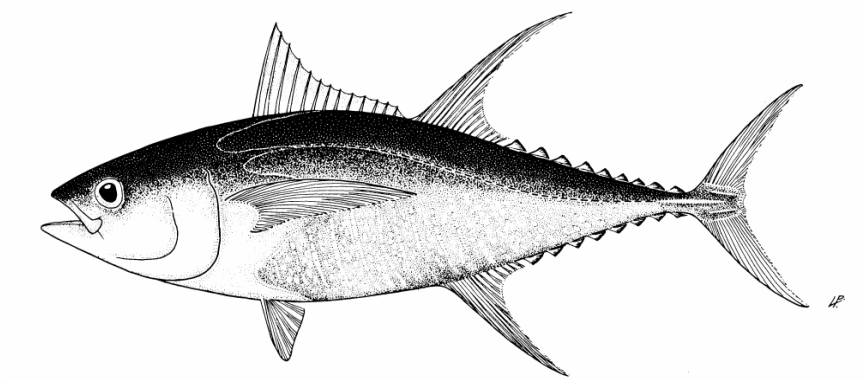
Stock assessment of yellowfin tuna in the western and central Pacific Ocean (SA WP-1).



John Hampton, Pierre Kleiber, Adam Langley, Yukio Takeuchi and Momoko Ichinokawa

Yellowfin Tuna Assessment

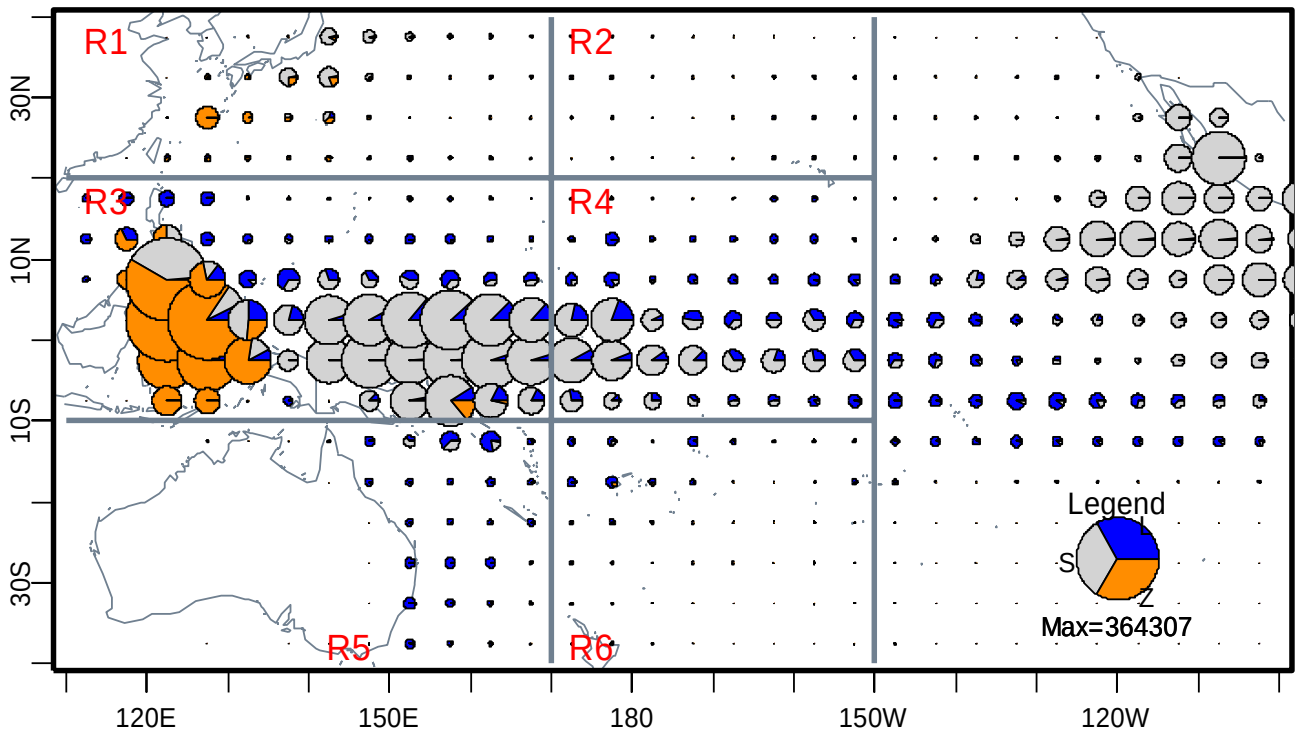
- Uses MULTIFAN-CL model
- Fit to catch, size and tagging data
- Cover the period 1952-2004, quarterly time step
- Age-structured model – 28 quarterly age-classes
- Estimated parameters – selectivity, catchability, movement, recruitment, SRR steepness, natural mortality, growth.

Main changes from 2004 – Data and model structure

- Significant changes to model regional structure, fishery definitions, and regional scaling of indices (see SA WP-8).
- Model period 1952-2004. Additional fishery data (catch, effort, LF and WF).

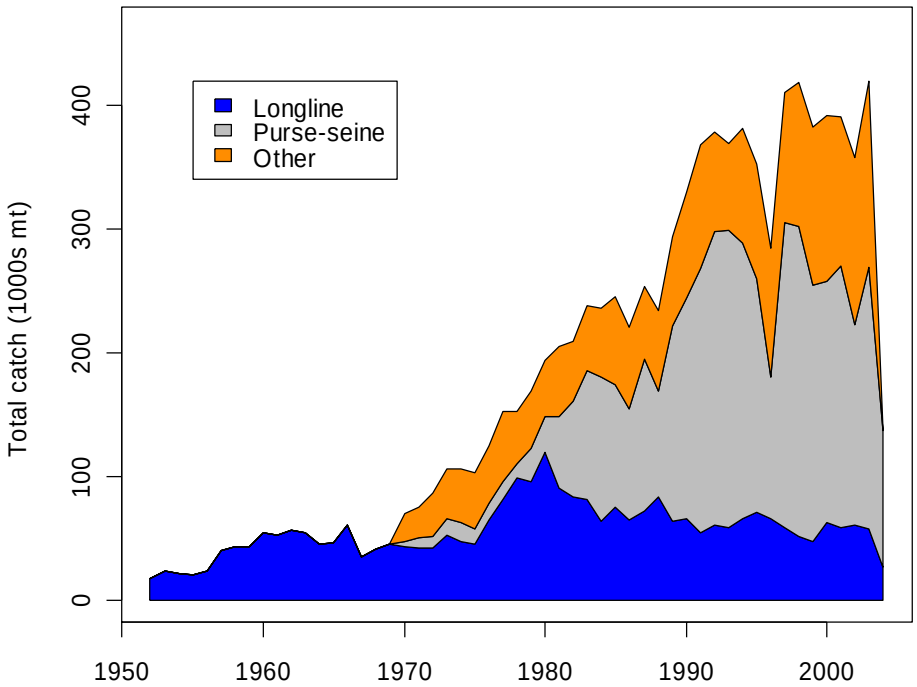
Substantive change to the conclusions of the assessment compared to 2004.

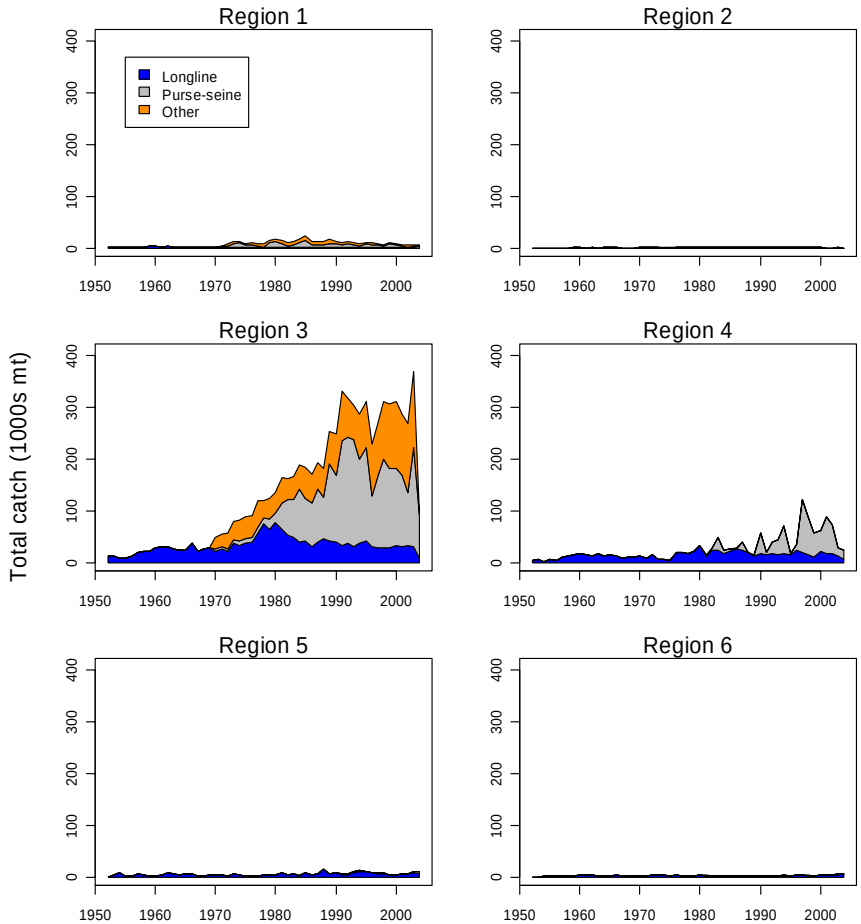
Regional structure



LL fishery 1-6, PS unassociated/associated 3 & 4, Domestic LL fisheries, TW/CH LL 3 & 4.

Total catch


Longline
Purse-seine
Other
Total catch (1000s mt)
0
100
200
300
400
1950
1960
1970
1980
1990
2000


Region 1
Region 2
Region 3
Region 4
Region 5
Region 6
Longline
Purse-seine
Other
Total catch (1000s mt)
0
100
200
300
400
1950
1960
1970
1980
1990
2000

Main Changes from 2004 – model parameterisation

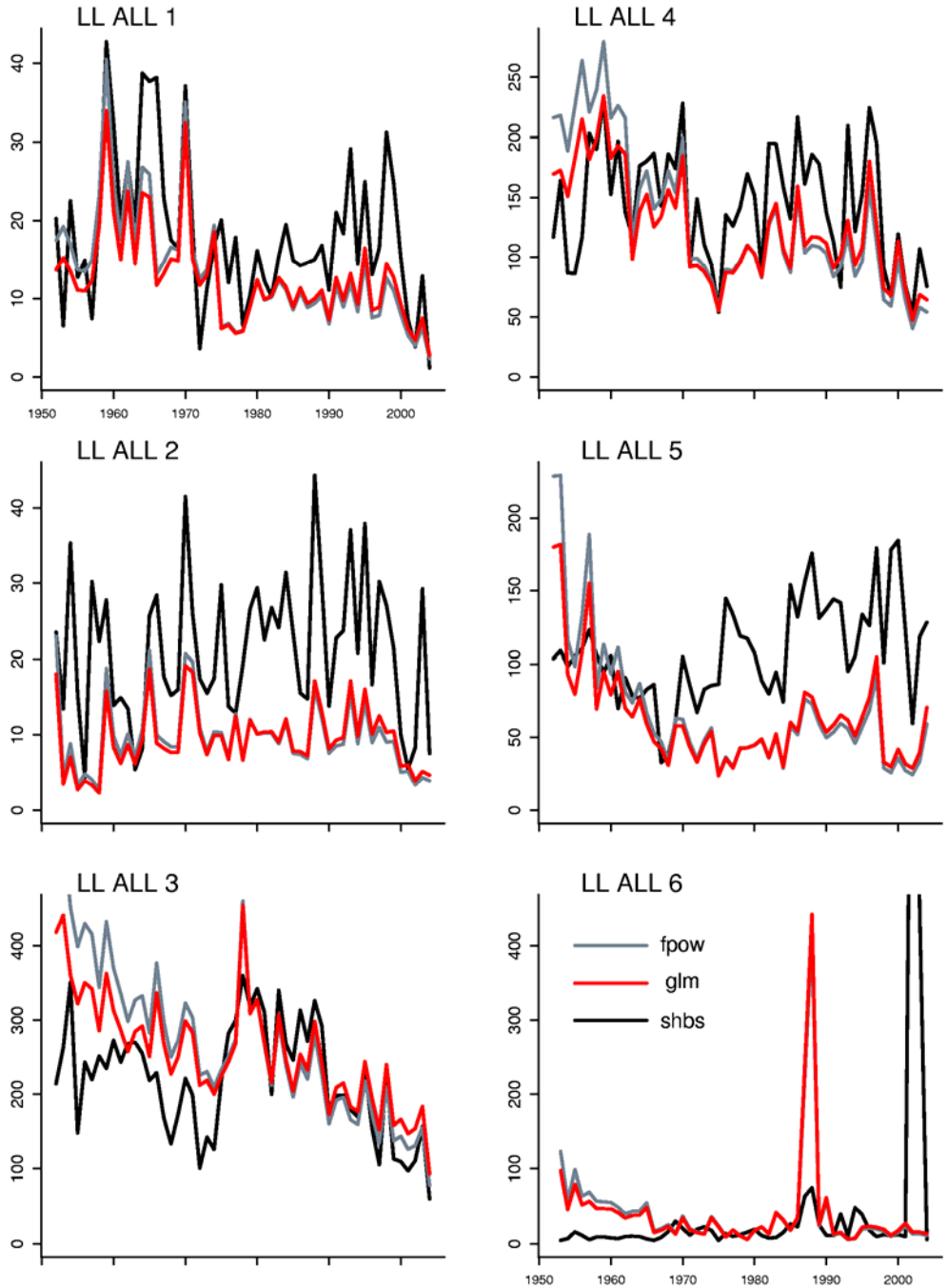
1. Longline size vs effort data weighting
2. Cubic spline selectivity
3. Weaker prior for Stock-Recruit Relationship steepness parameter
4. Inclusion of SRR in computation of unexploited population.

Sensitivity Analyses

- GLM vs SHBS standardised longline effort
- Fixed vs estimated natural mortality
- Constant longline catchability vs 1% annual expansion in fishing power from 1952
- The expanded fishing power runs also included a 4% annual expansion of purse seine fishing power

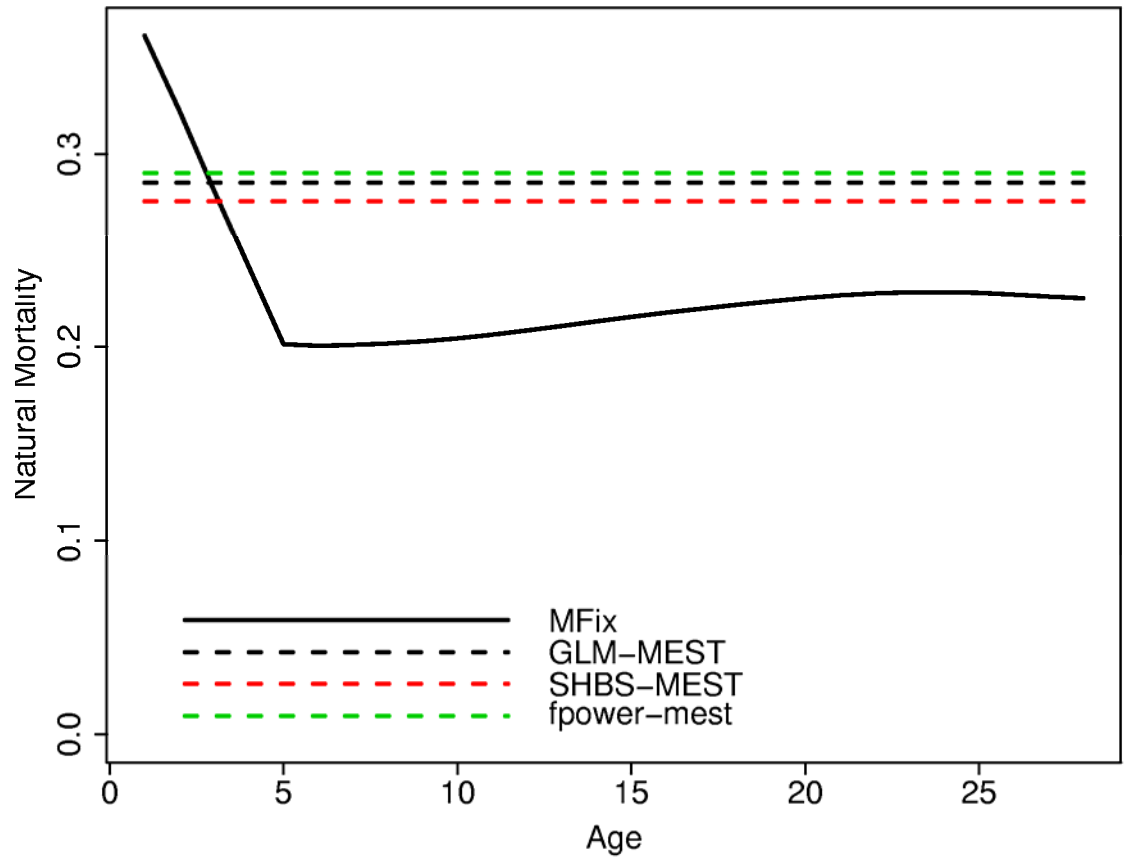
Sensitivity Analyses

GLM, SHBS, FPOW



Sensitivity Analyses

Fixed vs estimated *M*



Sensitivity Analyses

- GLM-MFIX (base-case)
- GLM-MEST
- SHBS-MFIX
- SHBS-MEST
- FPOW-MFIX
- FPOW-MEST

Fishery definitions

Fishery	Nationality	Gear	Region
LL ALL 1	Japan, Korea, Chinese Taipei	Longline	1
LL ALL 2	Japan, Korea, Chinese Taipei	Longline	2
LL HW 2	United States (Hawaii)	Longline	2
LL ALL 3	All excl. Chinese Taipei & China	Longline	3
LL TW-CH 3	Chinese Taipei and China	Longline	3
LL PG 3	Papua New Guinea	Longline	4
LL ALL 4	Japan, Korea	Longline	4
LL TW-CH 4	Chinese Taipei and China	Longline	4
LL HW 4	United States (Hawaii)	Longline	4
LL ALL 5	All excl. Australia	Longline	5
LL AU 5	Australia	Longline	5
LL ALL 6	Japan, Korea, Chinese Taipei	Longline	6
LL PI 6	Pacific Island Countries/Territories	Longline	6
PS ASS 3	All	Purse seine, log/FAD sets	3
PS UNS 3	All	Purse seine, school sets	3
PS ASS 4	All	Purse seine, log/FAD sets	4
PS UNS 4	All	Purse seine, school sets	4
PHID MISC 3	Philippines, Indonesia	Miscellaneous (small fish)	3
PH HL 3	Philippines, Indonesia	Handline (large fish)	3

Data sources

- Catch
- Effort – standardised (LL), nominal
- Length frequency
- Weight frequency
- Tag releases and recoveries.
- Auxiliary information used to formulate priors, e.g. estimates of tag reporting rates.

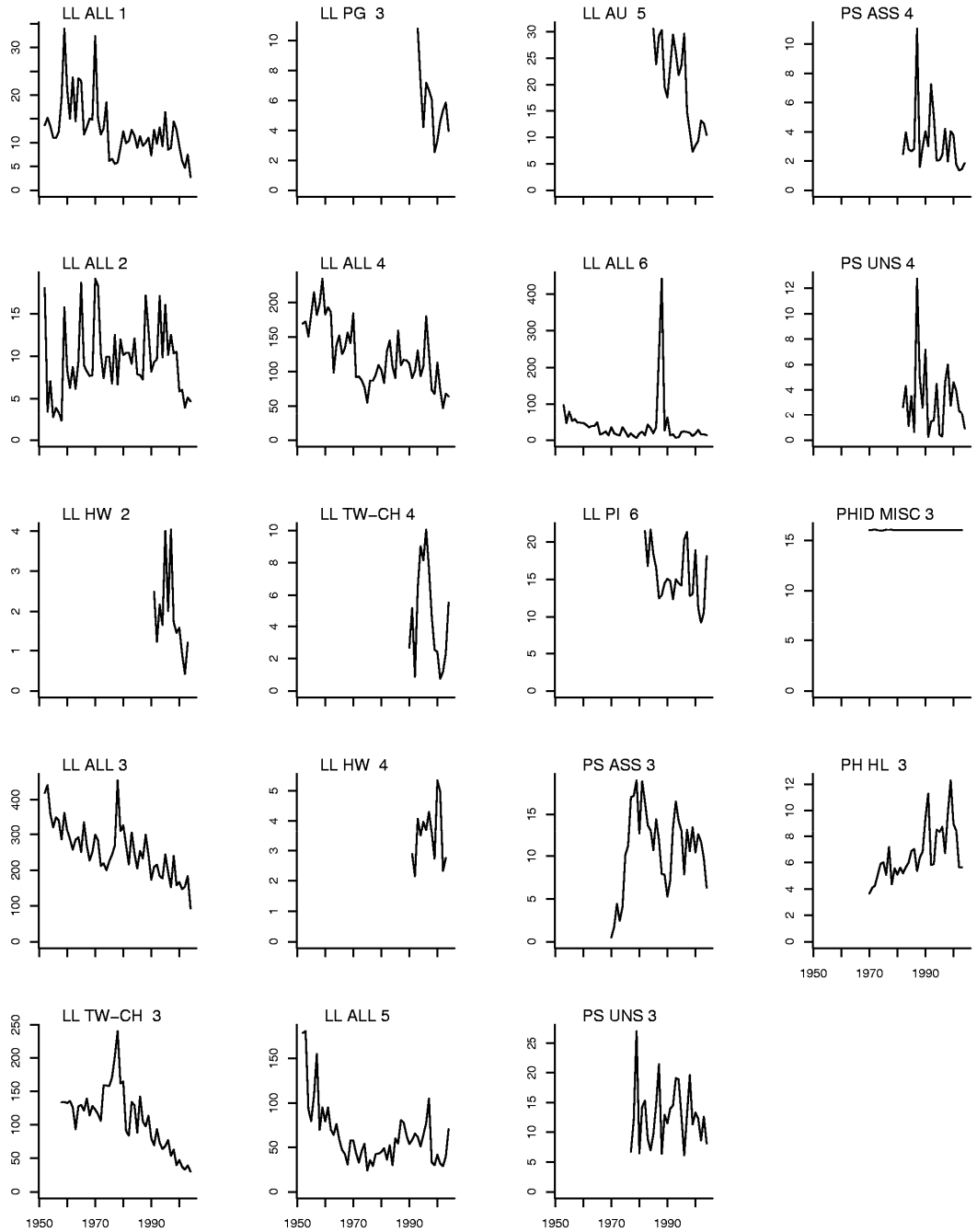
CPUE

Standardised JP LL indices principal index for monitoring LL exploitable biomass.

GLM and statHBS.

Scaled by area weighting factors.

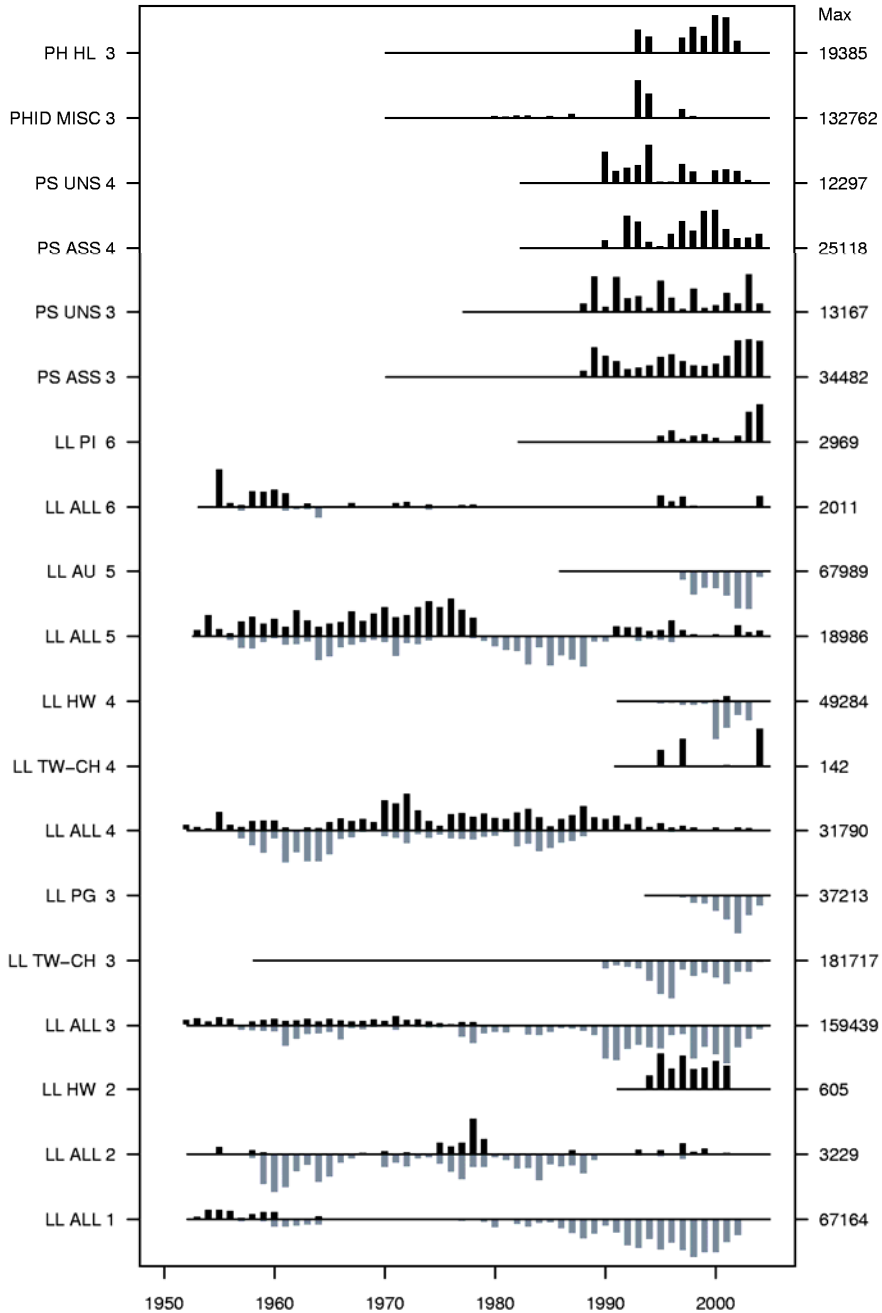
Constant catchability.



Length and weight data

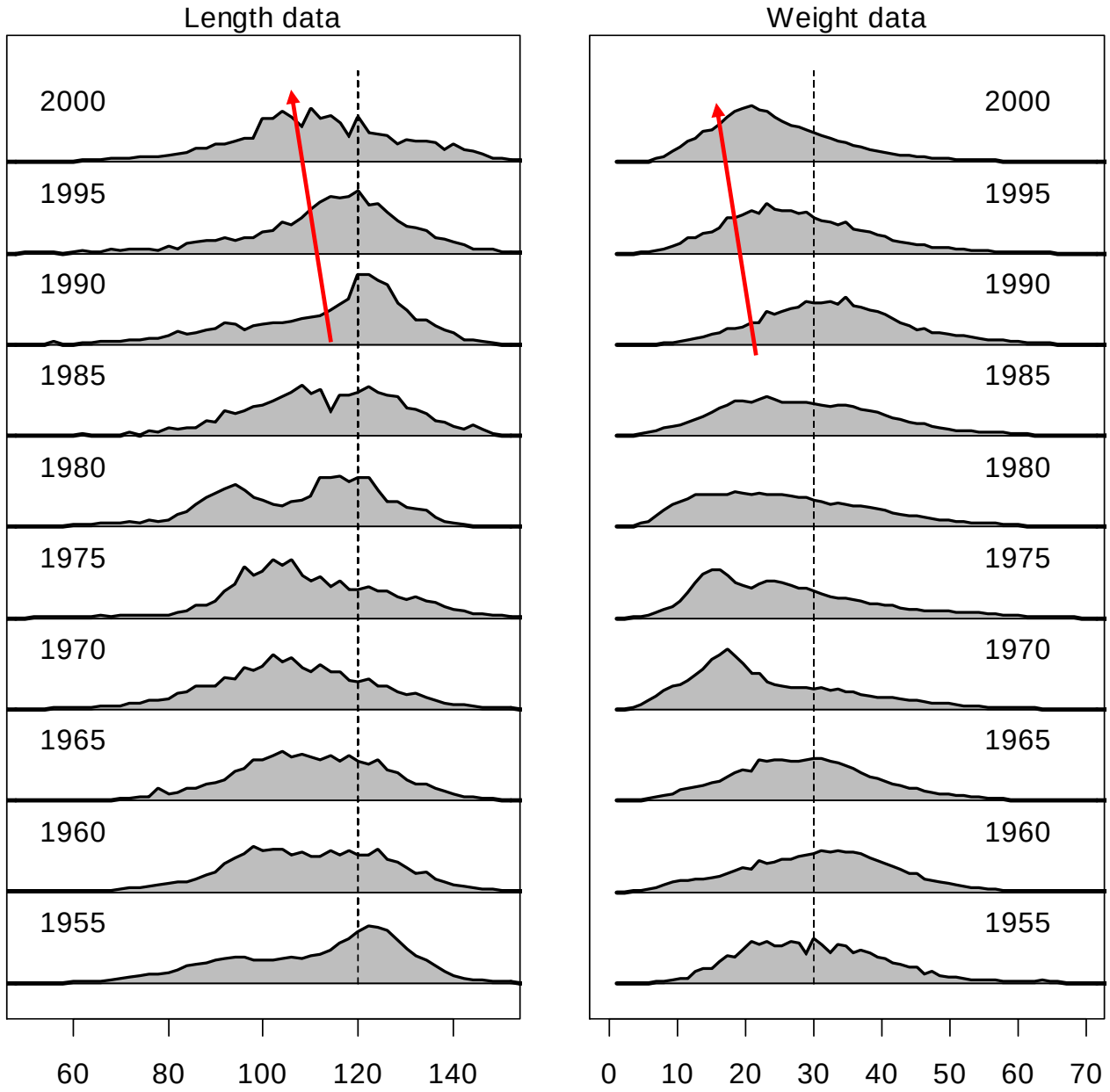
Good coverage for most of the main fisheries.

Recent improvement in data from PH.



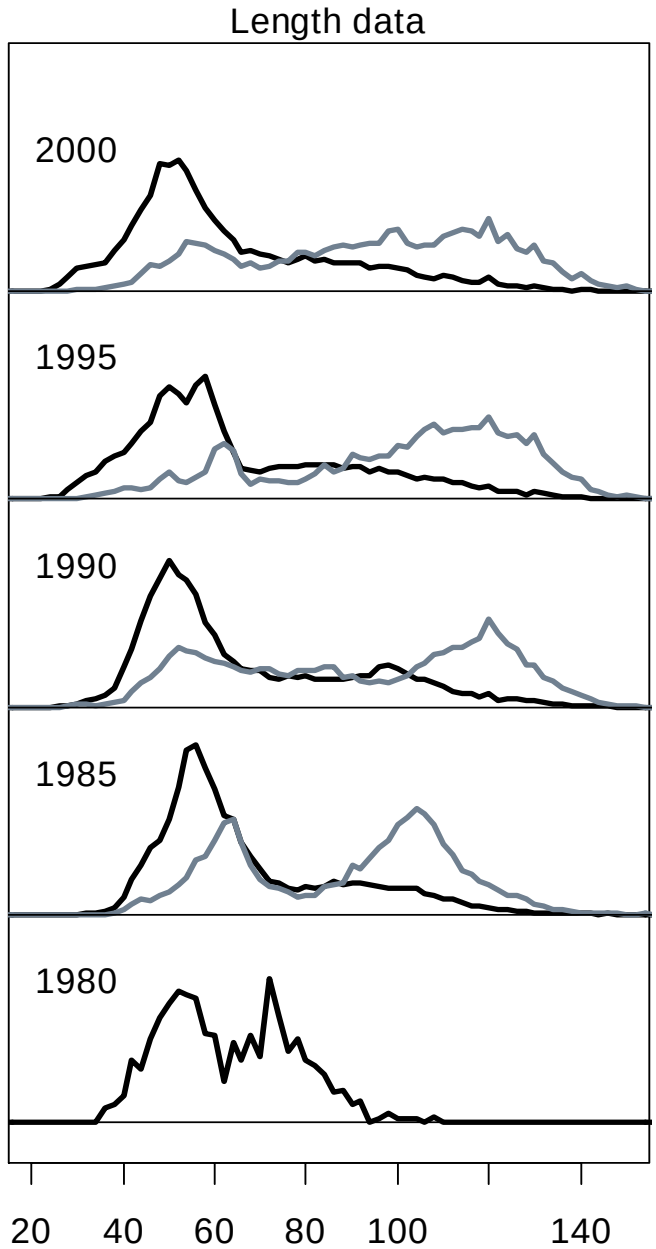
Length and weight data

LL region 3

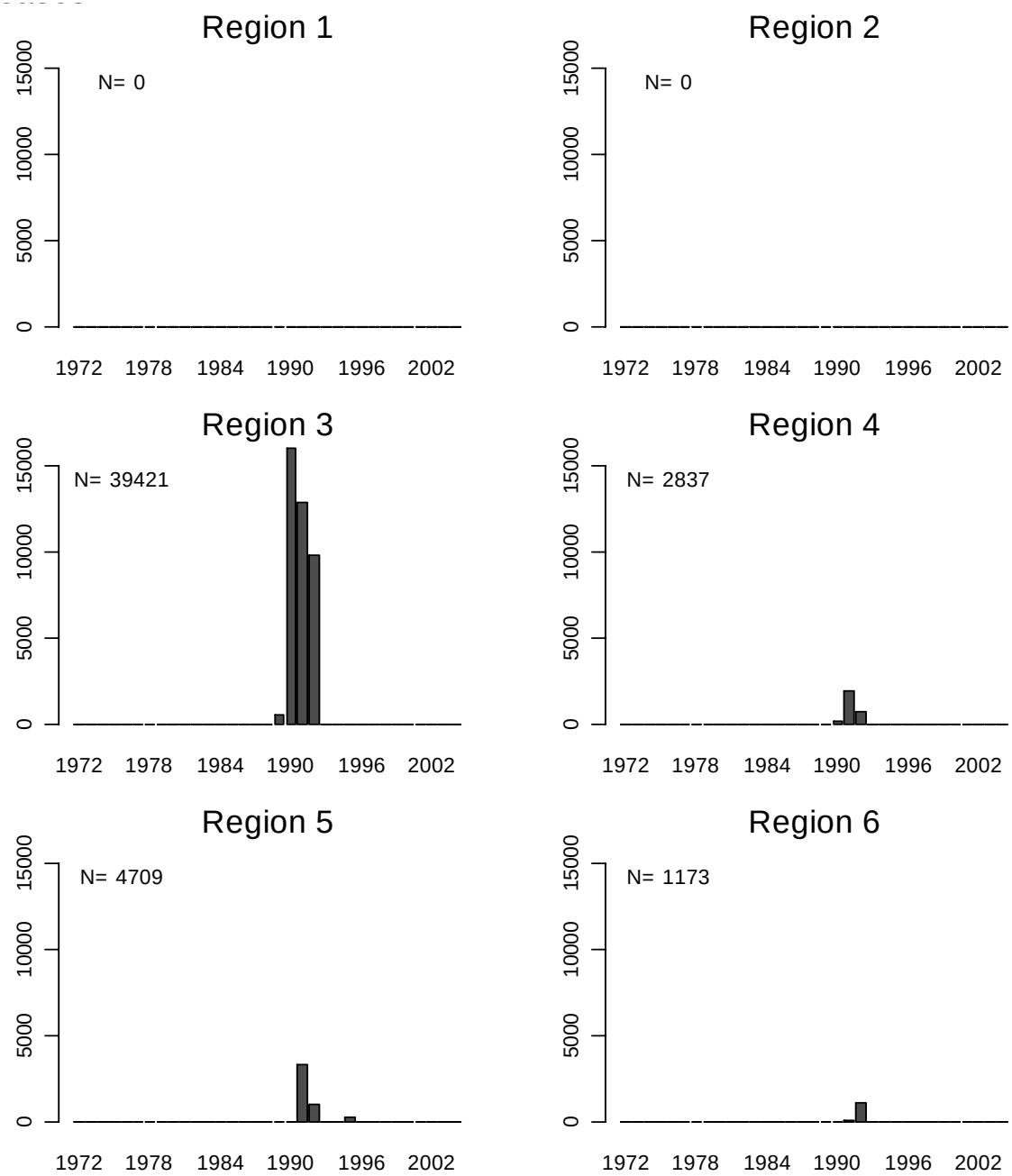


Length data

PS region 3

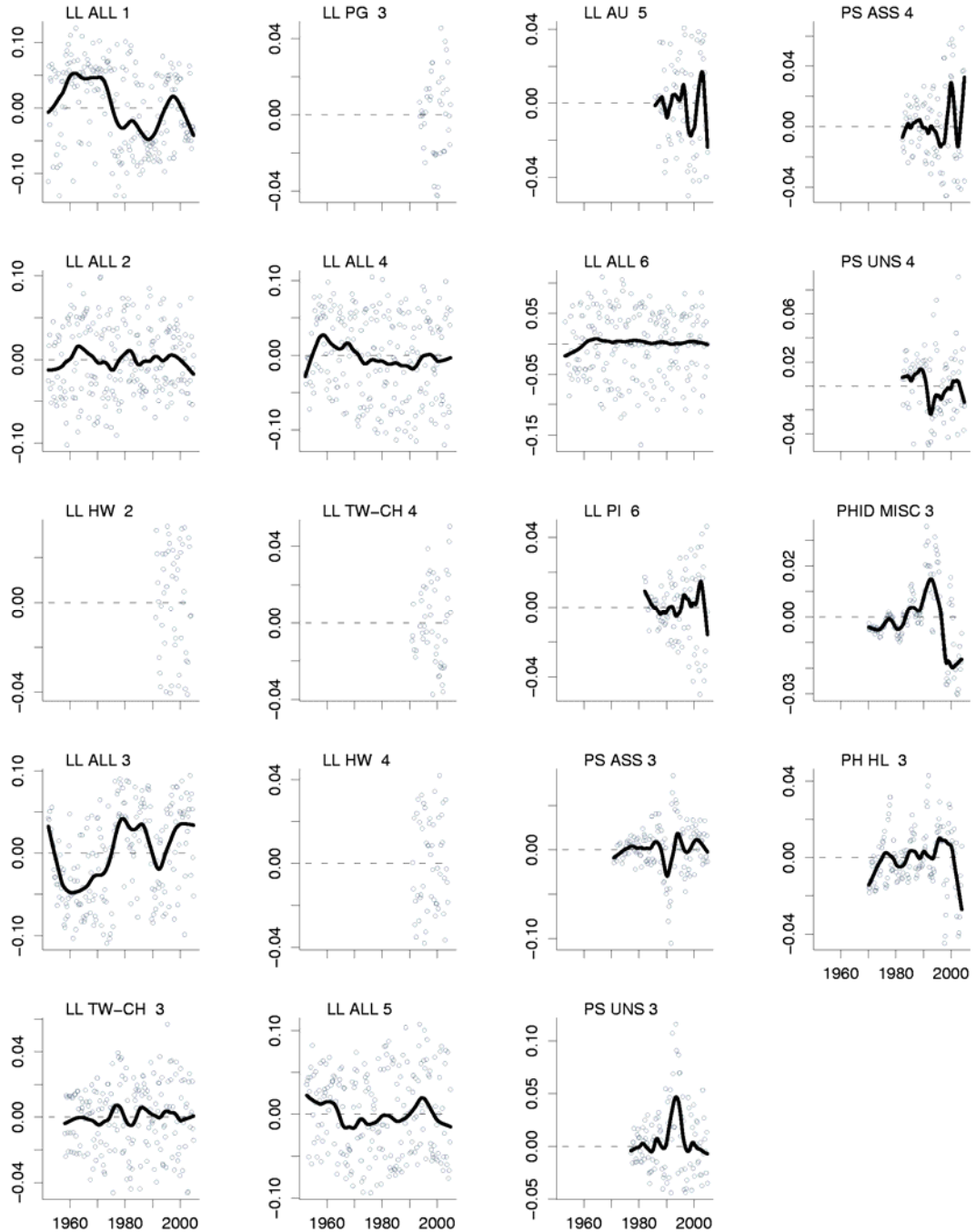


Tag data (releases)



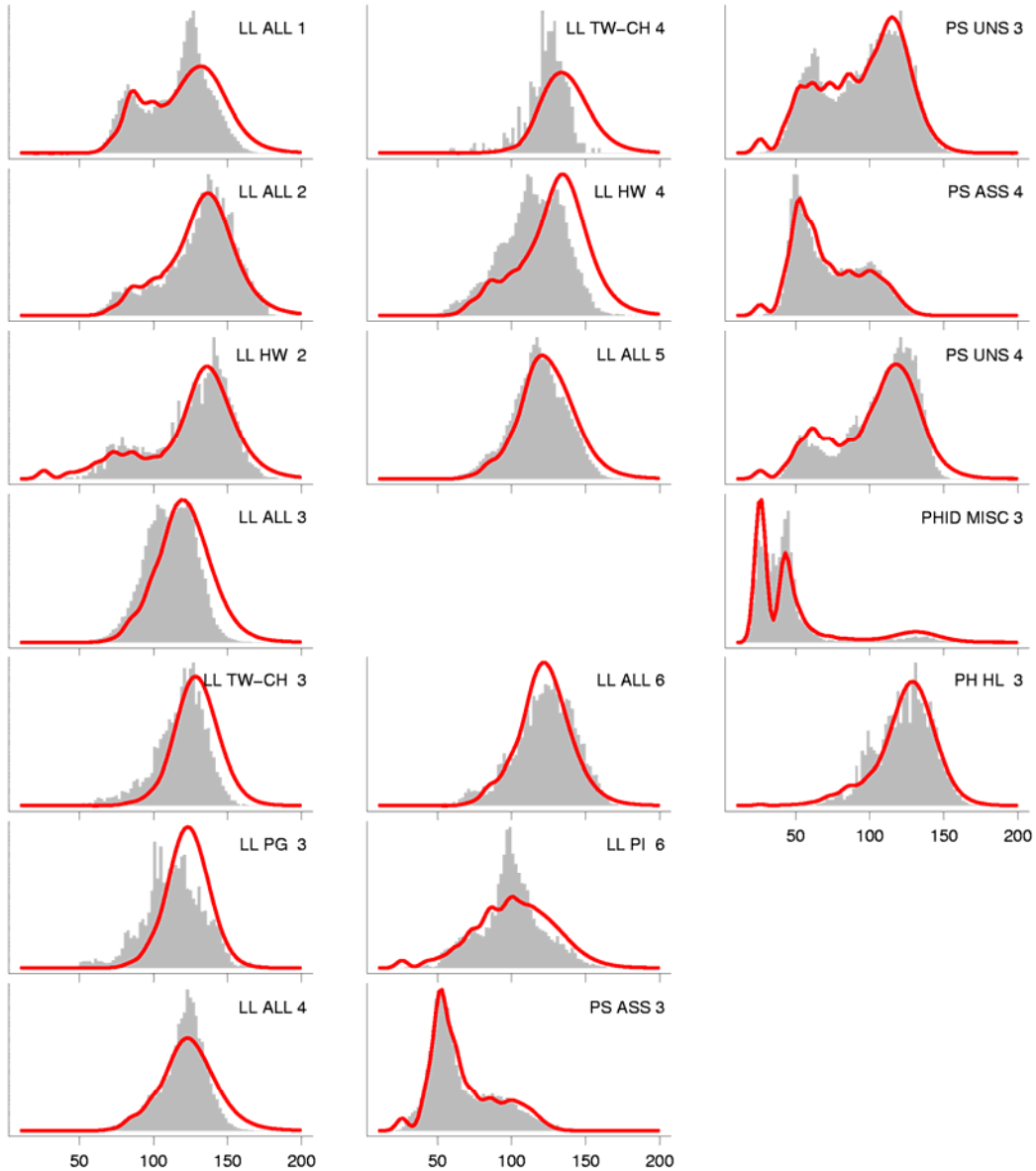
Model Diagnostics

1. Total Catch Fits (residuals)



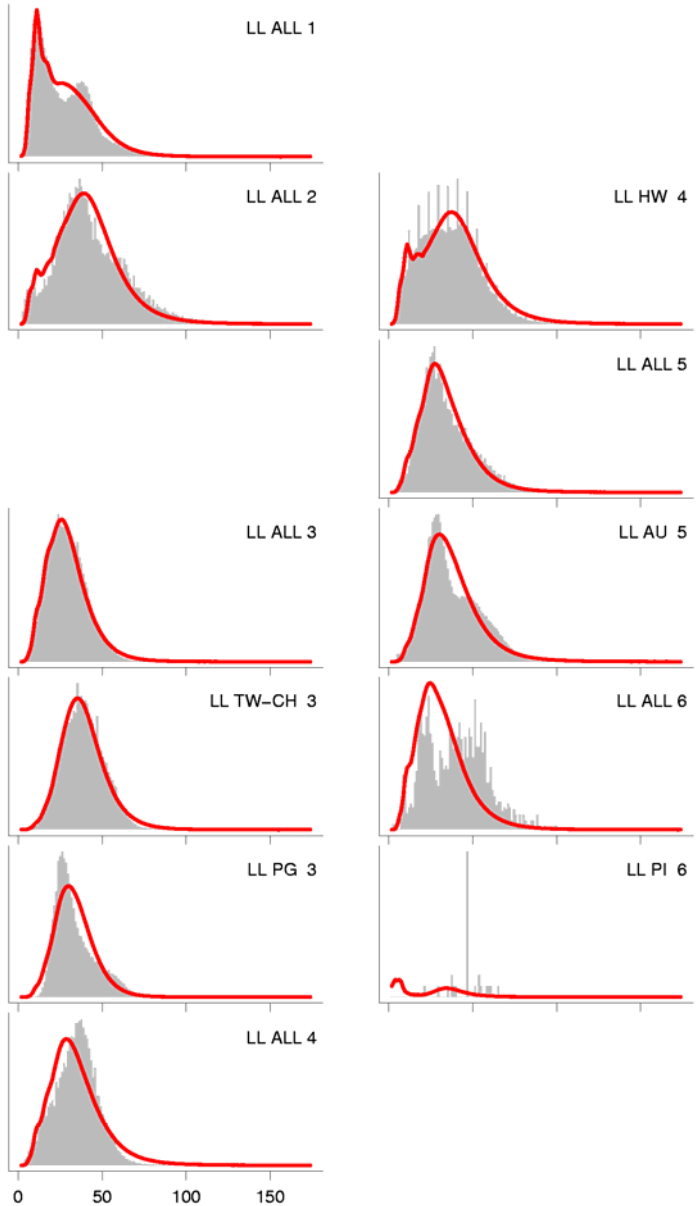
Model Diagnostics

2. Length Data Fits



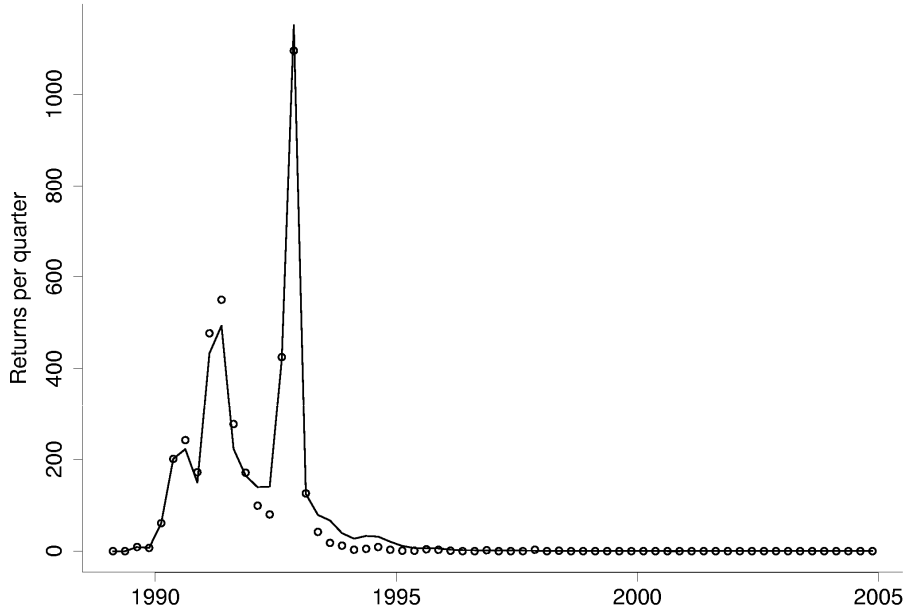
Model Diagnostics

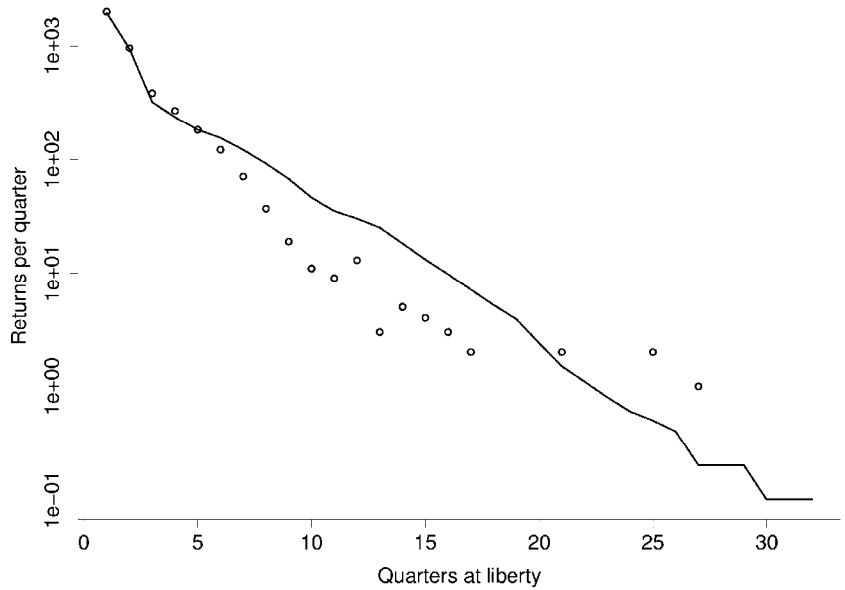
3. Weight Data Fits



Model Diagnostics

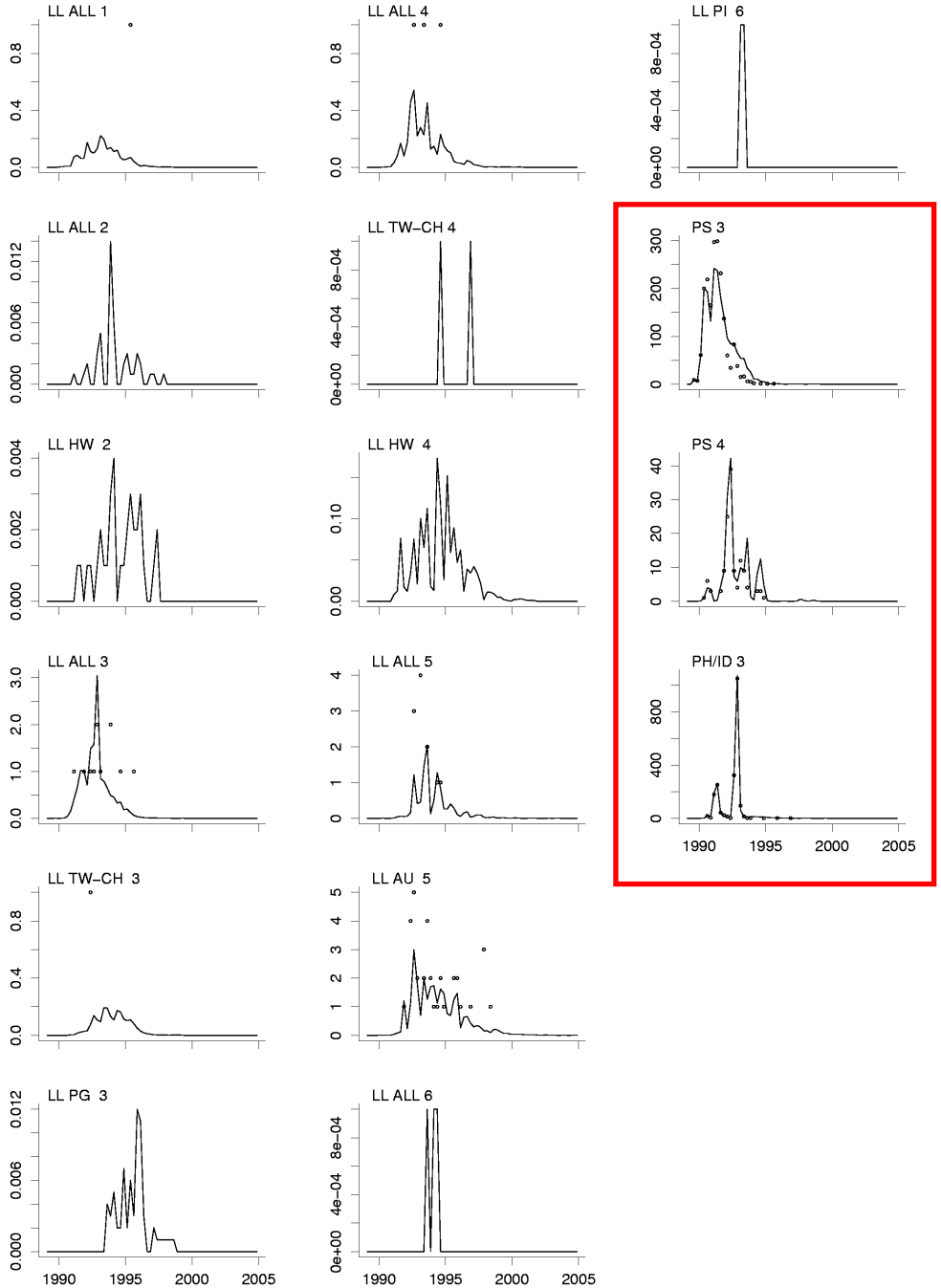
4. Tag Data Fits





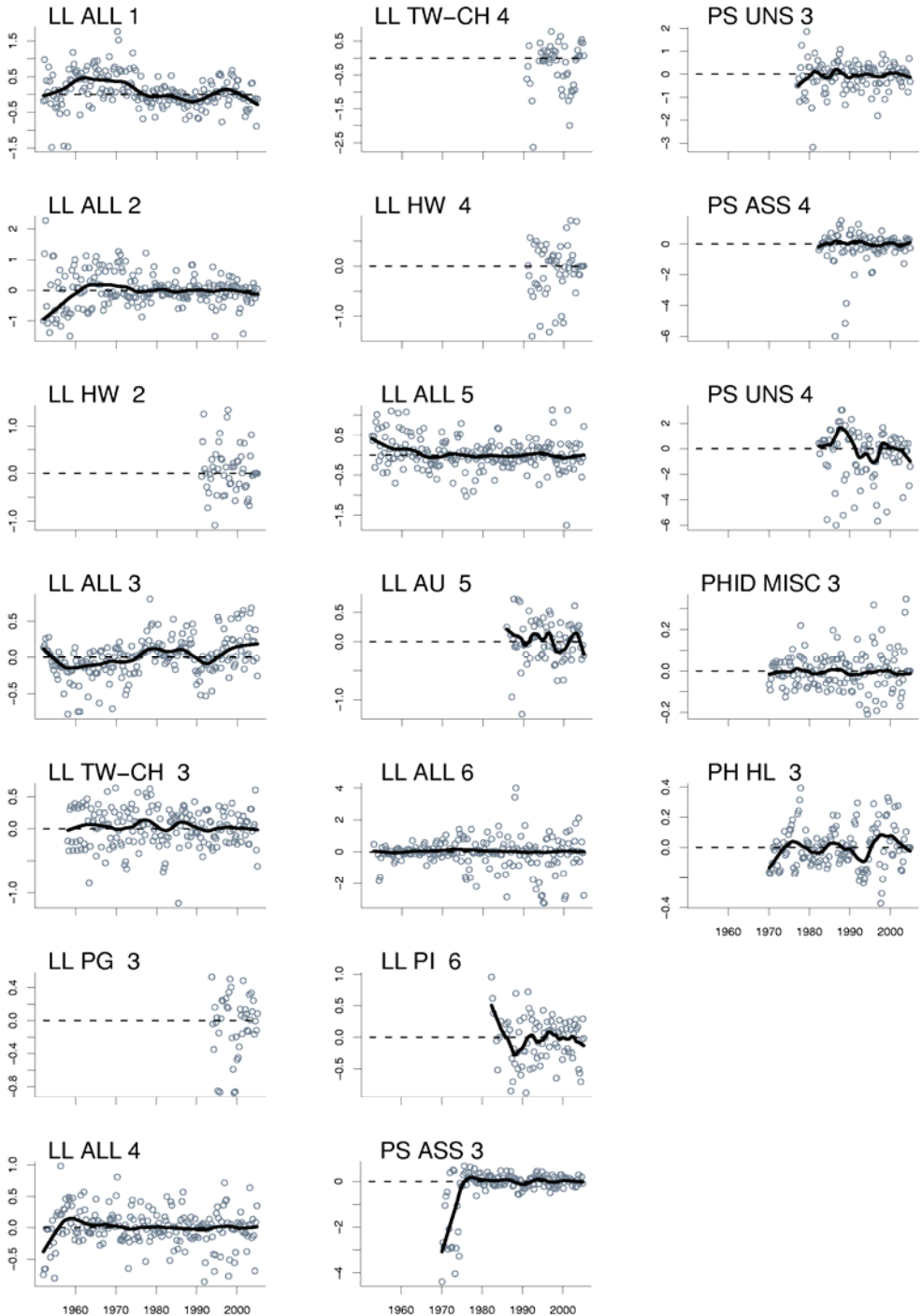
Model Diagnostics

4. Tag Data Fits by Fishery



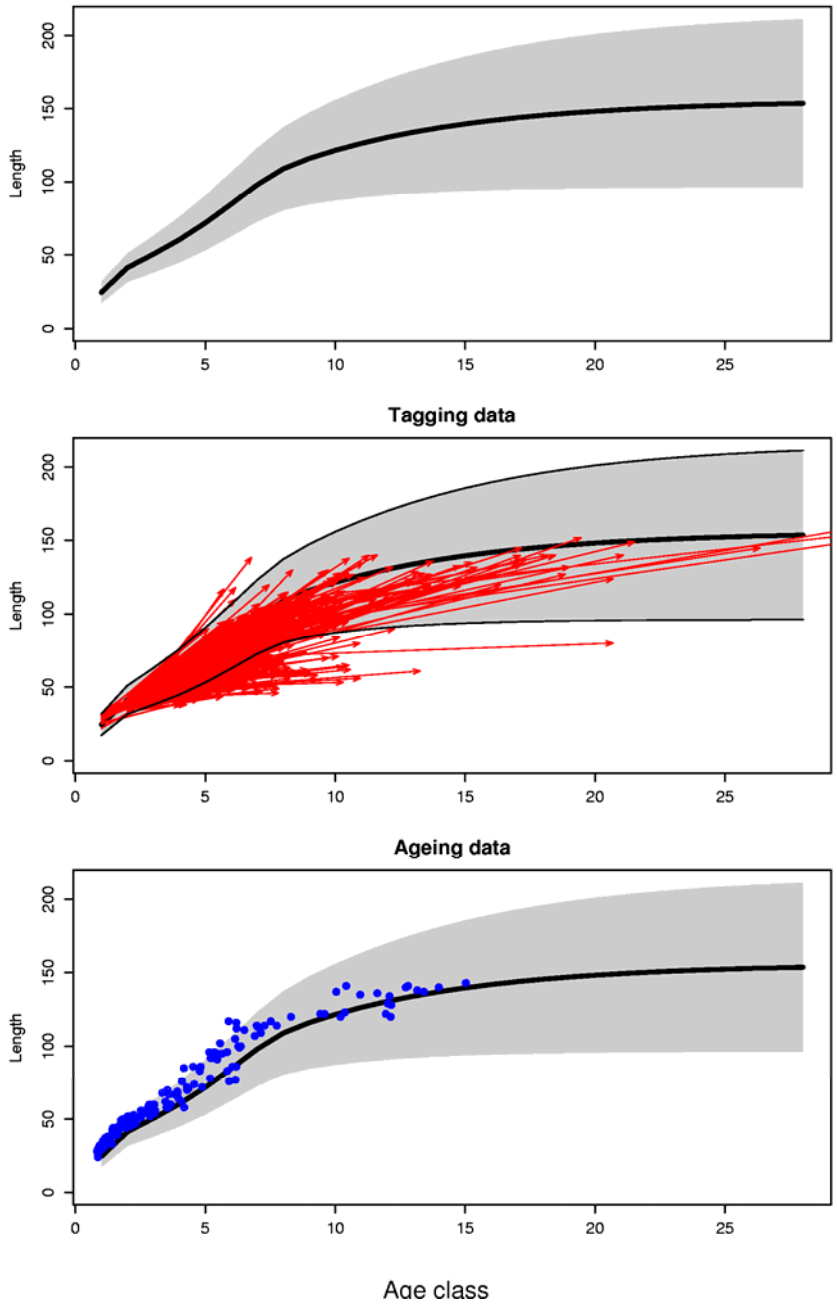
Model Diagnostics

5. Effort Deviations



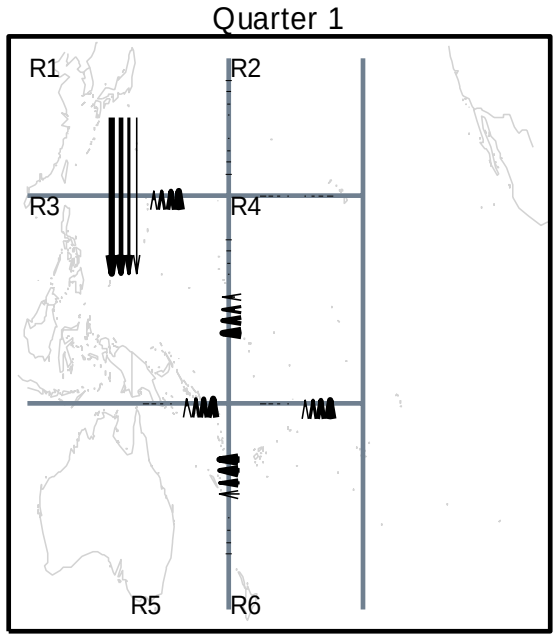
Model Diagnostics

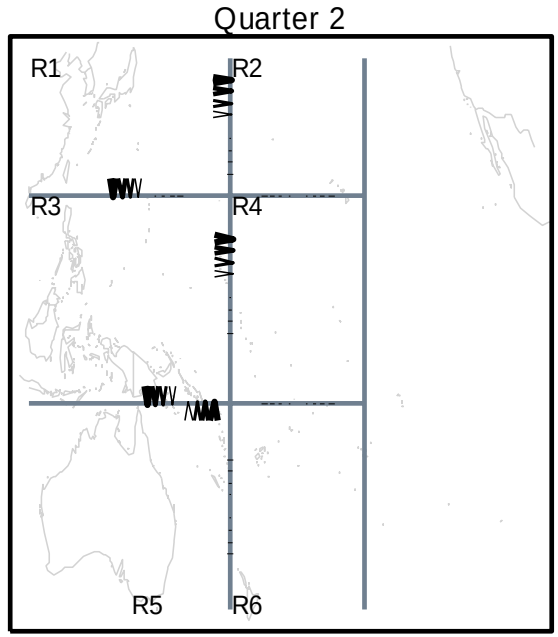
6. Growth Estimates

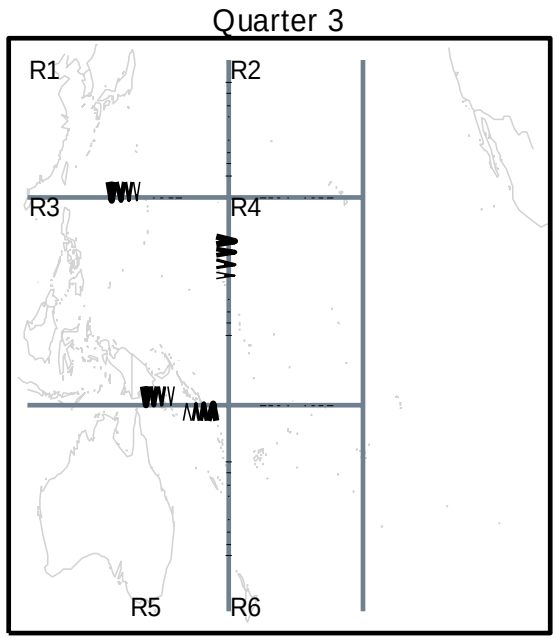


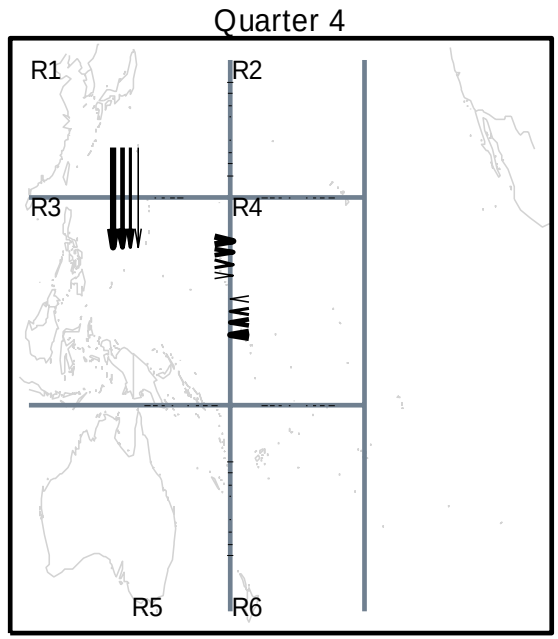
Parameter estimates

Movement estimates



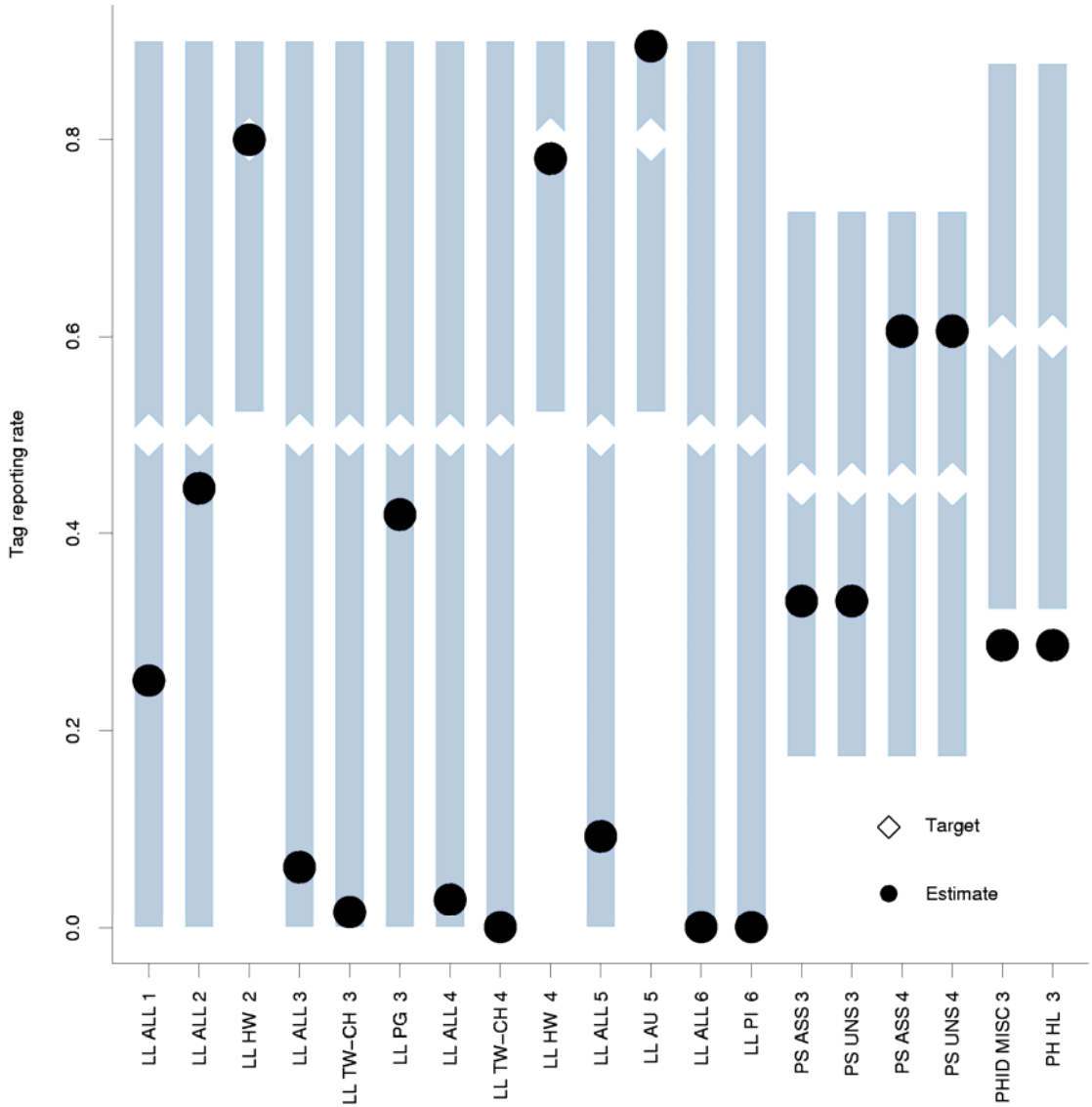






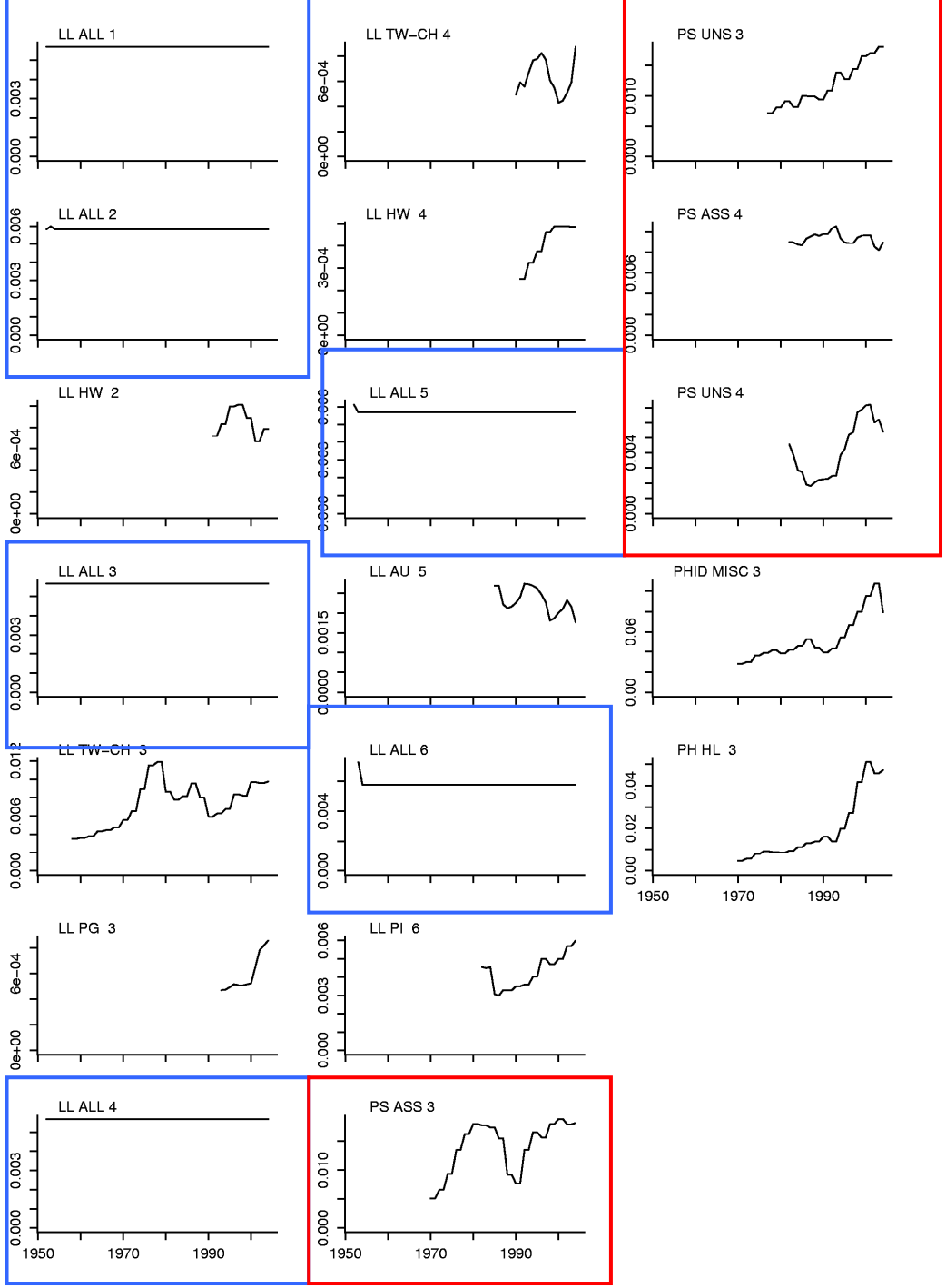
Parameter estimates

Tag reporting rates

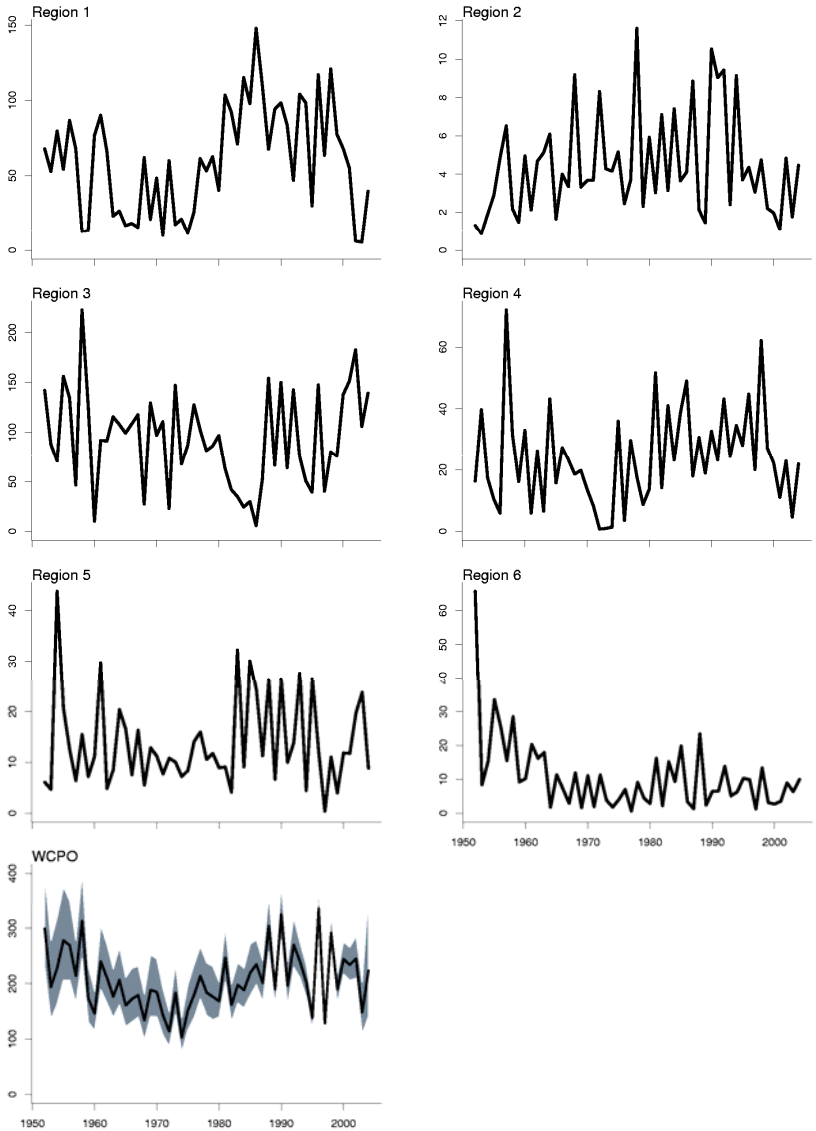


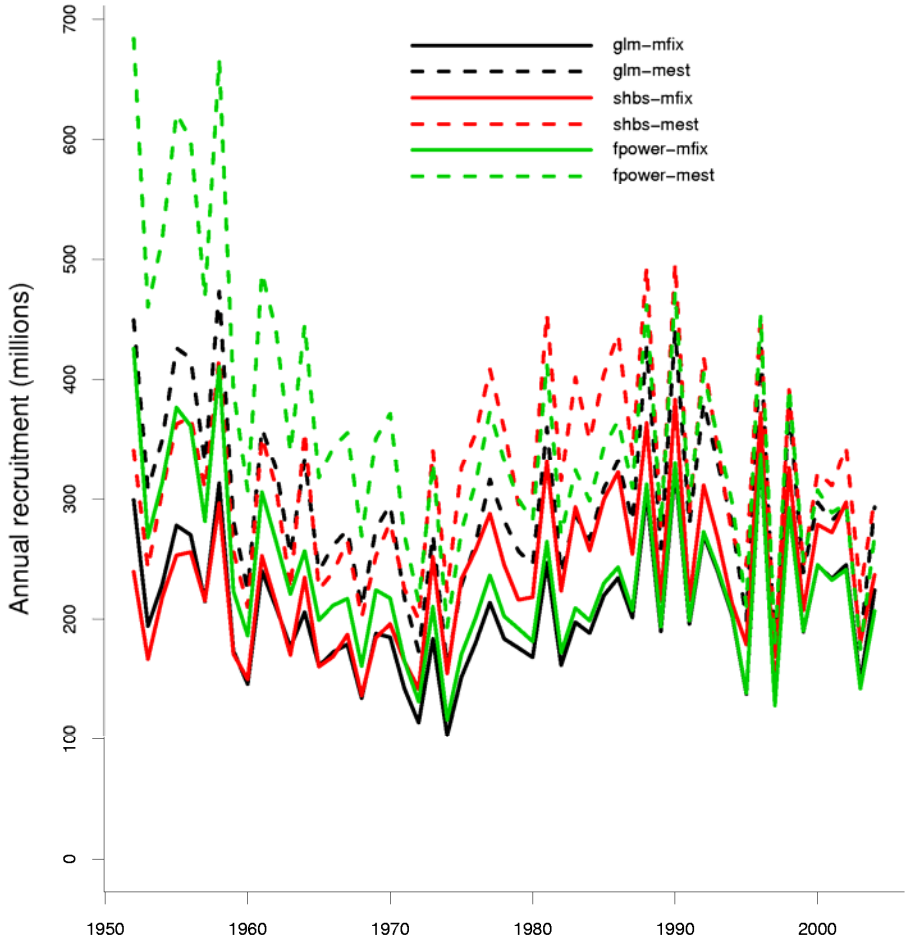
Parameter estimates

Catchability Estimates

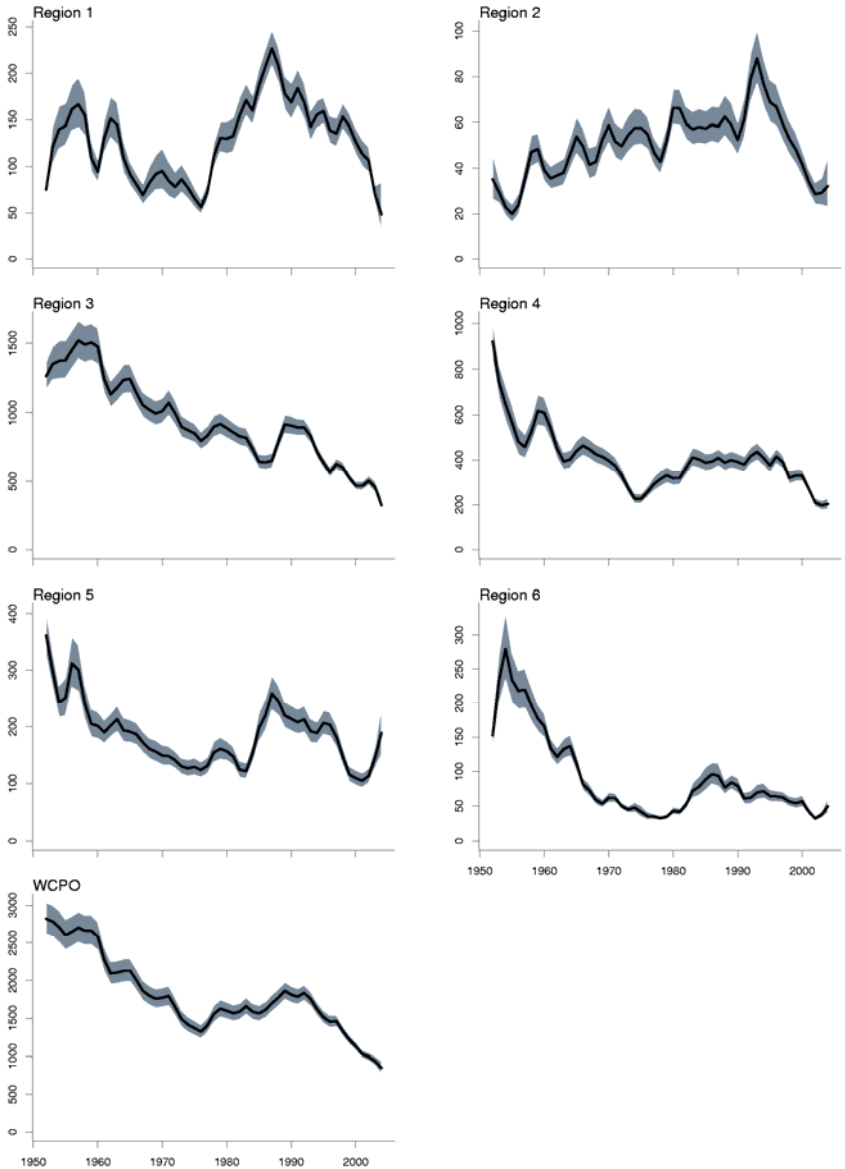


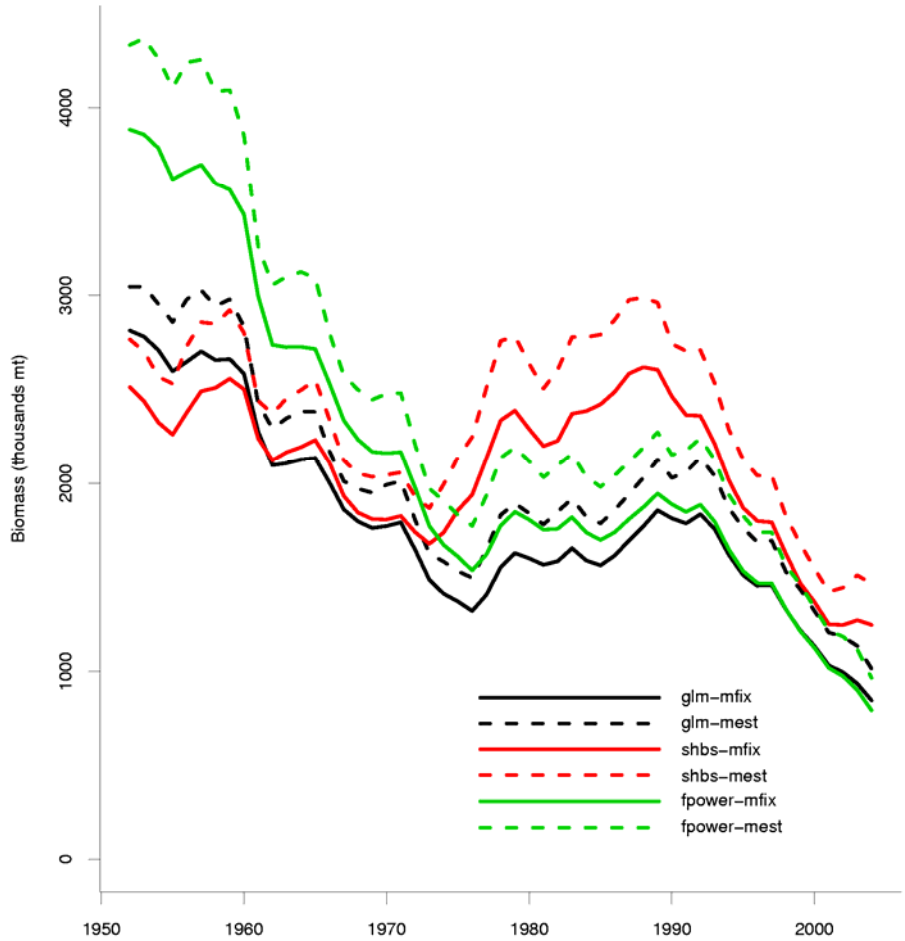
Assessment Results – Recruitment



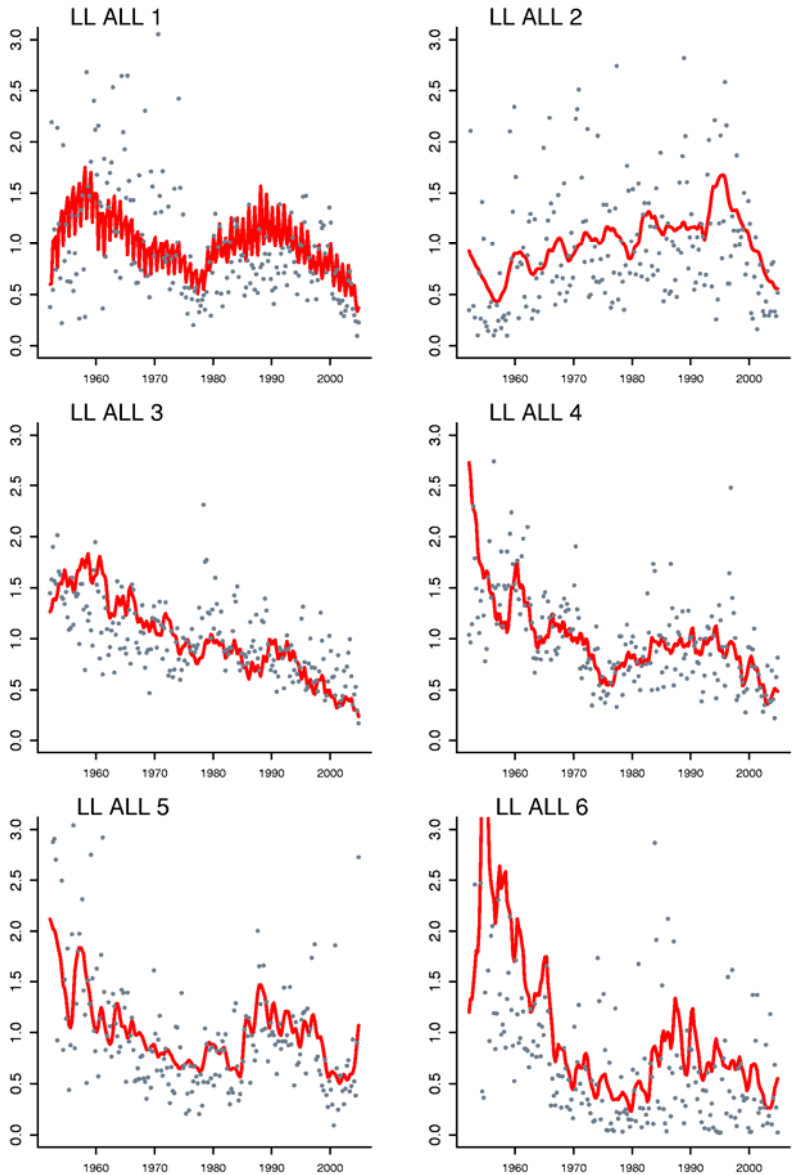


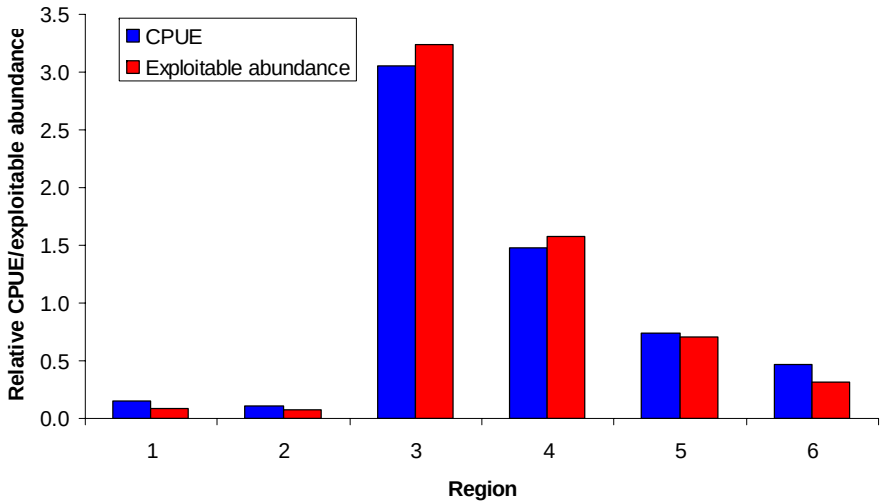
Assessment Results – Biomass



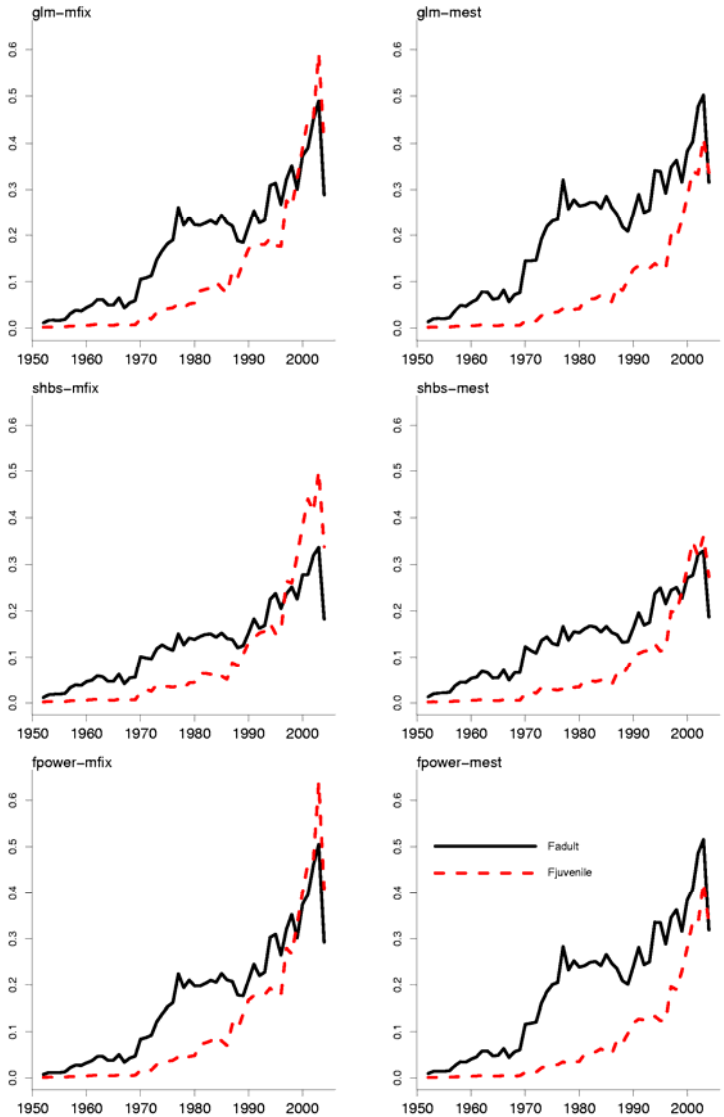


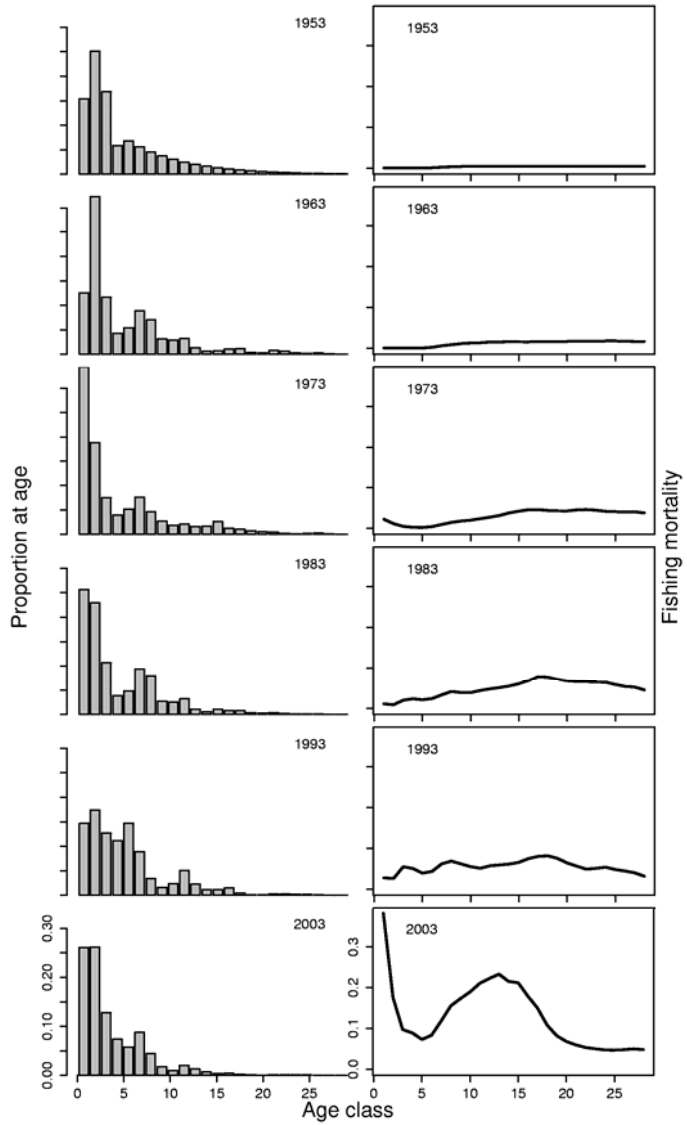
Assessment Results – Biomass



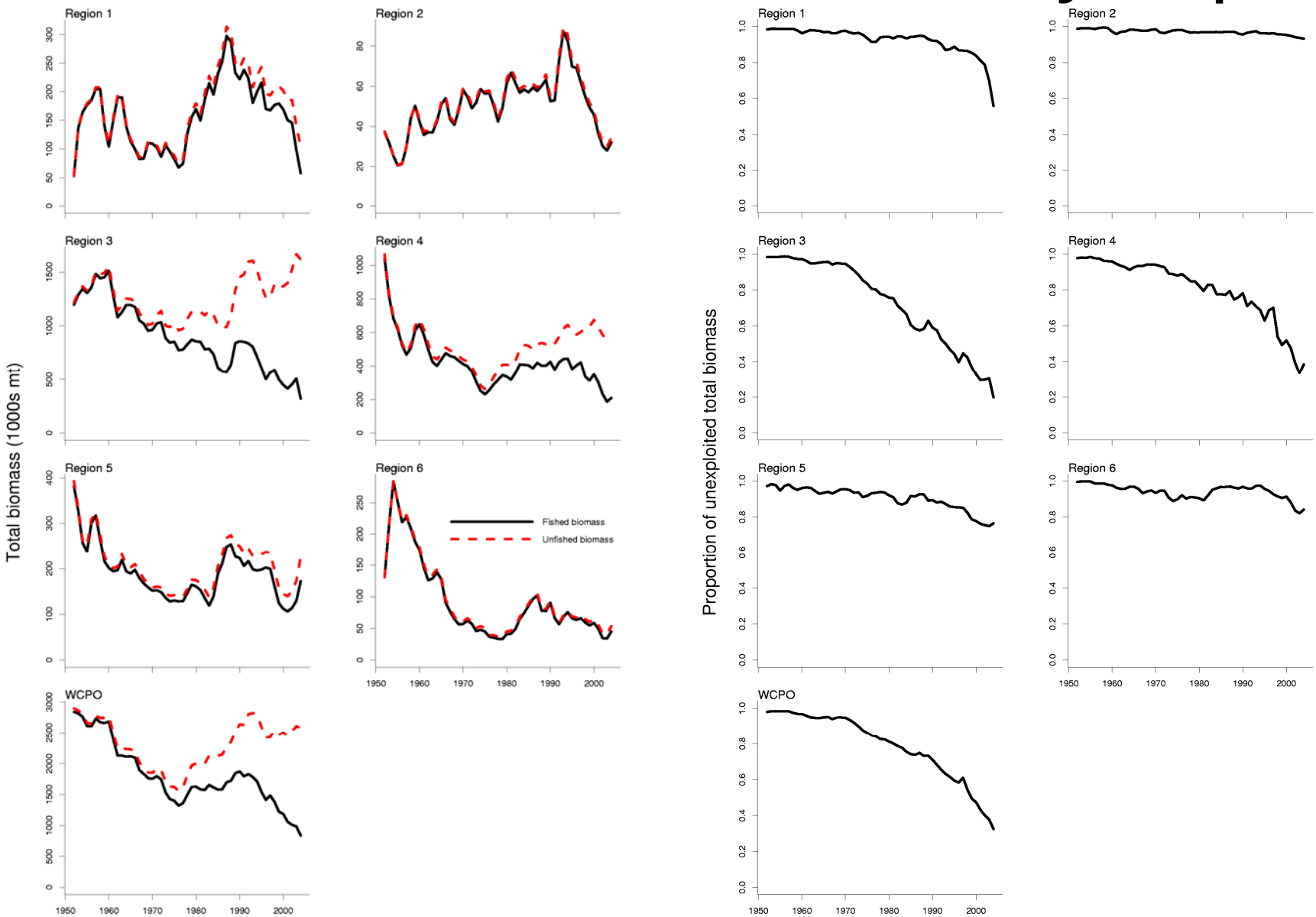


Assessment Results – Fishing Mortality

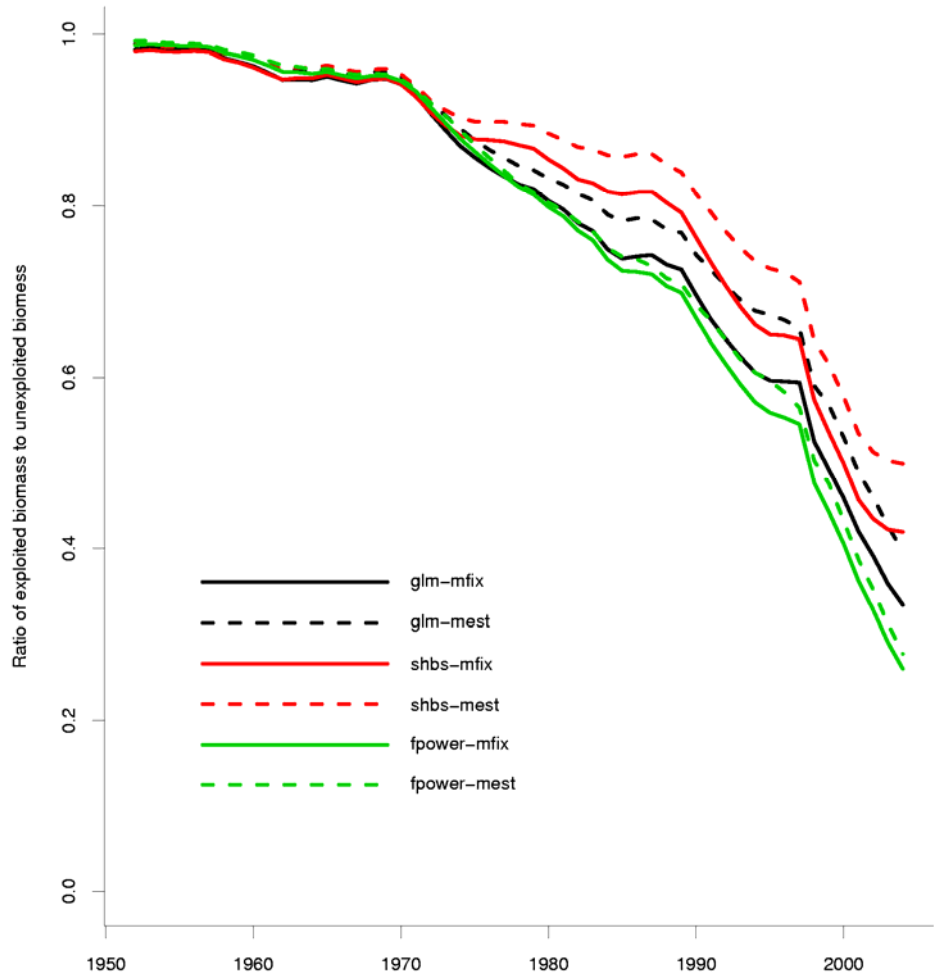




Assessment Results – Fishery Impact

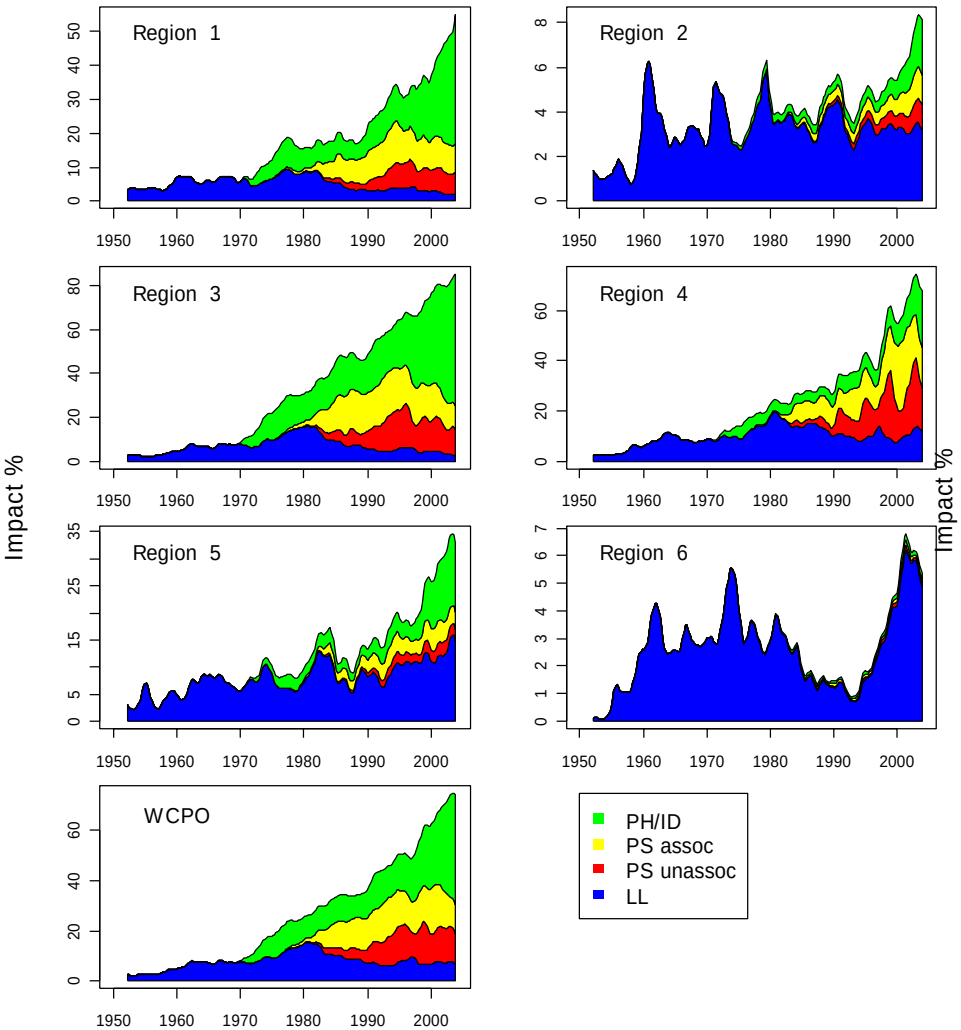


Assessment Results – Fishery Impact

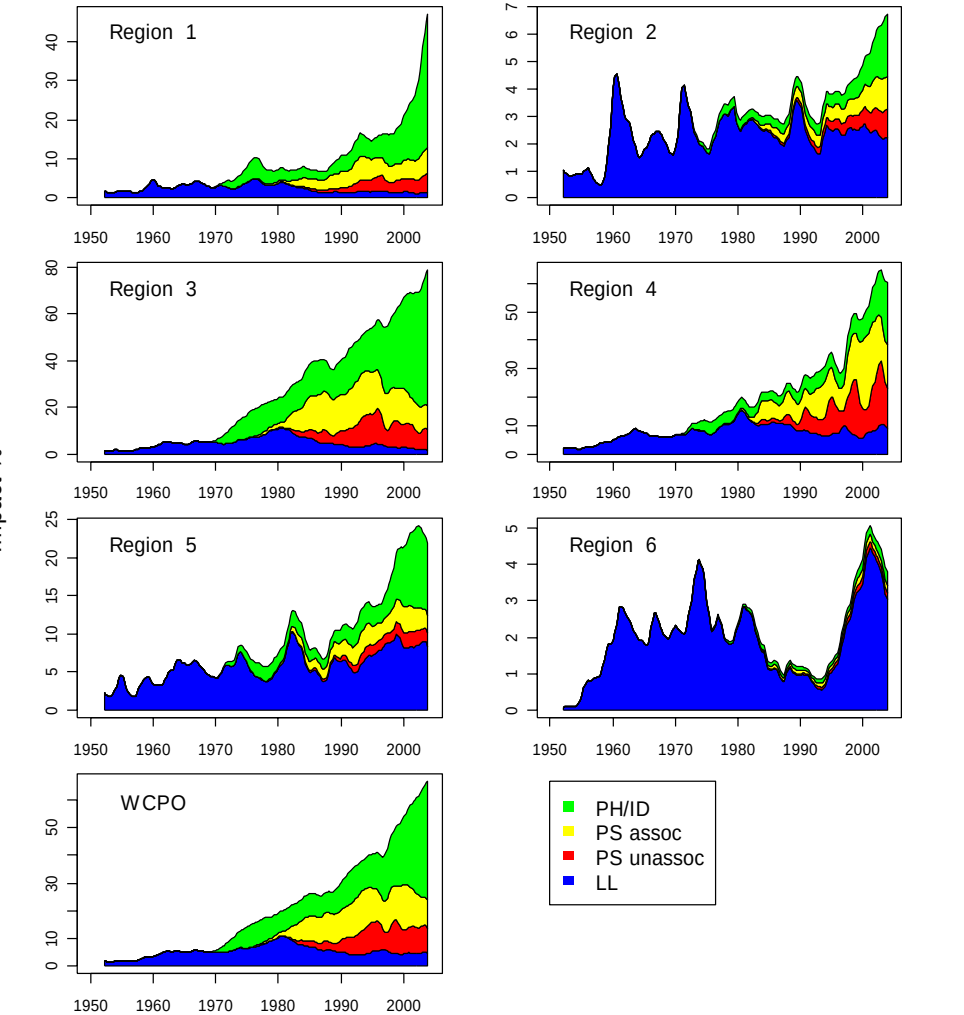


Assessment Results – Fishery Impact

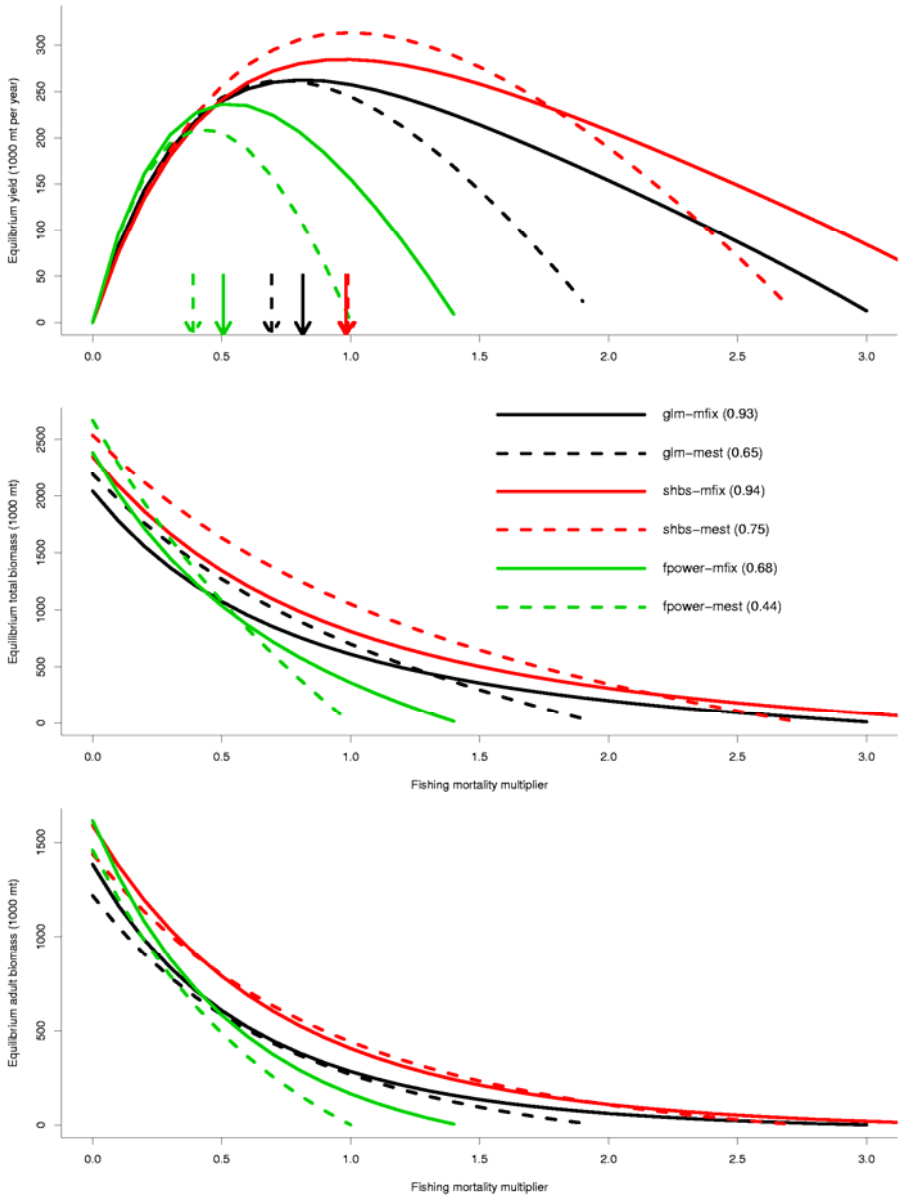
Adult Biomass

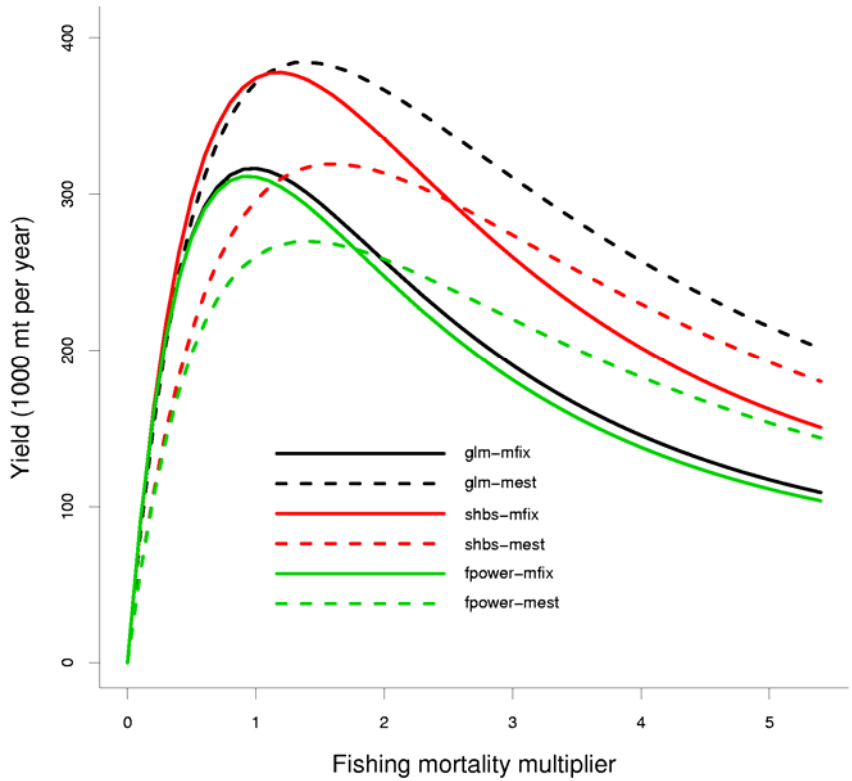


Total Biomass

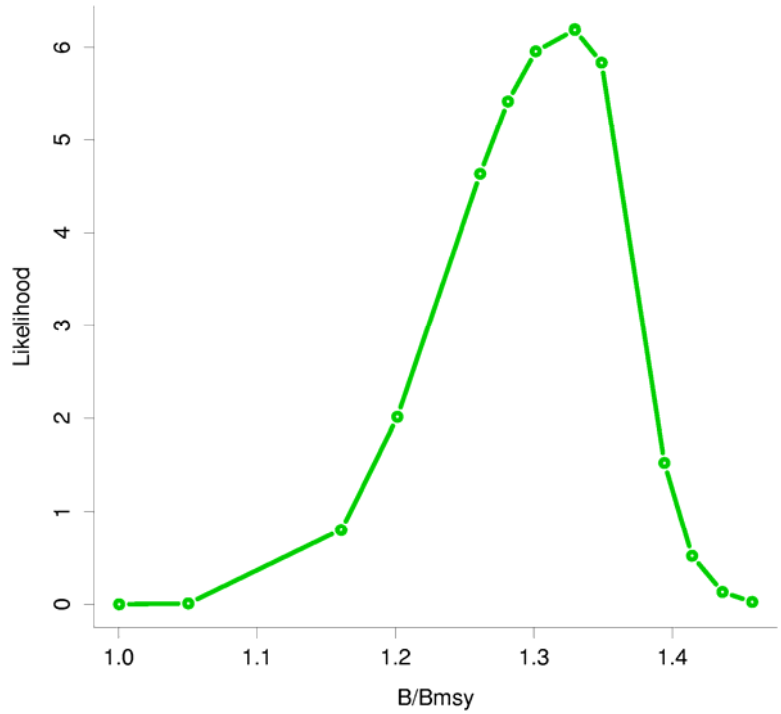


Assessment Results – Yield Analysis





Assessment Results – Reference points

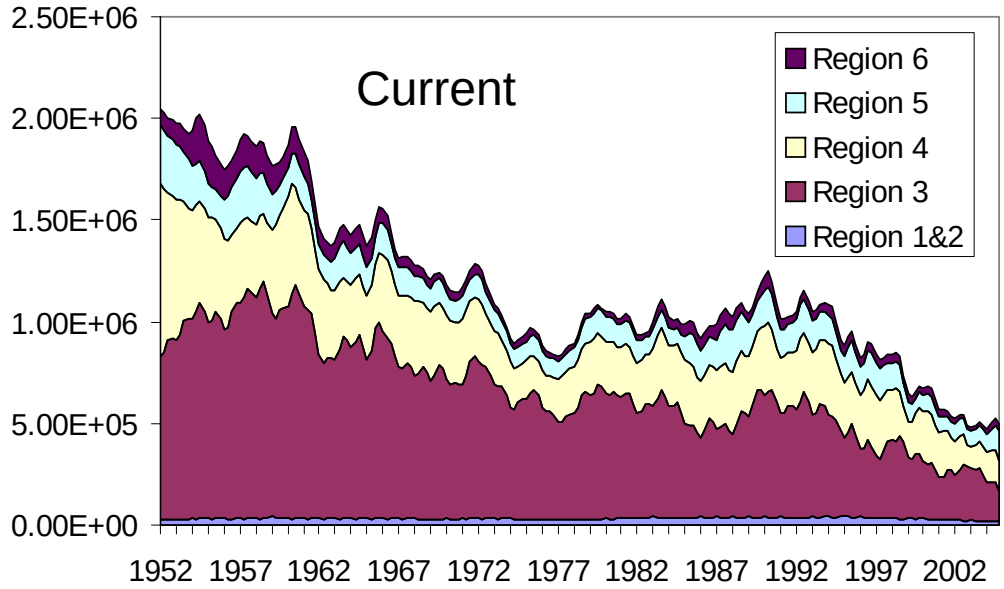


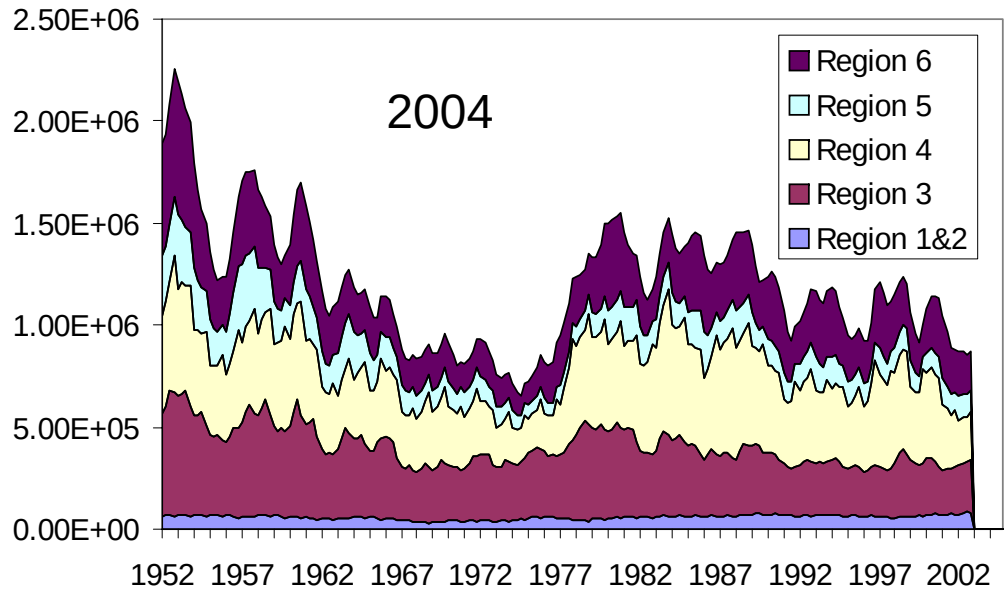
Assessment Results

Management quantity	Units	SHBS-MEST	SHBS-MFIX	GLM-MEST	GLM-MFIX	FPOW-MEST	FPOW-MFIX
$\tilde{Y}_{F_{current}}$	t per quarter	78,360	71,130	61,110	64,350	479	38,900
$\tilde{Y}_{F_{MSY}}$ (or *MSY*)	t per quarter	78,360	71,130	65,420	65,600	52,330	59,080
$\tilde{B}_0$	t	2,537,000	2,348,000	2,193,000	2,042,000	2,667,000	2,384,000
$\tilde{B}_{F_{current}}$	t	1,050,000	810,000	699,200	610,000	5,491	360,100
$\tilde{B}_{MSY}$	t	1,050,000	810,000	1,013,000	759,700	1,340,000	1,036,000
$\tilde{SB}_0$	t	1,439,000	1,591,000	1,219,000	1,384,000	1,459,000	1,615,000
$\tilde{SB}_{F_{current}}$	t	441,200	406,100	268,500	284,400	4	166,300
$\tilde{SB}_{MSY}$	t	441,200	406,100	433,400	383,100	629,300	583,800
$B_{current}$	t	1,459,299	1,256,340	1,175,319	1,005,103	1,172,996	964,877
$SB_{current}$	t	624,213	651,878	477,325	507,286	472,742	484,065
$B_{current,F=0}$	t	2,828,036	2,873,374	2,569,589	2,526,359	3,364,924	2,963,254
$B_{current}/\tilde{B}_0$		0.58	0.54	0.54	0.49	0.44	0.40
$B_{current}/\tilde{B}_{F_{current}}$		1.39	1.55	1.68	1.65	213.62	2.68
$B_{current}/\tilde{B}_{MSY}$		1.39	1.55	1.16	1.32	0.88	0.93
$B_{current}/B_{current,F=0}$		0.52	0.44	0.46	0.40	0.35	0.33
$SB_{current}/\tilde{SB}_0$		0.43	0.41	0.39	0.37	0.32	0.30
$SB_{current}/\tilde{SB}_{F_{current}}$		1.41	1.61	1.78	1.78	121,060.67	2.91
$SB_{current}/\tilde{SB}_{MSY}$		1.41	1.61	1.10	1.32	0.75	0.83
$\tilde{B}_{F_{current}}/\tilde{B}_0$		0.41	0.34	0.32	0.30	0.00	0.15
$\tilde{SB}_{F_{current}}/\tilde{SB}_0$		0.31	0.26	0.22	0.21	0.00	0.10
$\tilde{B}_{MSY}/\tilde{B}_0$		0.41	0.34	0.46	0.37	0.50	0.43
$\tilde{SB}_{MSY}/\tilde{SB}_0$		0.31	0.26	0.36	0.28	0.43	0.36
$F_{current}/\tilde{F}_{MSY}$		1.00	1.02	1.35	1.22	2.33	1.89
$\tilde{B}_{F_{current}}/\tilde{B}_{MSY}$		1.00	1.00	0.69	0.80	0.00	0.35
$\tilde{SB}_{F_{current}}/\tilde{SB}_{MSY}$		1.00	1.00	0.62	0.74	0.00	0.28
$\tilde{Y}_{F_{current}}/MSY$		1.00	1.00	0.93	0.98	0.01	0.66

Comparison with last year's assessment.

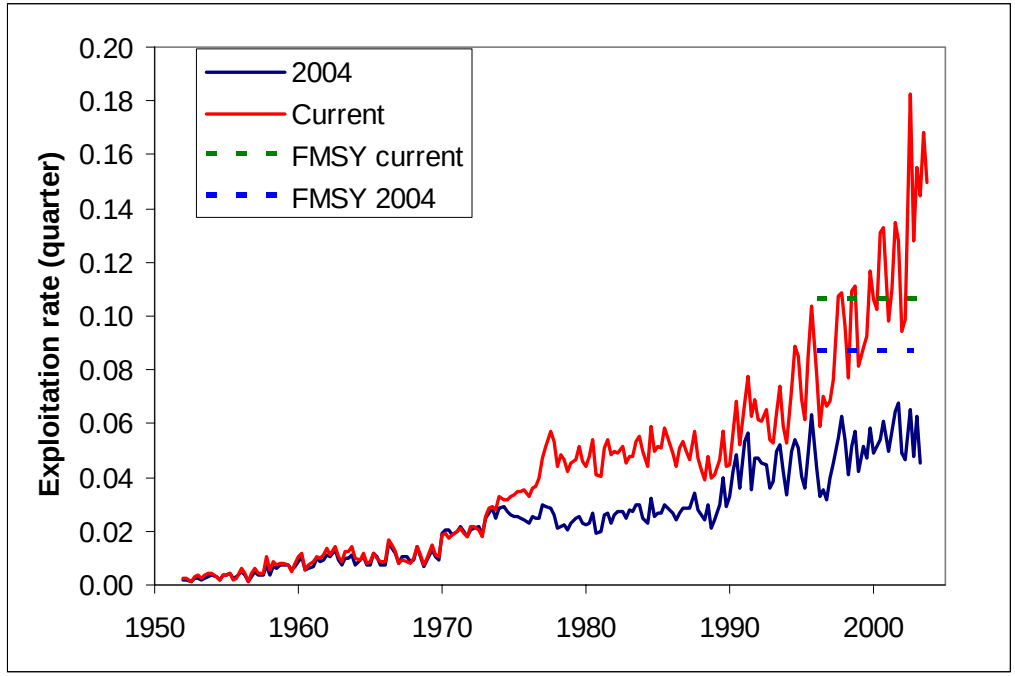
Longline exploitable biomass (mt) by region.

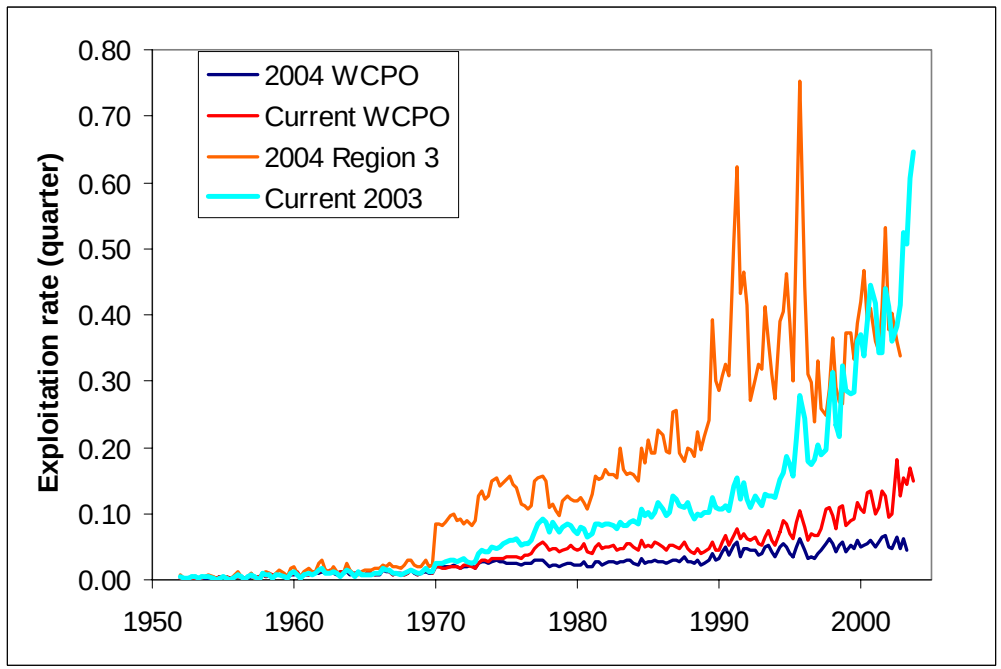




Comparison with last year's assessment.

Exploitation rates.





Main Conclusions

- Recruitment in all analyses increased from about 1980 and remained stable over last decade.
- Biomass declined to about half of its initial level by 1970 and was fairly stable until 1990. Sharp decline over last decade, particularly in region 3.
- Biomass is currently 0.33-0.52 of unexploited levels. Exploitation rates have increased steeply over last decade.
- Depletion more severe in tropical regions.
- Surface fisheries (PS & PH/ID) have highest impact. Longline fishery has lowest overall impact.
- Recent fishing mortality is near to or above the MSY level, i.e. it is likely that overfishing is occurring. Change in status from last year.
- Current biomass is above MSY levels, but adult biomass is below MSY levels for the FPOW analyses.
- Biomass is predicted to fall below MSY levels at current effort levels unless recruitment remains above average.