



Selectivity and two biomass measures in an age-based assessment of Antarctic krill

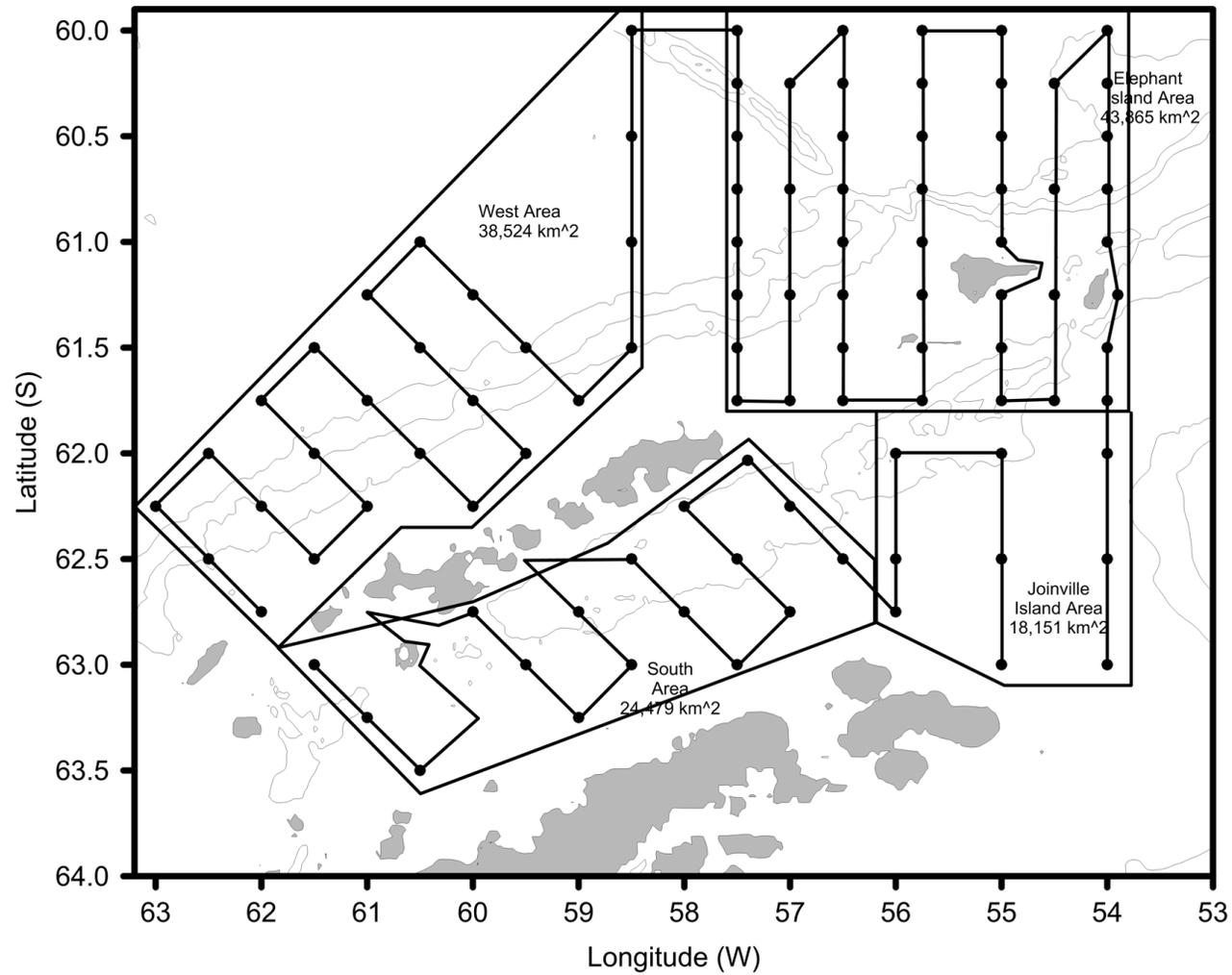
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NOAA/NMFS/SWFSC/AERD

CAPAM Workshop, March 14, 2013

AMLR survey program

- The Antarctic Marine Living Resources program of the NOAA Southwest Fisheries Science Center's Antarctic Ecosystem Research Division has been conducting research surveys of Antarctic krill (*Euphausia superba*) around the Antarctic peninsula since the late 1980s.
- The surveys expanded during this period from a grid of net tows around Elephant Island to four grids including adjacent regions, with acoustic biomass measured along transect lines between the stations.
- Two legs a month apart were generally sampled, but not every station or area was sampled every year.

AMLR Survey Grid



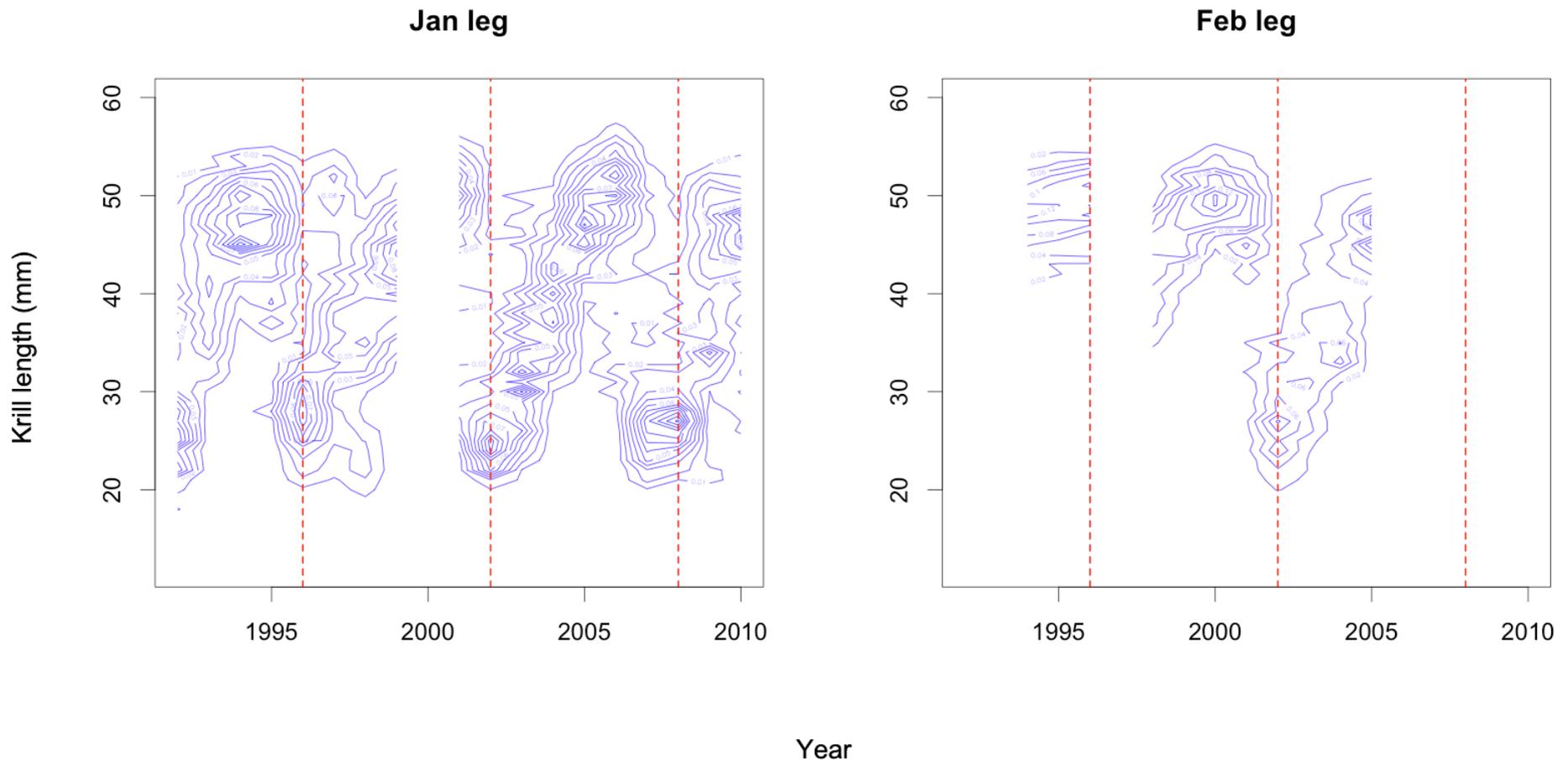
Krill model

- An age-based assessment coded in AD Model Builder that uses these data is under development.
- 19 years from the survey time series, 1991 to 2010, were chosen for modeling.
- The current data consist of;
 - 1) length compositions of krill in the net tows, and two potential measures of biomass densities derived from
 - 2) biomass from net trawls (numbers at length, weight at length, volume sampled)
 - 3) biomass from multifrequency acoustic data processed using SDWBA method.
- Natural mortality is estimated as a single value for all ages.
- Fishery removals are not included in the current models but will be incorporated in the future. The fishery for krill is believed to remove less than 1% of annual biomass.

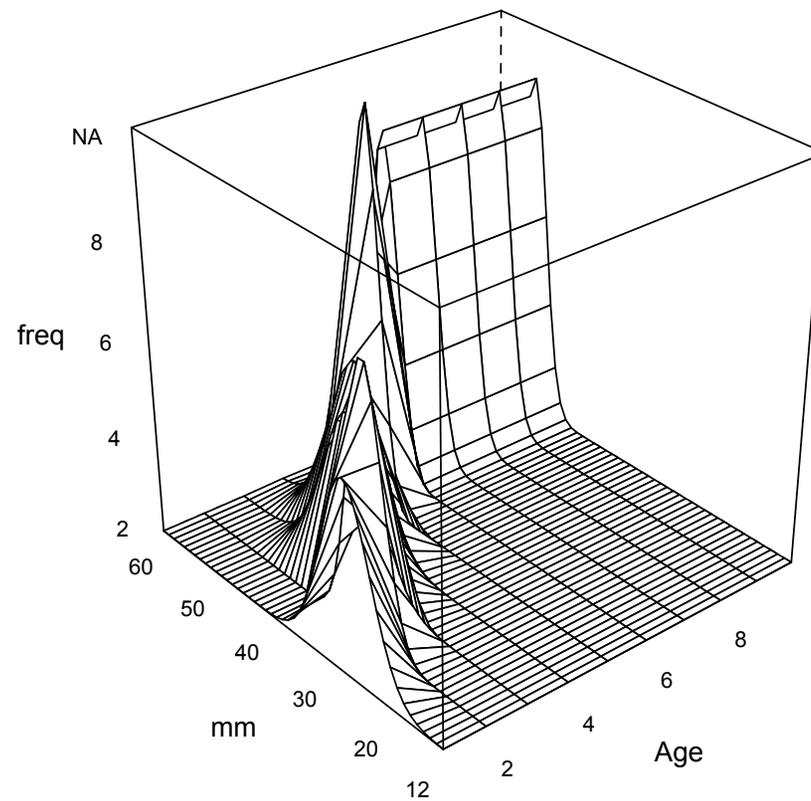
Age-length

- Individual Antarctic krill have lived as long as 11 years in aquaria but are thought to have maximum ages of around 5 or 6 years in nature.
- Krill ages in the models are supplied as assumed known age-length distributions inferred from density mixture models (“CMIX”).
- The models have 10 age classes with a plus group at 10, but very few individuals (100s or less) are estimated to be older than age 6 in most model configurations.

Krill size distributions in the AMLR data series are on an approximate 6-year cycle



Age (model) to length (data)



An issue: observed biomass densities from nets and from acoustics are not highly correlated over the 19 year period

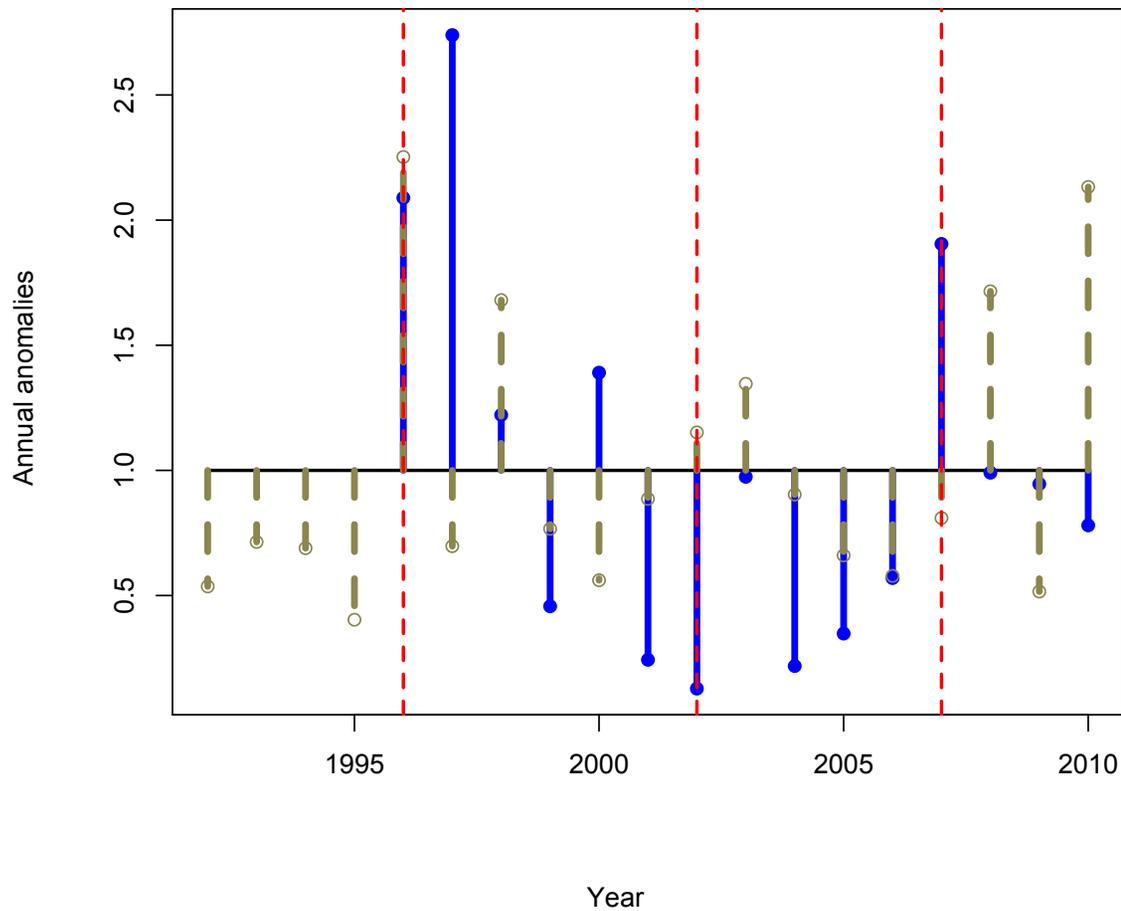
	combi
Pearson	0.16
Kendall	0.01
Spearman	0.08

	January	February
Pearson	0.41	0.22
Kendall	0.23	-0.05
Spearman	0.38	-0.08

More detail: annual anomalies

Acoustic biomass (blue lines), net biomass (greygreen dashes)

All combi leg (Spearman cor = 0.08)



Different selectivities?

- Can estimating selectivities separately for nets and acoustics account for annual differences in total biomass between the two time series?
- Approach: run models using both biomass measures, and models using only one or the other, with alternative weightings on the biomass data sources. Compare results.

Selectivity

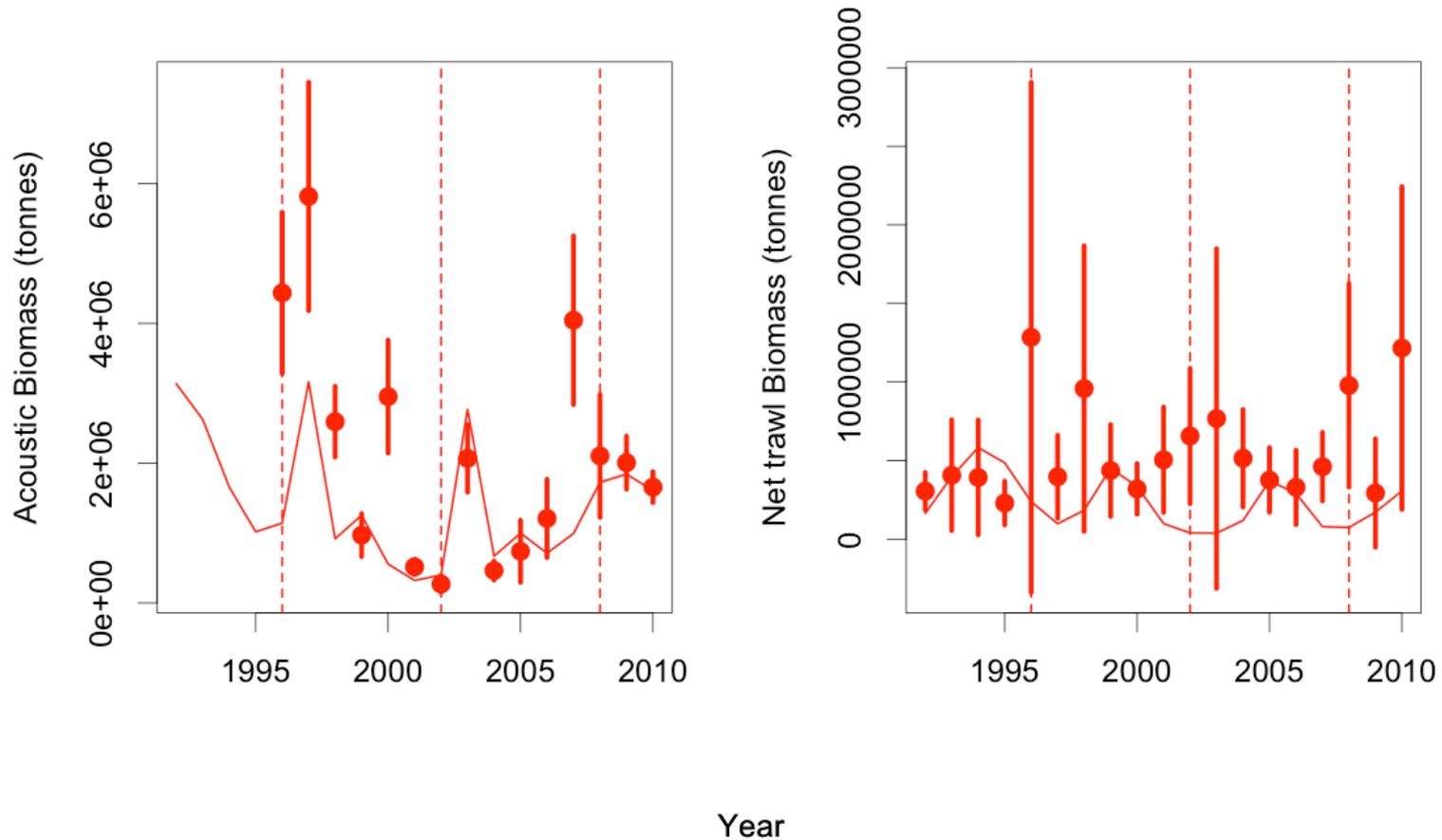
- ***contact selectivity***
- ***availability***
- The acoustic surveys are along transects between the tow stations but acoustics integrate krill biomass down to about 250 m, vs. 170 m for tows.
- Krill size and orientation affect the acoustic signal and are included in the acoustic model.
- Differences between the two methods for measuring biomass densities of krill could be due to either contact selectivity or availability.

Model configurations

- Biomass data: Supply different model configurations with
 - 1) both acoustic and net biomass with empirically calculated SEs
 - 2) acoustic biomass with 1% CVs only, no net biomass data
 - 3) net biomass with 1% CVs only, no acoustic biomass data
 - 4) acoustic biomass with 1% CVs, net biomass with empirical SEs
 - 5) net biomass with 1% CVs, acoustic biomass with empirical SEs
- Composition data: Supply all models with the length-frequency data from the tows.
- Allow the biomass measure in each configuration to have either logistic or double-logistic selectivity and choose the best-fitting.

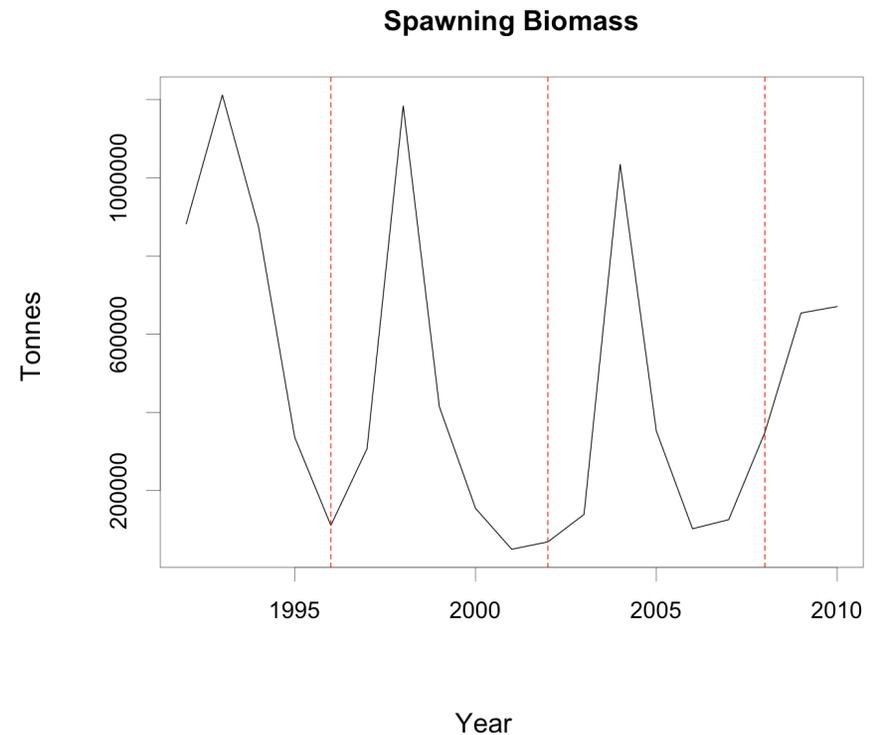
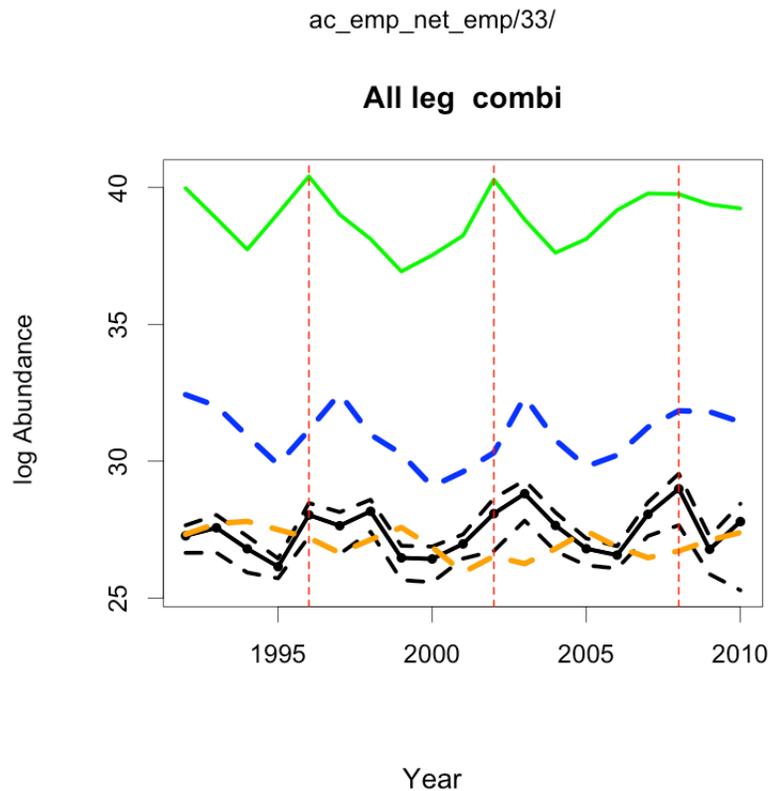
1) both net biomass and acoustic biomass in the same integrated model with empirically calculated SEs: Biomass fits

Model vs. Biomass Data



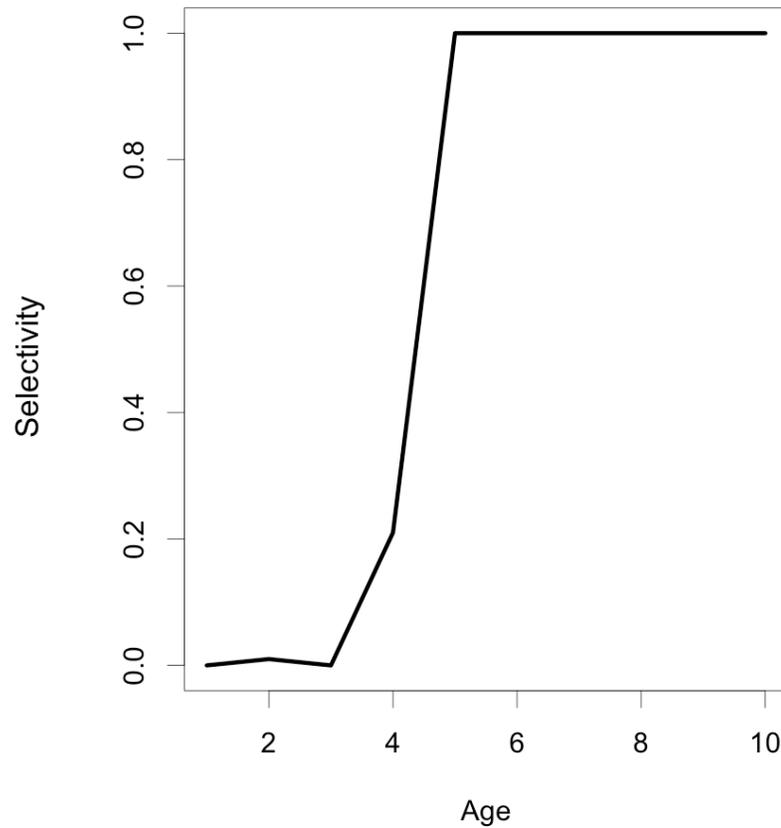
Configuration 1) both net and acoustic biomass with empirically calculated SEs: Abundances

Integrated population numbers **green** ($\sim 2.4e+17$)
Integrated numbers vulnerable to acoustics **blue**
Integrated numbers vulnerable to nets **orange**
TrawlCI numbers **black**

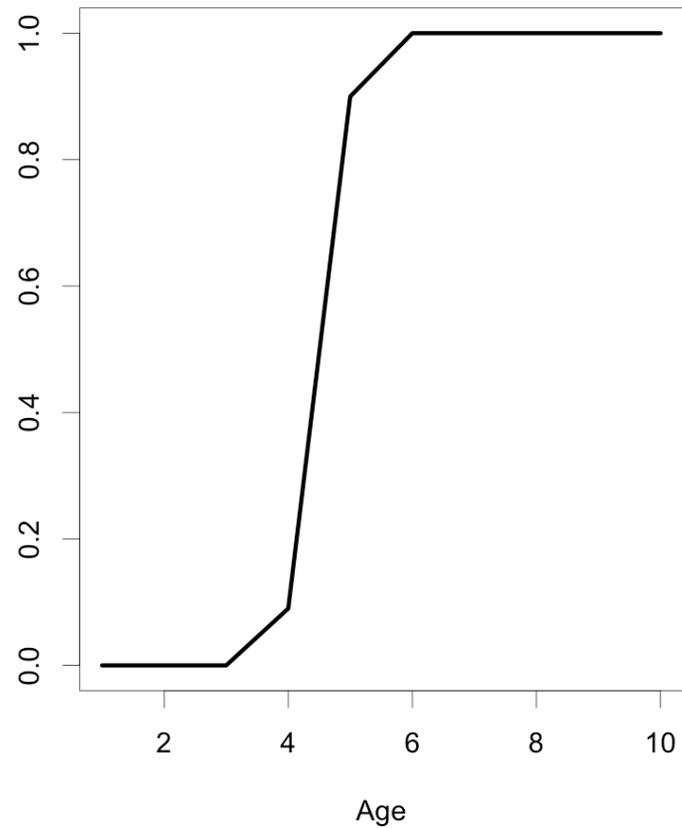


Configuration 1) both net and acoustic biomass with empirically calculated SEs: Selectivity

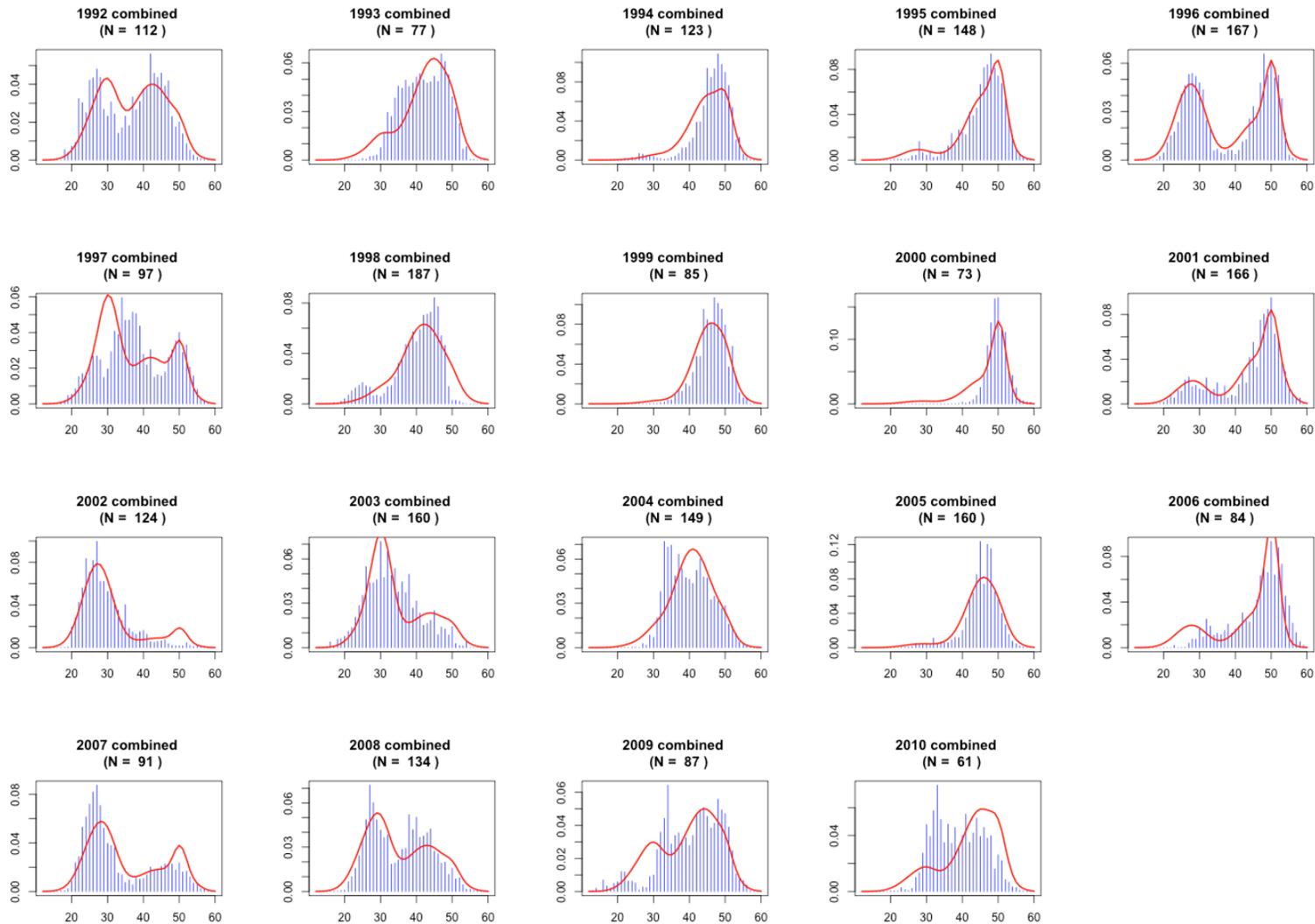
Biomass from Acoustics



Biomass from Net Trawls

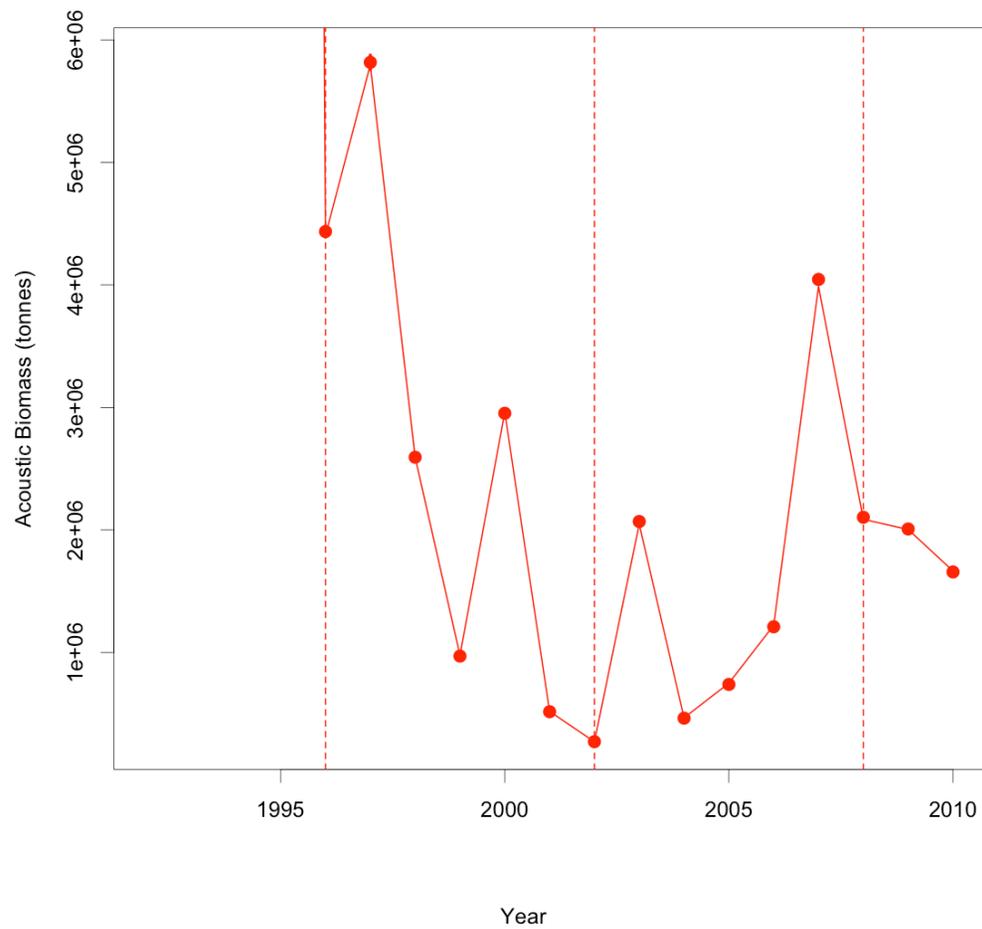


Configuration 1) both net and acoustic biomass with empirically calculated SEs: Composition fits



Configuration 2) acoustic biomass with 1% CVs, no net biomass data: Biomass fits

Model vs. Biomass Data

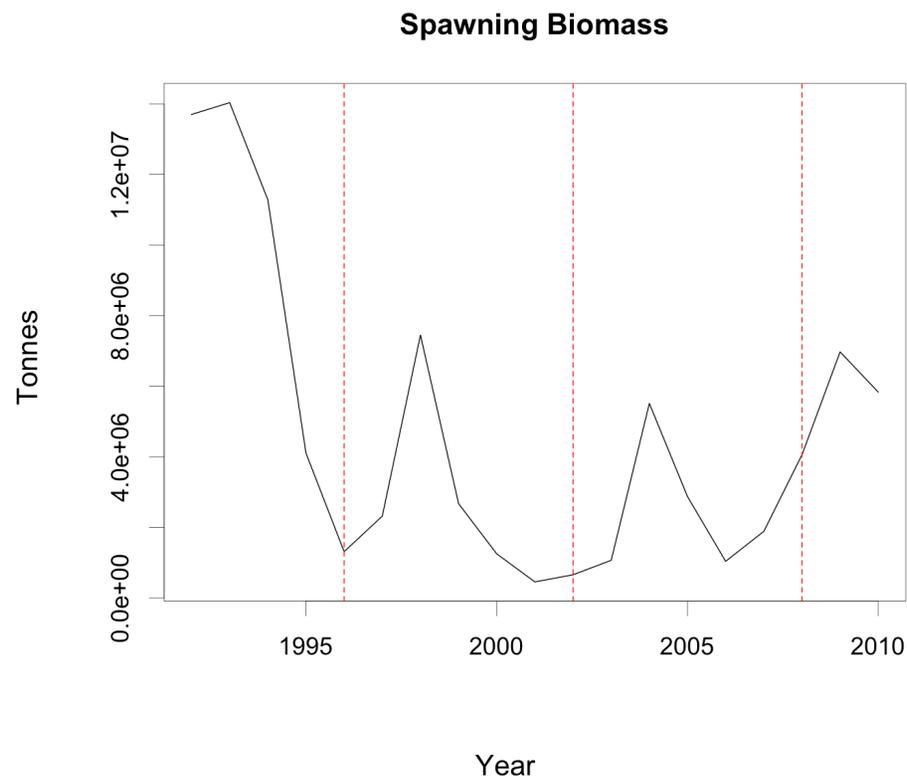
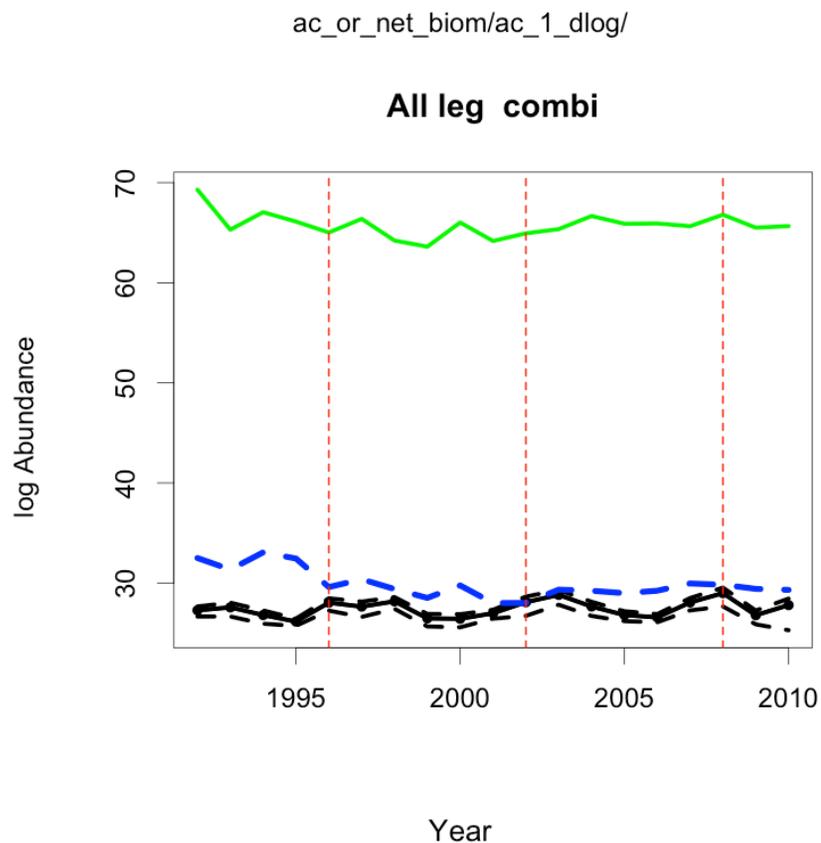


Configuration 2) acoustic biomass with 1% CVs, no net biomass data: Abundances

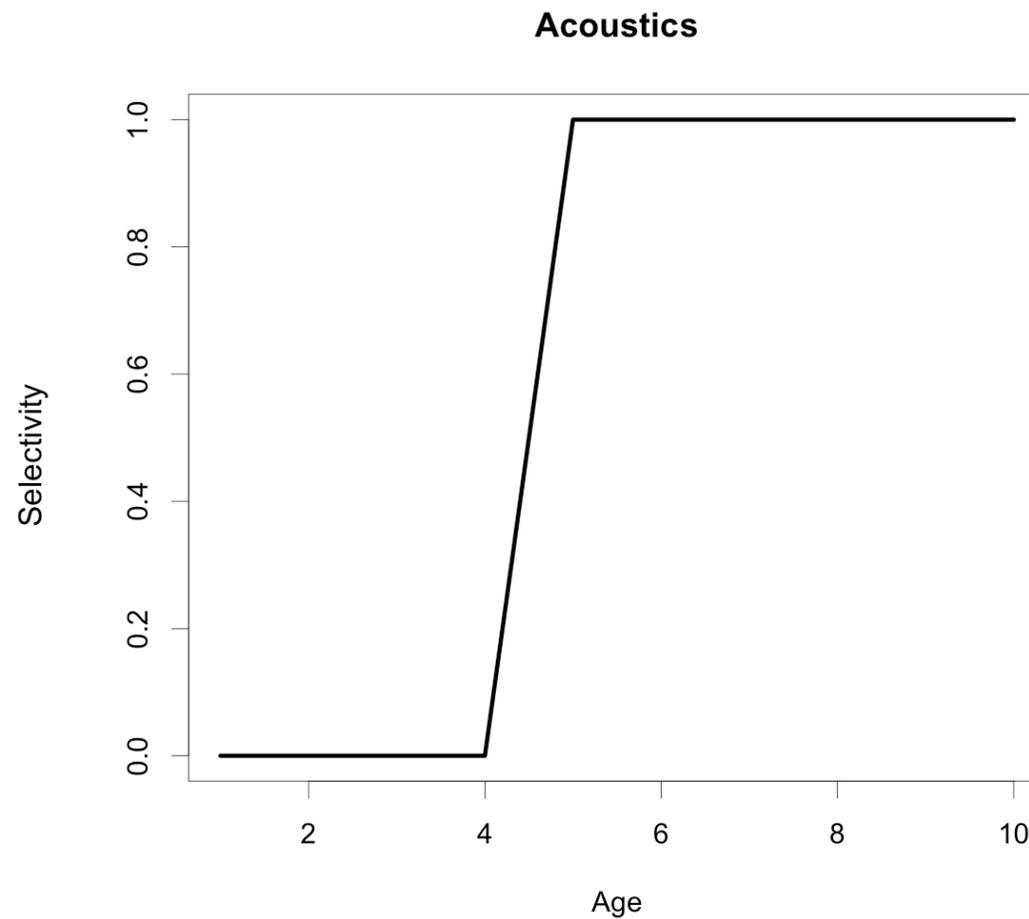
Integrated population numbers green ($\sim 2.5e+30$)

Integrated numbers vulnerable to acoustics blue

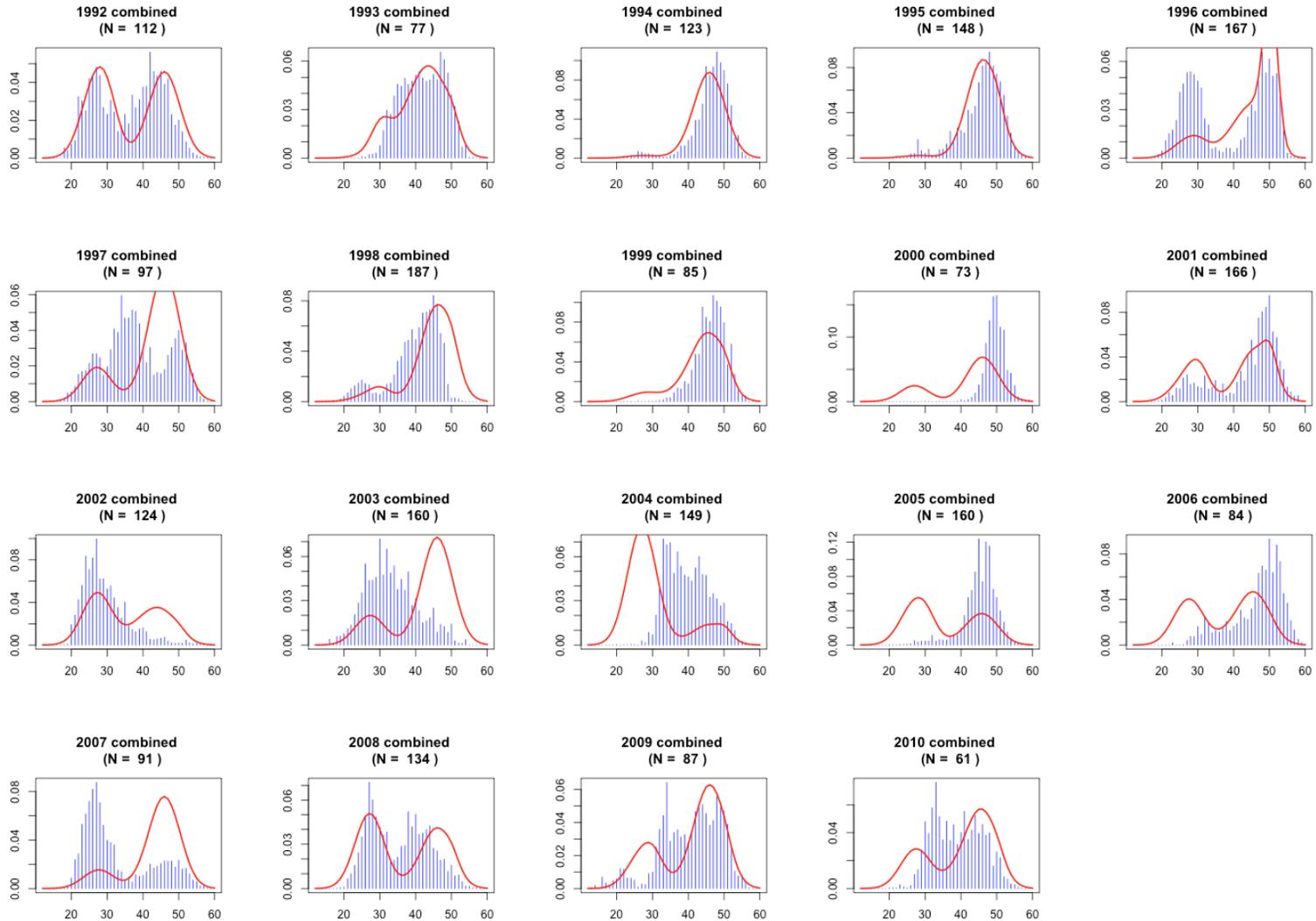
TrawlCI numbers black



Configuration 2) acoustic biomass with 1% CVs, no net biomass data: Selectivity

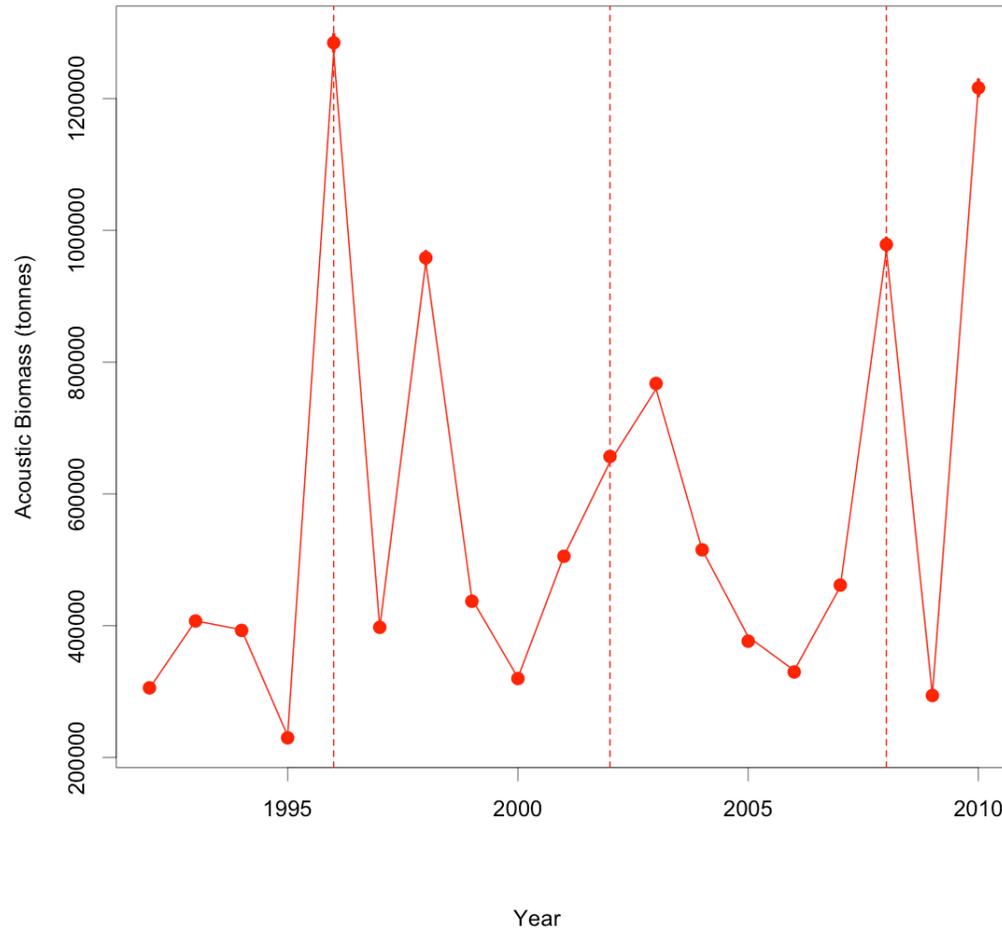


Configuration 2) acoustic biomass with 1% CVs, no net biomass data: Composition fits



Configuration 3) net biomass with 1% CVs only, no acoustic biomass data: Biomass fits

Model vs. Biomass Data

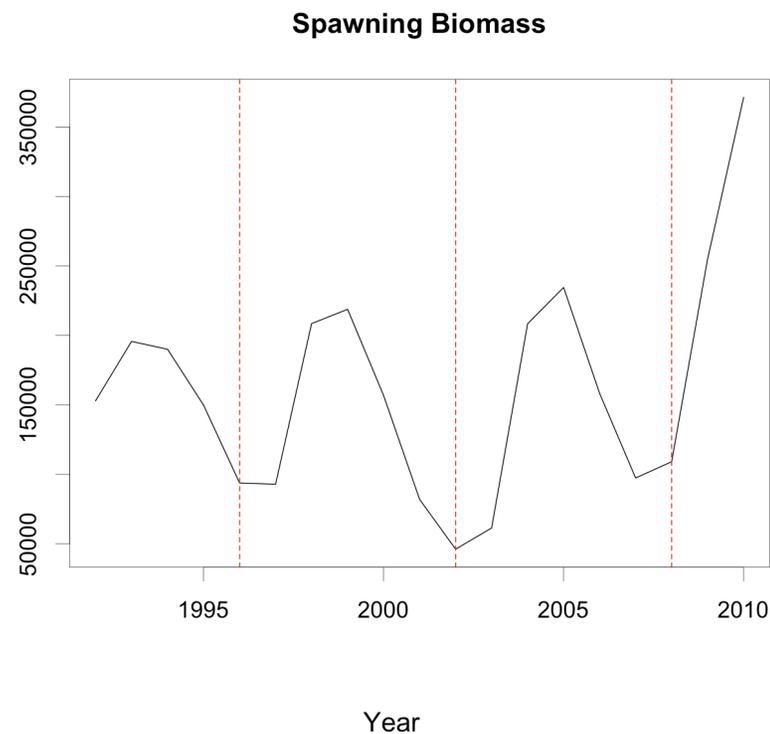
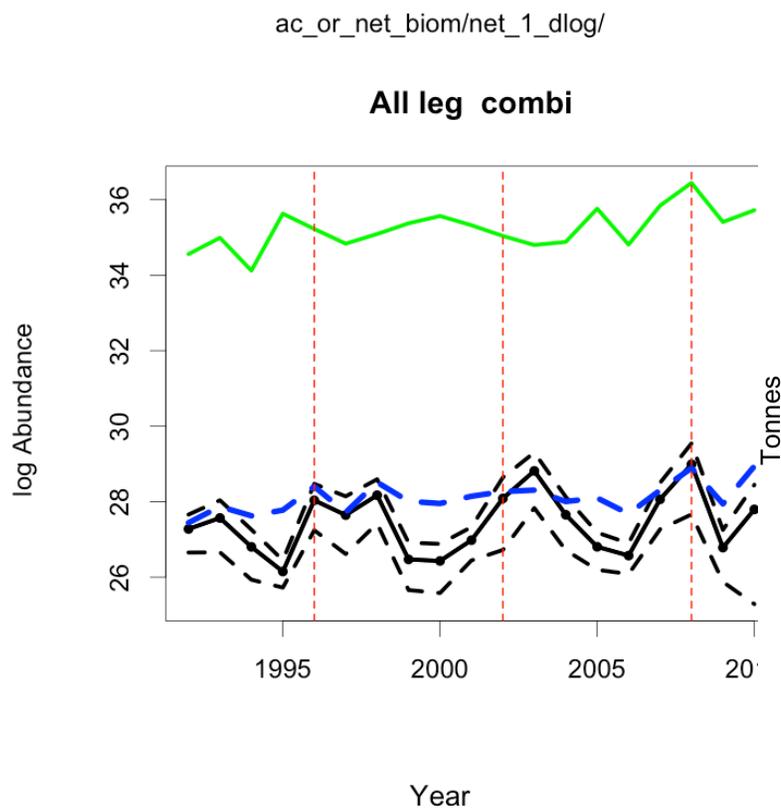


Configuration 3) net biomass with 1% CVs only, no acoustic biomass data: Abundances

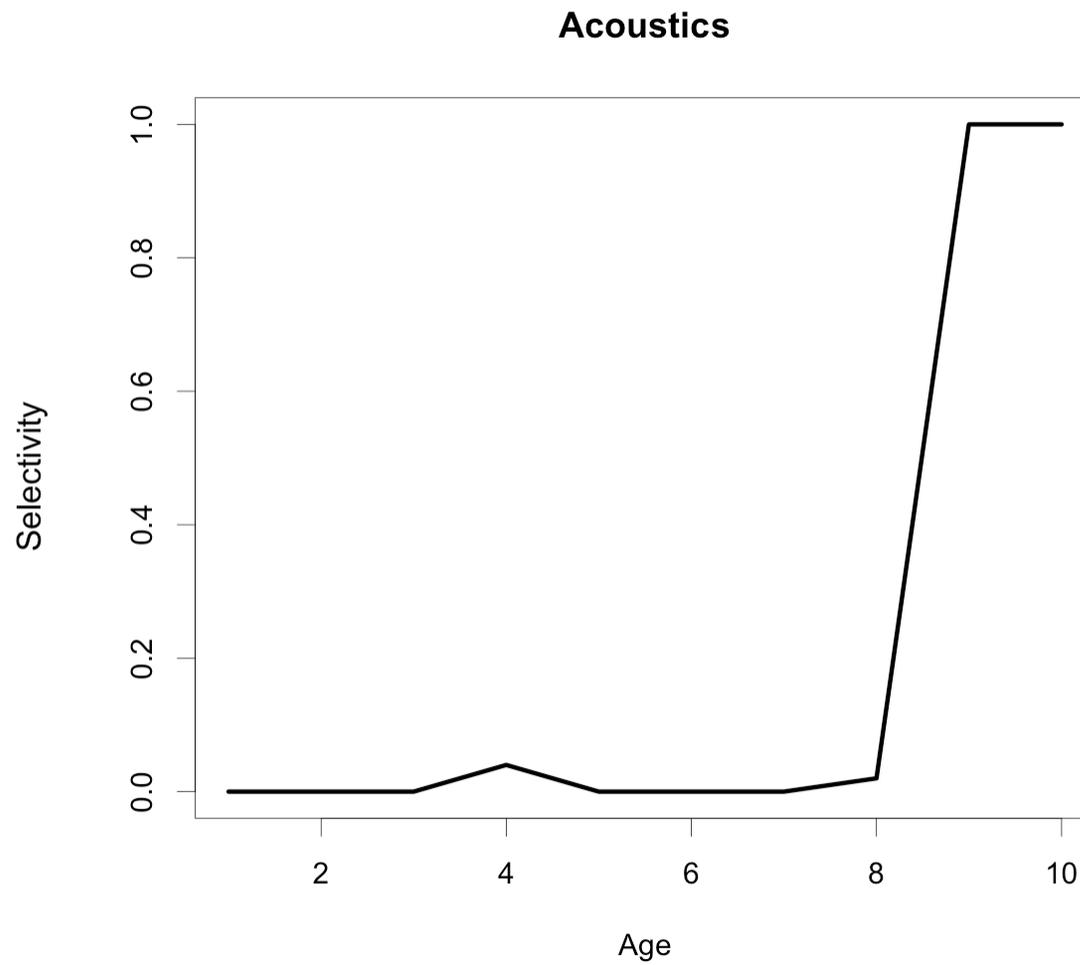
Integrated population numbers green ($\sim 1.6e+15$)

Integrated numbers vulnerable to nets blue

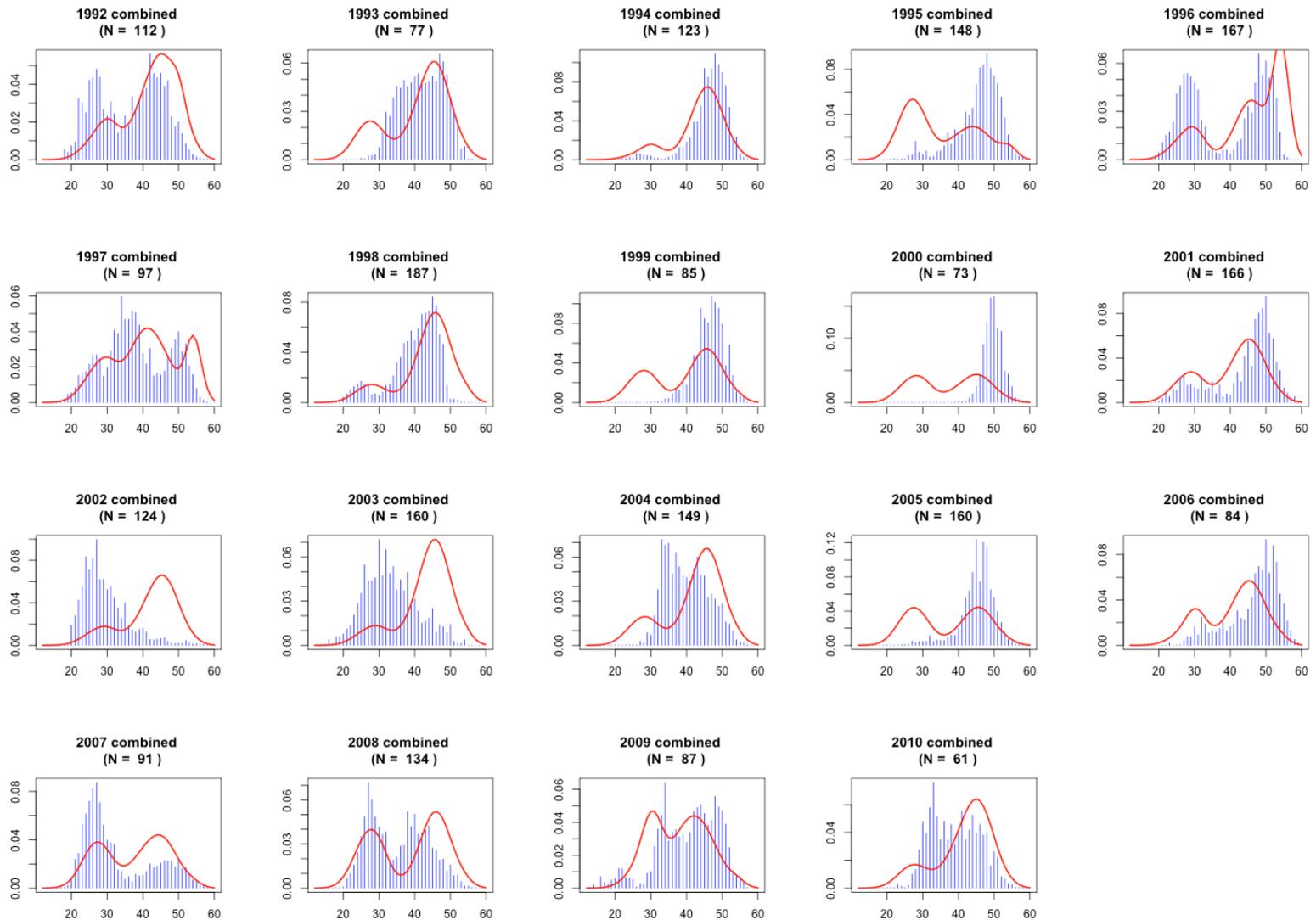
TrawlCI numbers black



Configuration 3) net biomass with 1% CVs only, no acoustic biomass data: Selectivity

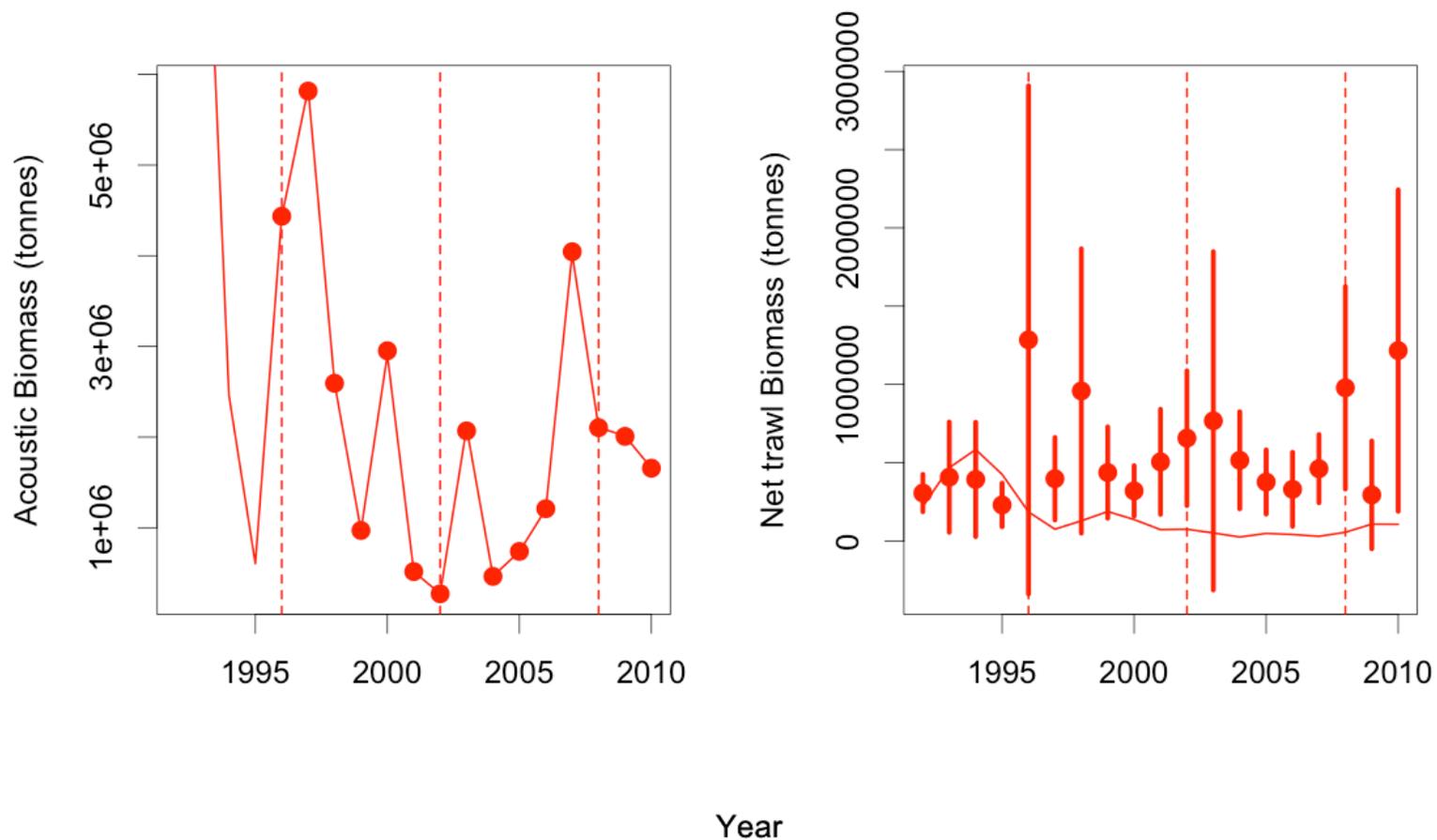


Configuration 3) net biomass with 1% CVs only, no acoustic biomass data: Composition fits



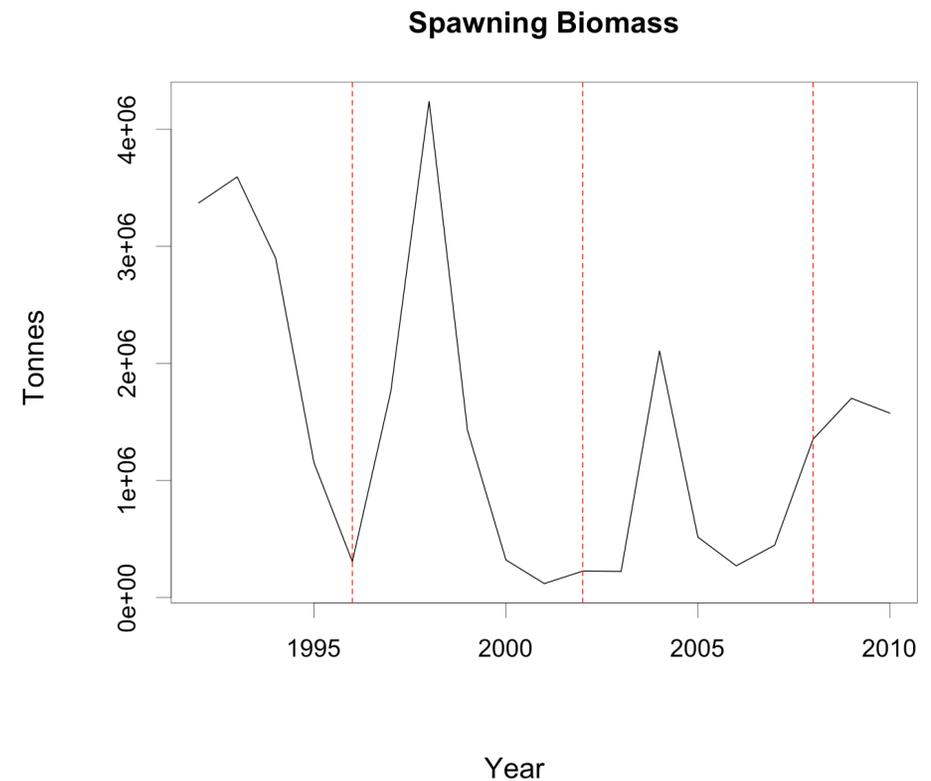
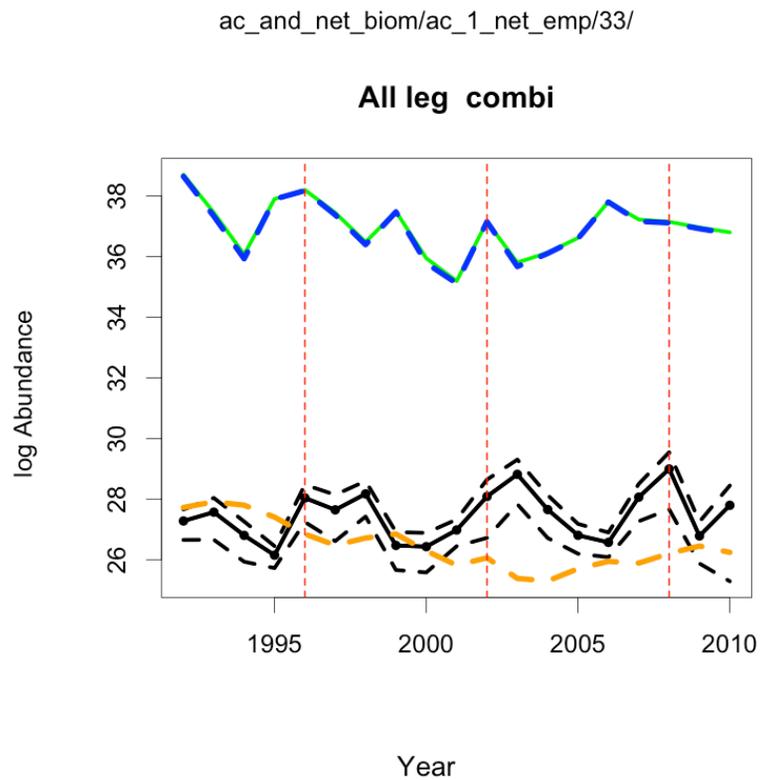
Configuration 4) acoustic biomass with 1% CVs, net biomass with empirical SEs: Biomass fits

Model vs. Biomass Data

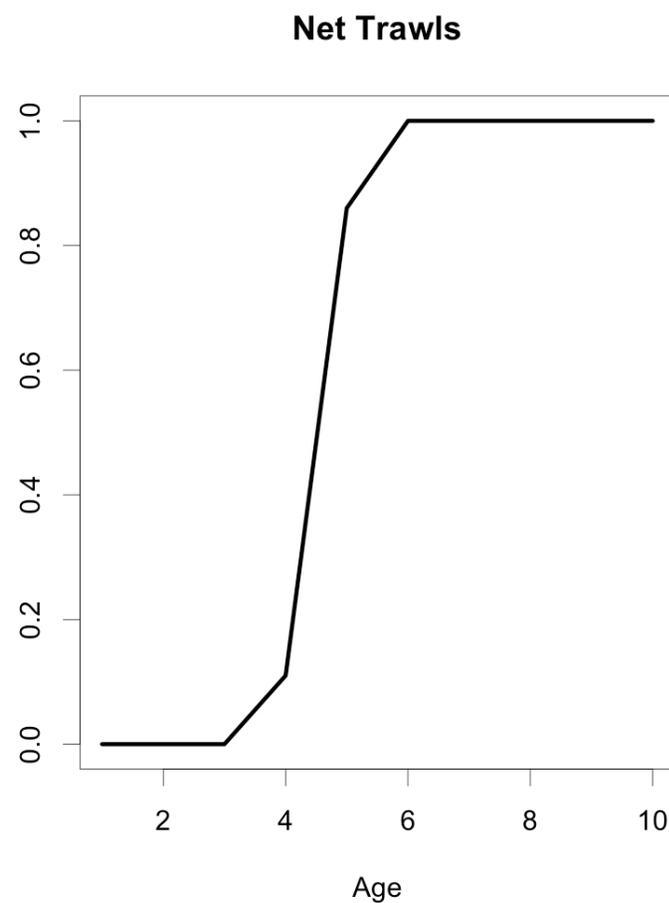
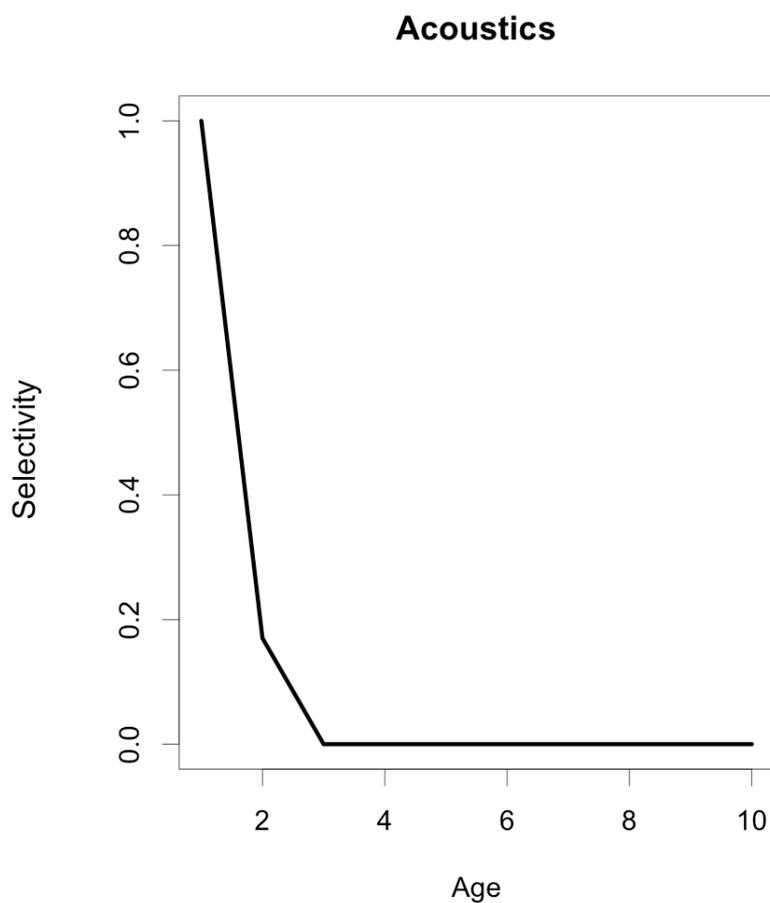


Configuration 4) acoustic biomass with 1% CVs, net biomass with empirical SEs: Abundances

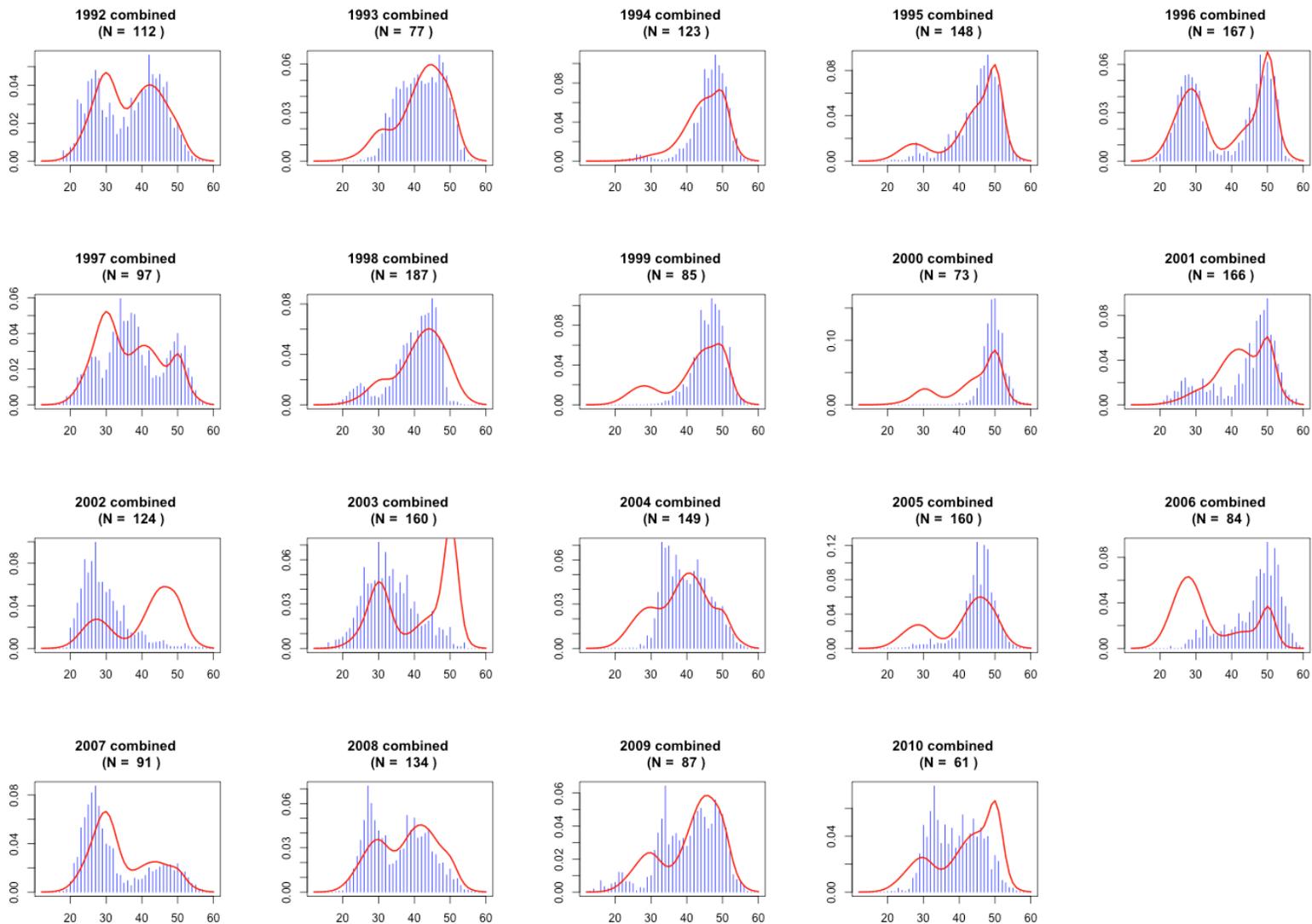
Integrated population numbers **green** ($\sim 3.23 \times 10^{16}$)
Integrated numbers vulnerable to acoustics **blue**
Integrated numbers vulnerable to nets **orange**
TrawlCI numbers **black**



Configuration 4) acoustic biomass with 1% CVs, net biomass with empirical SEs: Selectivities

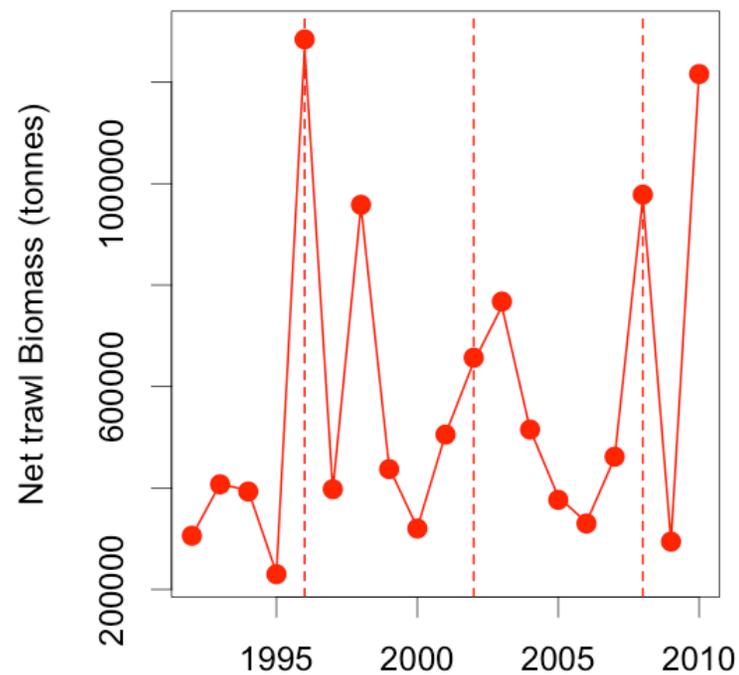
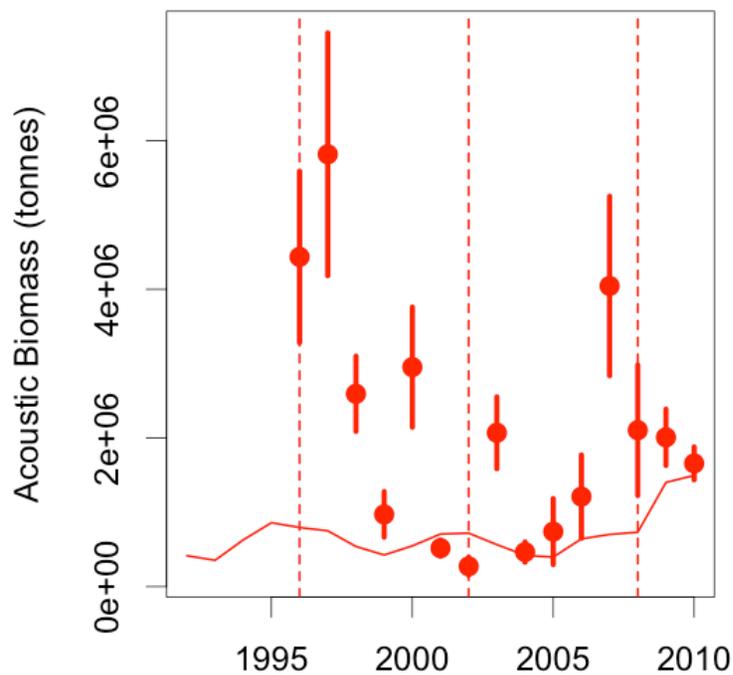


Configuration 4) acoustic biomass with 1% CVs, net biomass with empirical SEs: Composition fits



Configuration 5) net biomass with 1% CVs, acoustic biomass with empirical SEs: Biomass fits

Model vs. Biomass Data

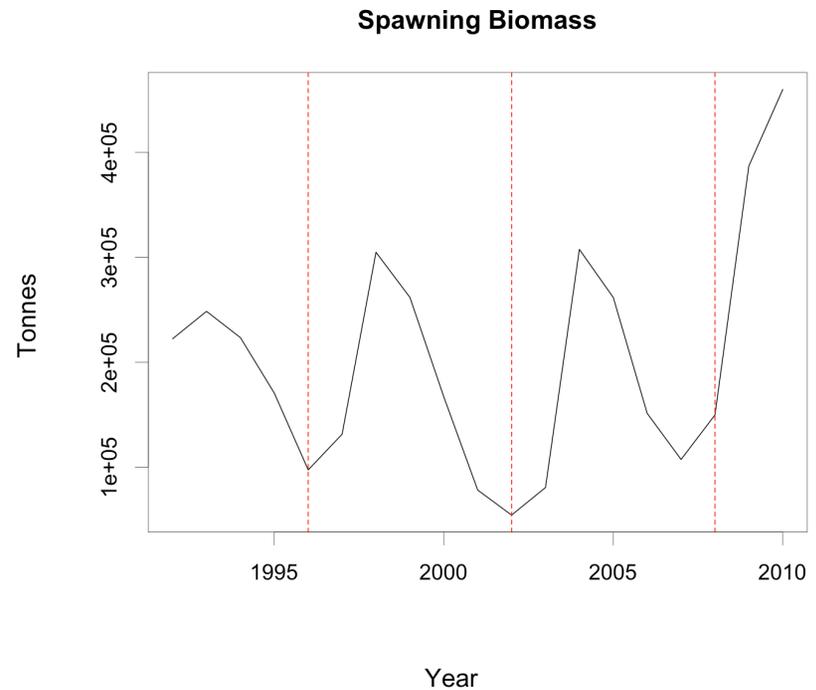
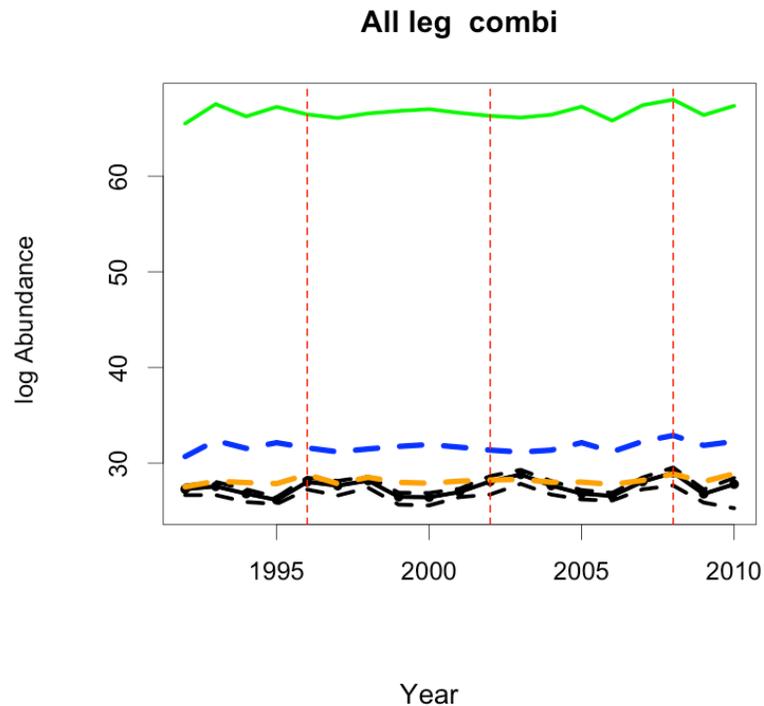


Year

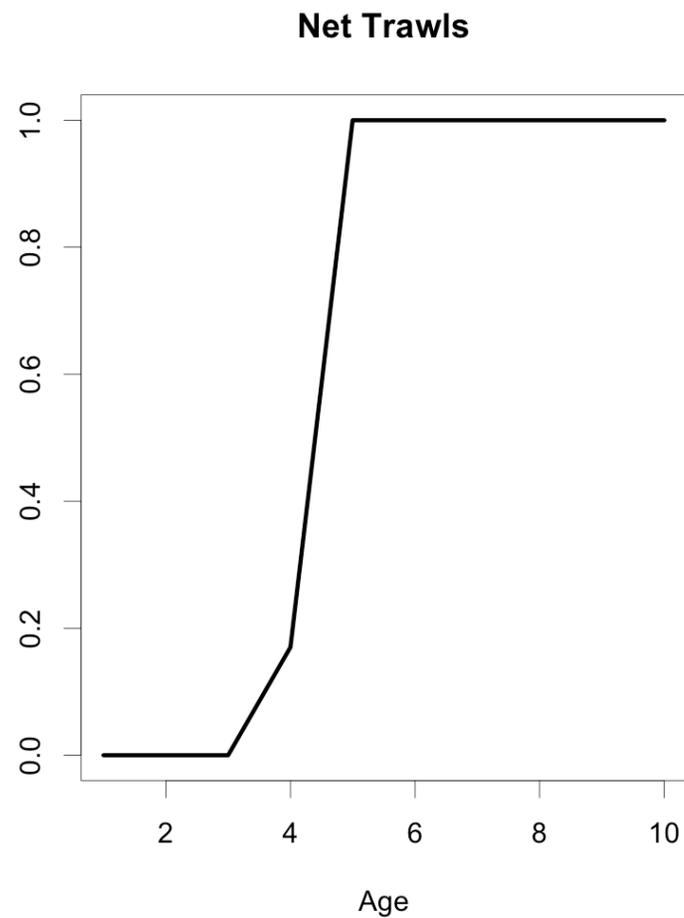
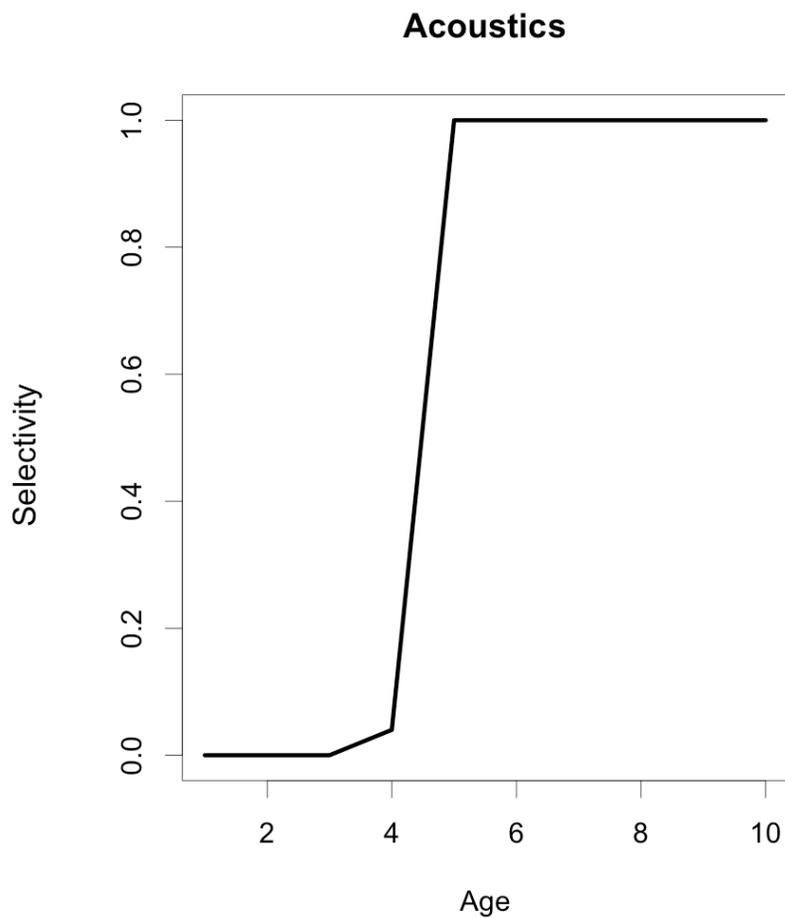
Configuration 5) net biomass with 1% CVs, acoustic biomass with empirical SEs: Abundances

Integrated population numbers **green** ($1.7e+28$)
Integrated numbers vulnerable to acoustics **blue**
Integrated numbers vulnerable to nets **orange**
TrawlCI numbers **black**

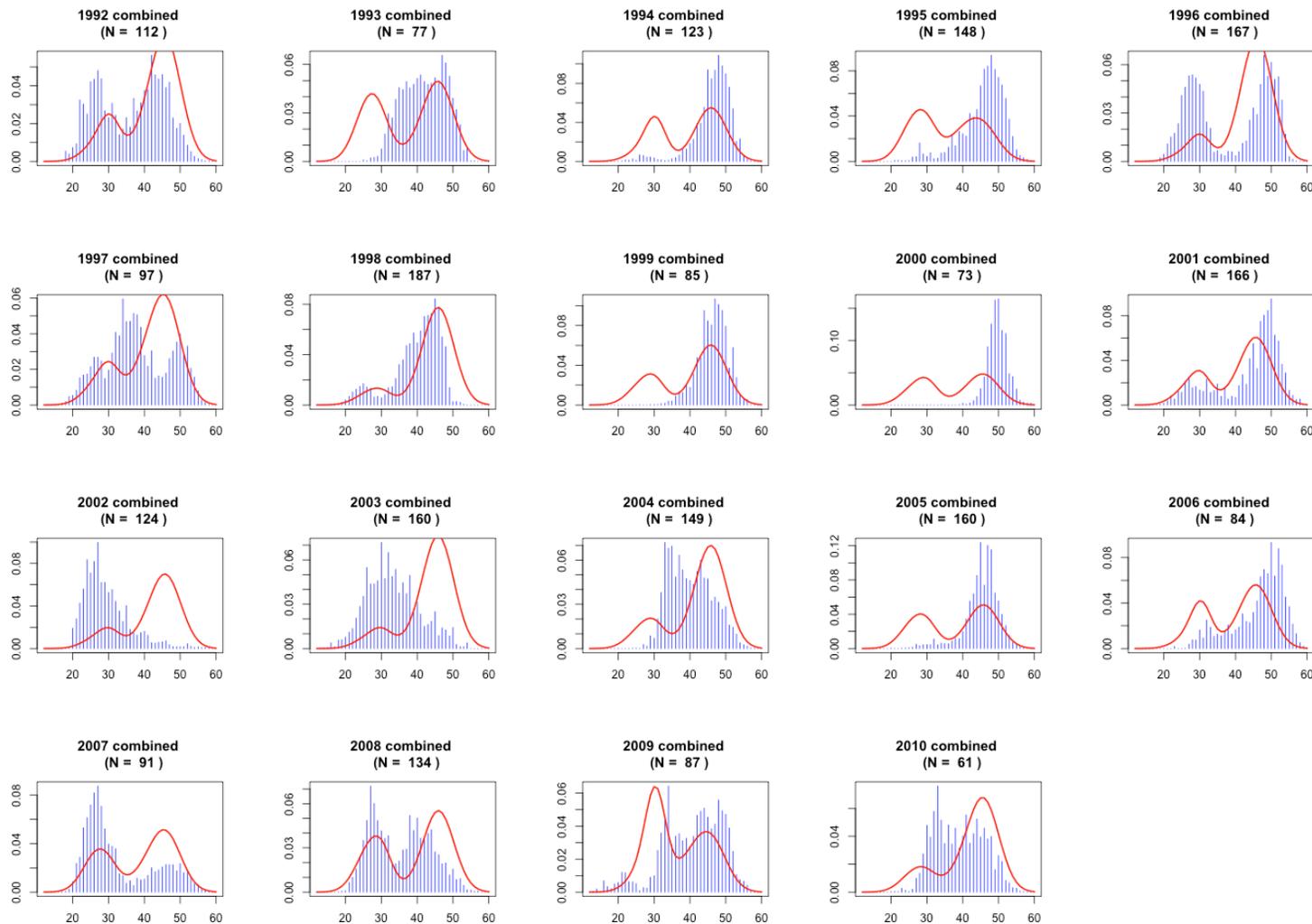
ac_and_net_biom/ac_emp_net_1/33/



Configuration 5) net biomass with 1% CVs, acoustic biomass with empirical SEs: Selectivities



Configuration 5) net biomass with 1% CVs, acoustic biomass with empirical SEs: Composition fits



Summary

- Krill annual biomass calculated based on net tows was usually less than the biomass produced by acoustics, and was uncorrelated with the acoustic values over a 19 year period.
- The assessment model able to fit both data series by using differences in age selectivity.
- Krill spawning biomass in the integrated model using only the acoustic biomass data was about twice the spawning biomass based on only the net trawls for most years.
- Heavier weightings on biomass from acoustics produced larger estimates of spawning biomass than when the biomass from net trawls were weighted more heavily.