Effects of reduced minimum-size limits on halibut biomass, yield, and wastage

Steven Martell

University of British Columbia

martell.steve@gmail.com

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Outline

Motivation for MSL

Purpose of MSL is to prevent growth over-fishing.

FACT: Halibut are getting smaller!

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Is this a fishing effect, environment, or both?

Should MSL change with changes in growth?

Objective

What are the short-term and long-term consequences of adopting a smaller size limit (26 inches or 66 cm) on the halibut spawning and exploitable biomass, yield, and wastage?

To answer this question:

Use a deterministic sex/age structured simulation model based on the IPHC assessment results to forecast biomass, harvest, and wastage using 26 and 32 inch MSL.

Using 2011 halibut prices from Homer Alaska, calculate the landed and discarded value in millions of dollars.

Outline

Model Setup & Assumptions

- Constant natural mortality rate.
- Selectivity remains constant over time.
- Selectivity is a fixed function of length.
- Fixed growth or density dependent growth.
- Coefficient of variation in length-at-age is 0.1
- Price is fixed with premiums for larger sizes (Homer).
- Price for 5-10lb set at \$5.00 lb^{-1} (66cm-81cm)
- Discard mortality rate in commercial fishery is 0.17
- Future catch based on current HR policy
- Future O32 & U32 bycatch based on 2011 values.

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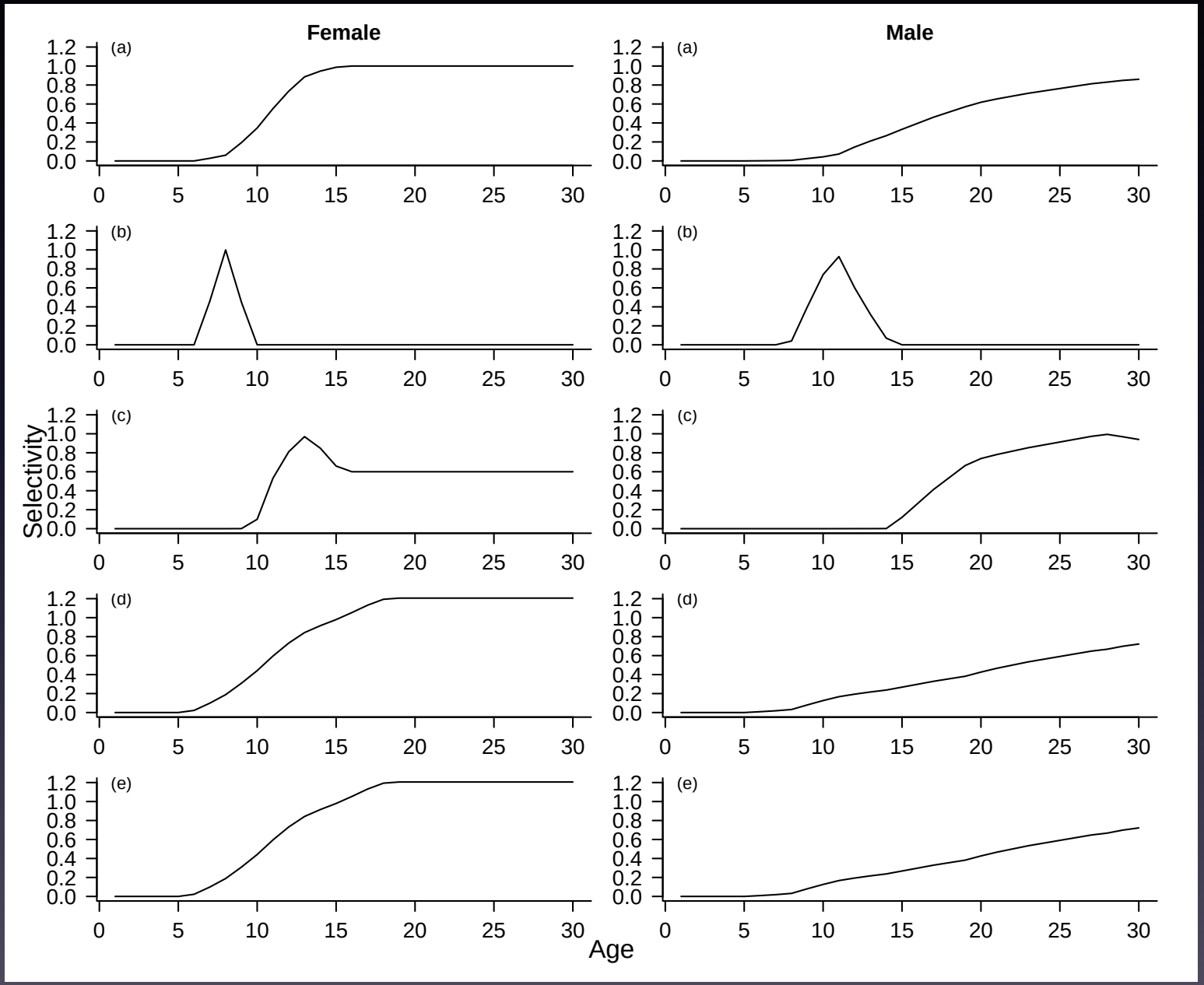
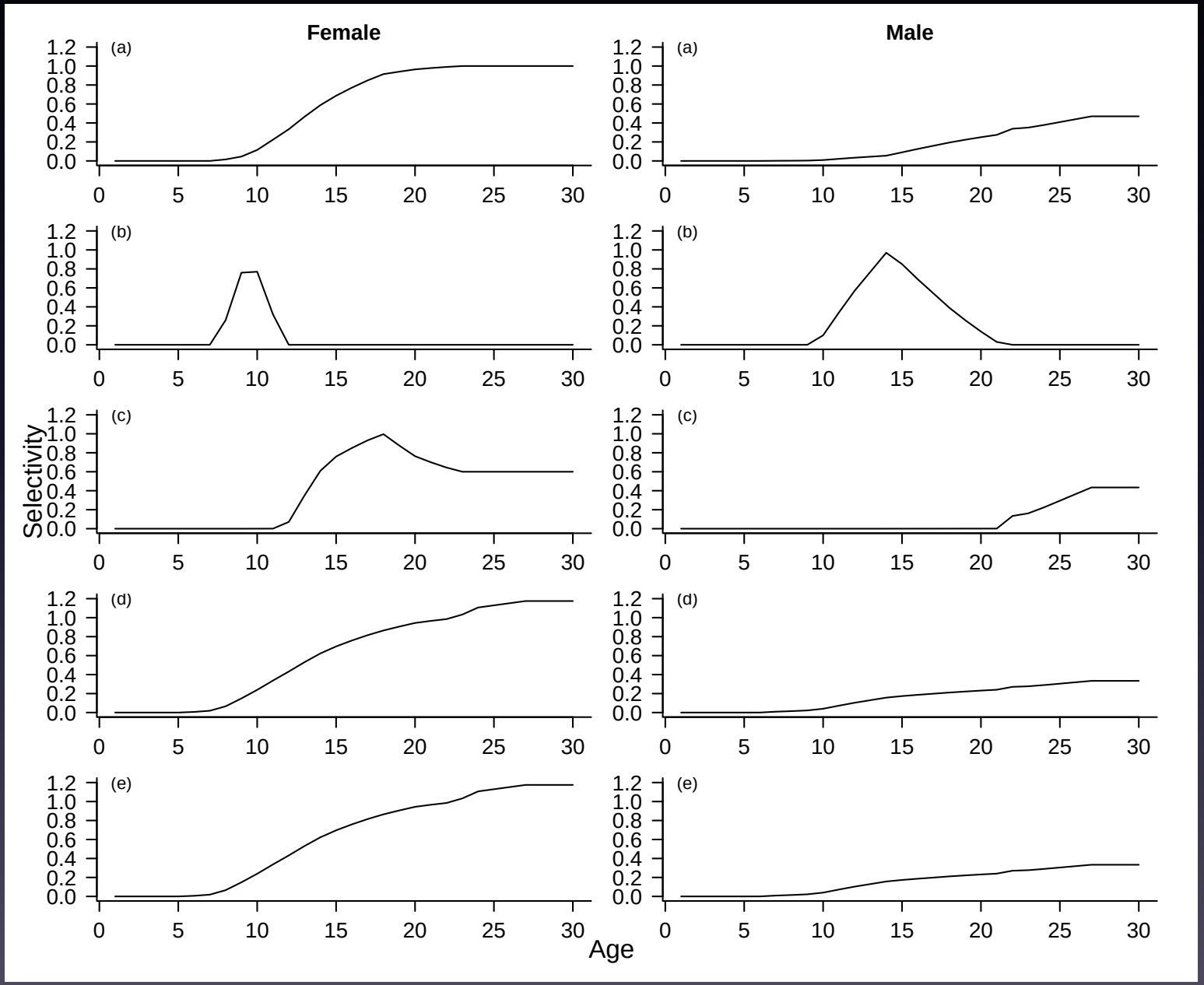
Age-based selectivity 1996



Age-based selectivity 2011



Capture & Retention

Probability of capturing a fish of a given size x:

$$P(x) = S(x) \cdot N(x)$$

Where $S(x)$ is the size selectivity of the gear, and $N(x)$ is the number of individuals in length interval x

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$$P(j) = v(j) \cdot N(j)$$

The probability of retaining a fish of age j is function of the mean length-at-age and variance in length-at-age. Approximate the integral using a logistic function:

$$P(r) = \frac{1}{1 + \exp[-(l_a - \mathrm{MSL})/\sigma_a]}$$

where MSL is the minimum size limit, l_a and σ_a are the mean length and standard deviation at age.

Joint probability model

Probability of capturing and retaining a fish age j is given by:

$$P(c_j) = P(j) \cdot P(r)$$

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Probability of discarding a fish of age j:

$$P(d_j) = P(j) \cdot (1 - P(r))$$

Probability of an age j fish dying due to commercial fishing:

$$P(h_j) = P(j) \cdot [P(r) \cdot (1 - P(r))d]$$

where d is the discard mortality rate.

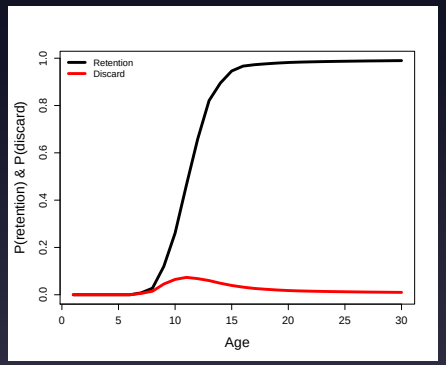
Outline

Scenarios

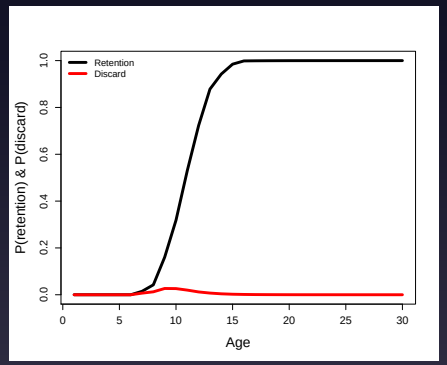
Three size limit options:

1. Size limit is 32 inches (81.28cm)
2. Size limit is 29 inches (73.66cm)
3. Size limit is 26 inches (66.04cm)

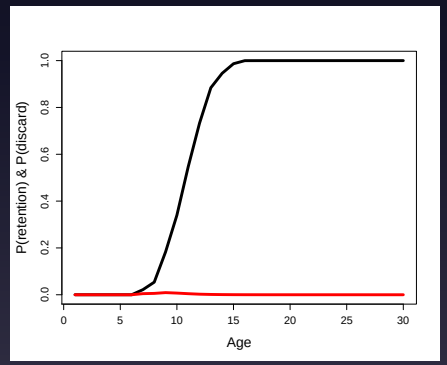
32" MSL



29" MSL



26" MSL



Assumed states of nature

Recruitment:

1. Poor (60% below average recruitment)
2. Average
3. Good (60% above average recruitment)

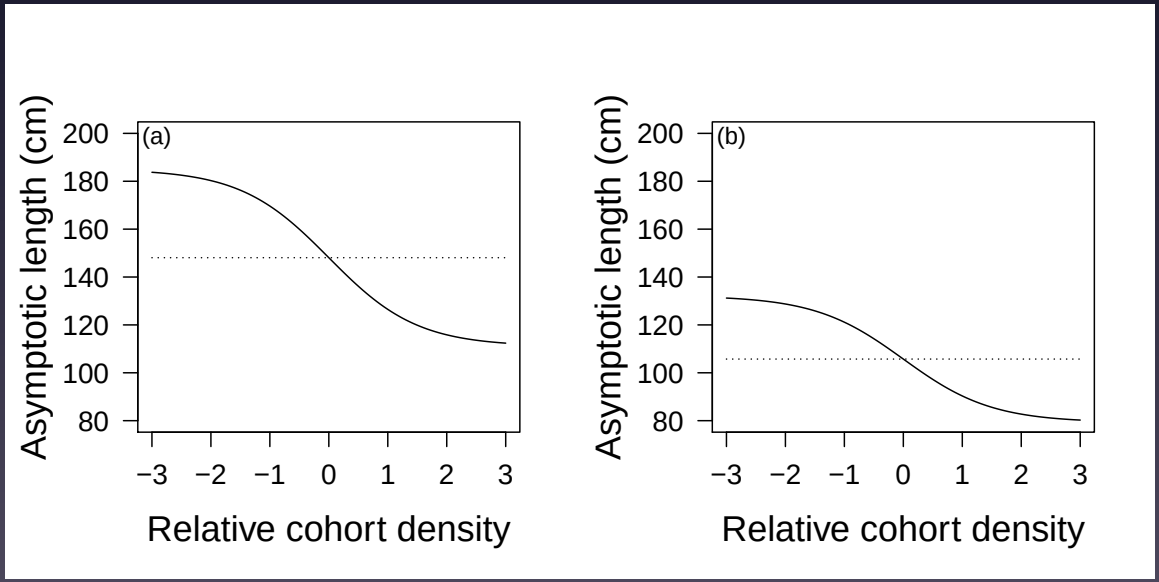
Growth:

Assumed states of nature

Recruitment:

Growth:

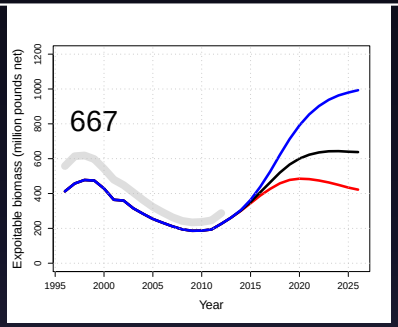
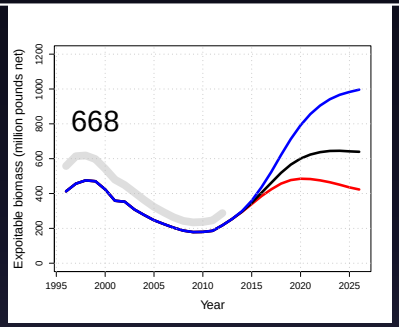
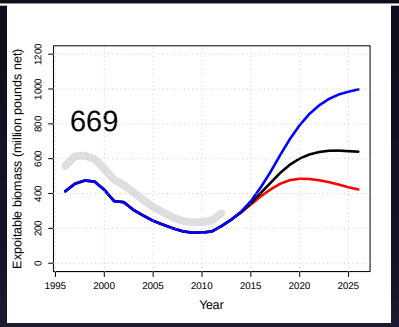
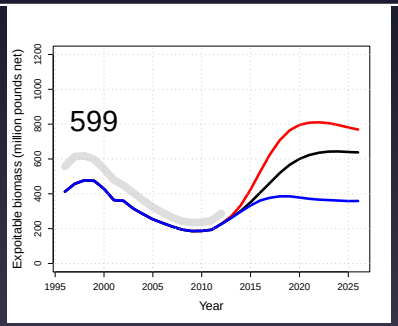
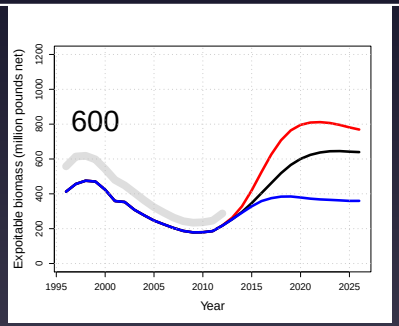
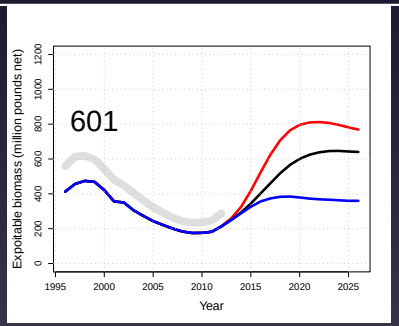
1. Density-independent (using 2011 average length-at-age)
2. Density dependent.



Outline

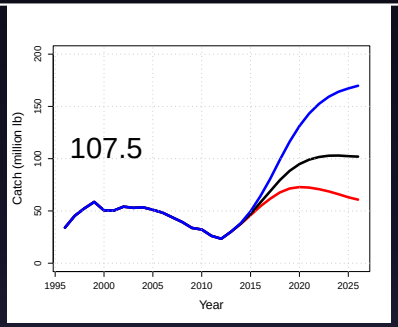
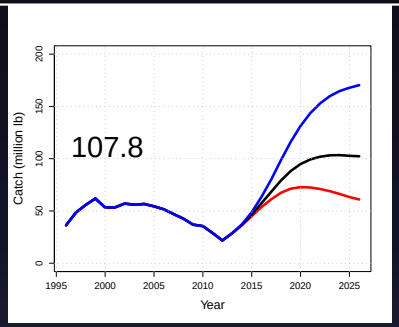
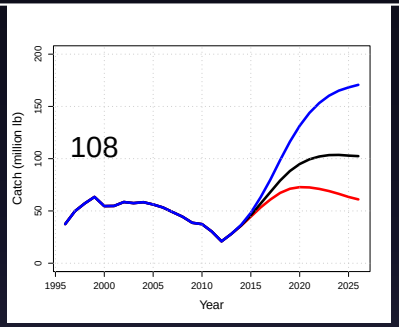
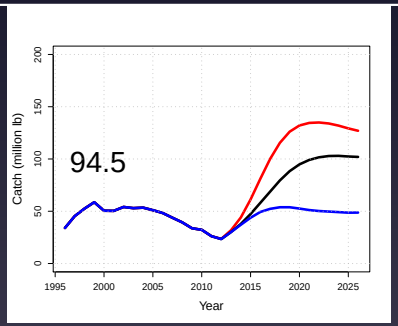
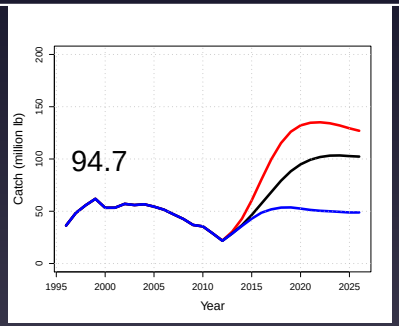
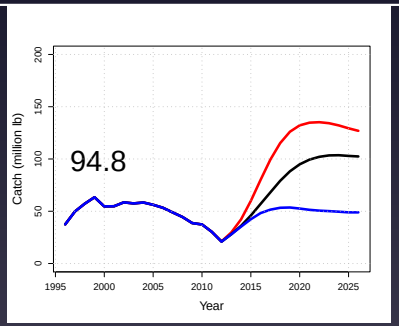
Decision Table: EBio

Size limit impacts on exploitable biomass.

Policy	32" MSL	29" MSL	26" MSL
DI Growth			
DD Growth			
Average	633	634	635

Decision Table: Yield

Size limit impacts on commercial yield.

Policy	32" MSL	29" MSL	26" MSL
DI Growth			
DD Growth			
Average	101	101.25	101.4

Decision Table: Comm. wastage

Size limit impacts on Wastage.

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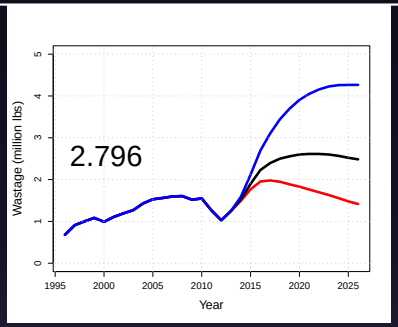
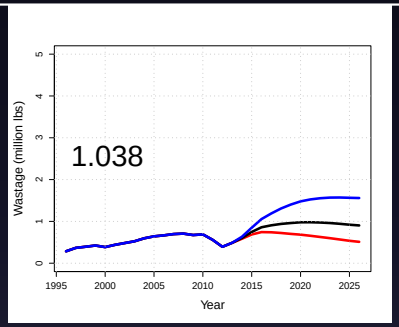
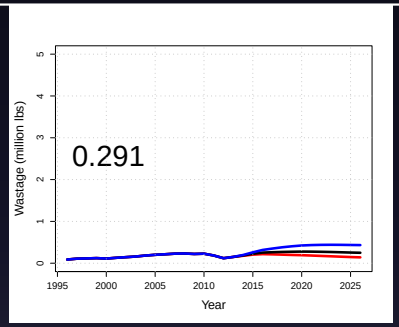
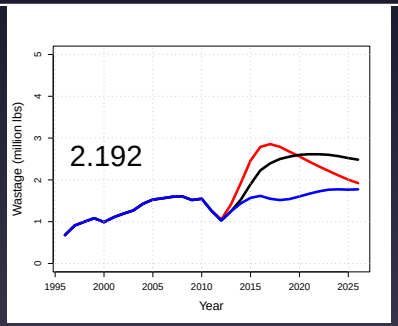
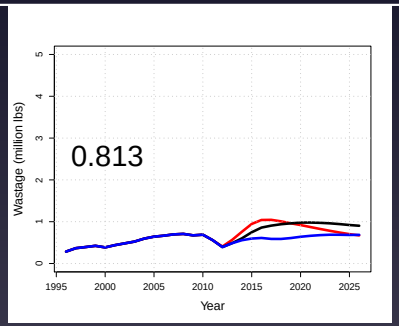
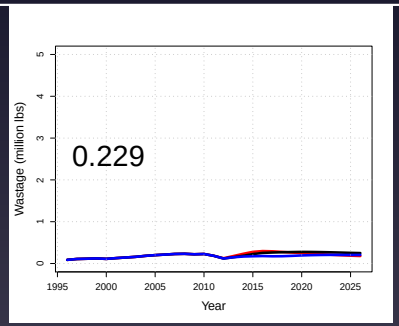
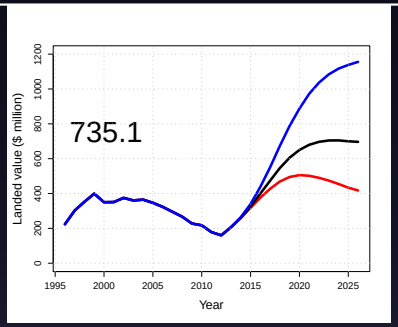
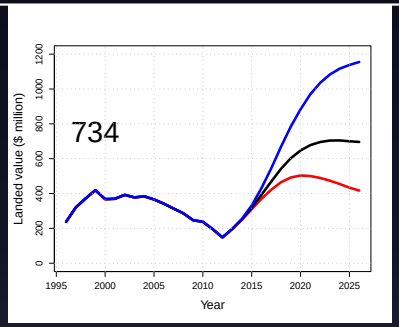
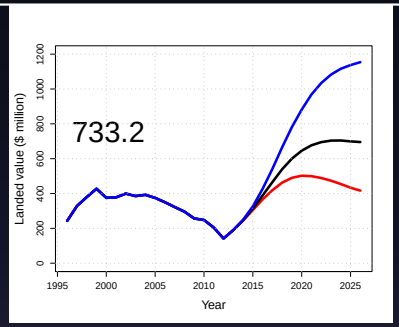
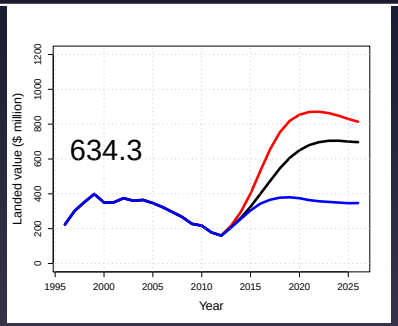
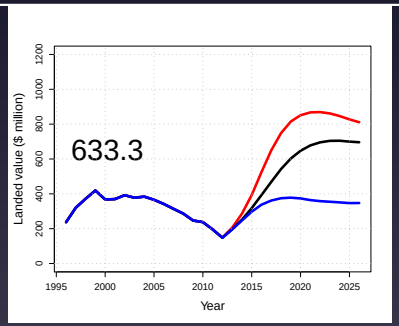
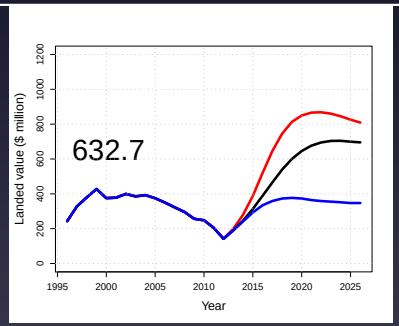
DI Growth			
DD Growth			
Average	2.494	0.925	0.260

Decision Table: Landed Value

Size limit impacts on Landed value in the directed fishery.

Policy	32" MSL	29" MSL	26" MSL
DI Growth			
DD Growth			
Average	684.7	683.6	683

Decision Table: Value of Wastage

Size limit impacts on value of commercial fishery wastage.

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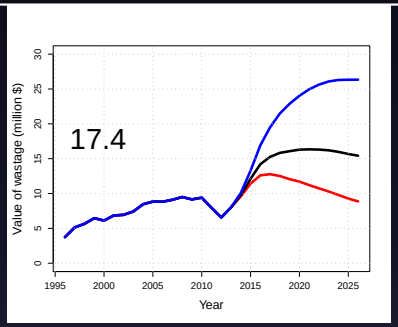
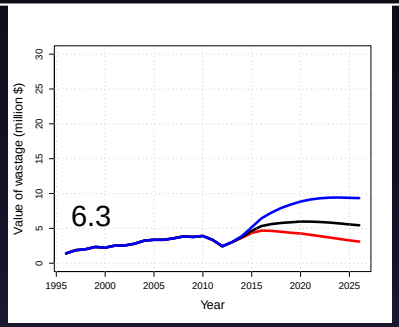
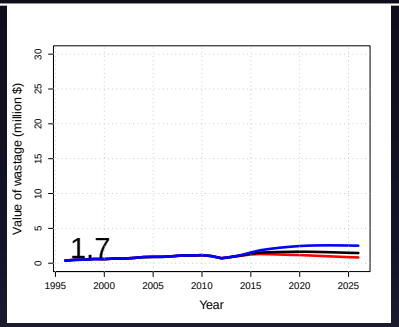
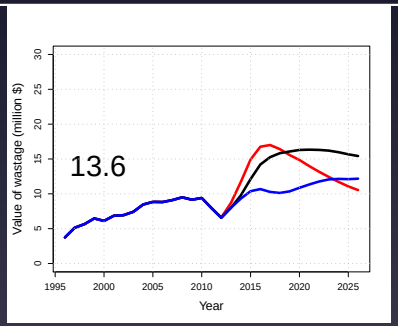
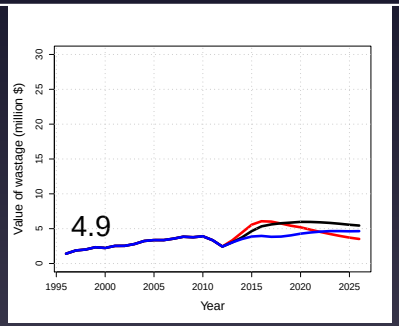
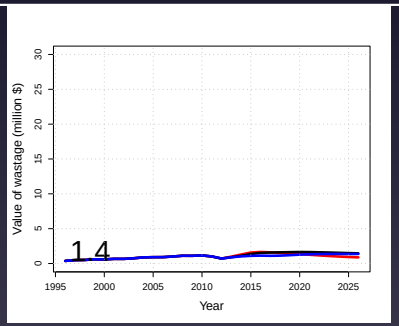
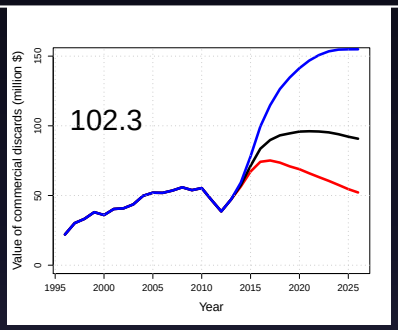
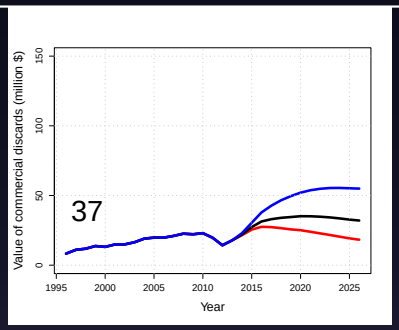
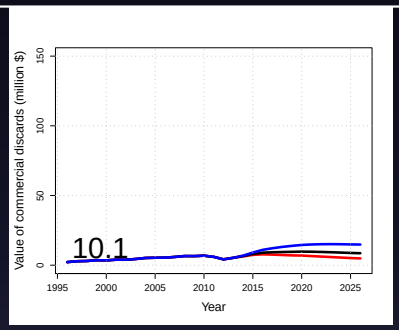
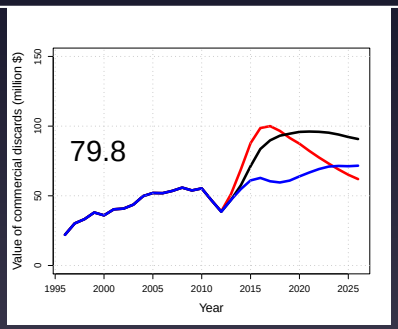
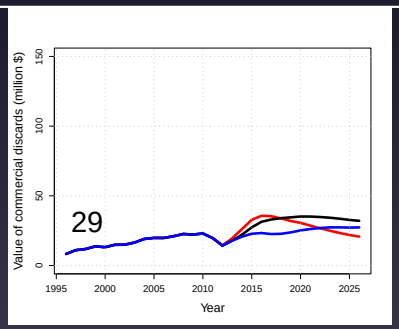
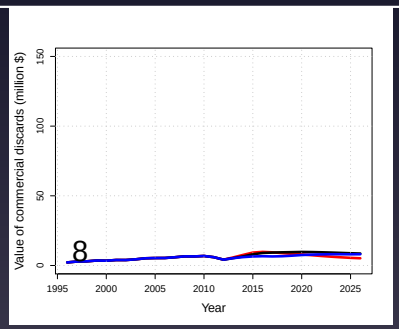
DI Growth			
DD Growth			
Average	15.5	5.6	1.55

Decision Table: Value all discards

Value of all fish less than MSL thrown overboard.

Policy	32" MSL	29" MSL	26" MSL
DI Growth			
DD Growth			
Average	91	33	9

Summary Table

Response (million lb)	32" MSL	29" MSL	26" MSL
EBio	633	634	635
Yield	101	101.25	101.4
Wastage	2.494	0.925	0.260
Response (million)			
Landed Value	$684.7	$683.6	$683
Waste Value[1]	$15.5	$5.6	$1.55
Discard Value[2]	$91	$33	$9

[1] Money you cannot recover in the future

[2] Extra cost incurred to throw away these fish.

Summary Table

A proximate measure of efficiency:
1-(Discard value)/(Landed Value)

Response (million lb)	32" MSL	29" MSL	26" MSL
EBio	633	634	635
Yield	101	101.25	101.4
Wastage	2.494	0.925	0.260
Response (million)			
Landed Value	$684.7	$683.6	$683
Waste Value[1]	$15.5	$5.6	$1.55
Discard Value[2]	$91	$33	$9

[1] Money you cannot recover in the future
[2] Extra cost incurred to throw away these fish.

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Efficiency	86.7%	95.2%	98.7%

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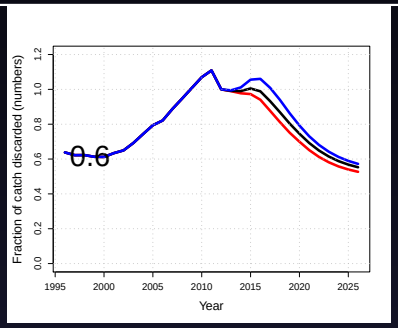
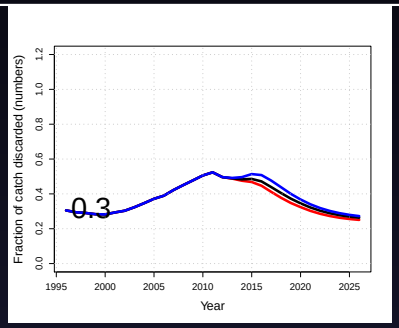
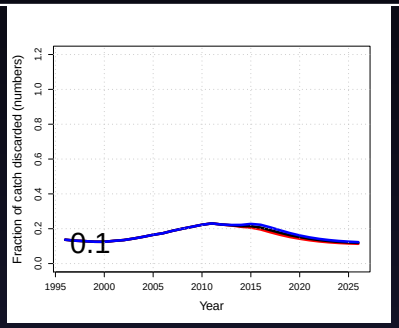
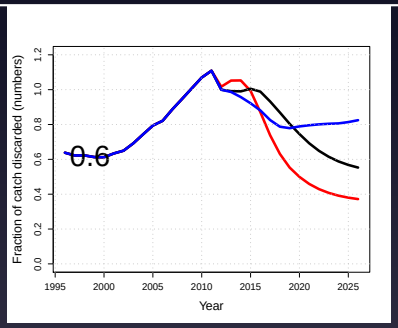
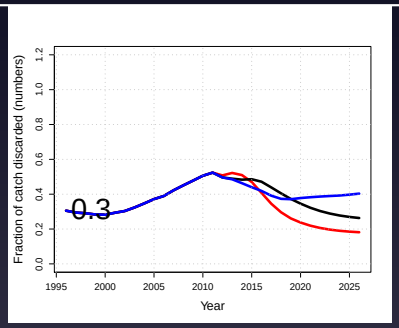
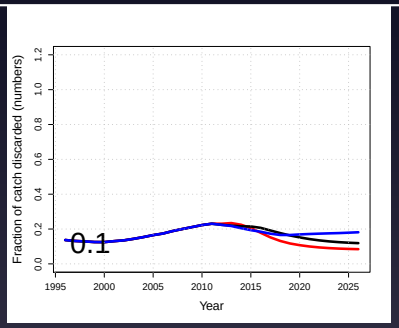
Handling efficiency

What fraction of the catch is below the MSL?

Policy	32" MSL	29" MSL	26" MSL
DI Growth			
DD Growth			
Average	60/100	33/100	9/100

Summary Table

Handling efficiency: (percent of fish kept)

Response (million lb)	32" MSL	29" MSL	26" MSL
EBio	633	634	635
Yield	101	101.25	101.4
Wastage	2.494	0.925	0.260
Response (million)			
Landed Value	$684.7	$683.6	$683
Waste Value[3]	$15.5	$5.6	$1.55
Discard Value[4]	$91	$33	$9
Efficiency	86.7%	95.2%	98.7%
Handling Efficiency	40%	66%	91%

[3] Money you cannot recover in the future

[4] Extra cost incurred to throw away these fish.

Outline

Objective

Simulation Model

Scenarios

Results

EBio
Yield
Wastage
Landed Value
Wastage Value
Discard Value
Size-limit Impacts
Efficiency

Summary

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- Lowering the size limit will not change the landed value of the fishery.
- No appreciable conservation concern with a lower size limit under the strict assumption that selectivity does not change.
- A lower size limit reduces waste and increases economic rent via lower operational costs (increased efficiency).

Acknowledgments

IPHC staff
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Alaska Whitefish Trawlers