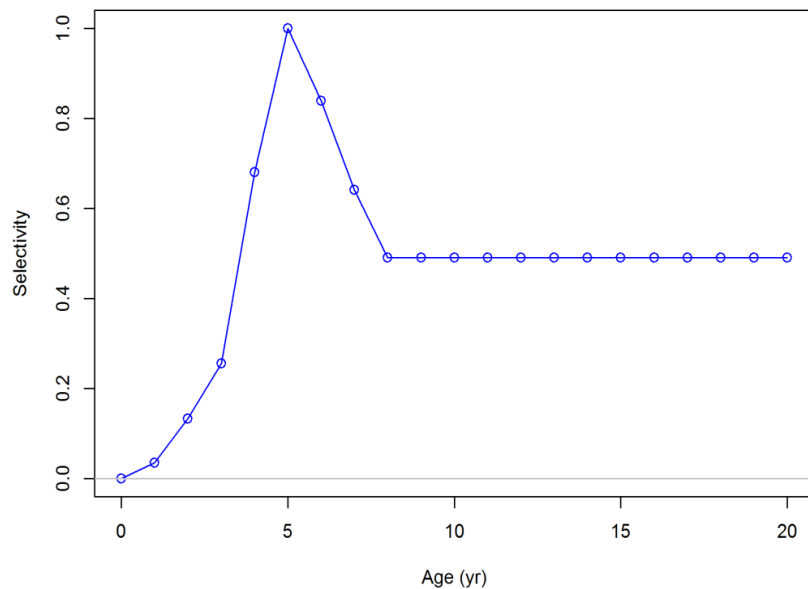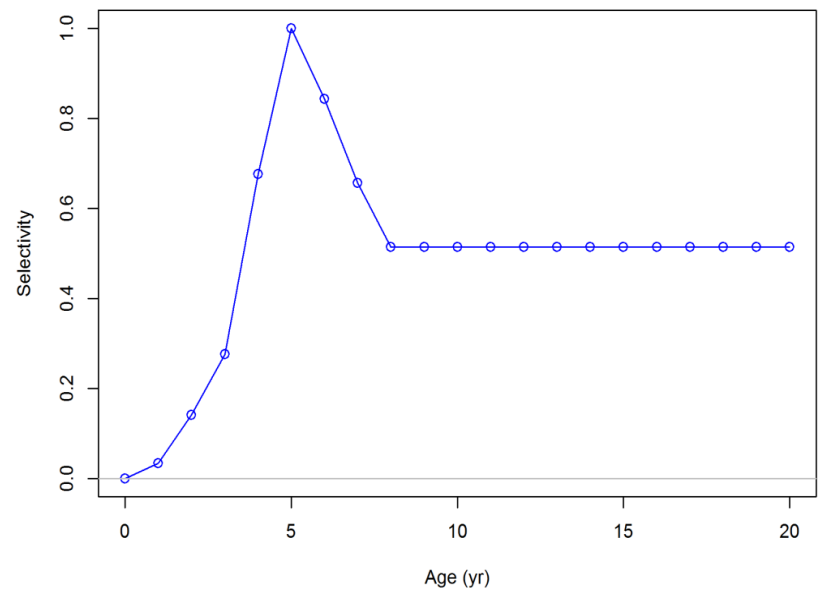
Model 16.4

Model 16.3

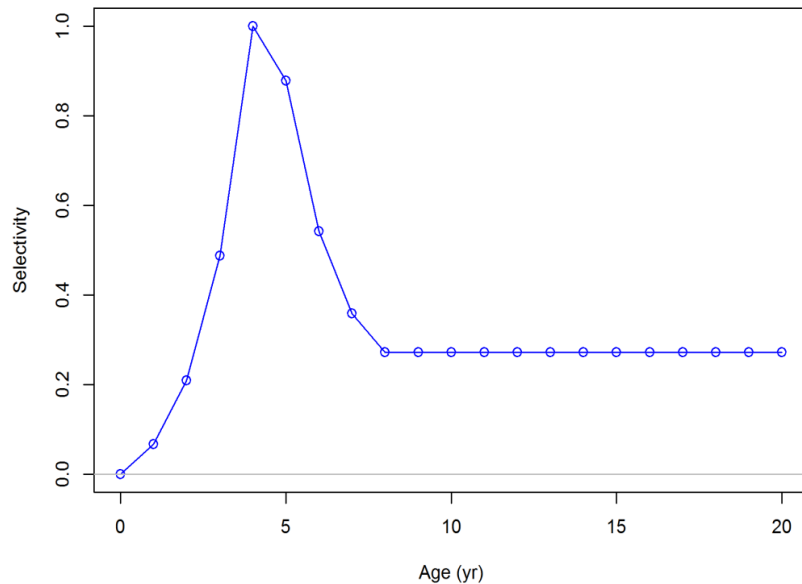Model 16.5

IPHC LL survey selectivity
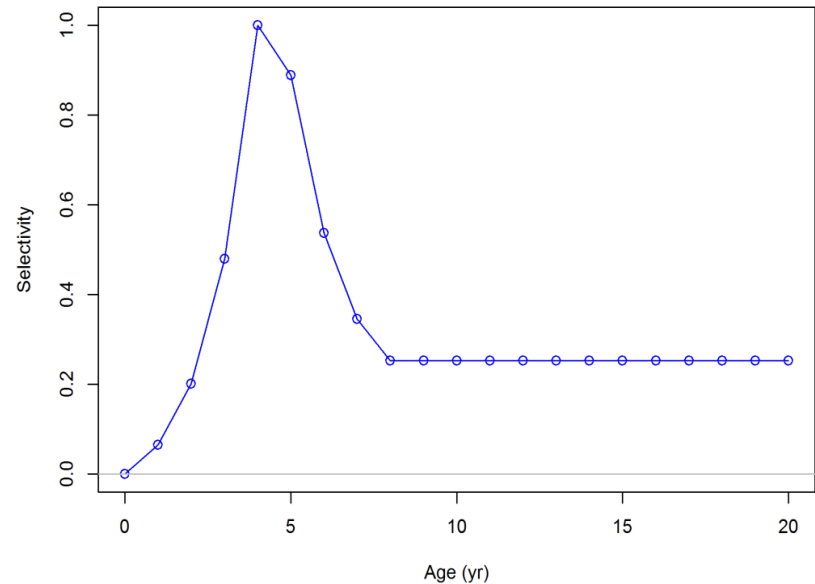

Model 16.2

Model 16.4
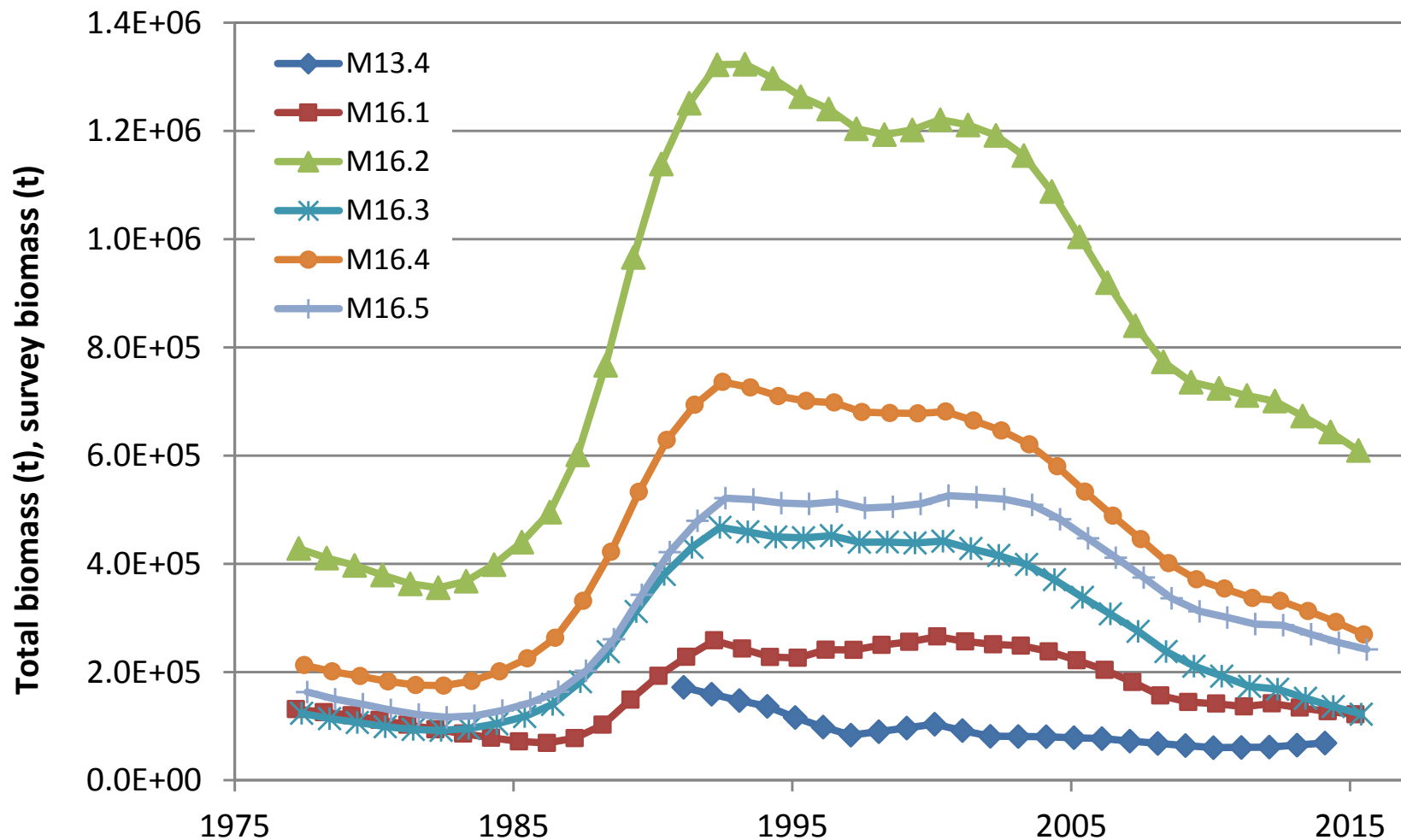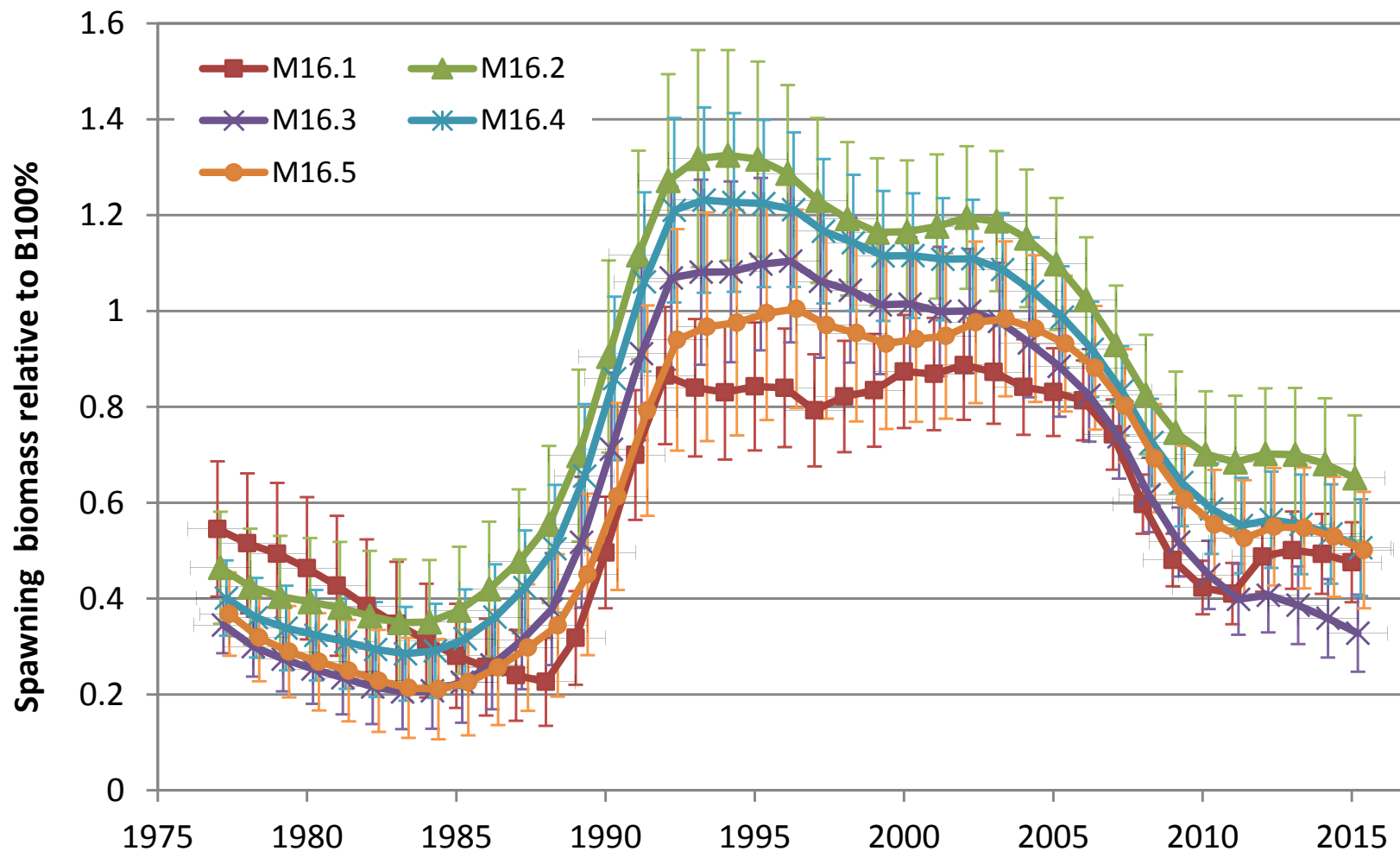
NMFS LL survey selectivity
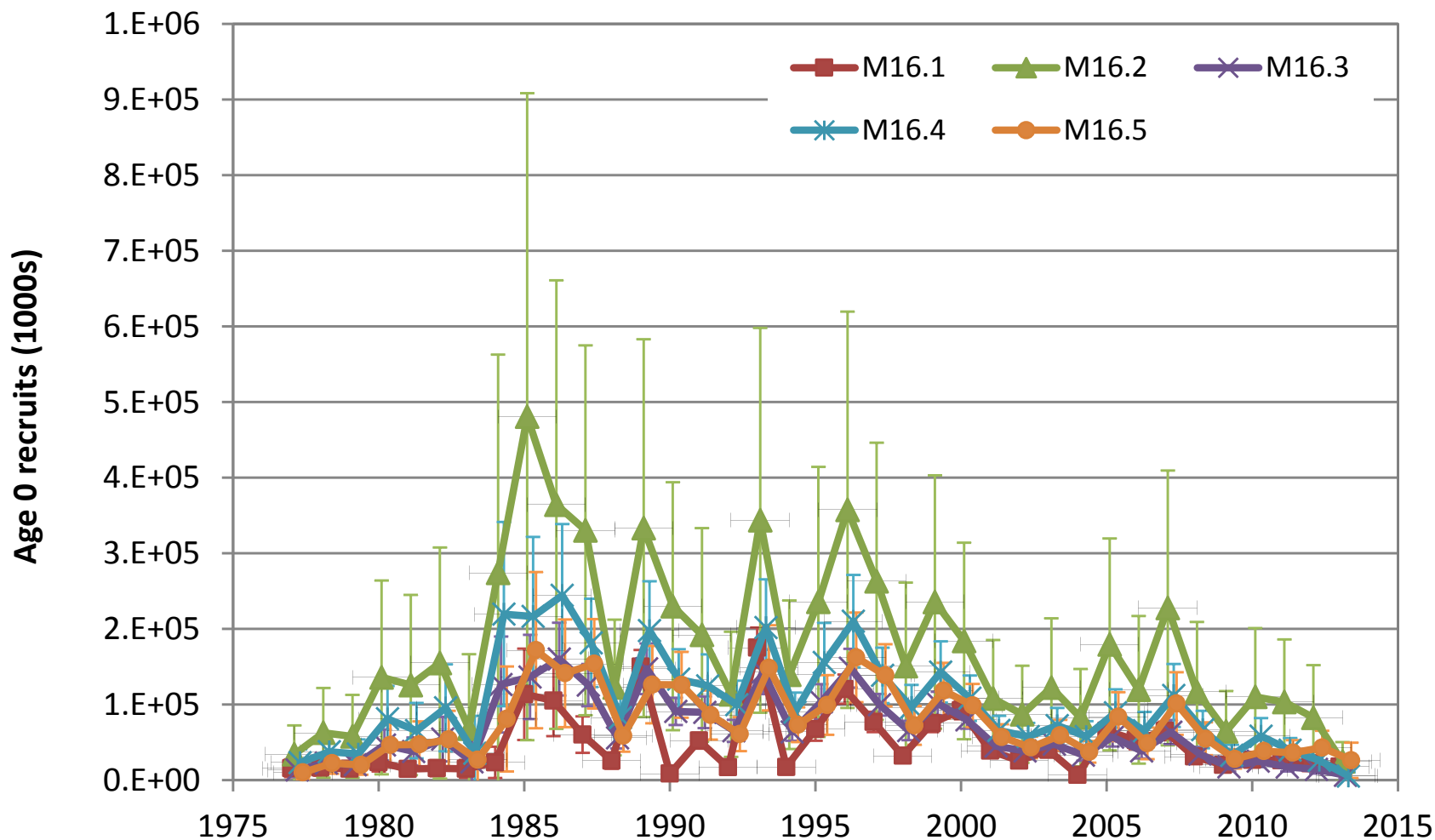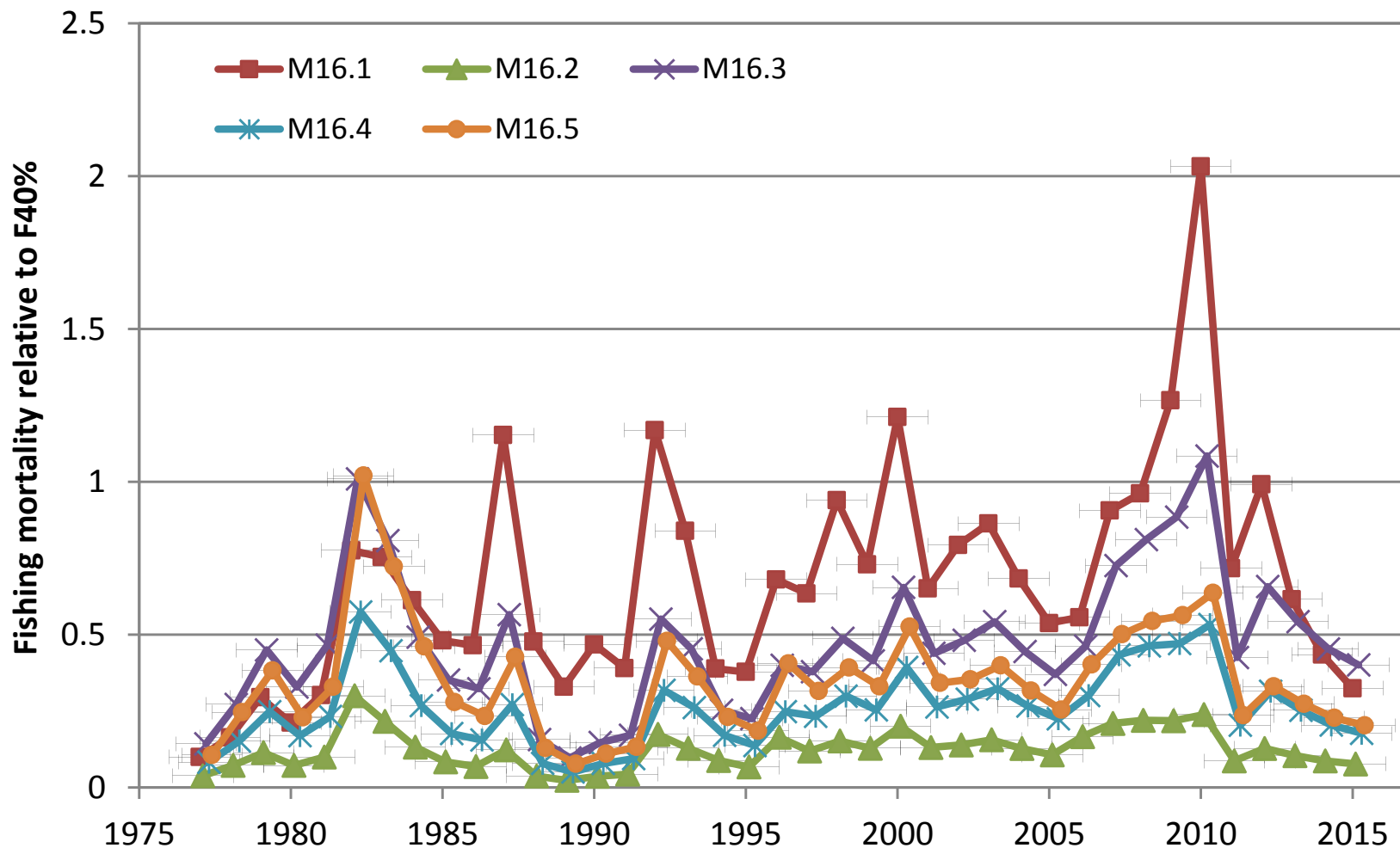

Model 16.3

Model 16.4

Total biomass time series
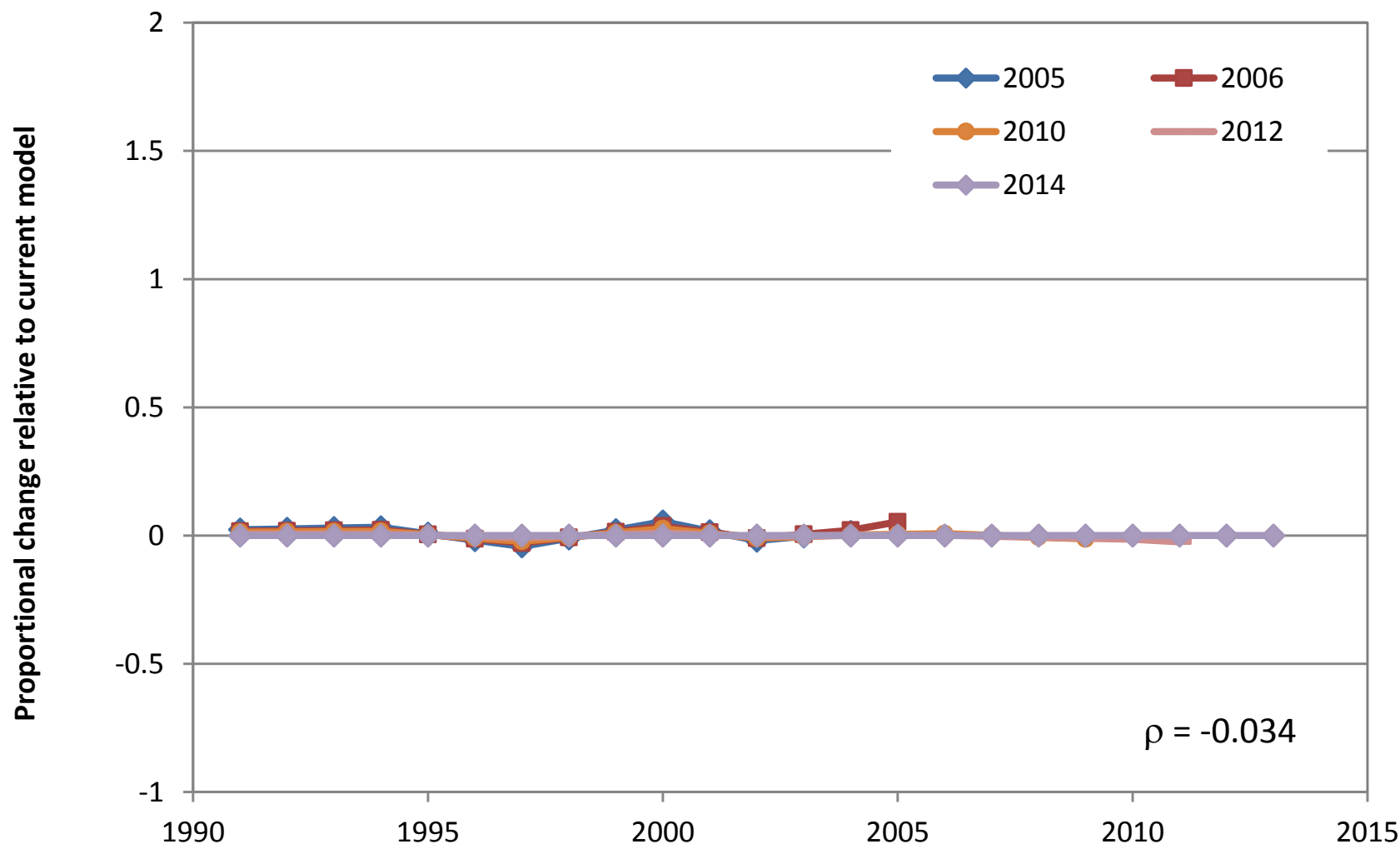
Relative spawning biomass time series
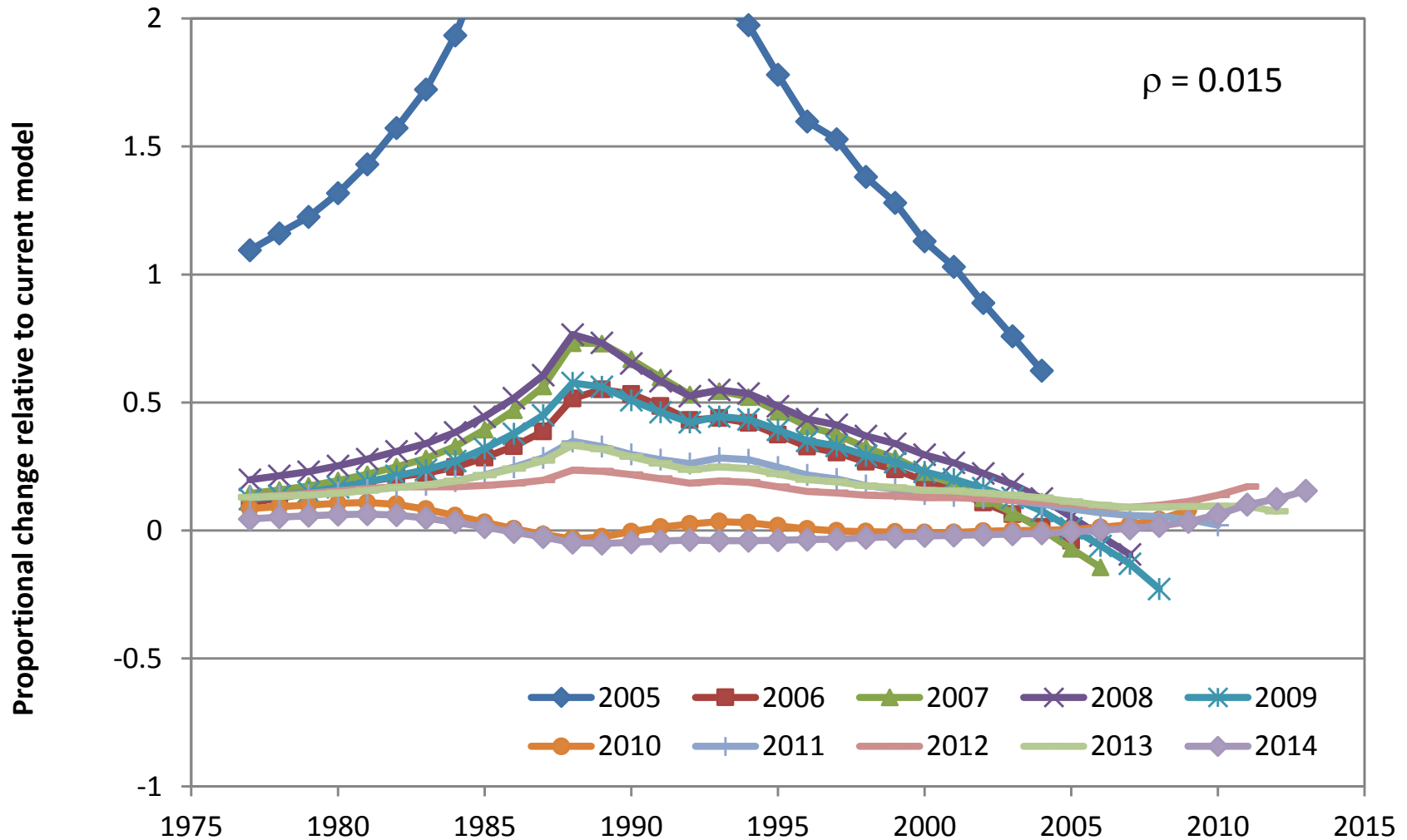
Recruitment time series

Relative fishing mortality time series
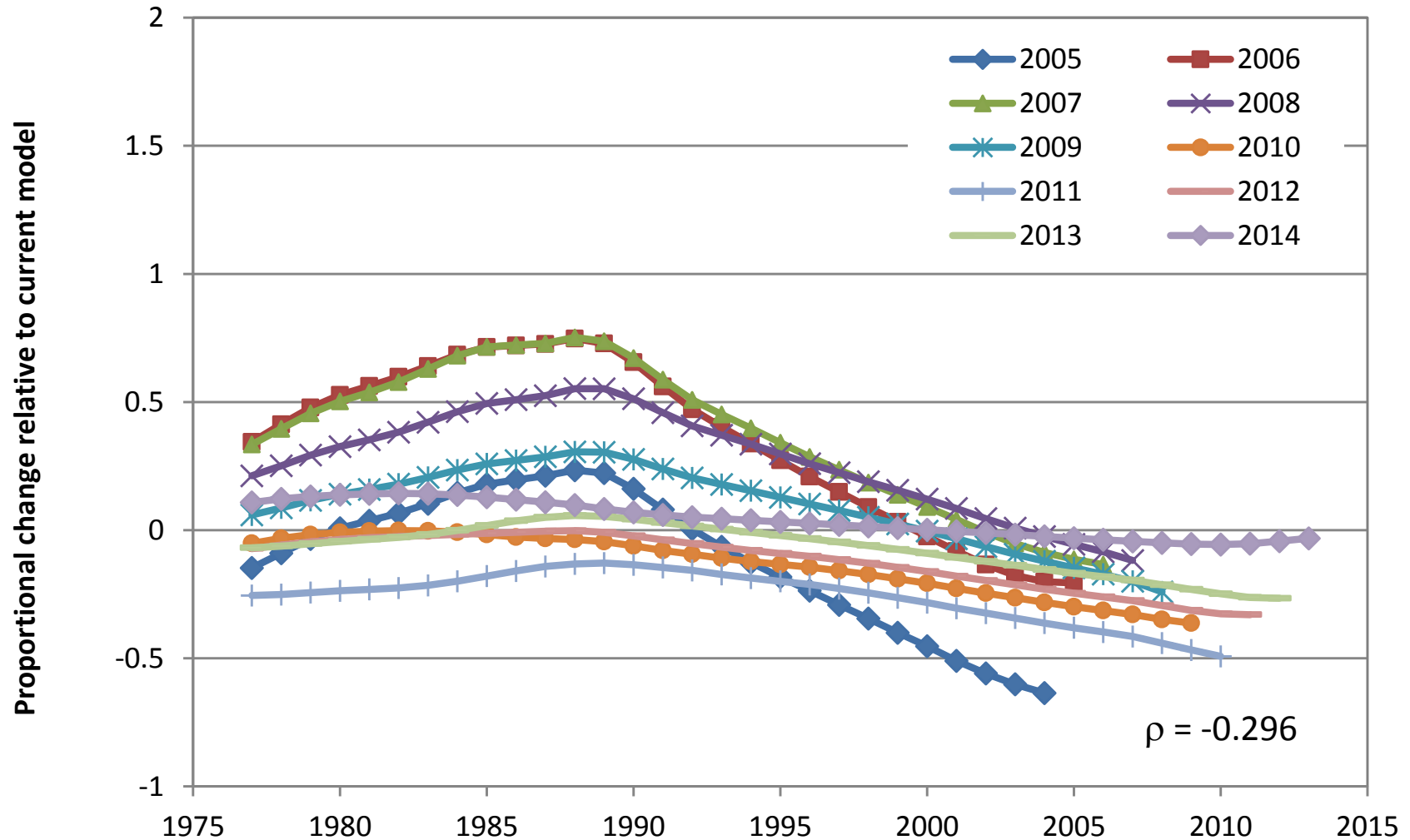
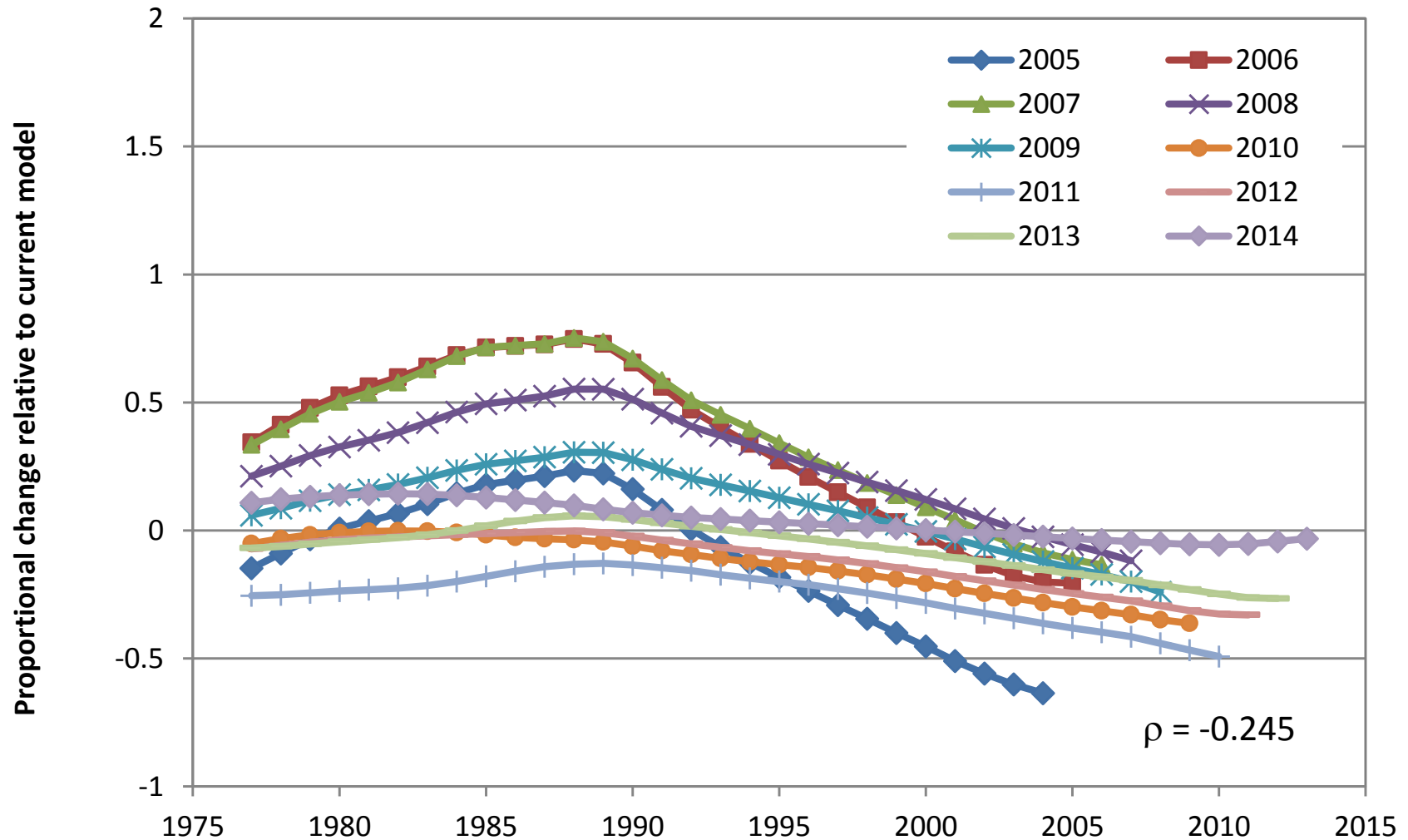# *Survey* biomass retrospective (Model 13.4)

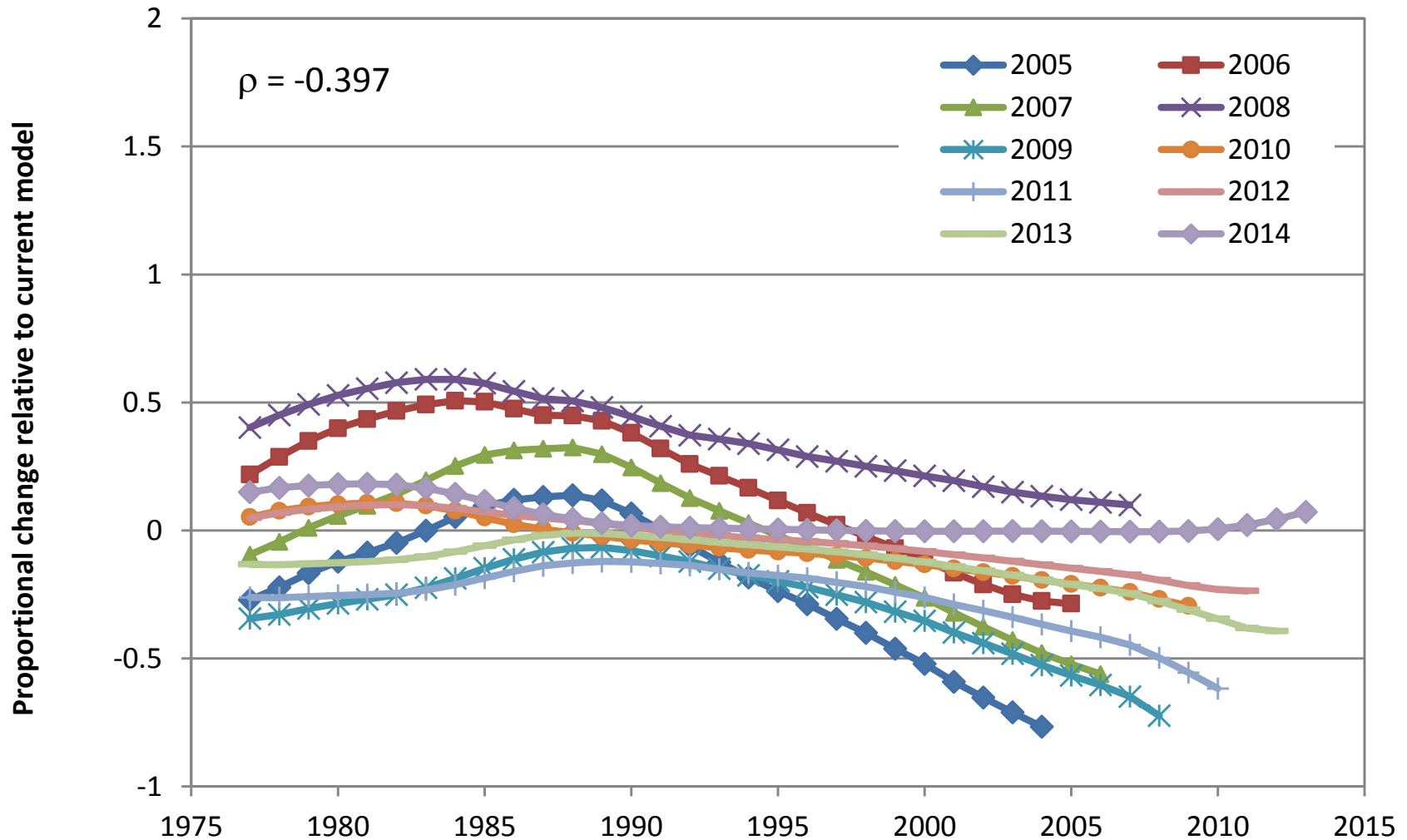# Spawning biomass retrospective (Model 16.1)

Spawning biomass retrospective (Model 16.2)

Spawning biomass retrospective (Model 16.3)

Spawning biomass retrospective (Model 16.4)

Spawning biomass retrospective (Model 16.5)