METHODS OF ACCOUNTING FOR BYCATCH IMPACTS

Steven R. Hare, Juan L. Valero, Ray A. Webster, Gregg H. Williams, Bruce M. Leaman, IPHC O. Staff

This presentation is intended to be complemented by a verbal interpretation. As such, it is offered here solely for informational purposes, and to allow some familiarity with the material prior to its formal presentation.

Historical Treatment of bycatch - 1

- 1981 – Bycatch "compensation" begins
  - Refers to how the halibut stock is "compensated" for loss of halibut
- Initial emphasis was on Yield Loss
  - A calculation of how much yield was lost to the commercial fishery per pound of bycatch (all sizes)
  - Initial YL factor was 1.40, then 1.58 in late 1980's
  - Total CEY reduced by 1.40 (1.58) pounds per pound of bycatch
  - Reduction made in proportion to coastwide EBio distribution
    - Reasoning was that most bycatch was EBS juveniles that would eventually recruit to summer grounds in similar proportions as EBio.

Historical Treatment of bycatch - 2

- 1990 – Emphasis changed from Yield Loss to Lost Egg Production
  - Harvest strategy based on maintaining an optimum spawning biomass (and, thus, egg production)
  - Compensation (Adult Reproductive Compensation) was computed as amount commercial catch needed to be reduced to replace lost egg production
  - Value of 1.0 pounds commercial/pound bycatch established
  - Compensation distributed in proportion to coastwide EBio.

Halibut size definitions

- In commercial fishery, “legal” size limit is 32 in. (81.3 cm).
- For bycatch and wastage, it has been common practice to refer to “legal-sized” (32 in+) and sublegal-sized (32 in-)
- Those size definitions don’t apply to sport and subsistence catches
- From this point forward, we will use the terms:
  - U32 for halibut **under** 32 inches
  - O32 for halibut **over** 32 inches (includes exactly 32 in)

Historical Treatment of bycatch - 3

- 1995 – Downstream Compensation Model developed, but not implemented
  - O32 bycatch treated same as O32 commercial, ALL sport, and ALL subsistence removals – subtracted from CEY in area of capture
  - U32 bycatch impacts "downstream" calculated in terms of lost egg production
  - Regulatory area reductions (compensation) dependent on migration model used to compute downstream losses
  - Controversial, initially recommended then withdrawn

Historical Treatment of bycatch - 4

- 1996 – O32 and U32 components of bycatch treated differently
  - O32 bycatch treated same as O32 commercial, O32 wastage, ALL sport, and ALL subsistence removals – subtracted from CEY in area of capture
  - U32 bycatch and wastage – factored into optimum harvest rate calculation
    - Directly considers impact on spawning biomass rather than simply replacing lost egg production
  - Has the effect of lowering coastwide harvest rate thus primarily impacting fishery CEY
- ALL removals now accounted for in management (assessment and harvest policy)

New and improved Yield Loss calculations

Between 1981 and 1990, bycatch compensation was done on a Yield Loss basis. This section updates those calculations and restricts them to U32 bycatch (and wastage)

Estimating Yield Loss - 1

- Yield Loss: Cumulative amount of yield lost to the fishery due to U32 bycatch or wastage (assuming a commercial size limit and 20% harvest rate)

- Generally listed as ratio of Yield Loss to weight of bycatch:

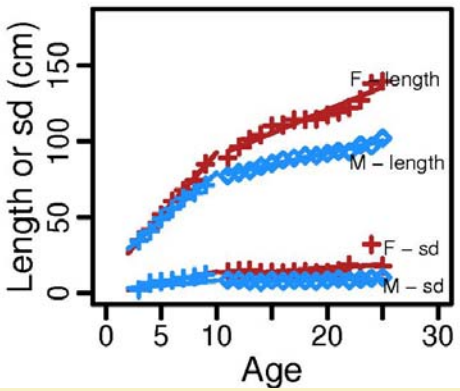
$$YL_{ratio} = \frac{\text{Wt. of Yield Loss}}{\text{Wt. of Bycatch}}$$

- Requires an estimate of age and sex composition of bycatch

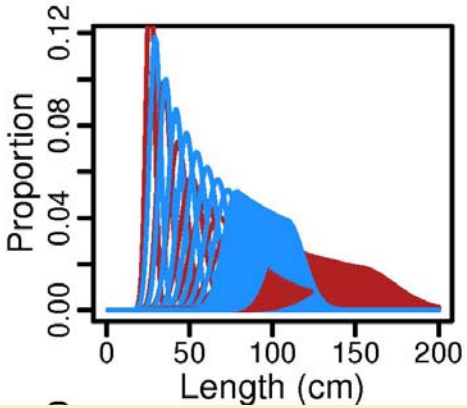
Estimating Yield Loss - 2

- Growth (size-at-age) models – Area 4CDE example

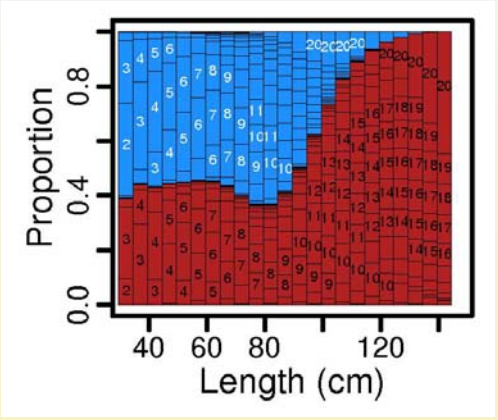
Length and st. dev. at age



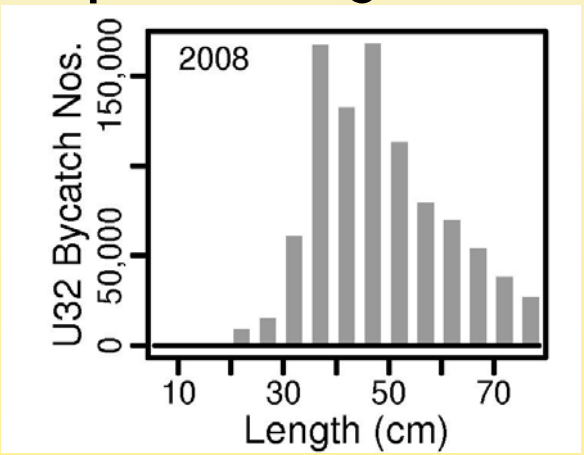
Distribution of sizes at age

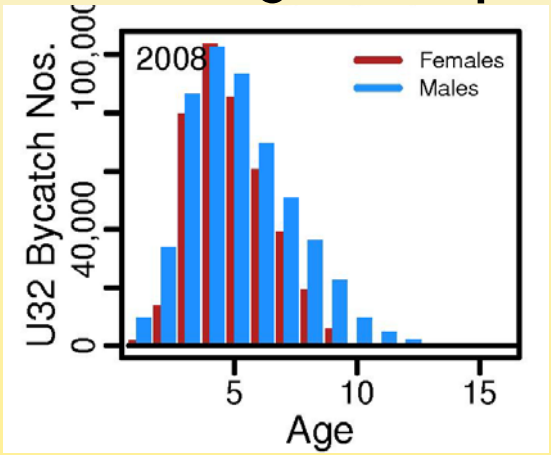


Sex and age proportions at length

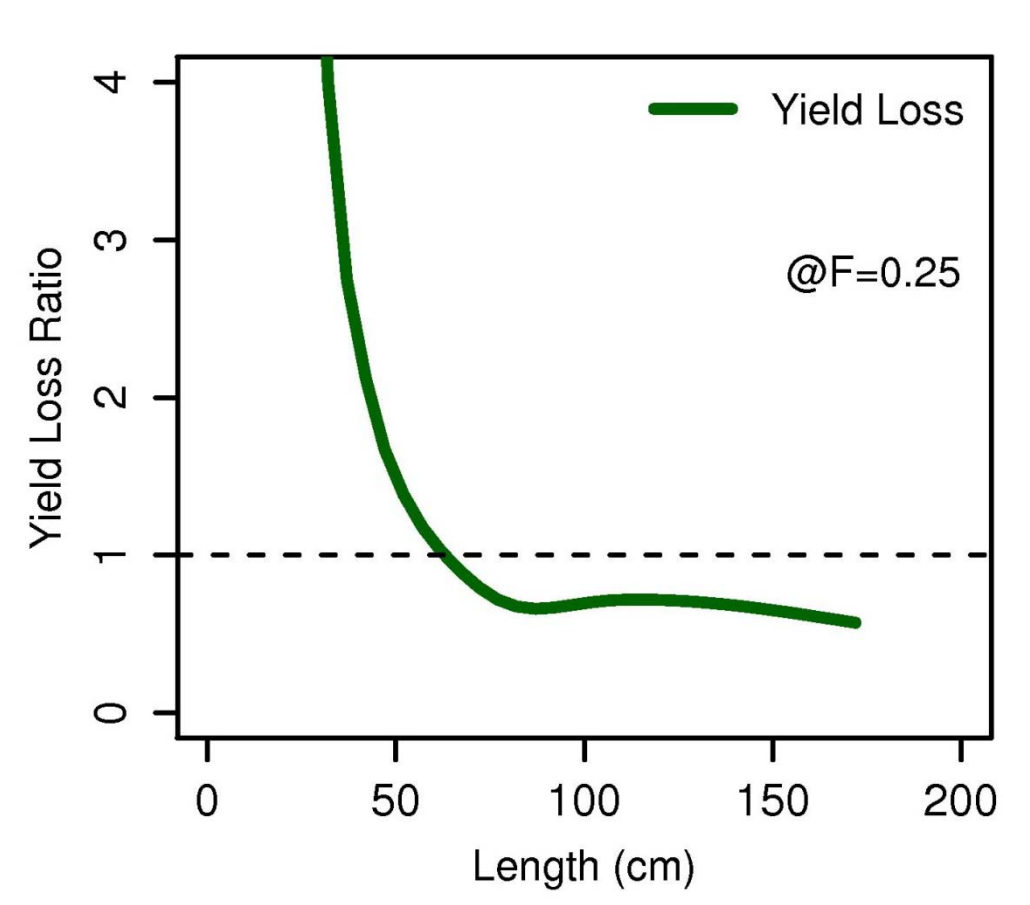


- Decompose length data to sex and age composition



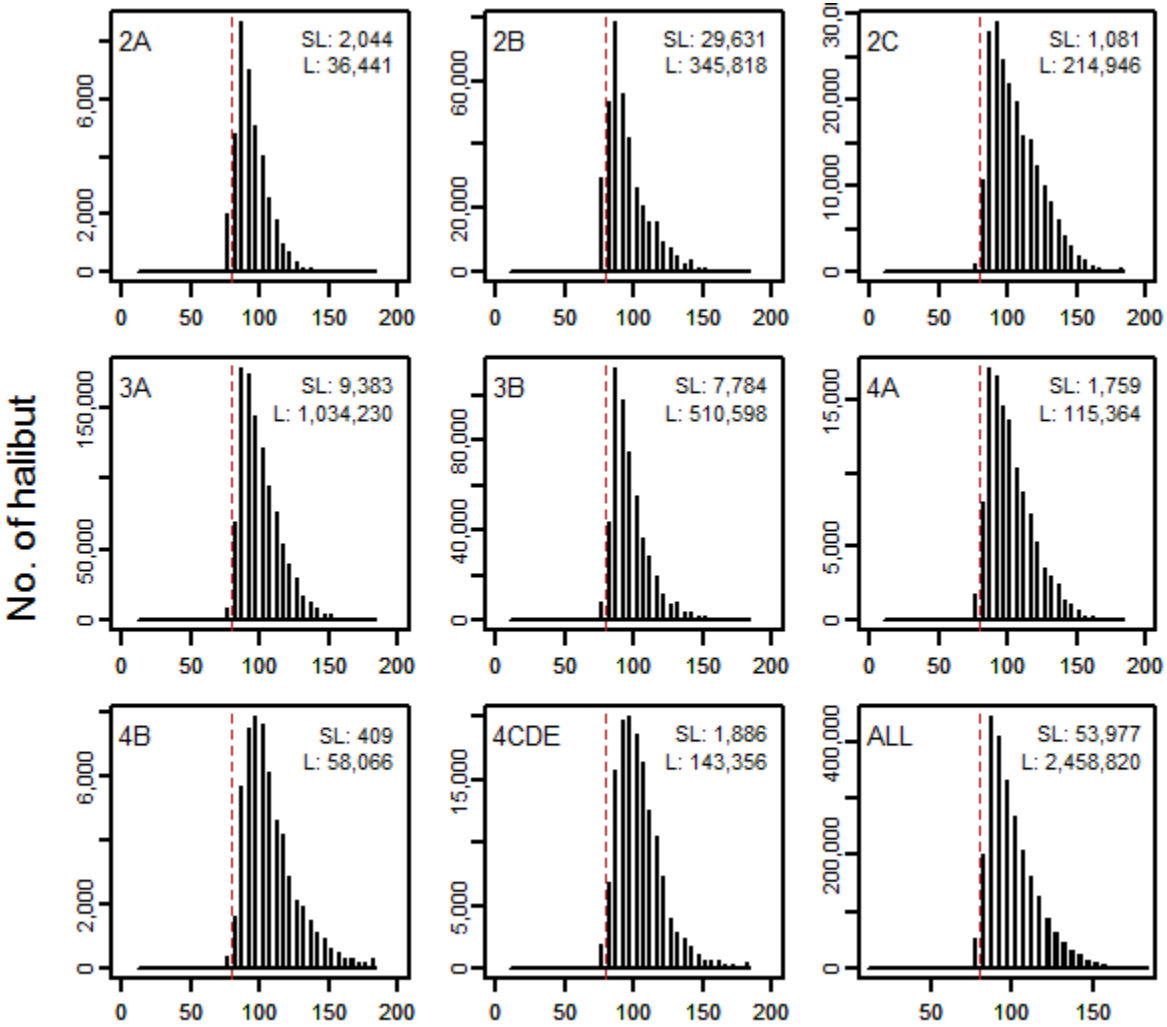


Yield Loss varies with size of catch

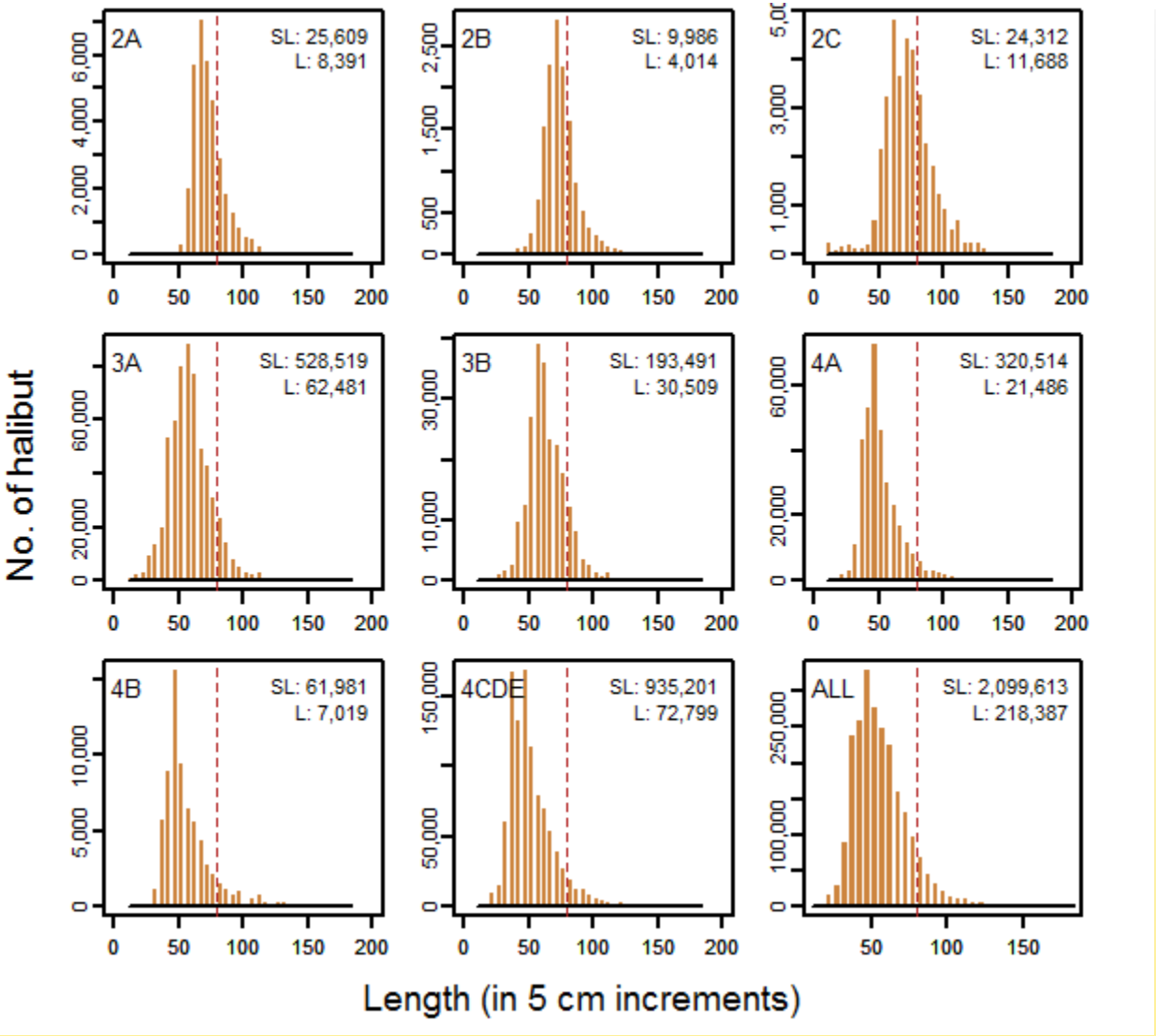


Yield Loss ratio is how much commercial catch is lost (in the future) due to each pound of bycatch.

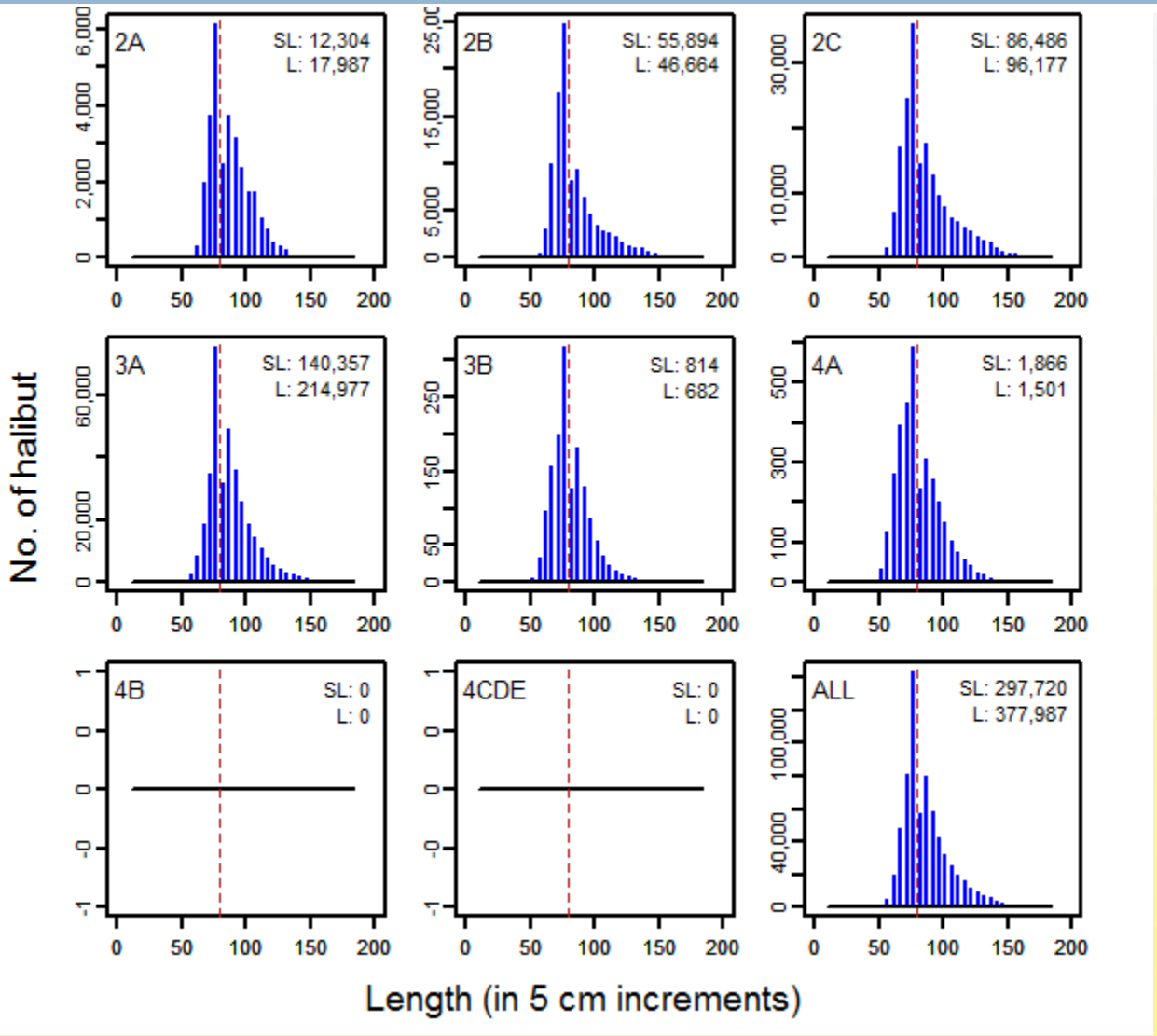
Commercial catch LF Distributions



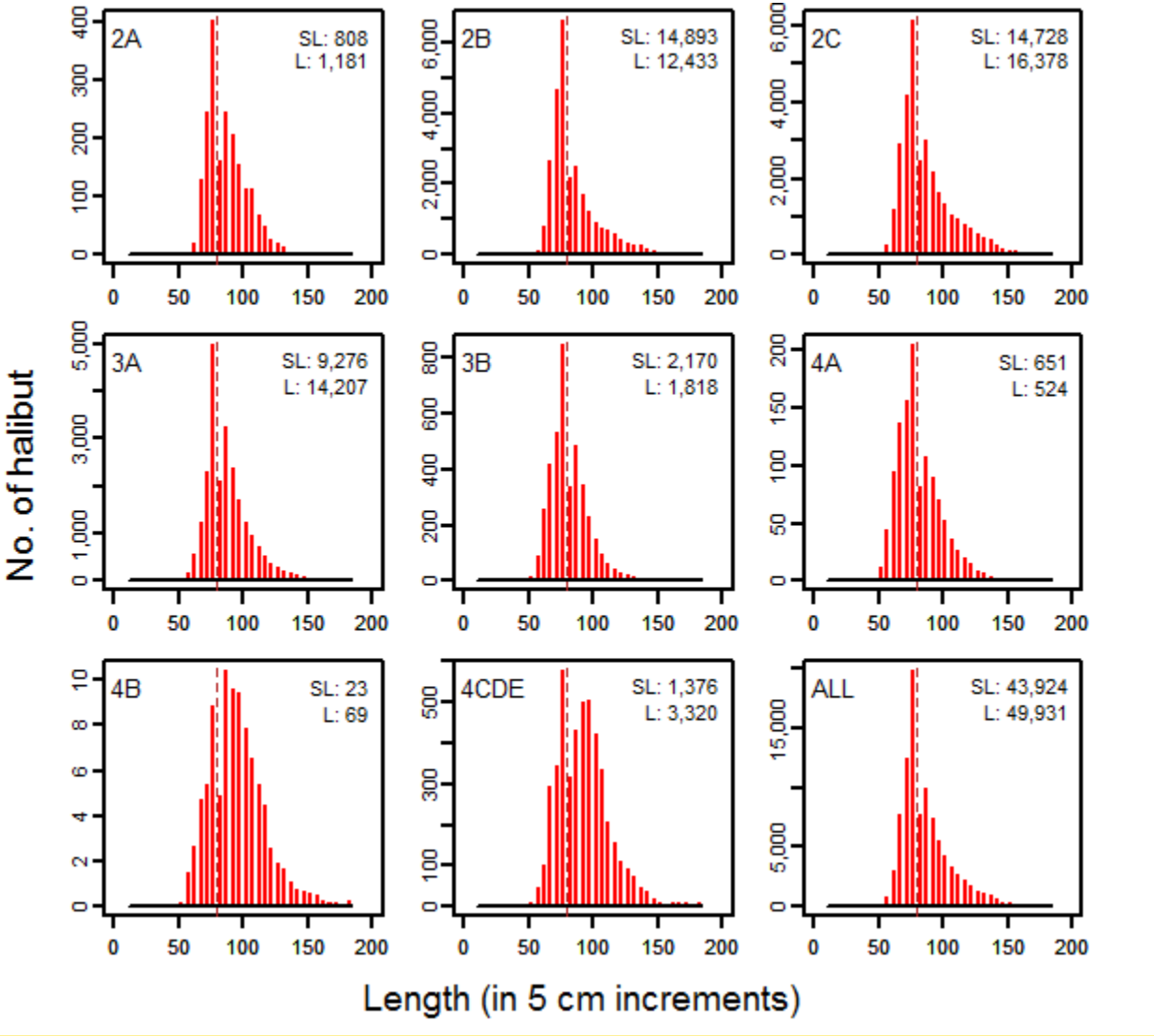
Bycatch LF Distributions



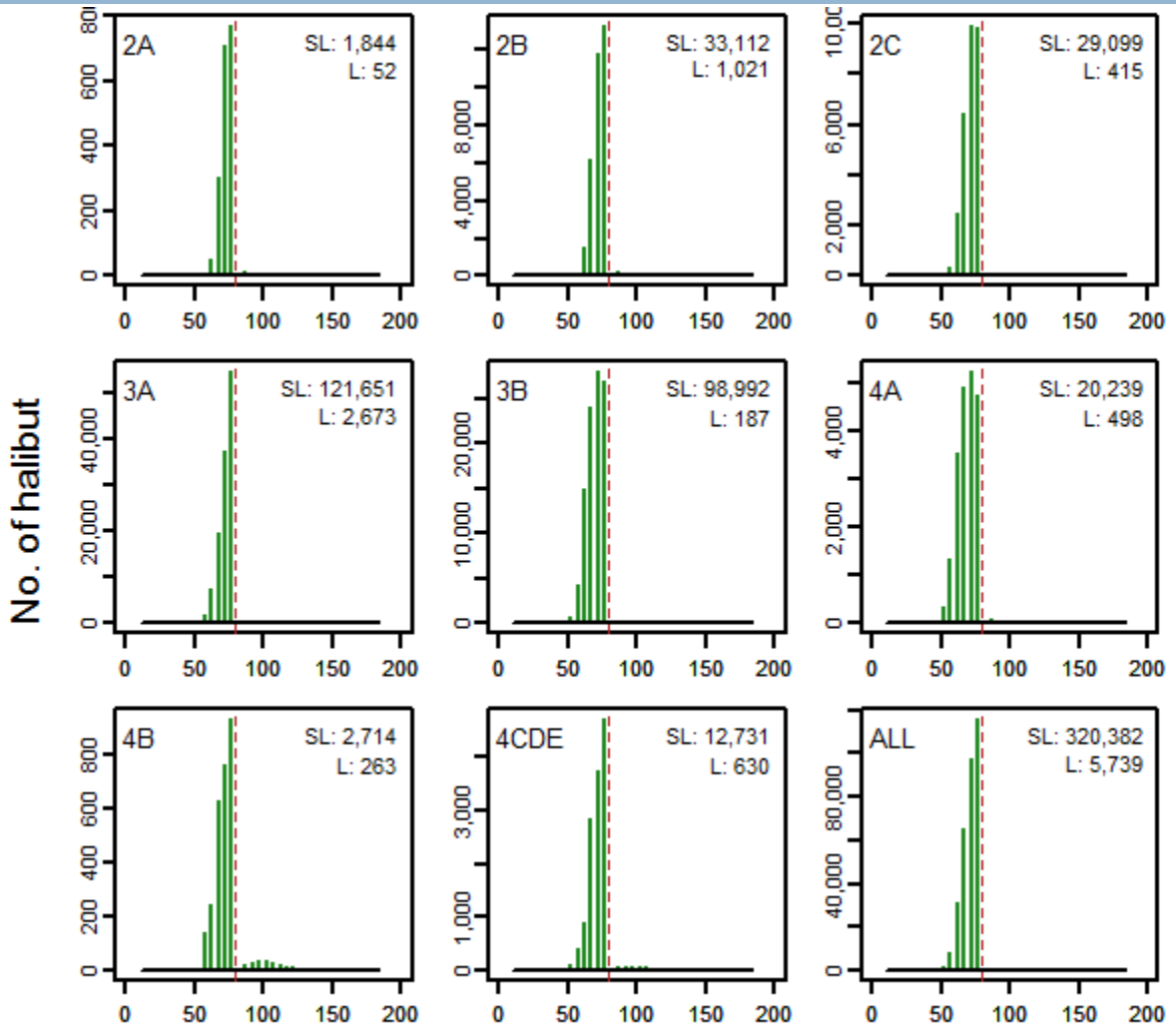
Sport catch LF Distributions



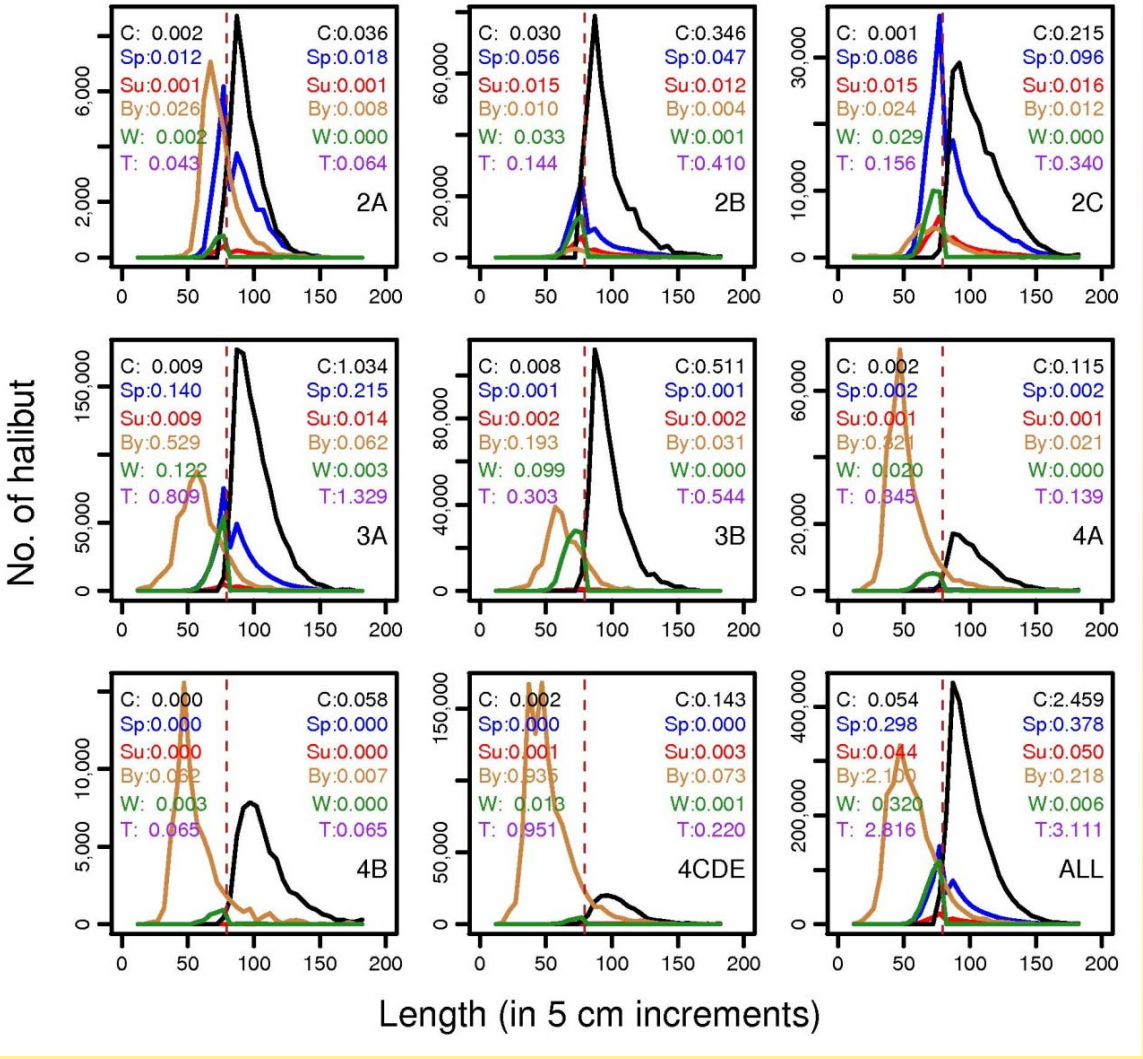
Subsistence catch LF Distributions



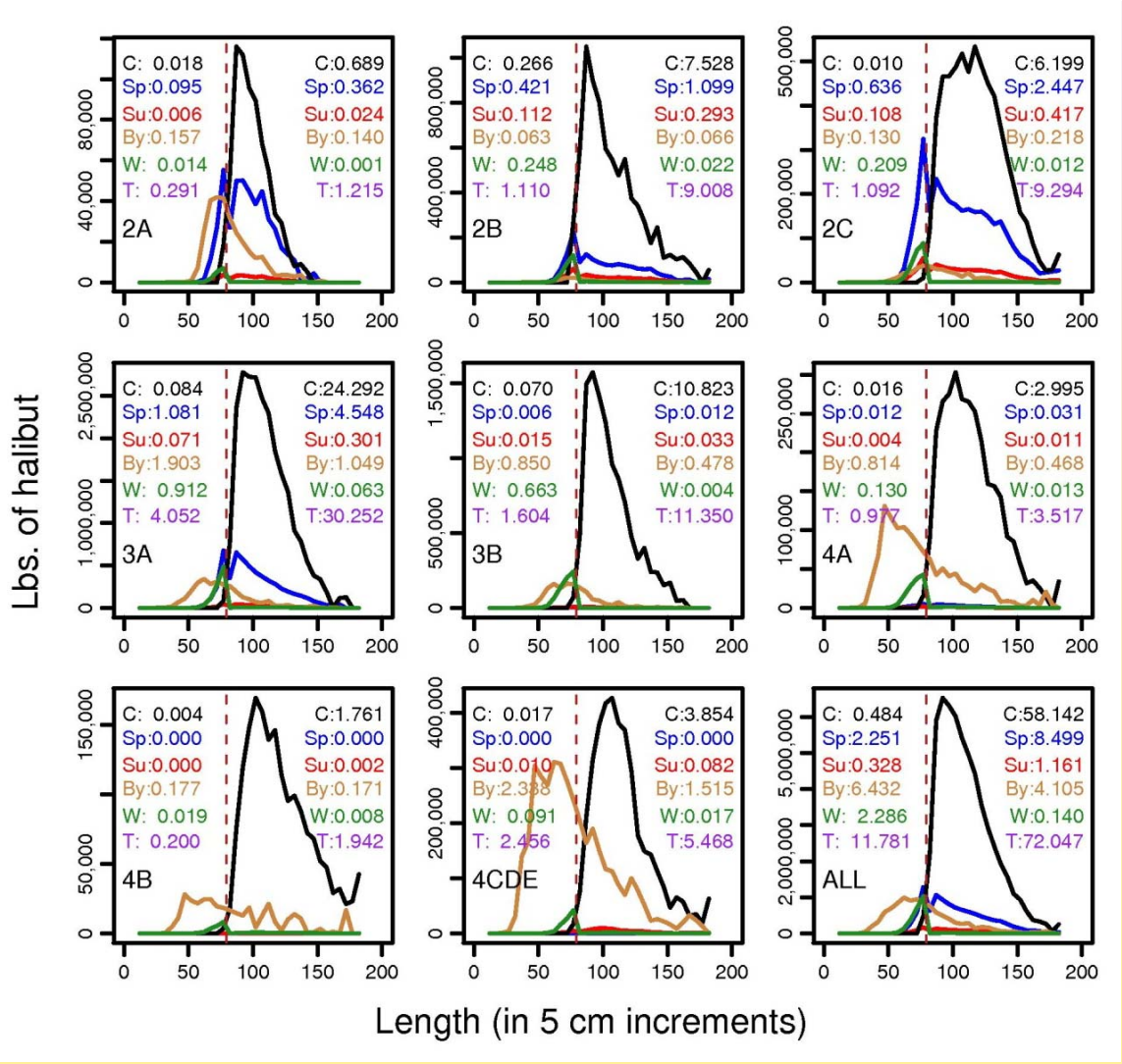
Commercial wastage LF Distributions



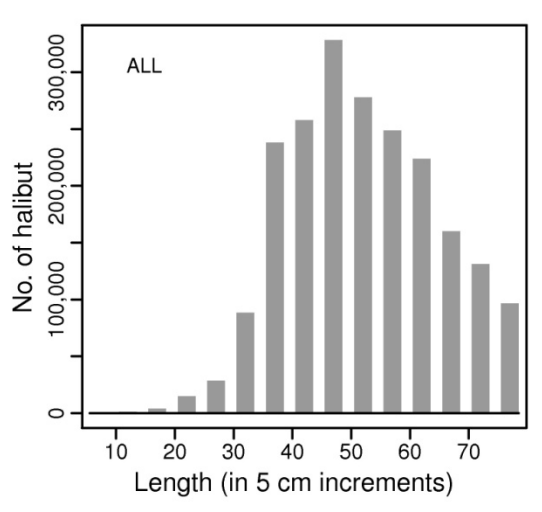
2008 Total Removals (by number)

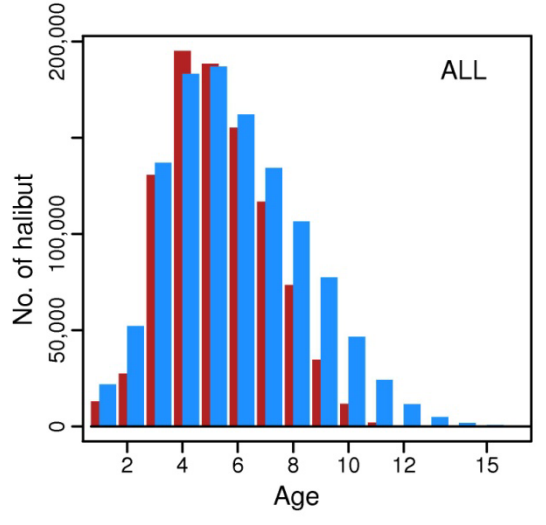


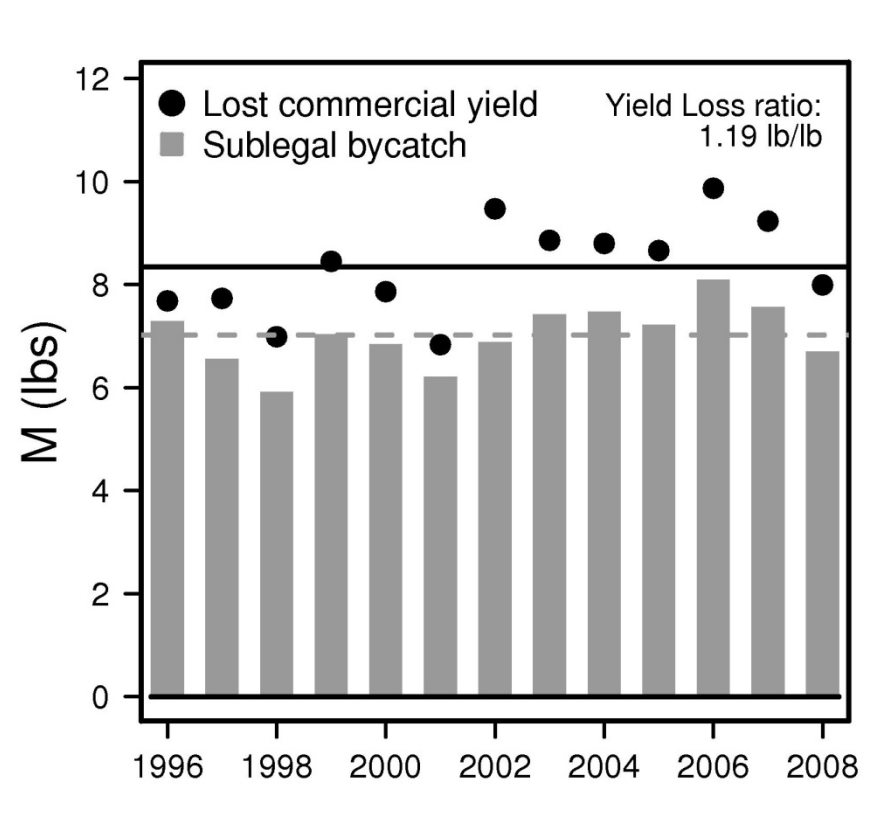
2008 Total Removals (by weight)



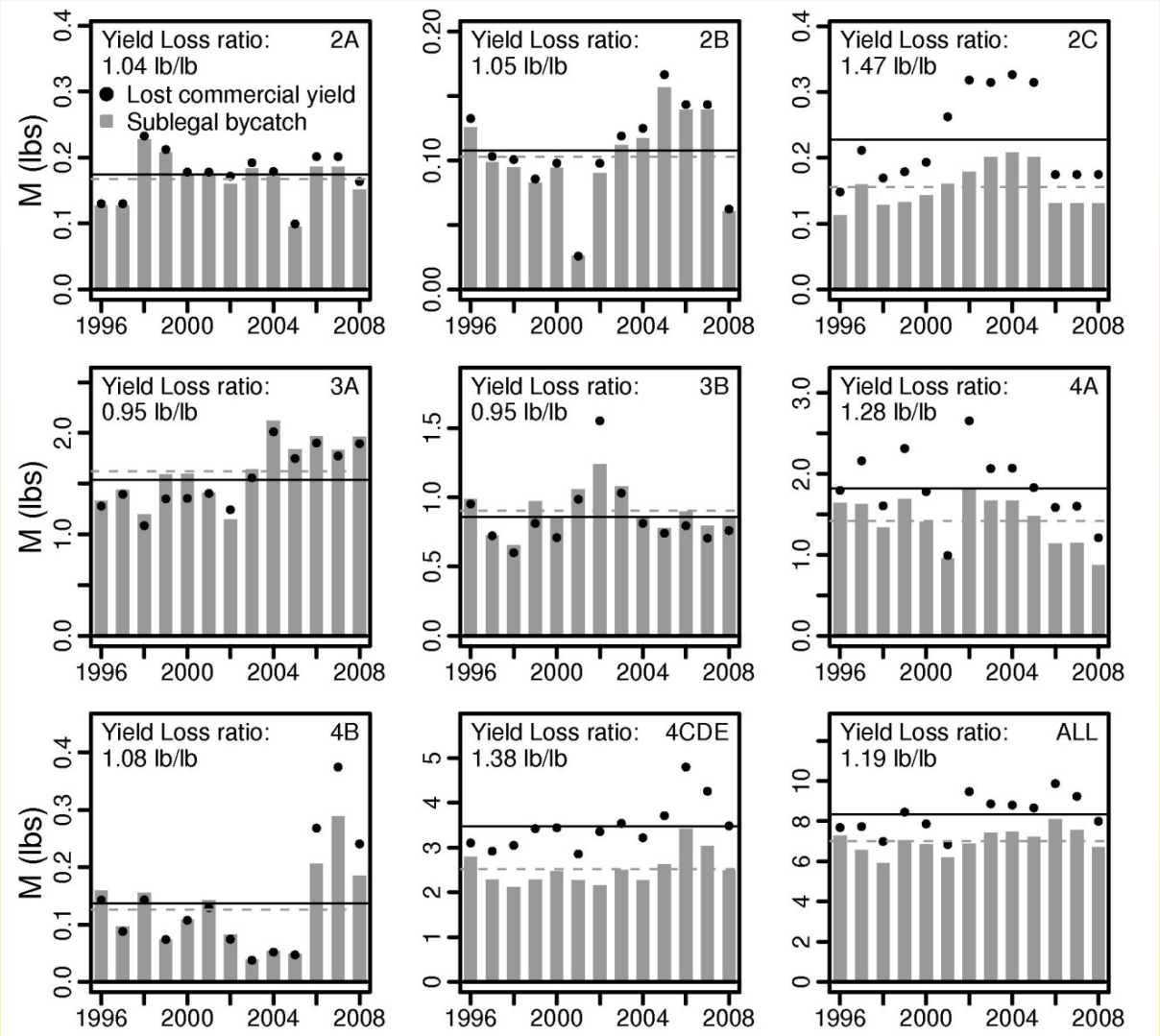
2008 coastwide size and age distributions and yield loss ratios







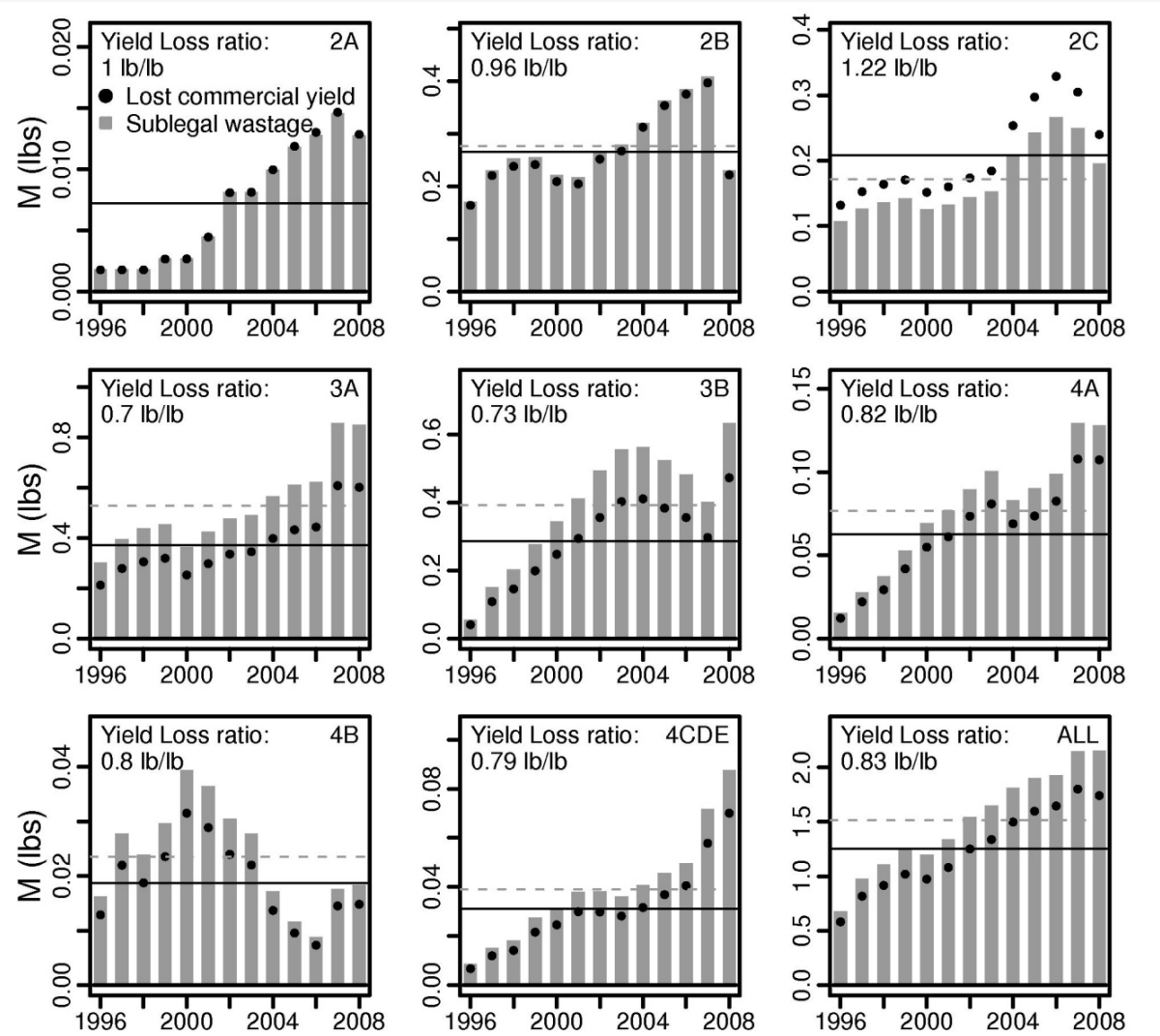
Estimates of lost yield from U32 bycatch



Yield Loss ratio is how much commercial catch is lost (in the future) due to each pound of bycatch.

- Bars show weight of U32 bycatch in that area
- Dots show Yield Loss due to that wt of U32 bycatch

Estimates of lost yield from U32 wastage



Yield Loss ratio is how much commercial catch is lost (in the future) due to each pound of bycatch.

- Bars show weight of U32 wastage in that area
- Dots show Yield Loss due to that wt of U32 wastage

New and improved Egg Loss and Egg Replacement ratio calculations

Between 1991 and 1995, bycatch compensation was done on a Egg Replacement (then termed Reproductive Compensation) basis. This section updates those calculations and restricts them to U32 bycatch (and wastage)

Estimating lost egg production

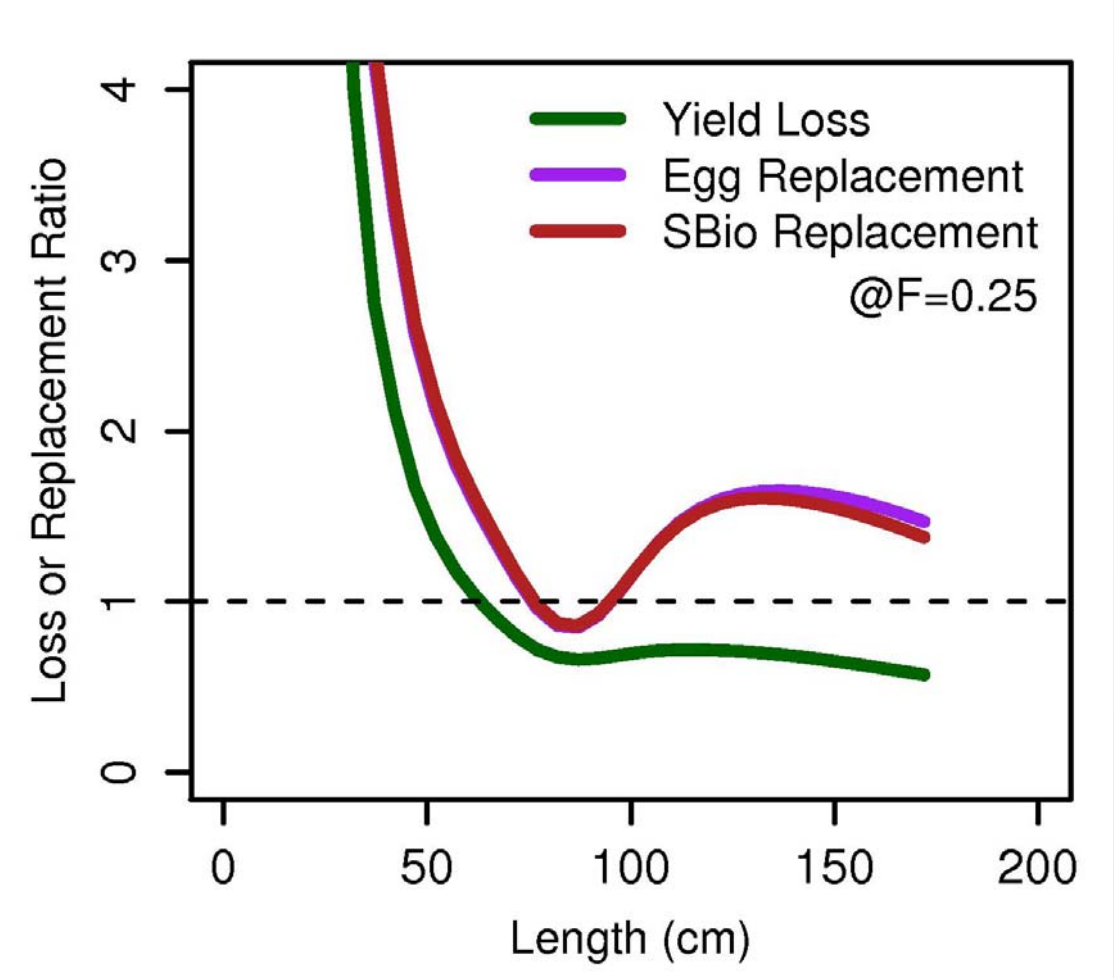
- Loss Egg Production: Cumulative amount of egg production lost to the population due to U32 bycatch or wastage (assuming a commercial size limit and 20% harvest rate)

- Egg Replacement (ER) ratio for lost egg production is ratio of egg production per lb of bycatch to a lb of commercial catch. In other words, how much commercial catch (per pound of U32 bycatch) must be foregone to replace lost egg production

$$ER_{ratio} = \frac{\text{Egg production/lb of bycatch}}{\text{Egg production/lb of setline catch}}$$

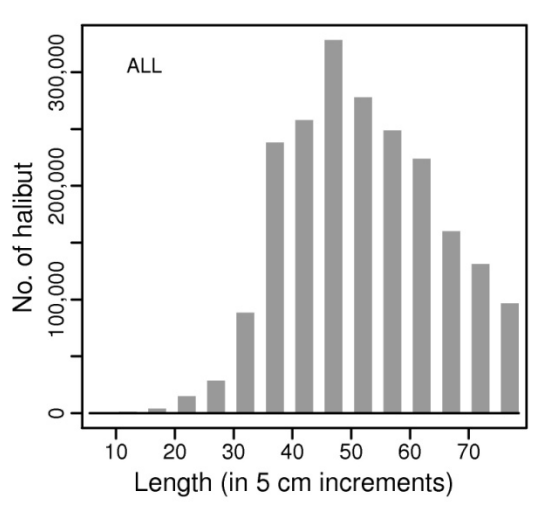
- Requires an estimate of age and sex composition of bycatch (same model as for yield loss calculations)

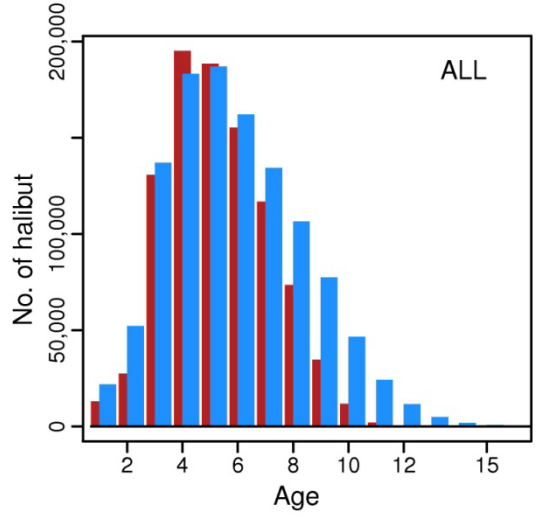
Egg replacement ratio varies with size of catch

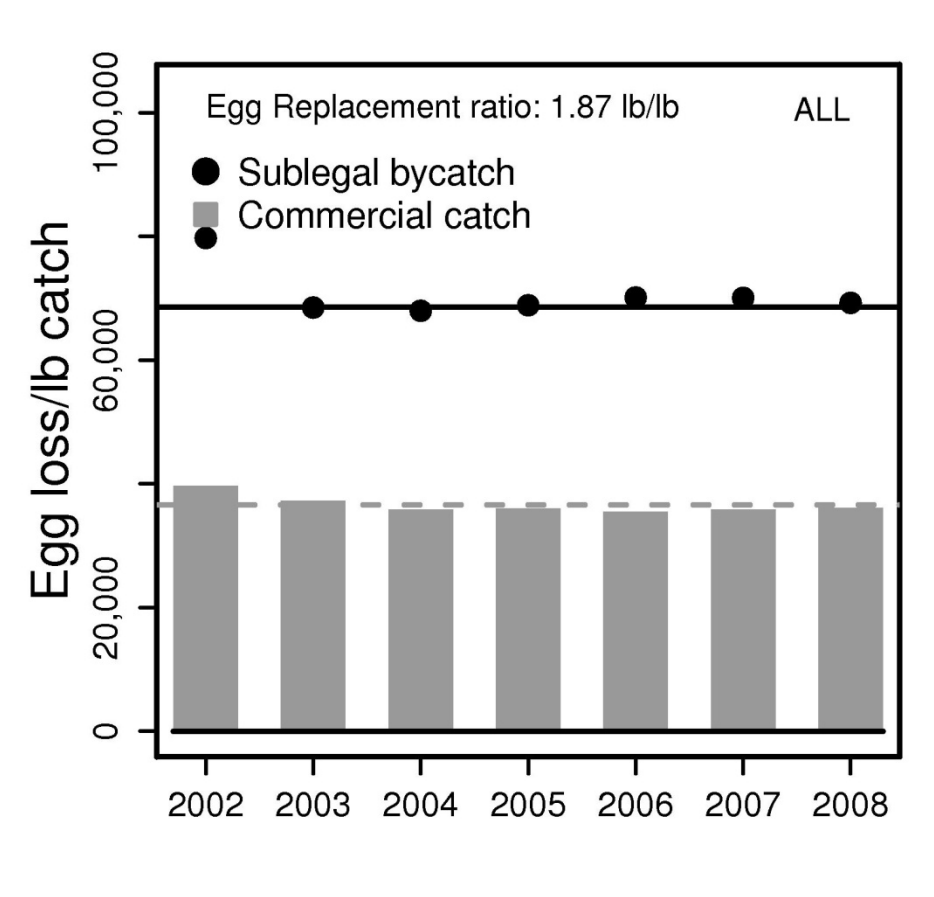


Replacement ratio is how much commercial catch – per pound of bycatch - must be foregone to replace lost egg production (or Spawning Biomass)

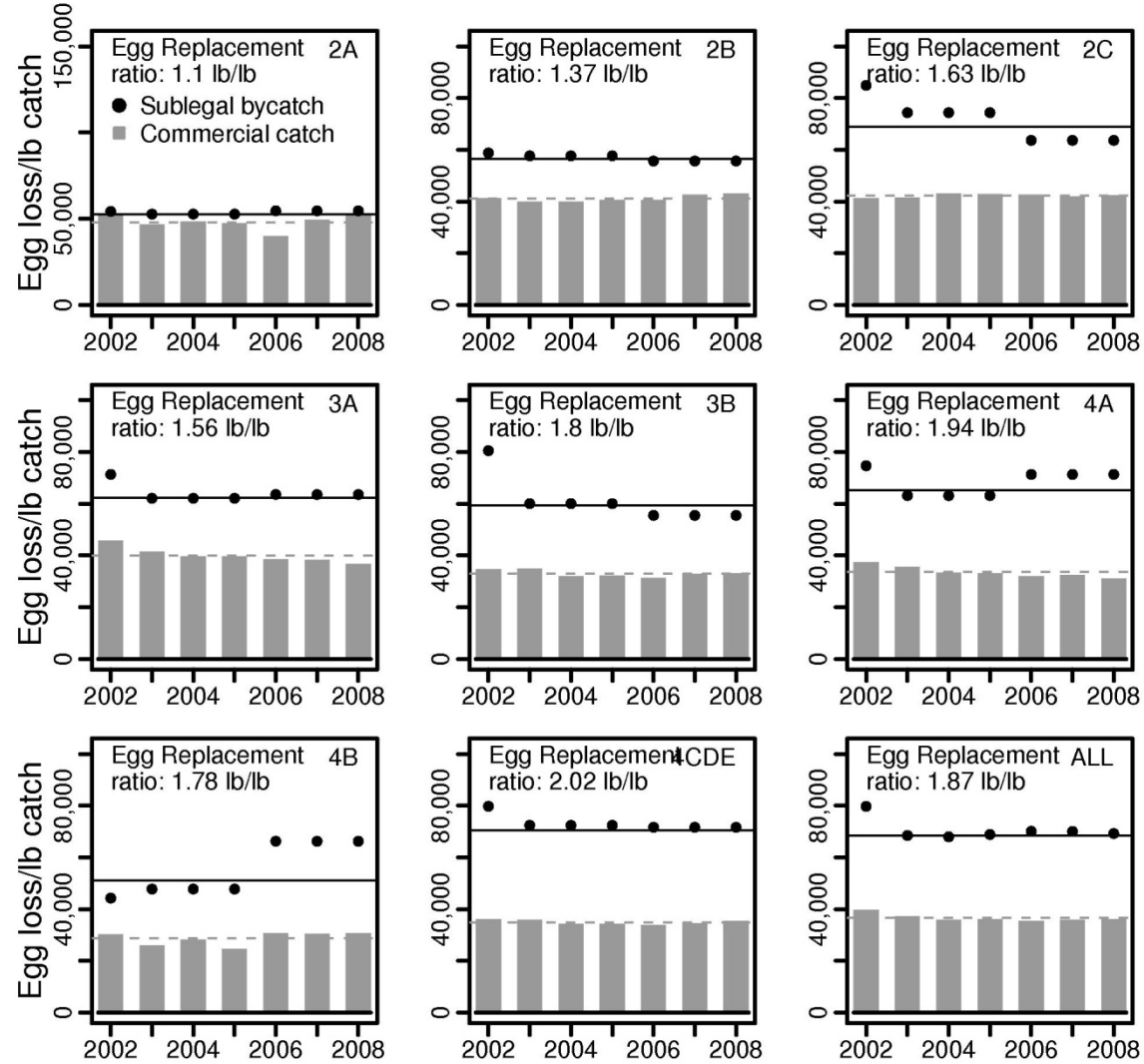
2008 coastwide size and age distributions and Egg replacement ratios







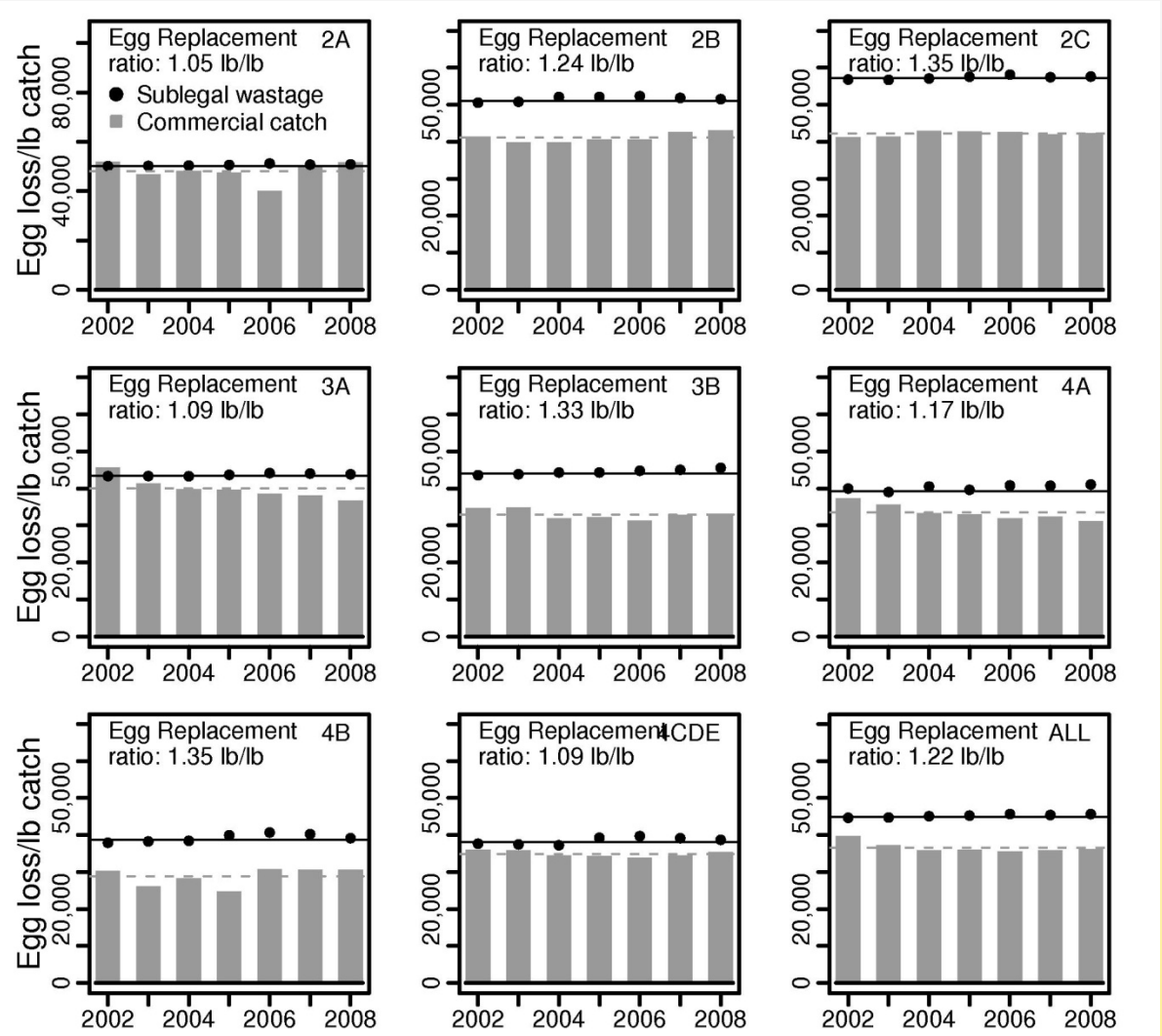
Estimates of lost egg production and ER ratios due to U32 bycatch



Replacement ratio is how much commercial catch – per pound of bycatch - must be foregone to replace lost egg production (or Spawning Biomass)

- Bars show egg production per lb of commercial catch
- Dots show egg production per lb of U32 bycatch

Estimates of lost egg production and ER ratios due to U32 wastage



Replacement ratio is how much commercial catch – per pound of wastage - must be foregone to replace lost egg production (or Spawning Biomass)

- Bars show egg production per lb of commercial catch
- Dots show egg production per lb of U32 wastage

Effect of migration on up/downstream distribution of yield loss and lost spawning biomass

… over to Juan

Additional Background and Policy Issues

… break to Bruce here

Options for treatment of bycatch and U32 fish

… Bruce and Steven

To regularize or not?

- ALL halibut catches must be accounted for in harvest policy (i.e., nothing is free).
  - Direct accounting by deduction from CEY
  - Factored into calculation of target harvest rate
- Size matters. Impacts on stock are greater when bycatch (or other catch) is smaller in composition
  - Large number of halibut in bycatch
  - Growth rate still exceeds mortality rate

- Deducted from CEY
  - ALL Commercial
  - ALL sport
  - ALL subsistence
  - O32 bycatch
  - O32 commercial wastage
- Factored into target harvest rate
  - U32 bycatch
  - U32 wastage

Status quo

- Rationale: differential impacts due to size, particularly of bycatch
- Pros: Machinery in place, factored into current harvest strategy
- Cons: Rational (but inconsistent) treatment of different kinds of catches and sizes

- Deducted from CEY
  - ALL Commercial
  - ALL sport
  - ALL subsistence
  - O32 bycatch
  - O32 commercial wastage
- Factored into target harvest rate
  - U32 bycatch
  - U32 wastage

Eliminate size limit

- Rationale: A "self-consistent" solution. All catches treated the same
- Pros: Same as Rationale
- Cons:
  - Where to deduct U32 bycatch;
  - Area 4 directed fishery could be eliminated.
  - Would commercial (and sport) fisheries "highgrade" their catch?
  - Potential SBio concerns
  - Would require recalculation of allocation among user groups, e.g. 2A and 2B
- Deducted from CEY
  - ALL Commercial
  - ALL sport
  - ALL subsistence
  - ALL bycatch
  - ALL commercial wastage
- Factored into target harvest rate
  - Nothing

Drop size limit to 26 in. (65 cm)

- Rationale: A nearly "self-consistent" solution. Most catches treated the same
- Pros: Same as Rationale
- Cons:
  - Where to deduct U32 bycatch;
  - Area 4 directed fishery could be eliminated.
  - Would commercial (and sport) fisheries "highgrade" their catch?
  - Potential SBio concerns
  - Would require recalculation of allocation among user groups, e.g. 2A and 2B
- Deducted from CEY
  - ALL Commercial
  - ALL sport
  - ALL subsistence
  - O26 bycatch
  - ALL commercial wastage
- Factored into target harvest rate
  - U26 bycatch

Common size limit of 32 in. (81 cm)

- Rationale: Common definition of "legal-sized" halibut
- Pros: Sport and subsistence catches resemble commercial catch
- Cons:
  - Requires sampling programs for sport and subsistence fisheries
  - Enforcement concerns

- Deducted from CEY
  - ALL Commercial
  - O32 sport
  - O32 subsistence
  - O32 bycatch
  - O32 commercial wastage
- Factored into target harvest rate
  - U32 sport wastage
  - U32 subsistence wastage
  - U32 bycatch
  - U32 commercial wastage

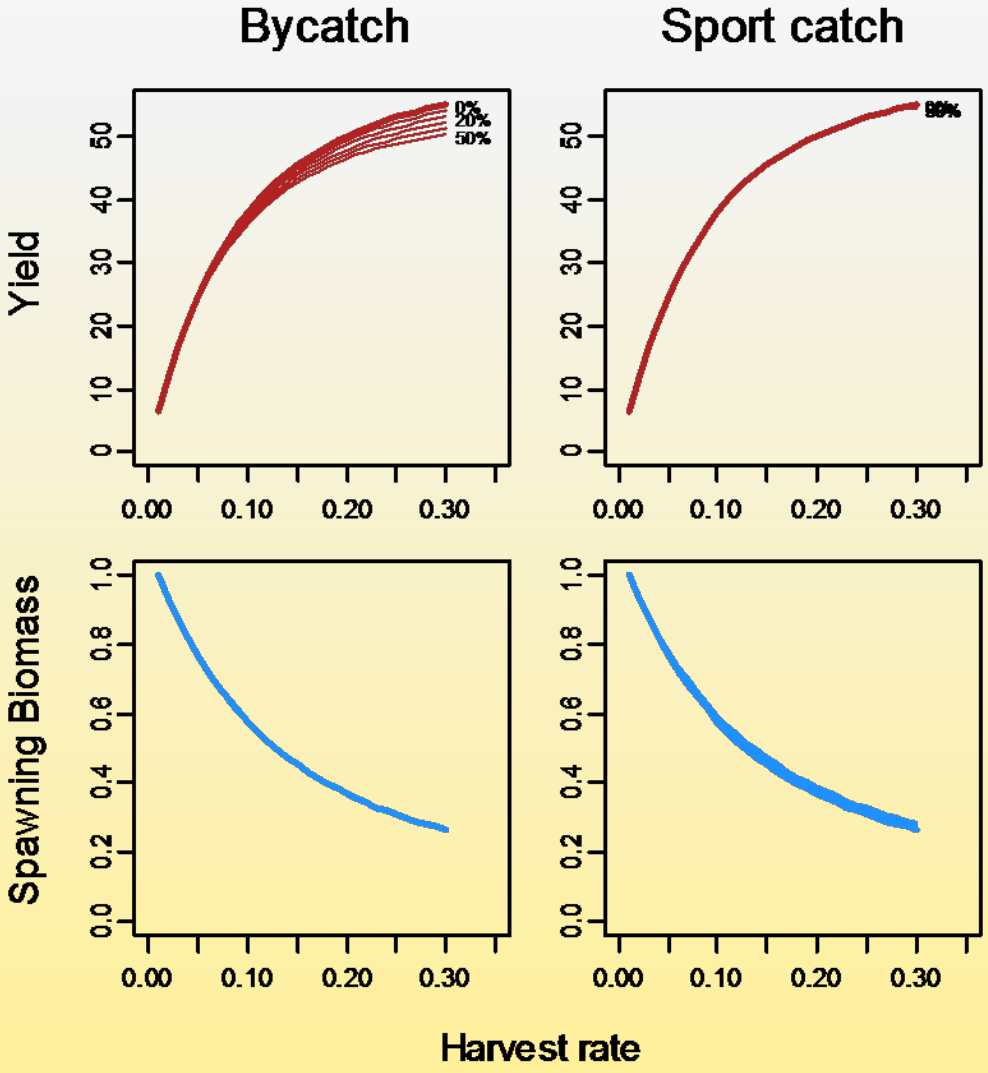
Treat sport catch same as bycatch

- Rationale: consistent treatment of O32 and U32 halibut
- Pros: same as rationale
- Cons:
  - No cap on sublegal sport catch – harvest rate determination difficulty
  - no programs in place to estimate size compositions and wastage
  - Impacts differ greatly between U32 bycatch and other U32 catches
  - Would require recalculation of allocation among user groups, e.g. 2A and 2B
- Deducted from CEY
  - ALL Commercial
  - O32 sport
  - O32 subsistence
  - O32 bycatch
  - O32 commercial wastage
- Factored into target harvest rate
  - U32 bycatch
  - U32 commercial wastage
  - U32 sport
  - U32 subsistence

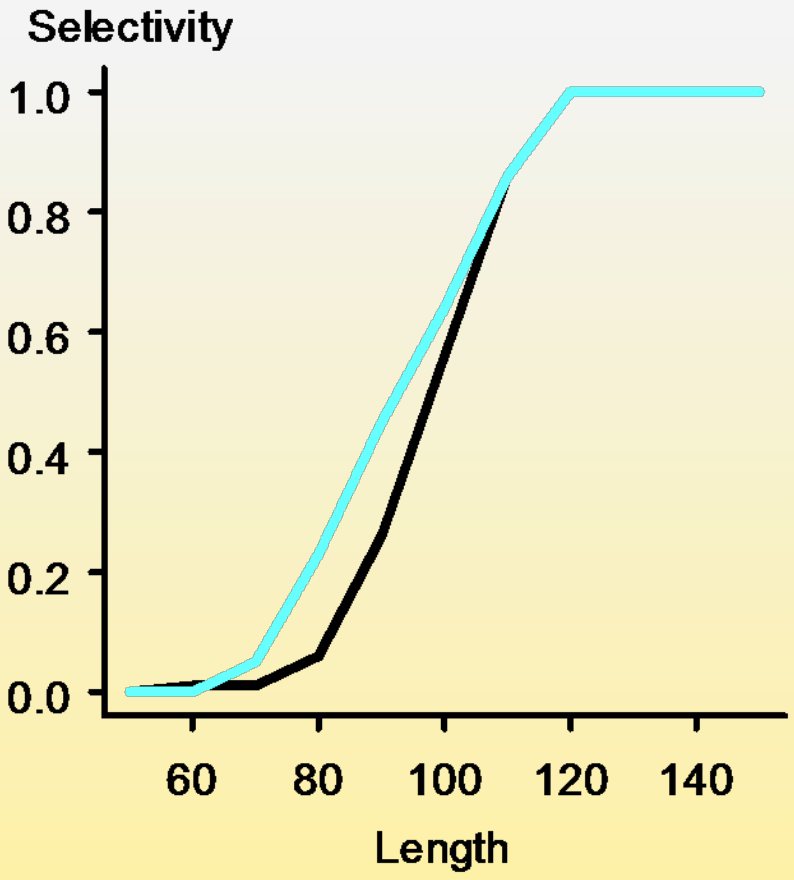
How yield and SBio are differentially affected by the size of the catch

Relative yield and spawning biomass vary with the size distribution of the catch

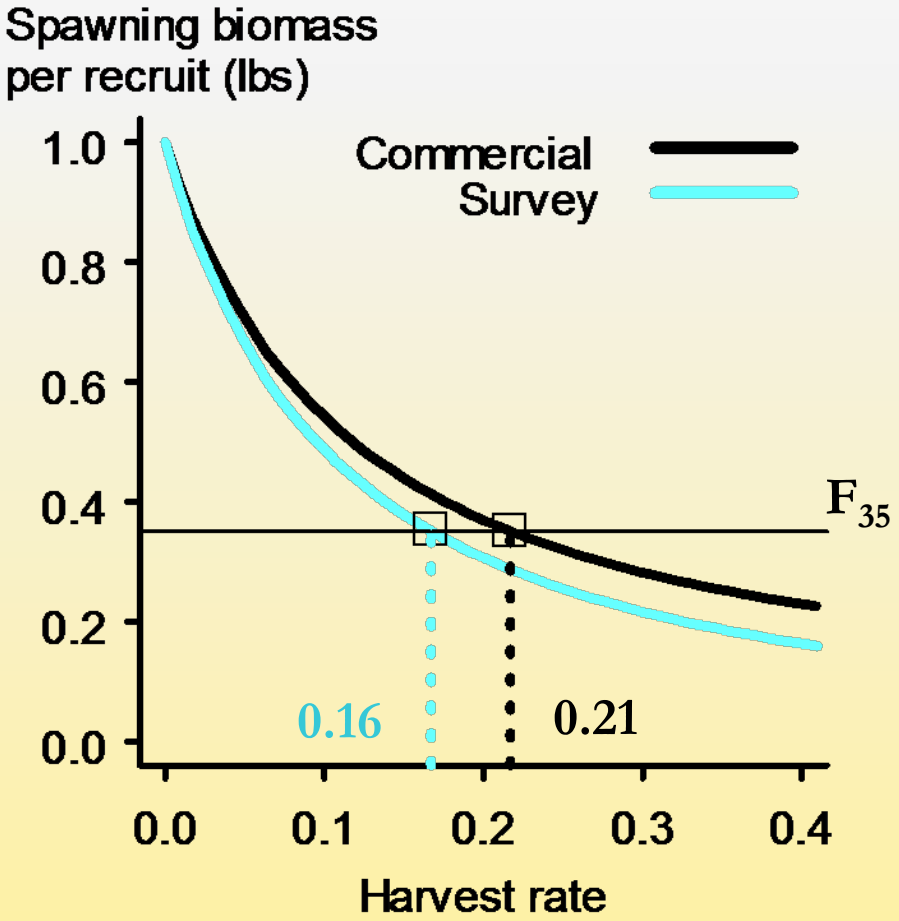
Relative impacts on yield and SBio



What if there was no minimum size limit?



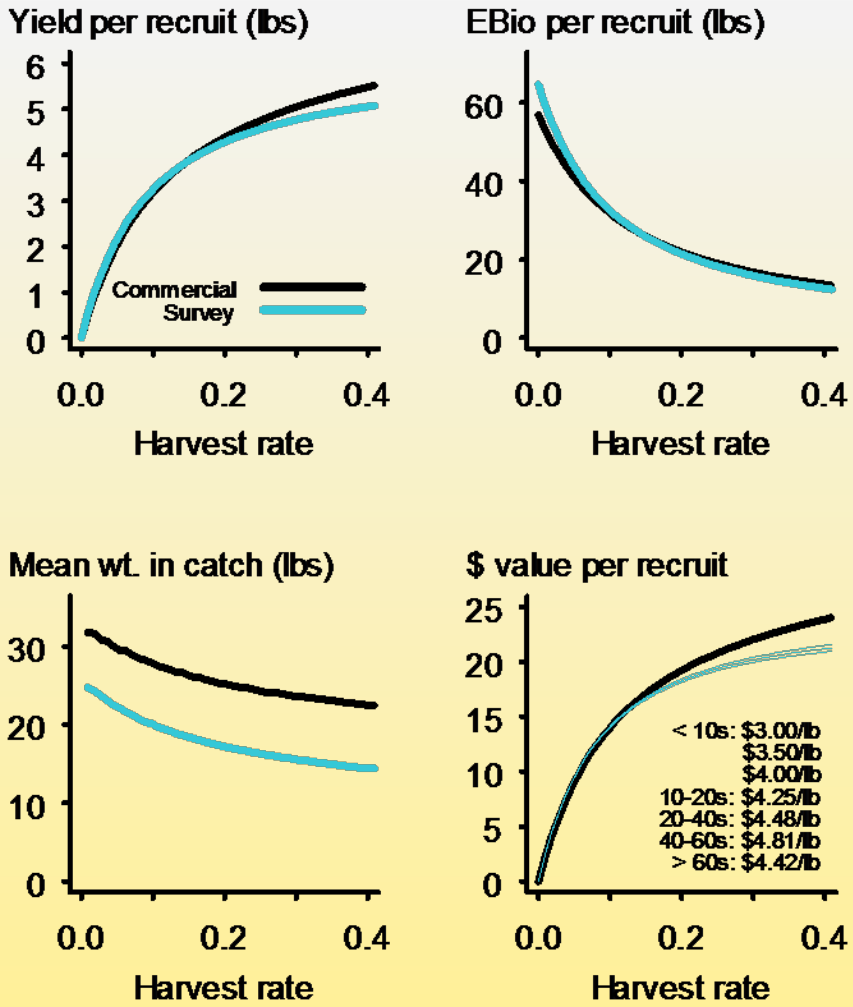
Selectivity defines EBio



SBR determines long-term HR

What if there was no minimum size limit?

Long-term effects

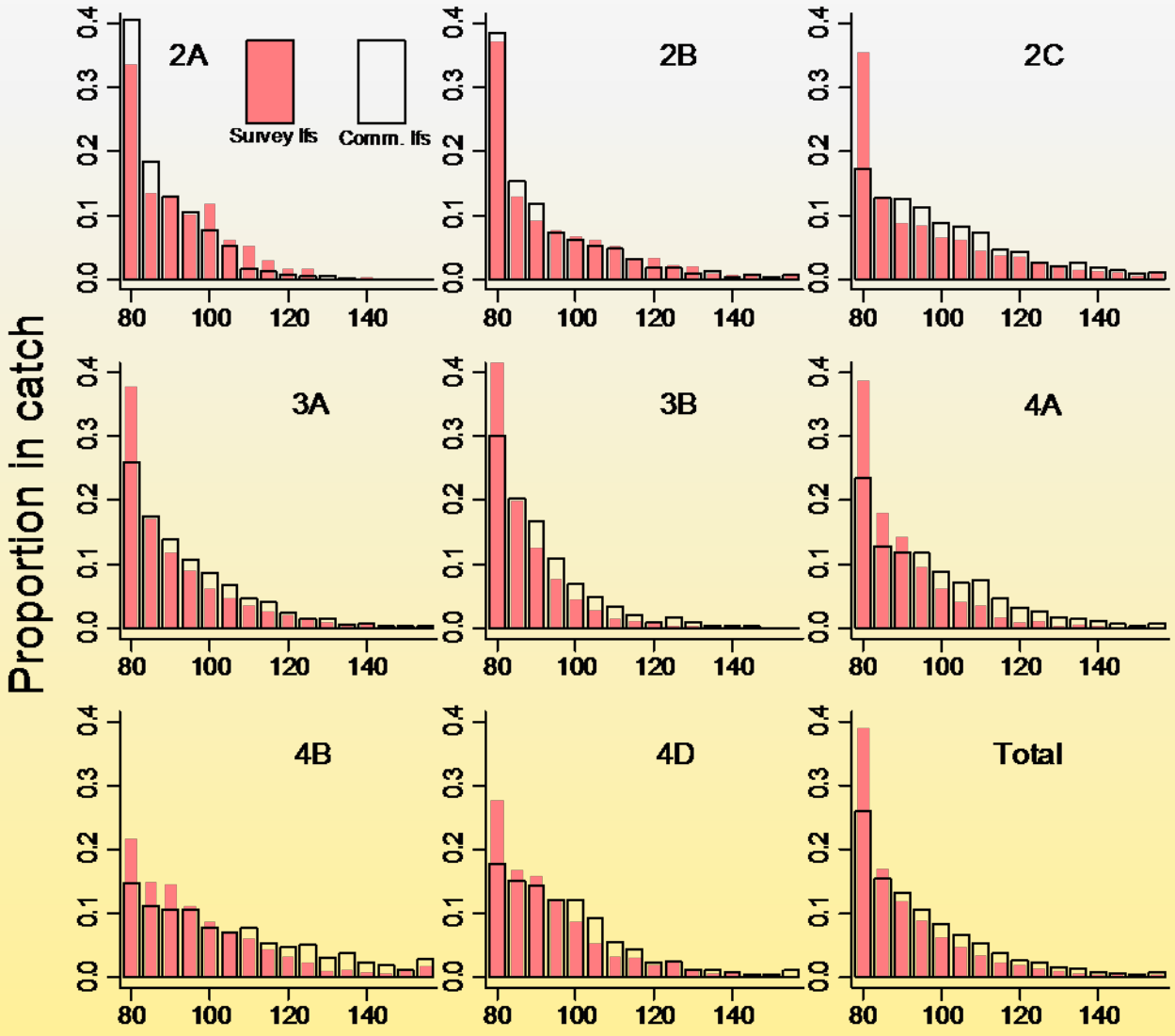


One year effect

2008, by the numbers

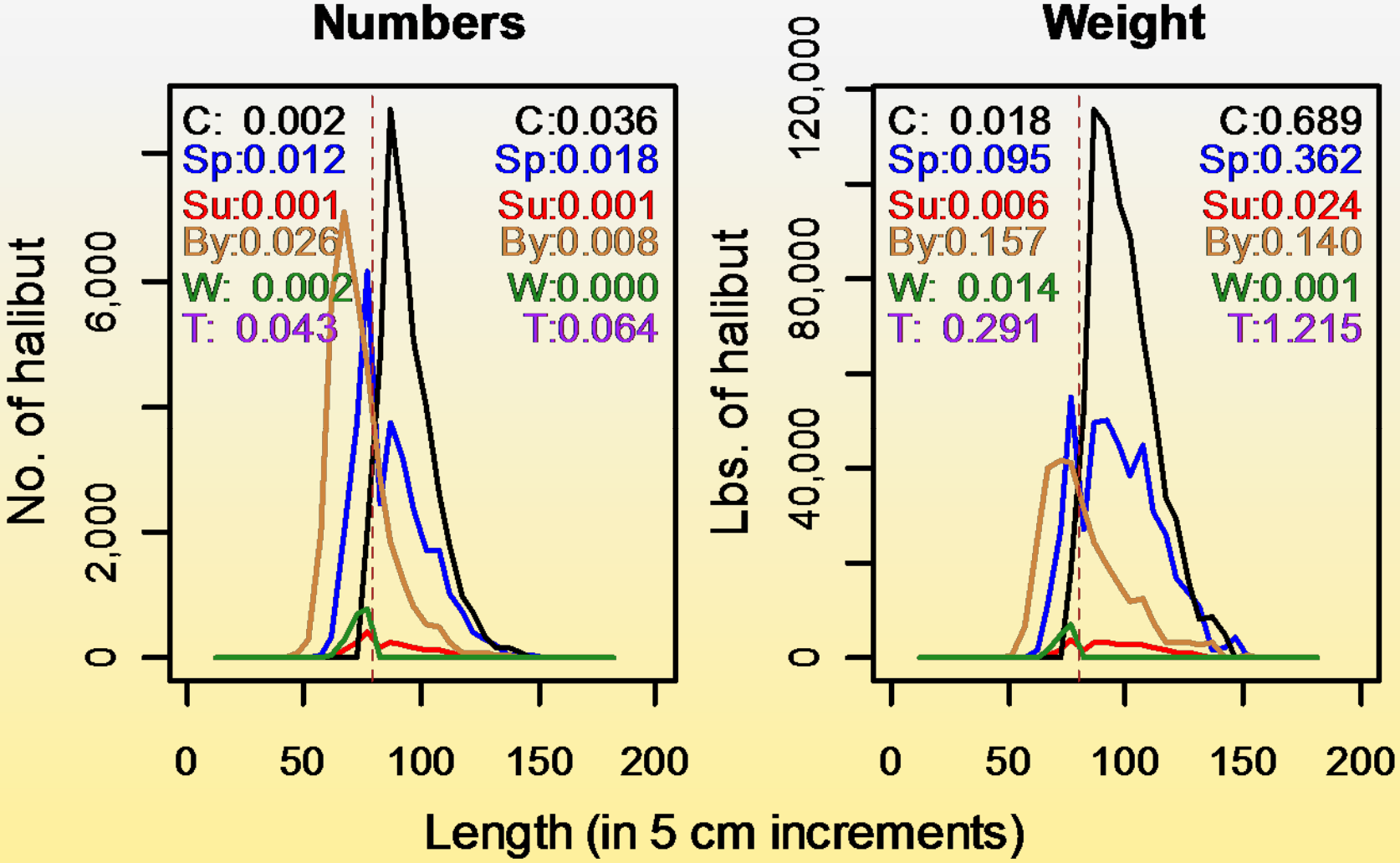
- $EBio_{commercial}$: 361 M lbs
  - ✓ $CEY_{0.20}$: 72.2
  - ✓ $SBio_{2009}$: 337
- $EBio_{survey}$: 482 M lbs
  - ✓ $CEY_{0.20}$: 96.4
  - ✓ $SBio_{2009}$: 339 or 327
  - ✓ $CEY_{0.16}$: 77.1
  - ✓ $SBio_{2009}$: 346 or 335
  - ✓ $CEY_{0.15}$: 72.2
  - ✓ $SBio_{2009}$: 347 or 337

Comparison of survey and setline LFs

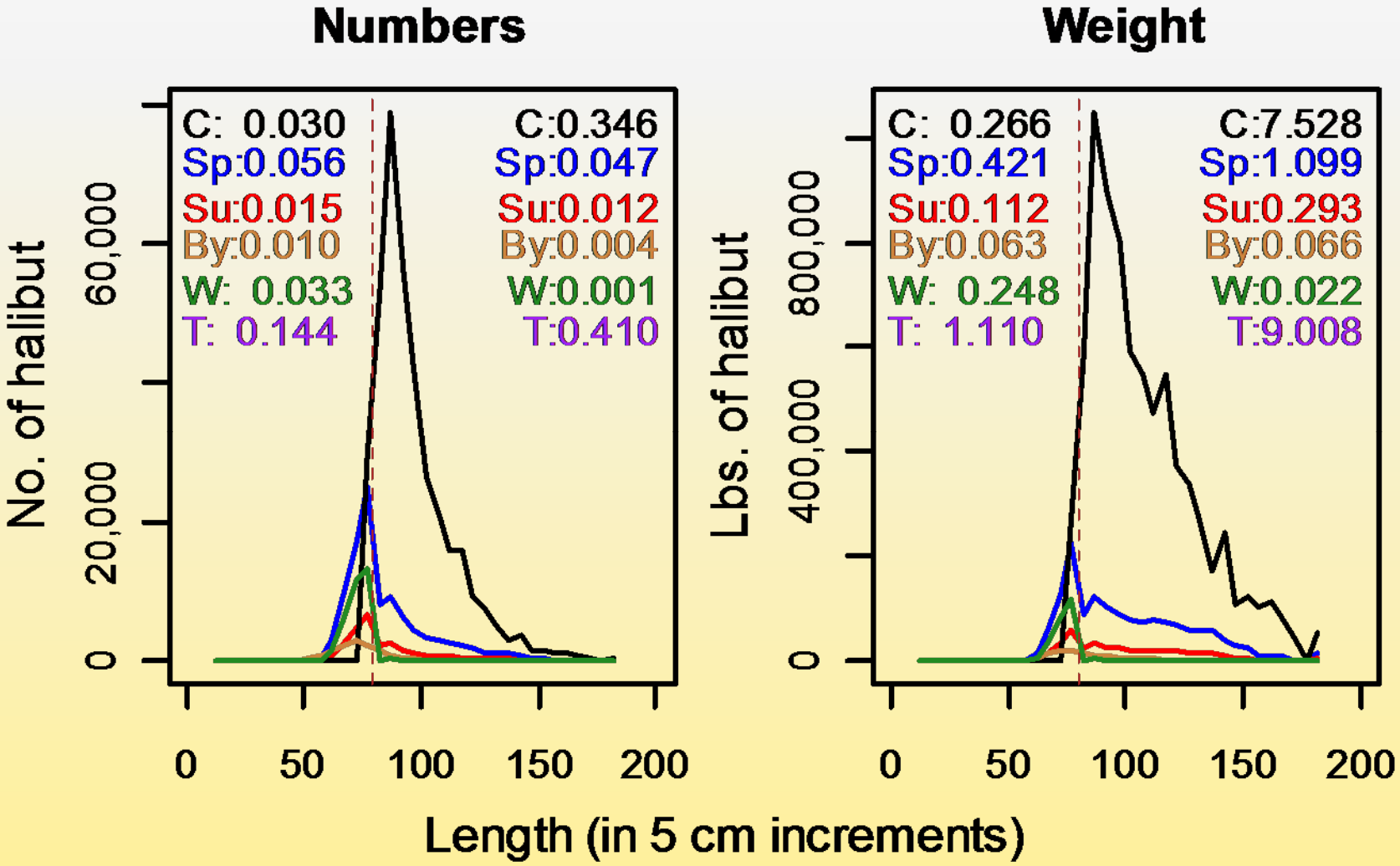


Extra slides

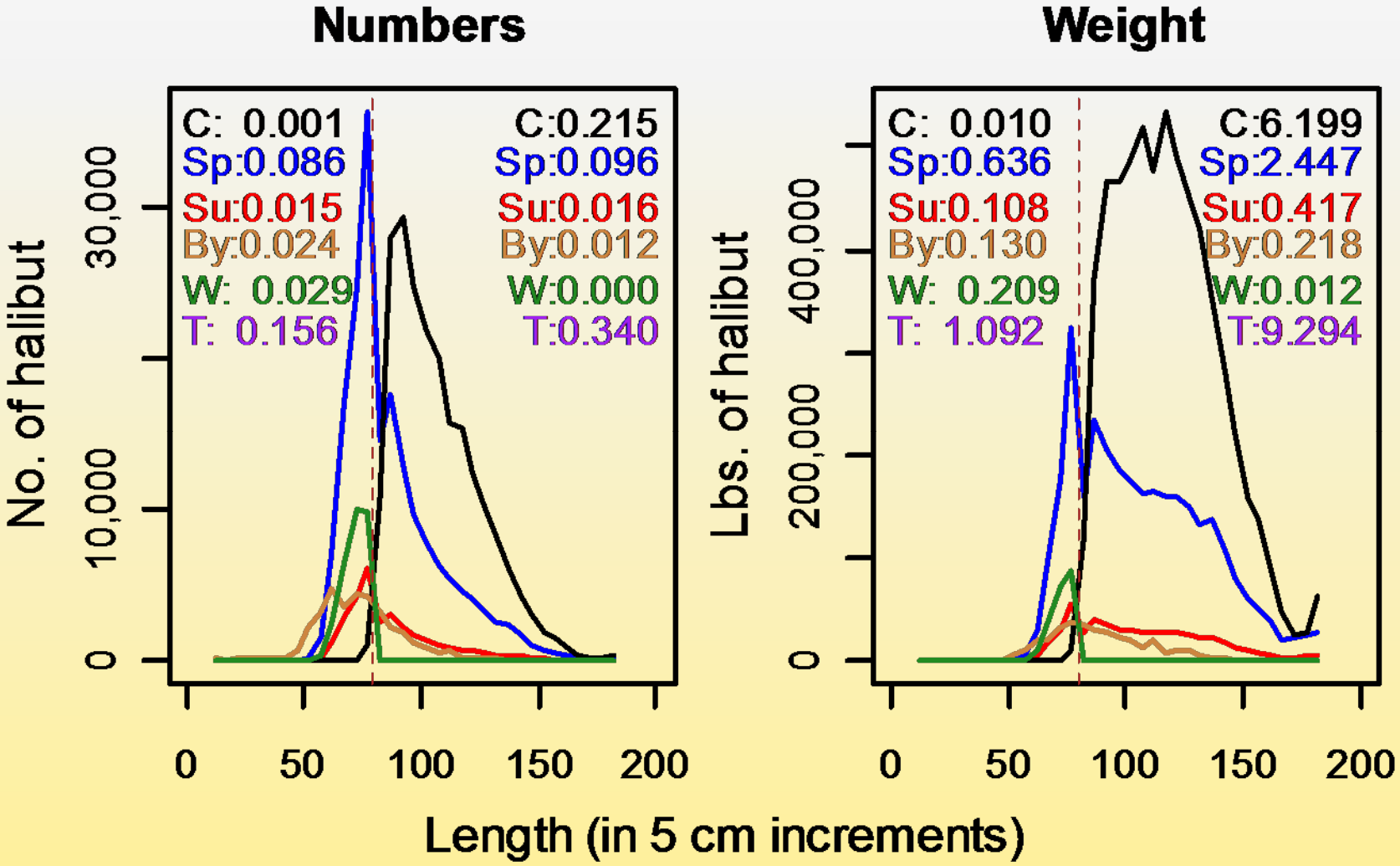
2A Total Removals in 2008



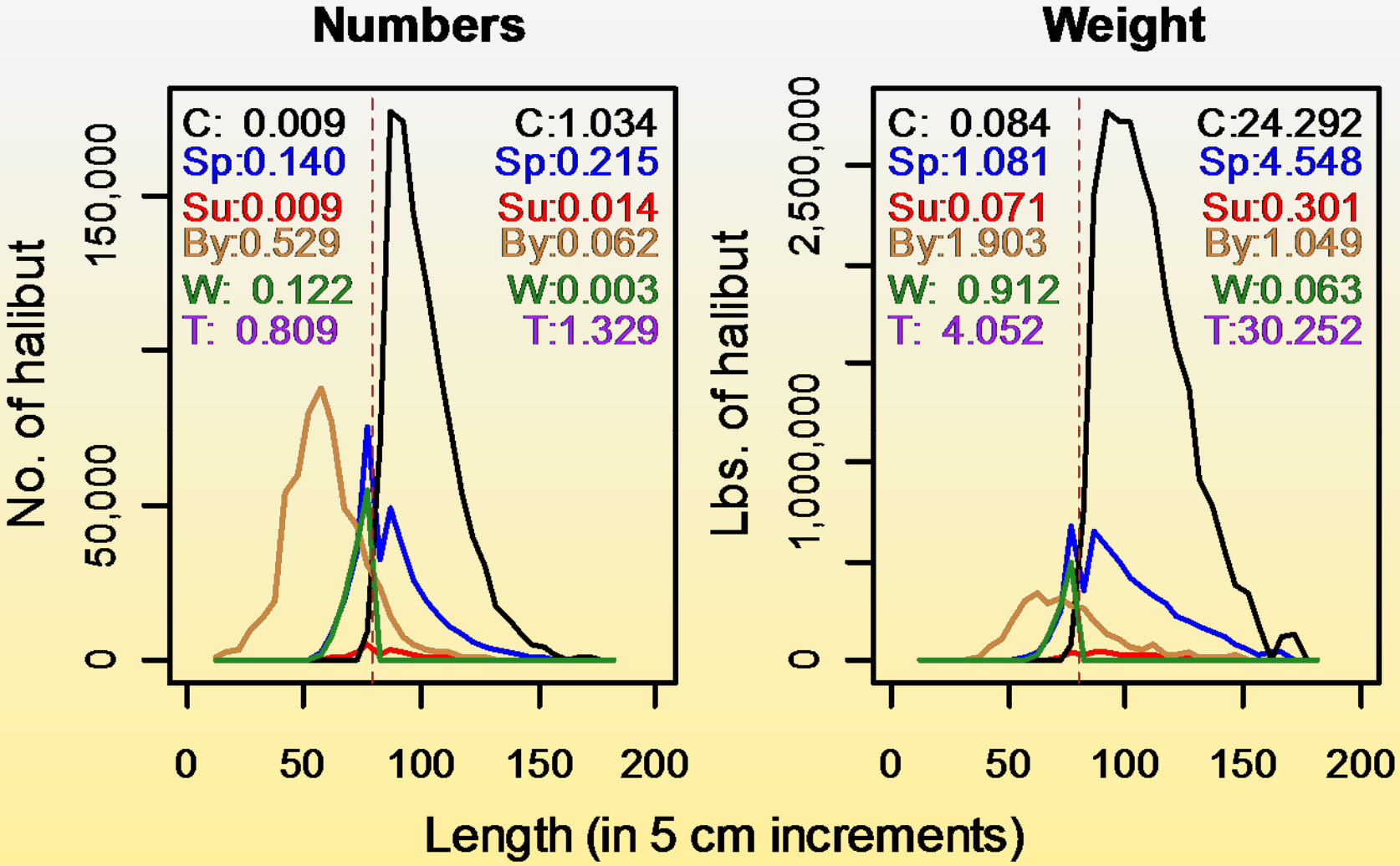
2B Total Removals in 2008



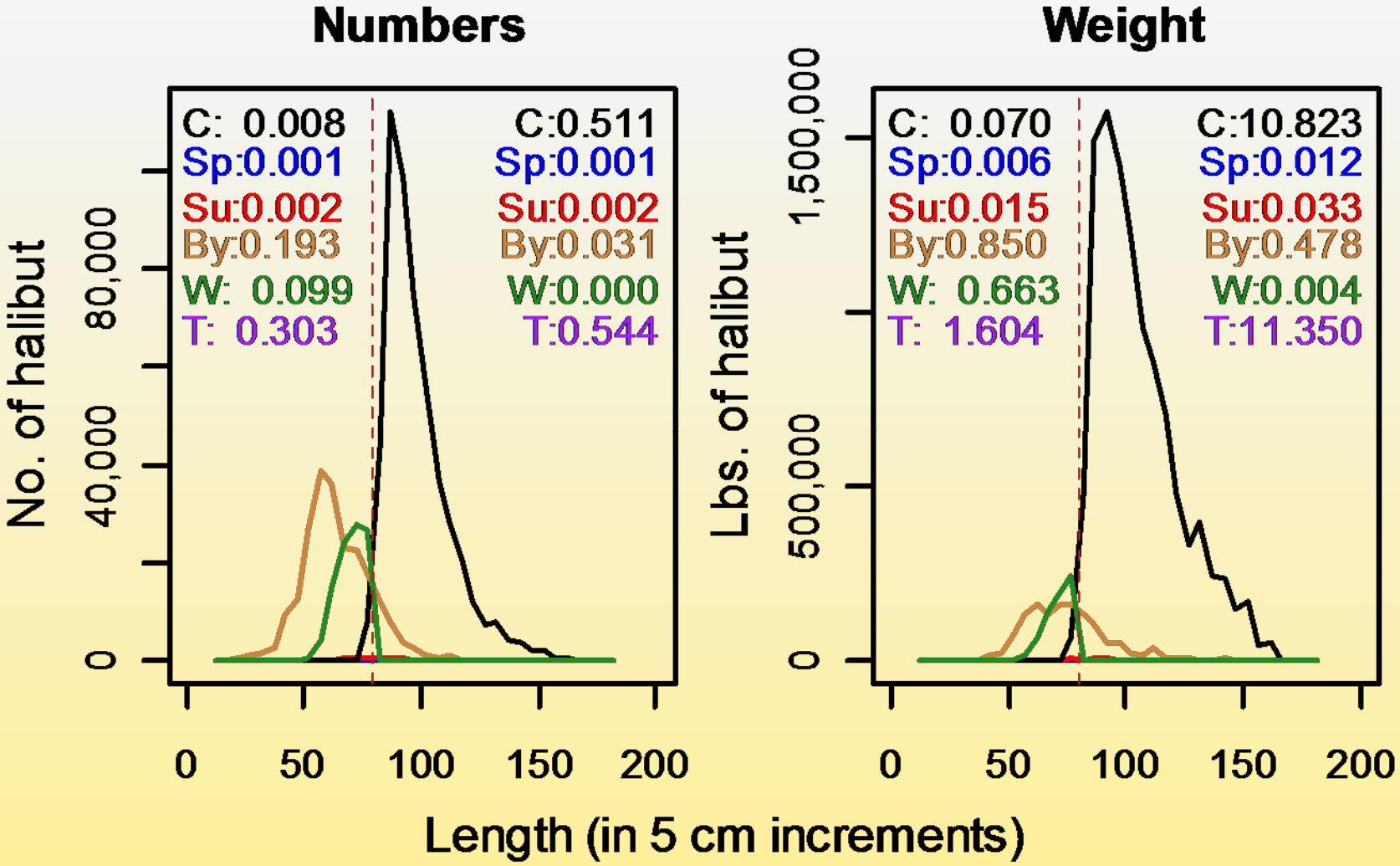
2C Total Removals in 2008



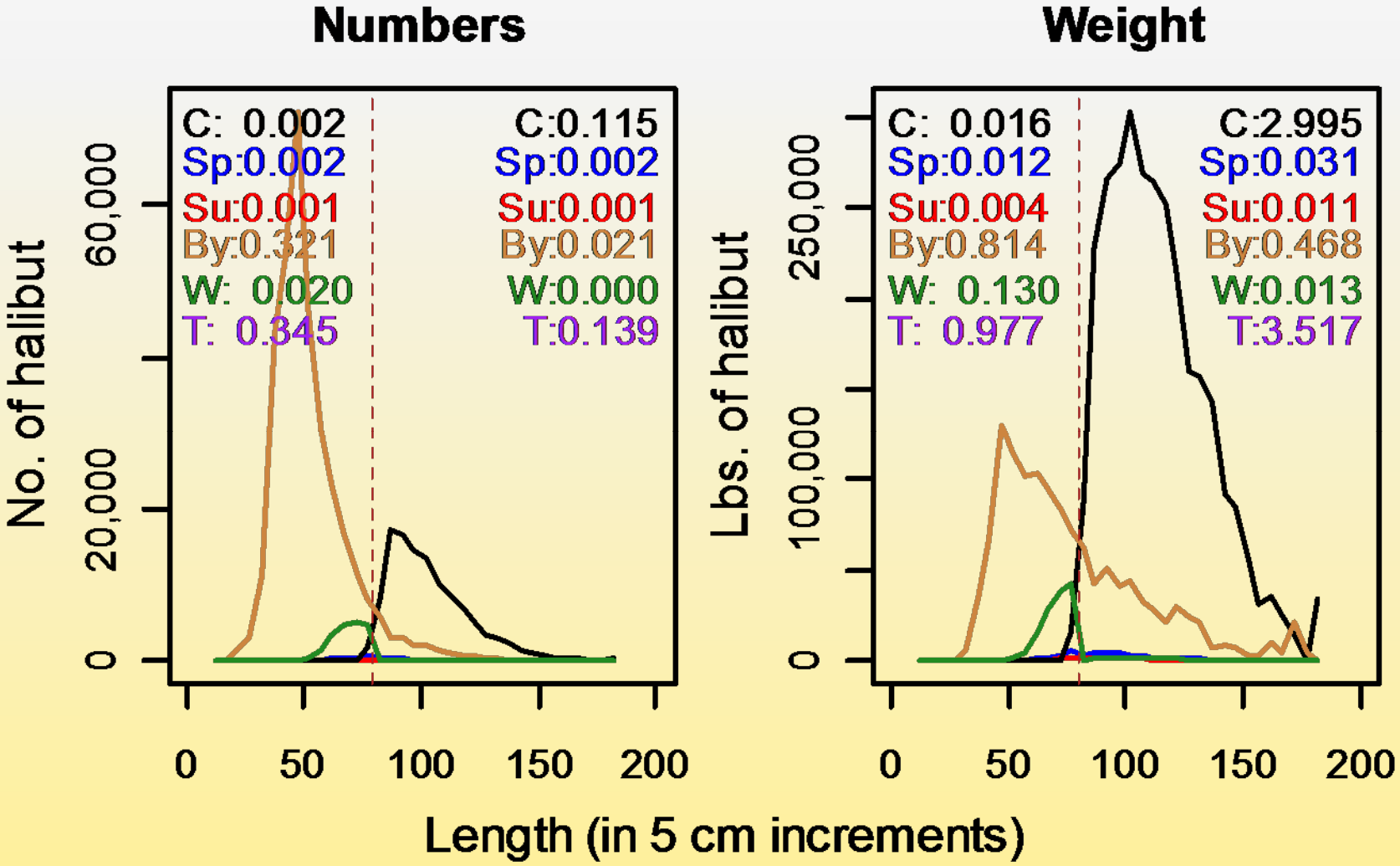
3A Total Removals in 2008



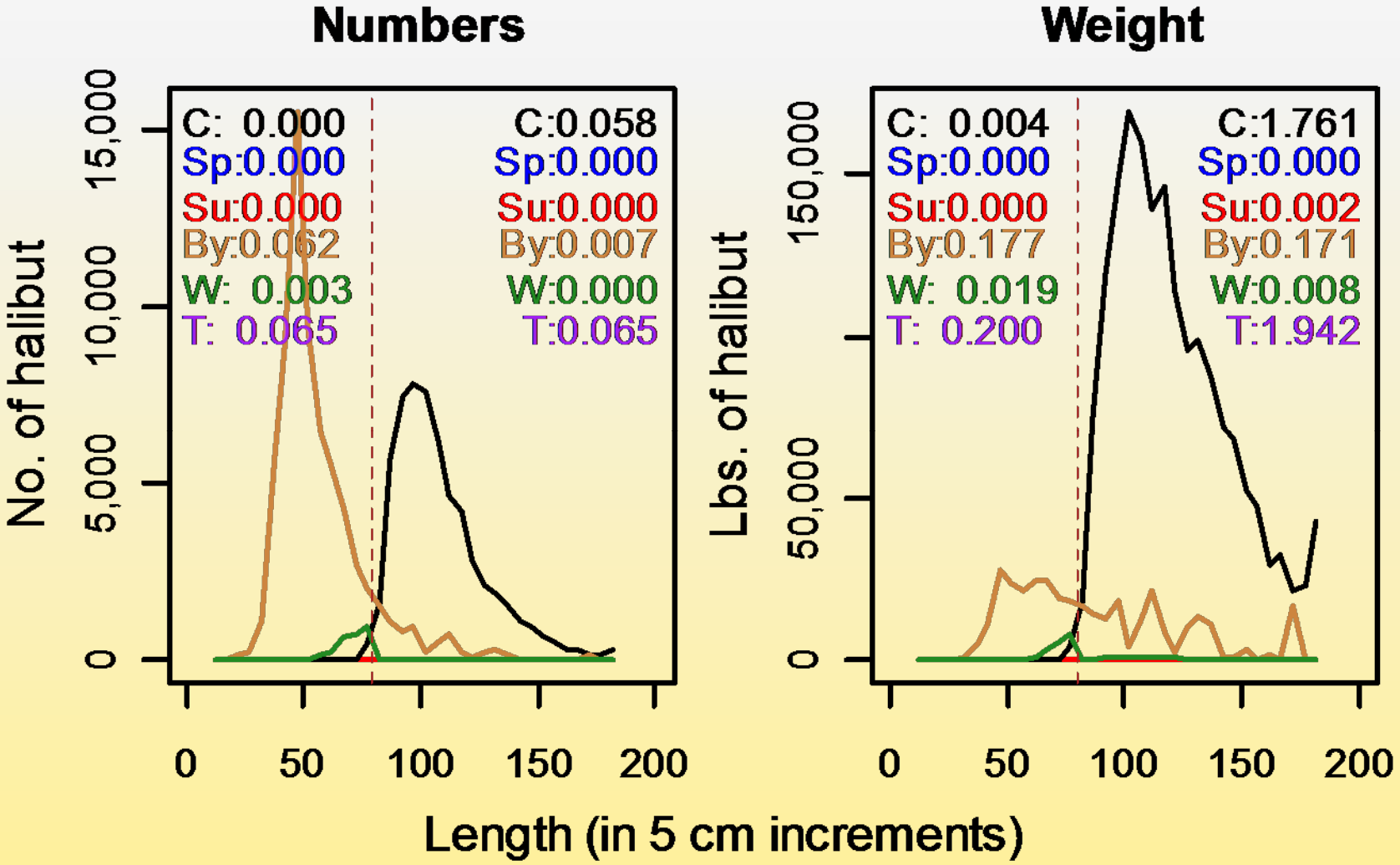
3B Total Removals in 2008



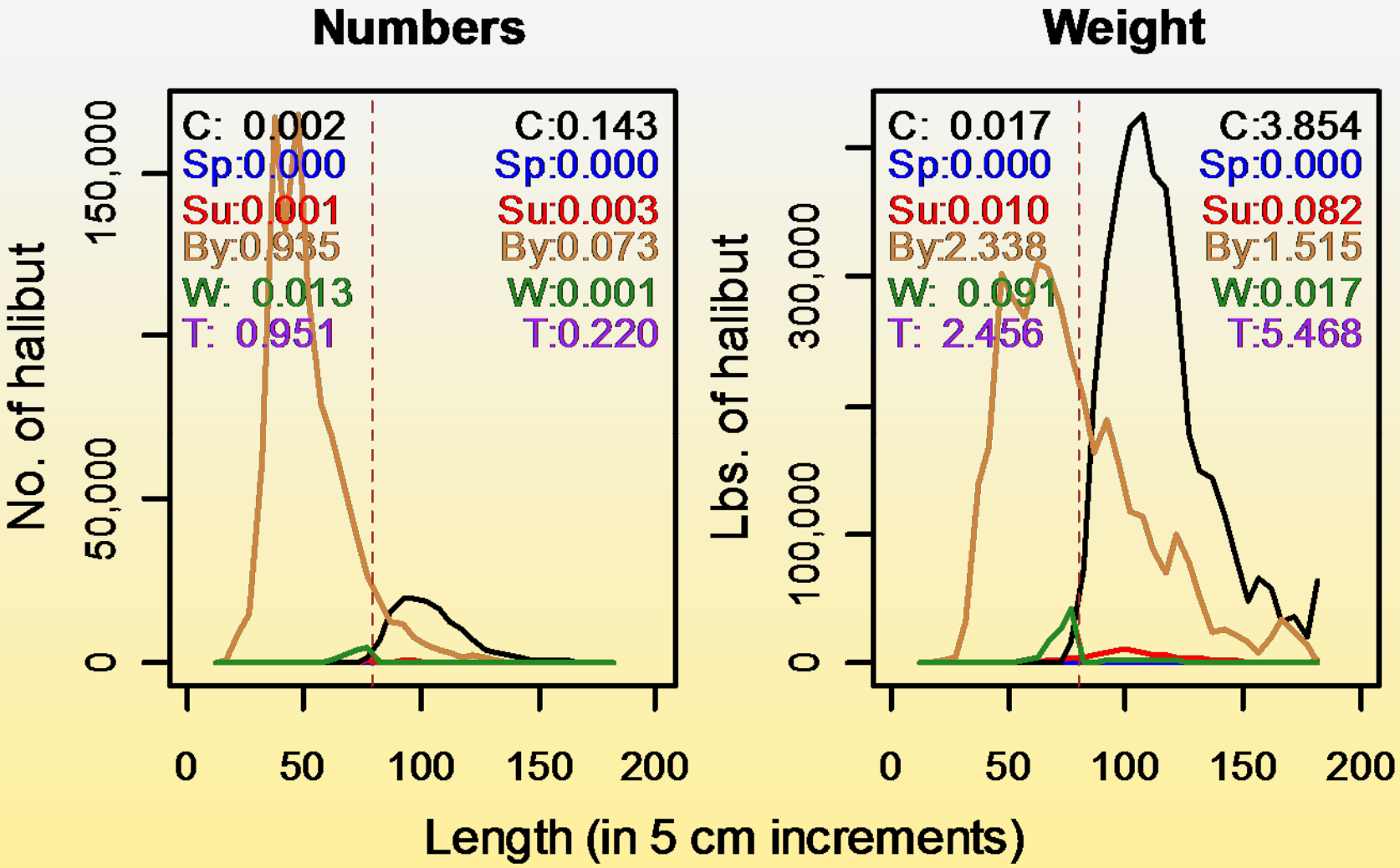
4A Total Removals in 2008



4B Total Removals in 2008



4CDE Total Removals in 2008



Loss equations

- Lost Yield

$$\text{Yield Loss} = \sum_{g=1}^{2}\sum_{t=1}^{30}\sum_{a=t}^{30} N_{g,a,t}\frac{F_{g,a,t}sel_{g,a}}{F_{g,a,t}sel_{g,a}+m}\left(1-e^{-\left(F_{g,a,t}sel_{g,a}+m\right)}\right)W_{g,a}$$

$$W_{g,a} = 0.00000692L^{3.24}$$

- Lost Egg Production

$$\text{Egg Loss} = \sum_{t=1}^{30}\sum_{a=t}^{30} NF_{a,t}M_aE_a$$

$$E_a = 0.0256L^{3.5601}$$

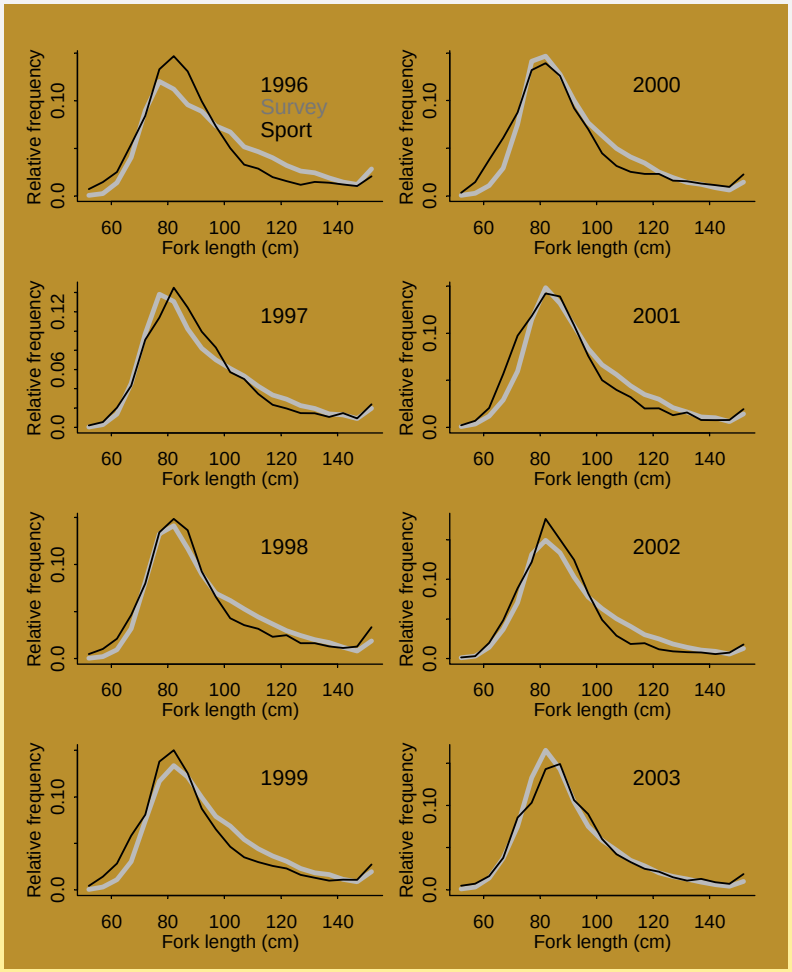
- Lost Spawning Biomass

$$\text{SBio Loss} = \sum_{t=1}^{30}\sum_{a=t}^{30} NF_{a,t}M_aW_a$$

$$\mathrm{W}_a = 0.00000692L^{3.24}$$

Comparison of survey and sport LFs

Area 3A



Area 2B