Science, Service, Stewardship

Vessel Calibration Analysis Review
11-13 August 2009

Northeast Fisheries Science Center

Presentation To:
New England Fishery Management Council
Portsmouth, NH
January 26-28, 2010

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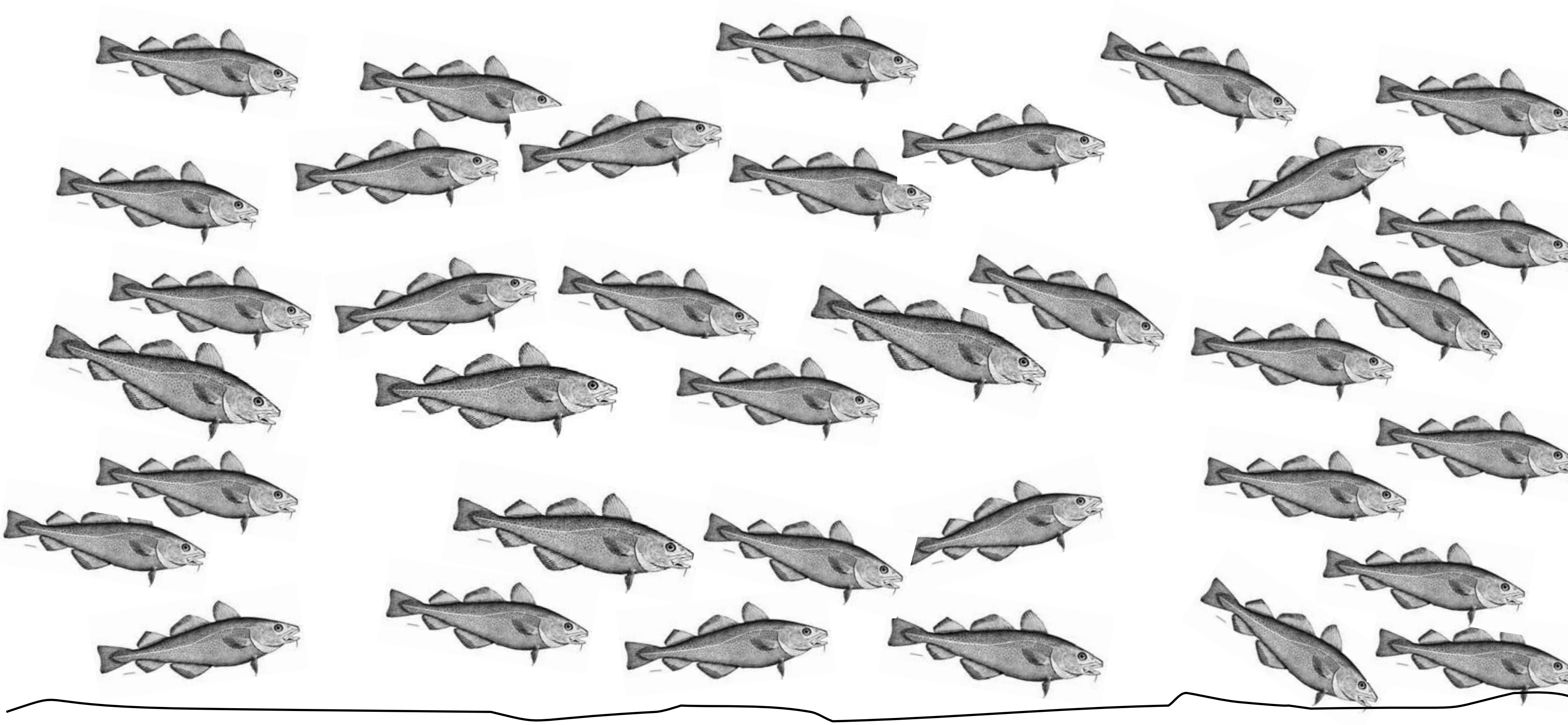
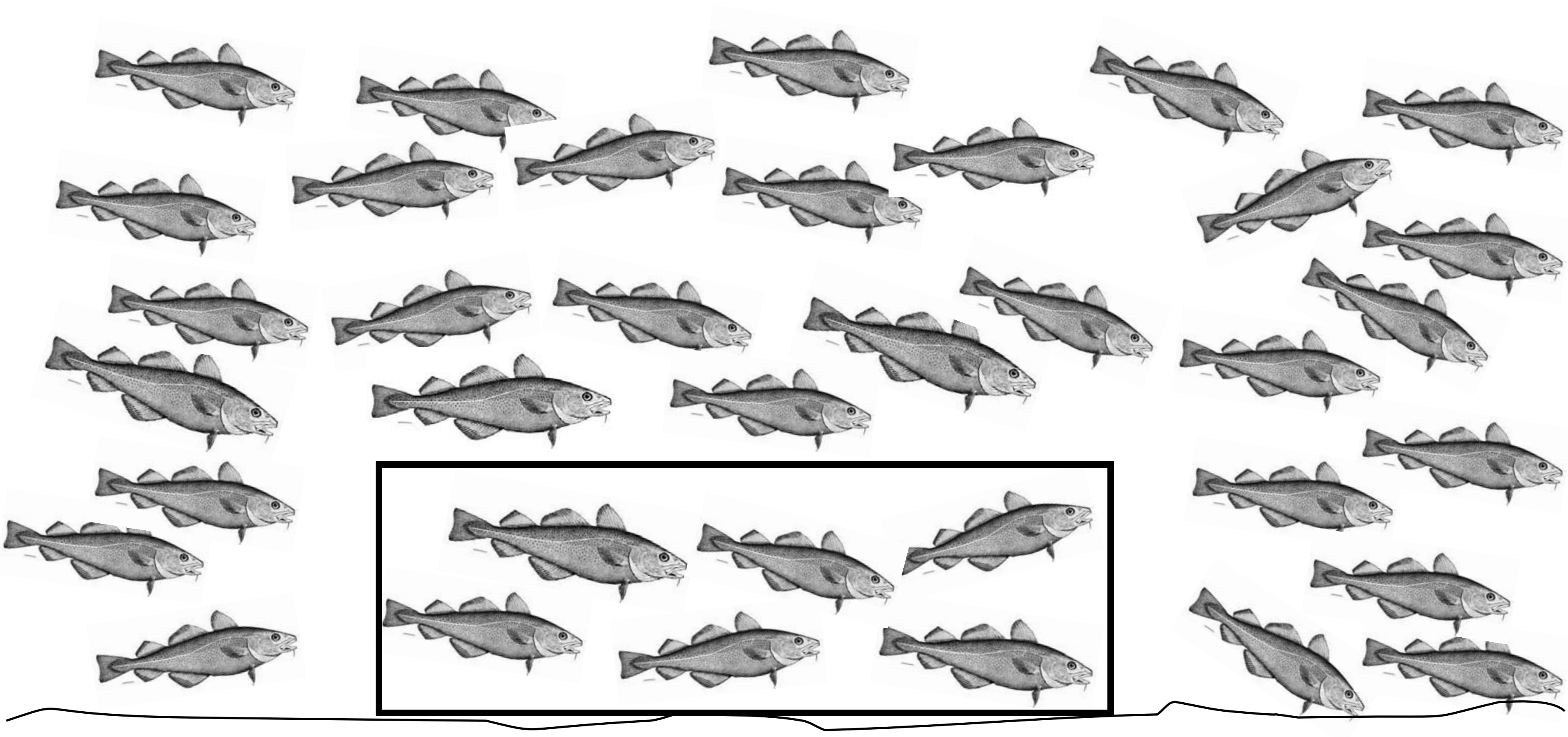
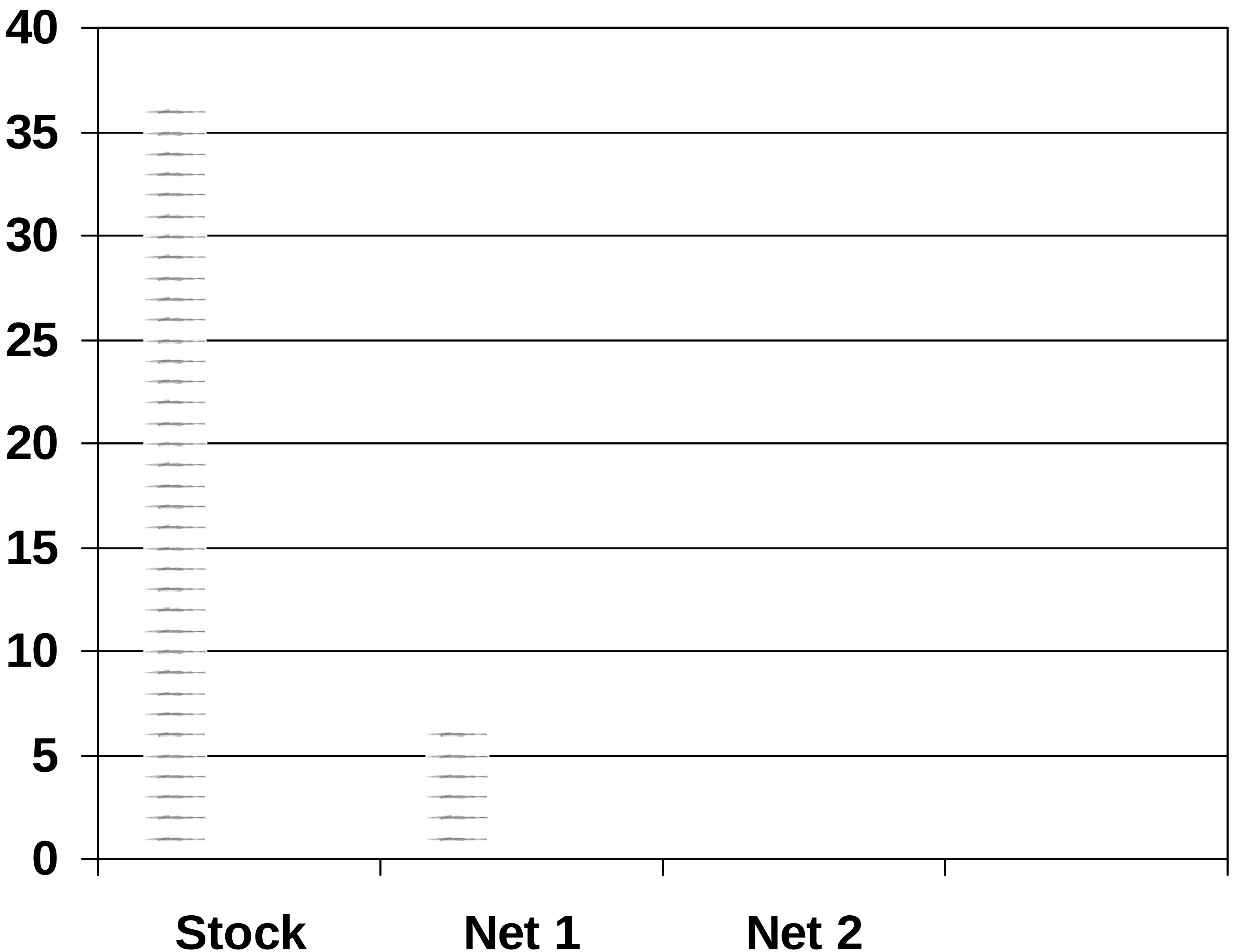
Calibration Workshop
1. Introduction
11-13 August 2009

How does calibration work?



Surveys catch a standard sample.




40
35
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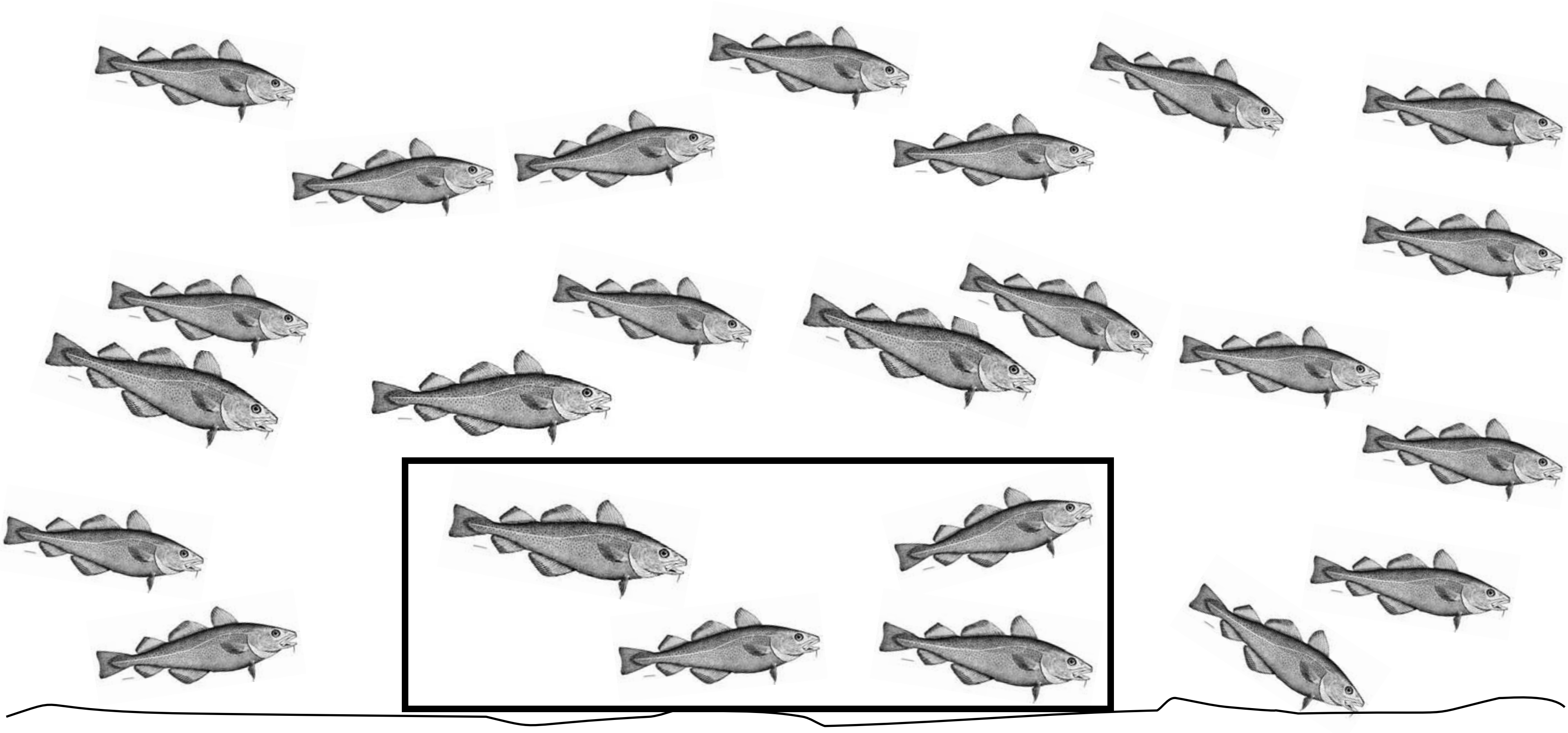
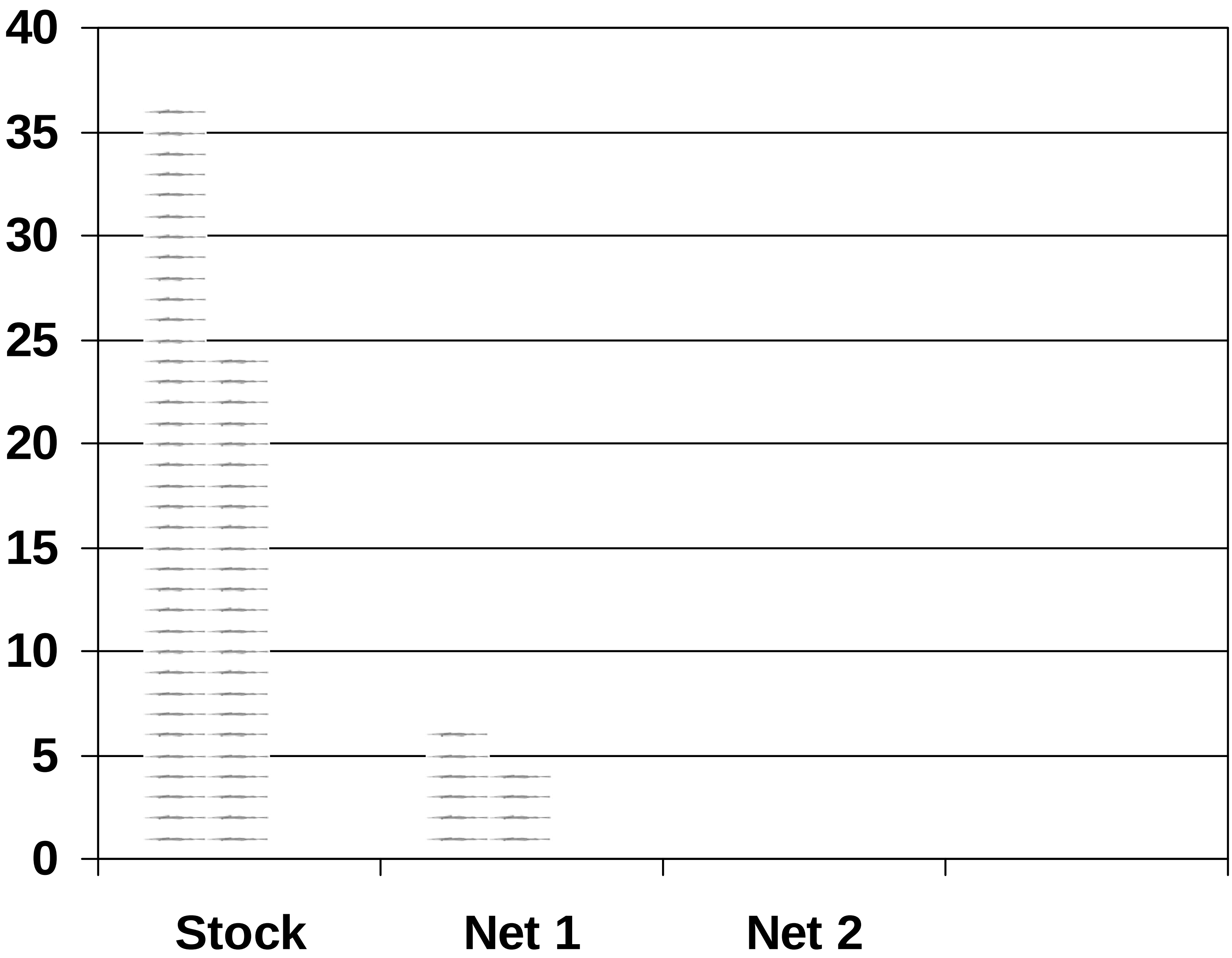
5
0
Stock
Net 1
Net 2

When the total stock declines, the amount in the sample declines.





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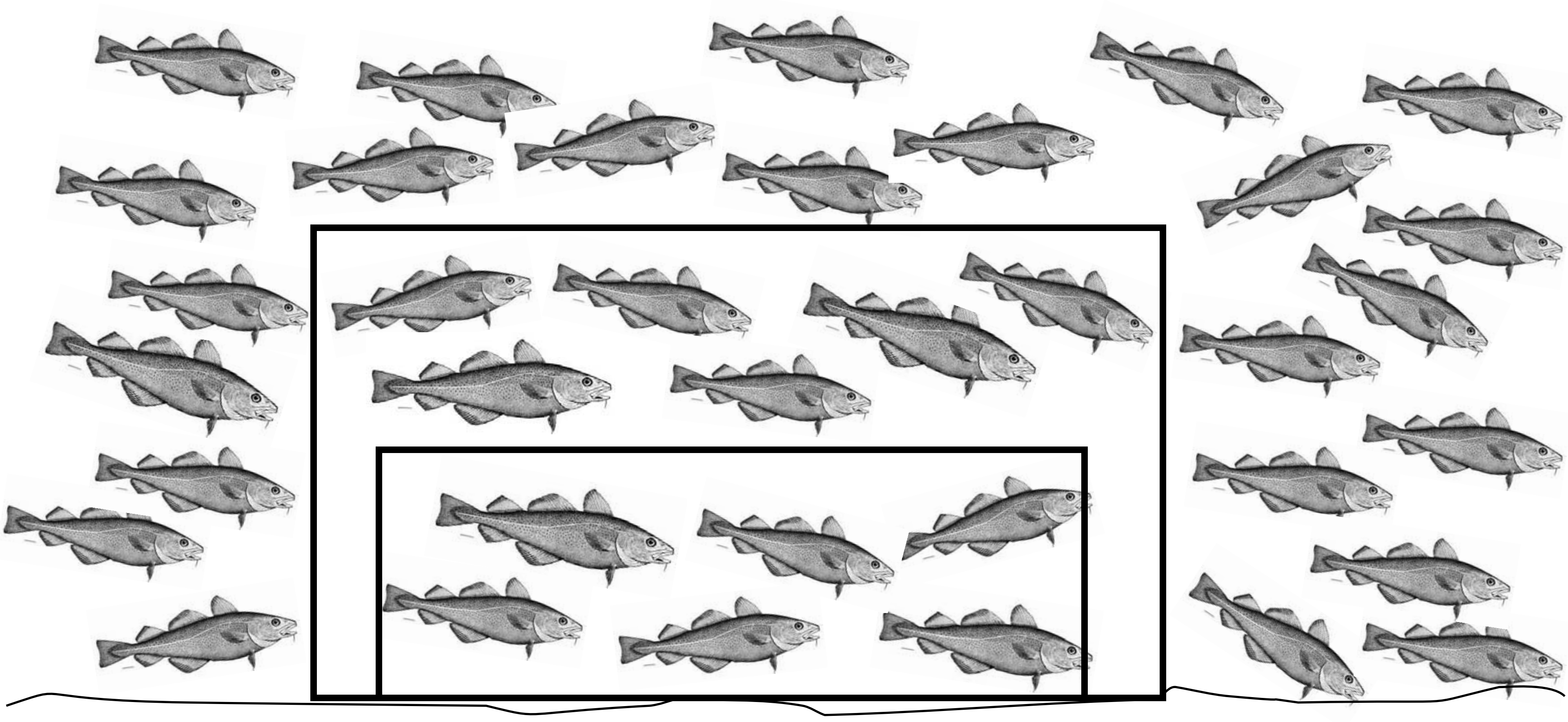
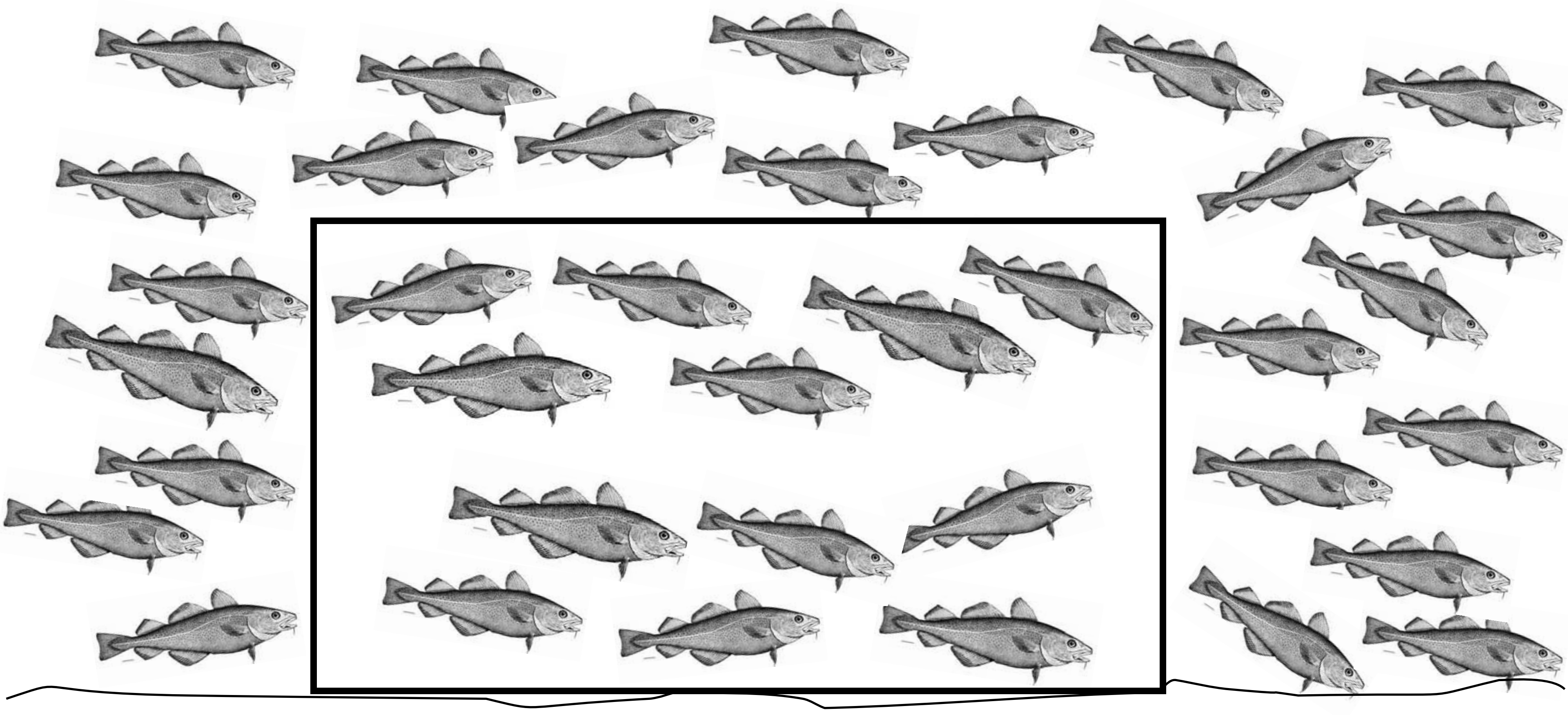
0
Stock
Net 1
Net 2

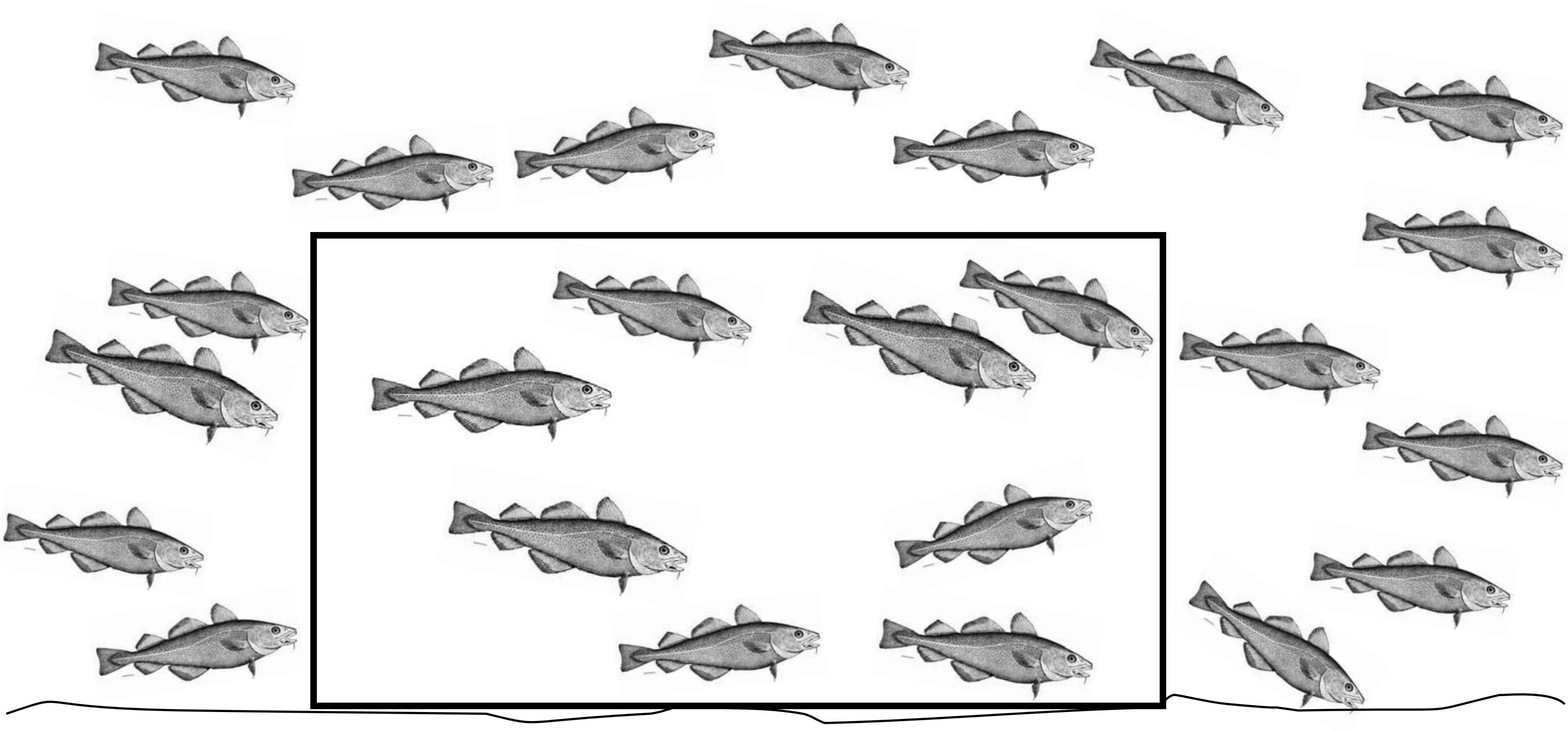
Increasing the size of the sample does not increase the abundance of fish.

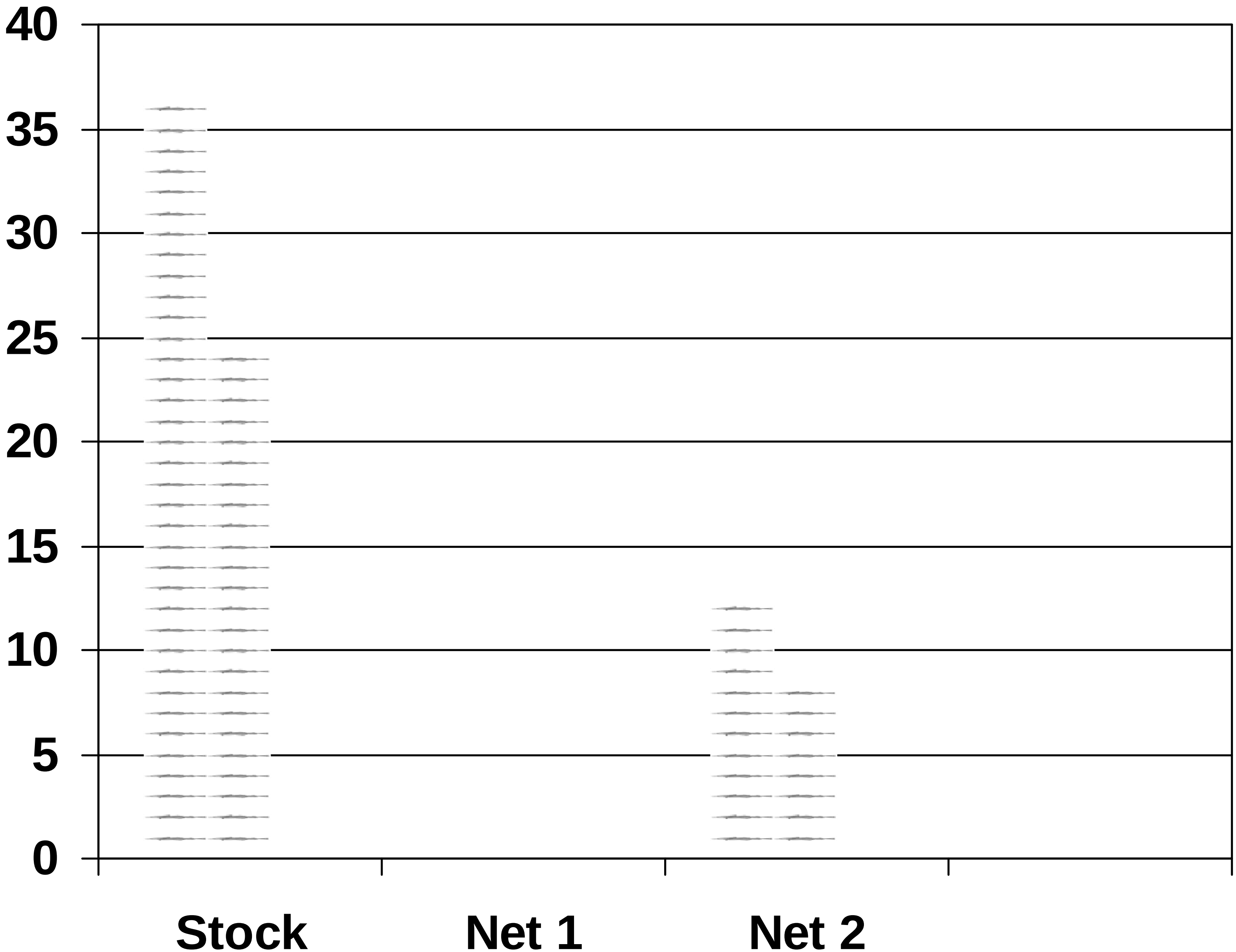


Increasing the size of the sample does not increase the abundance of fish.

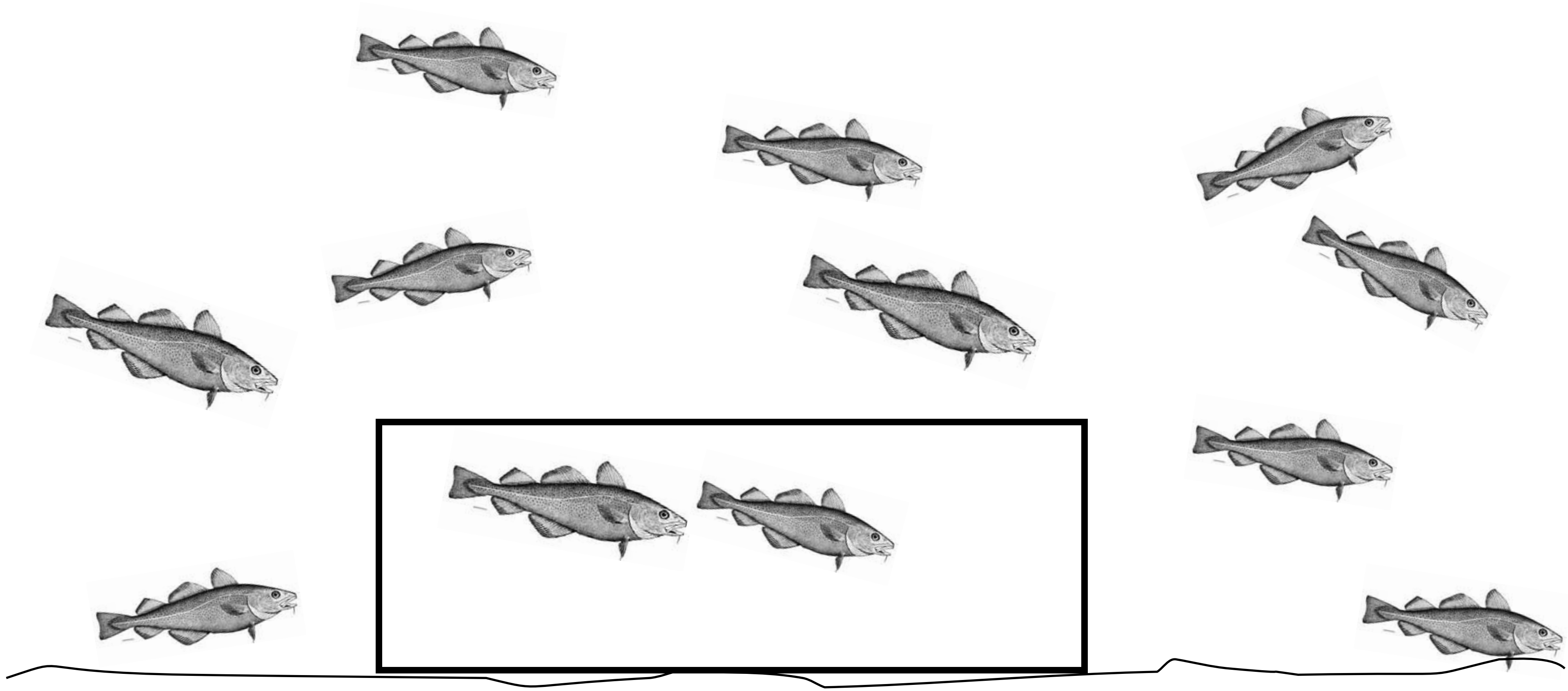


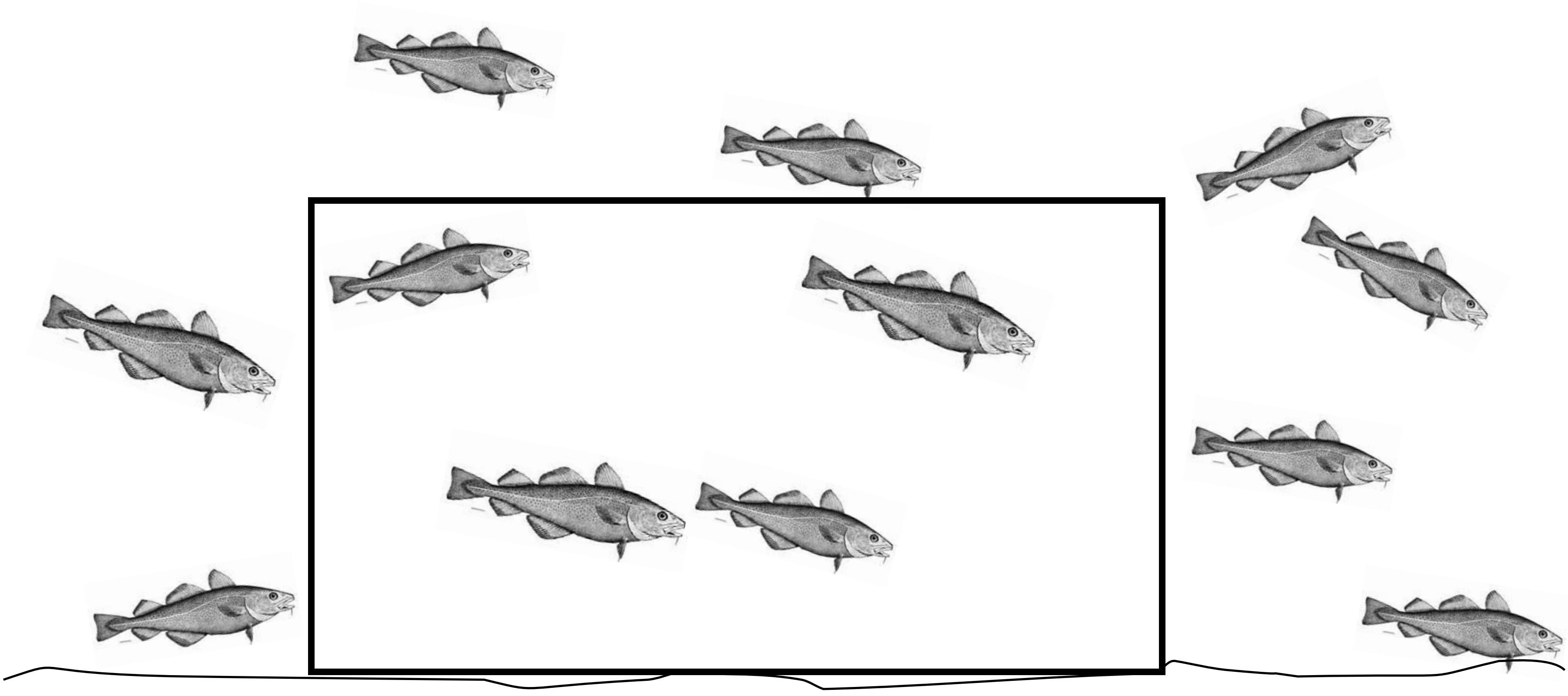
When the total stock declines, the amount in the sample declines.

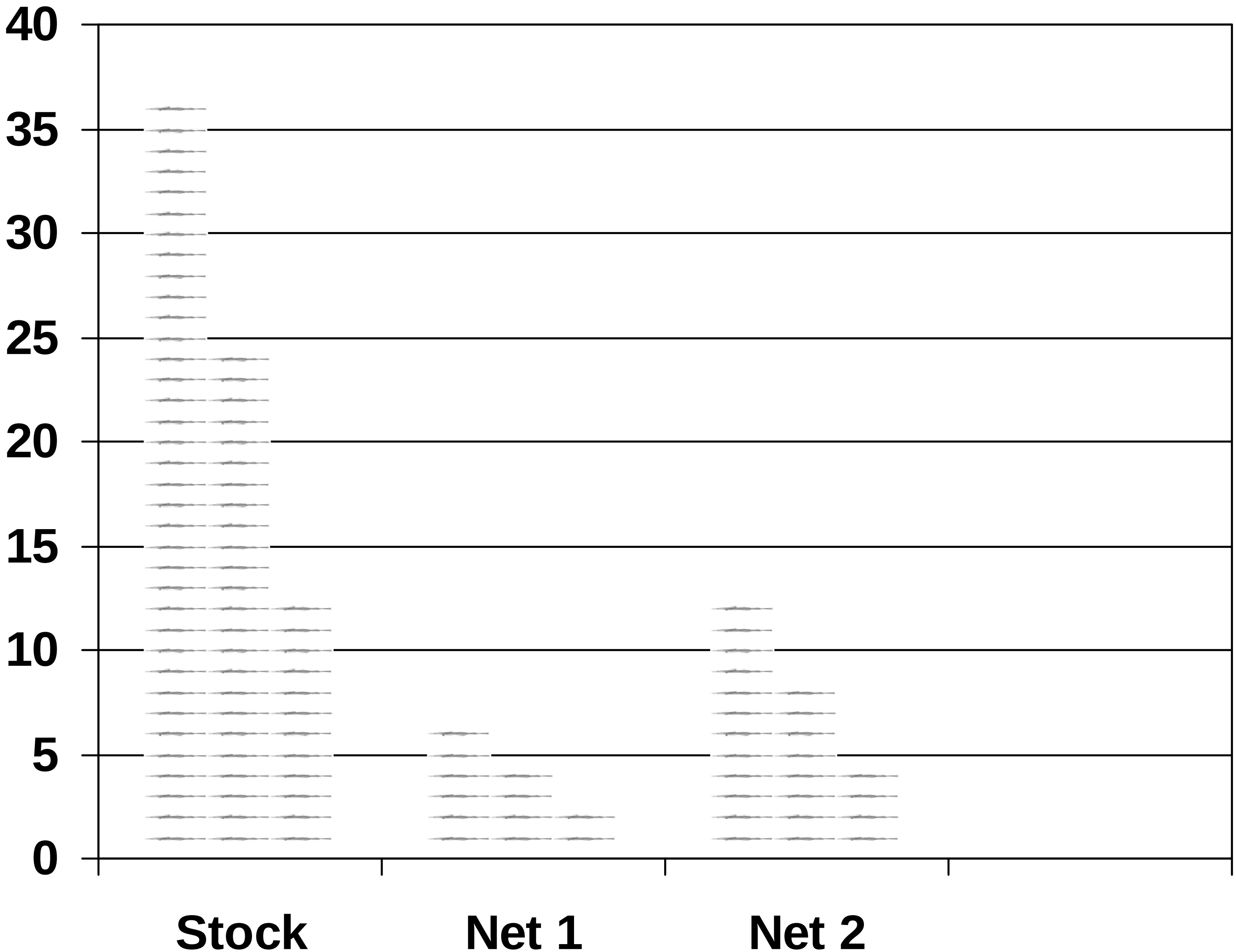




40
35
30
25
20
15
10
5
0
Stock
Net 1
Net 2






40
35
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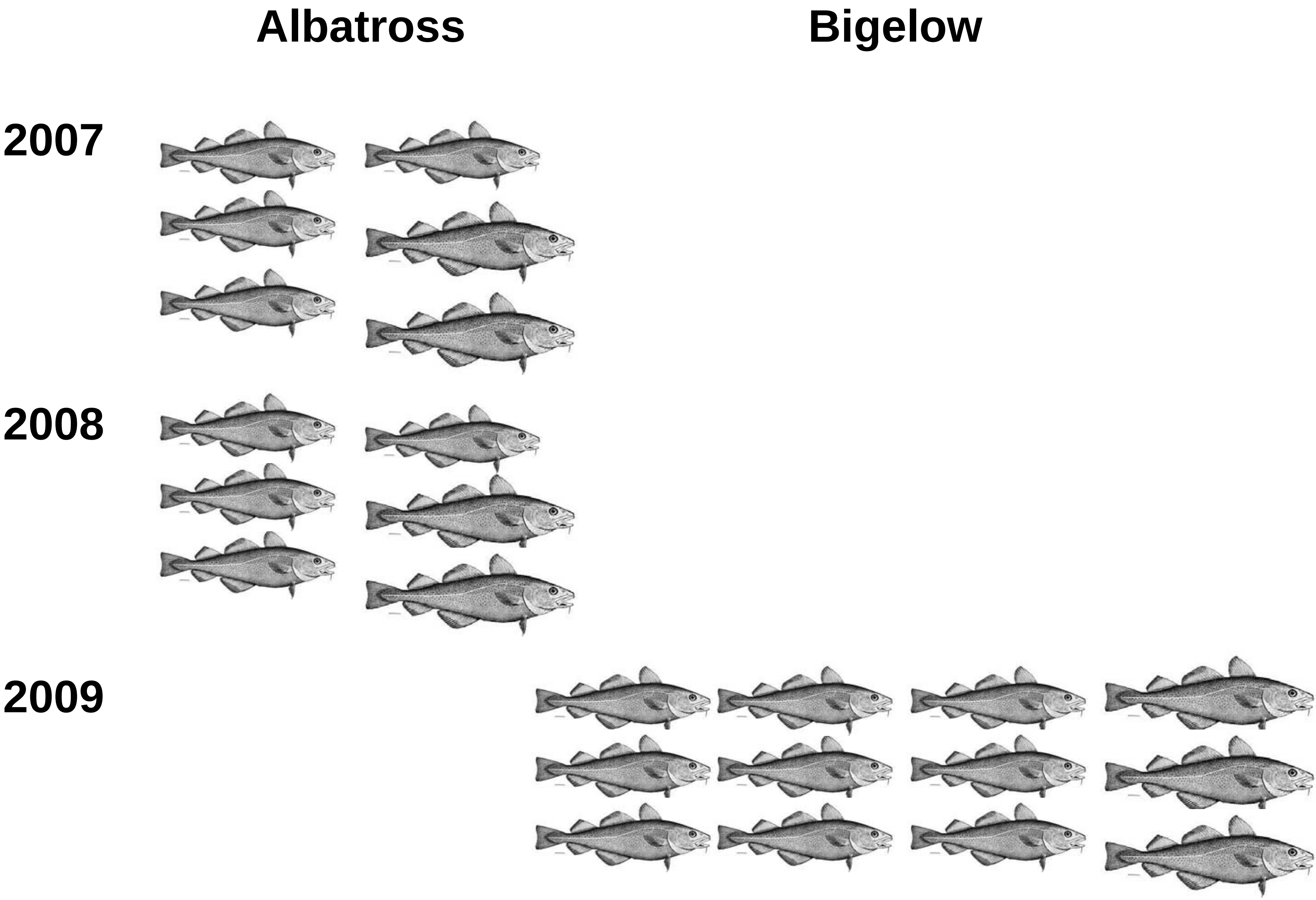
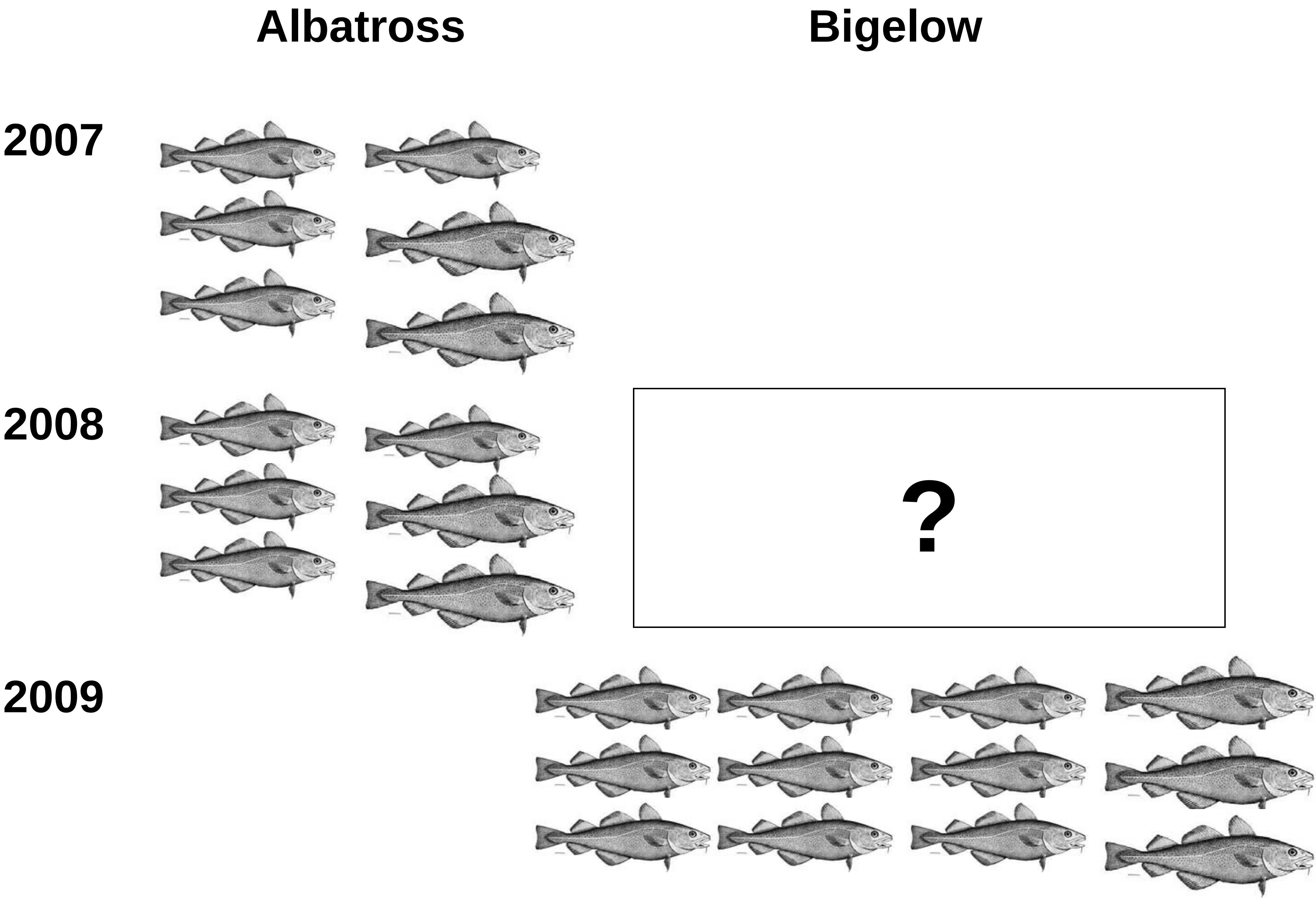
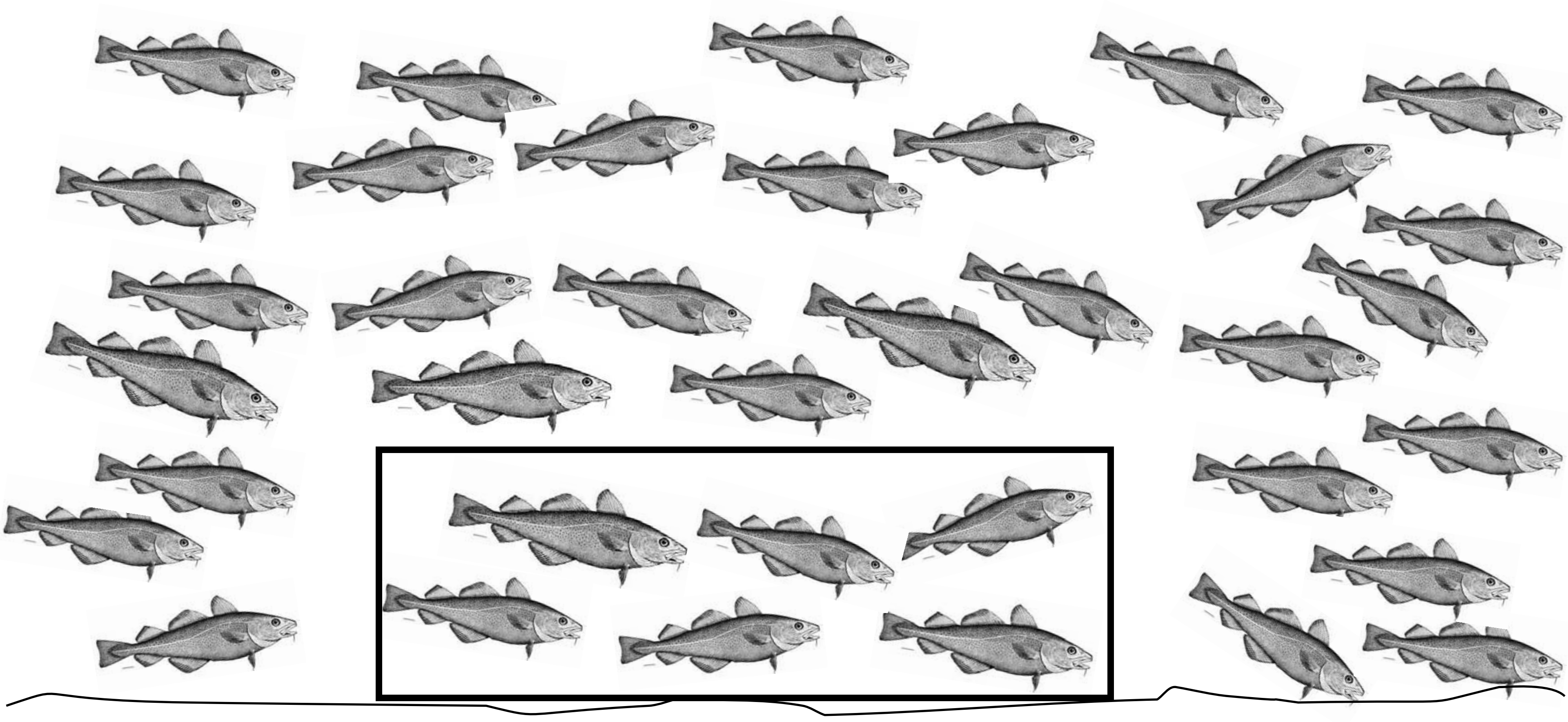
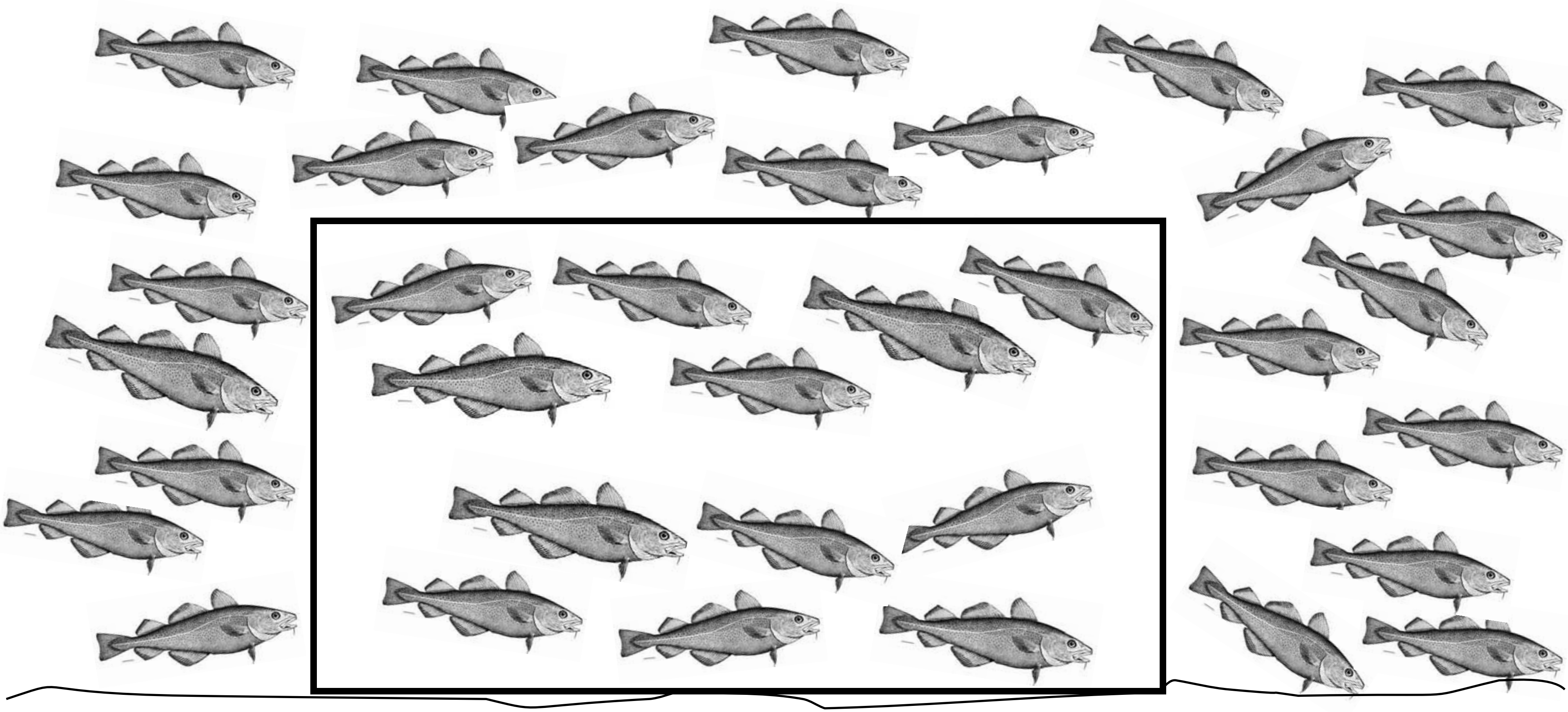
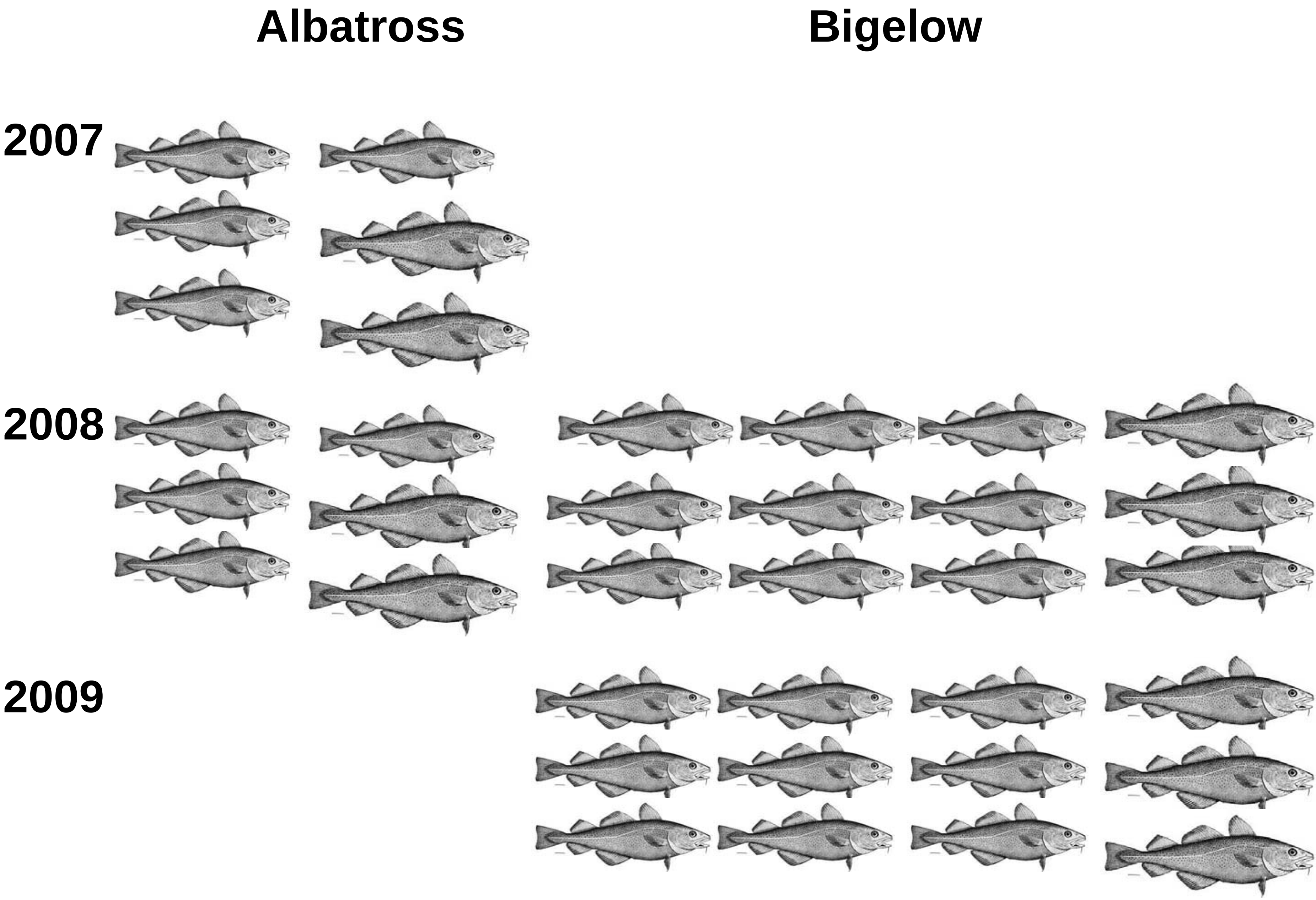
Stock
Net 1
Net 2


Albatross
Bigelow
2007
2008
2009


Albatross
Bigelow
2007
2008
2009
?






Albatross
Bigelow
2007
2008
2009

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Calibration Workshop
2. Process
11-13 August 2009

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Context

- Many changes that affect survey catchability (q)
- Simultaneous calibration for the net effect of all changes (vessel, trawl gear, protocols)
- Short term (1-6 years) needed even if long term solution is two separate time series

Process

1. Experimental design: 27-27 April 2007
2. Experiment execution: 2008
3. Products:
   - Reviewers' reports: 11-13 August 2009 (3)
   - Science reports (Final documents in prep.)
4. Individual assessment applications

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Vessel Calibration Analysis Review

11-13 August 2009

Stephen H. Clark Conference Room

Northeast Fisheries Science Center

Woods Hole, MA 025540

Chair: Mr. Stephen Walsh (DFO Canada, retired)

Dr. Stephen Smith (DFO Canada)

Dr. Mark Kaiser (Iowa State University

http://www.nefsc.noaa.gov/nefsc/saw/

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Vessel Change

Vessel Characteristics	Albatross IV	Delaware II	Henry Bigelow
Length	57.0	47.4	63.6
Width (m)	9.8	9.1	15.0
Draft	5.1	5.0	6.0 Centerboard Up
Displacement (mt)	987.9	687.6	2,479
Shaft Horsepower	1,130	1,230	3,016
ICES Radiated Noise	No	No	**Yes**

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Vessel Change

Vessel Characteristics	Albatross IV	Delaware II	Henry Bigelow
Drive	Direct	Direct	Indirect
Number of Maine Engines	2 Diesel	1 Diesel	2 Electric Motors powered by up to 3 diesel generators
Propeller Type	Variable Pitch	Fixed Pitch	Highly Skewed Fixed Pitch
Rudder Type	Kort Nozzle	Standard	Becker High-Lift
Autotrawl	Fixed Warps	Fixed Warps	**Autotrawl**
Distance between tow points	3.0 m	4.9 m	**11.3 m**

Gear Change

Gear Characteristics	Albatross IV Yankee 36		Henry Bigelow 4 Seam 3 Bridle
Wing Spread (m)	10-12		12-14
Door Spread (m)	18-24		30-36
Headrope Height (m)	1-2		4-5
Mesh (Body) (cm)	12.7 (5”)		12 to 6 to 3 taper
Mesh (Codend liner) (cm)	1.27 (0.5”) hexagon		2.54 (1”) diamond

Gear Change

Gear Characteristics	Albatross IV Yankee 36		Henry Bigelow 4 Seam 3 Bridle
Door Type	Euronet Polyvalent , 450 kg.		2.2 m^2 Poly-Ice Oval 550 kg.
Bridle angle	20-29		11-15
Sweep	Roller		Rockhopper

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Summary of Protocol Changes

	1963-2008	2009 – 20??
Tow Speed	3.8 knots	3.0 Knots
Tow Duration	30 minutes	20 minutes
Tow Definition	Winch Lock to Winch Reengage	Actual Bottom Time
Tow Distance	1.9 nm	1.0 nm

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1. Experimental Design Workshop

25-27 April 2007

Shadow surveys: Both vessels undertake regular stratified random survey, pairing tow-by-tow

Site-specific stations: Both vessels occupy areas of high fish concentration and diversity, pairing tow-by-tow

Separate the vessels by 0.25- 1 n.m. to minimize disturbance effects by first vessel.

Evaluate effects of rockhopper vs. cookie sweep in later experiments, to maximize precision of rockhopper-based estimates

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2. Execution

- **636 Usable Paired Tows**

- **Spring: March 9 – May 16, 2008**
  - Shadow stratified random stations only
  - 190 usable tows
- **June: May 28 – June 8, 2009**
  - Site specific stations only
  - 124 usable tows
- **September 3 – November 14, 2009**
  - Shadow stratified random and site specific stations
  - 251 stratified random and 71 site specific tows

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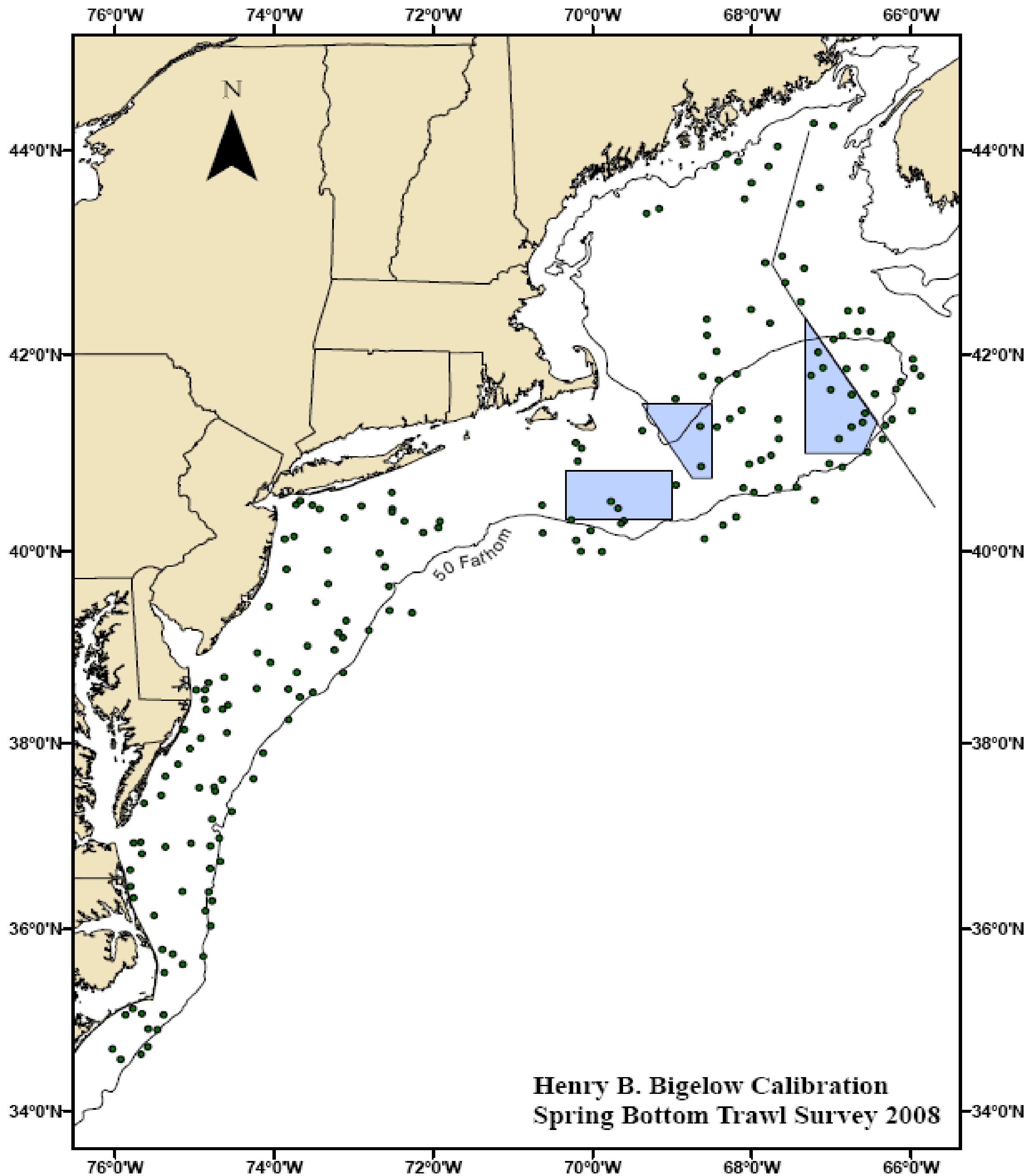
Spring Calibration Station Locations

- Spring 2008
- 190 usable pairs
- All stratified random
- plotted based on Bigelow start tow location



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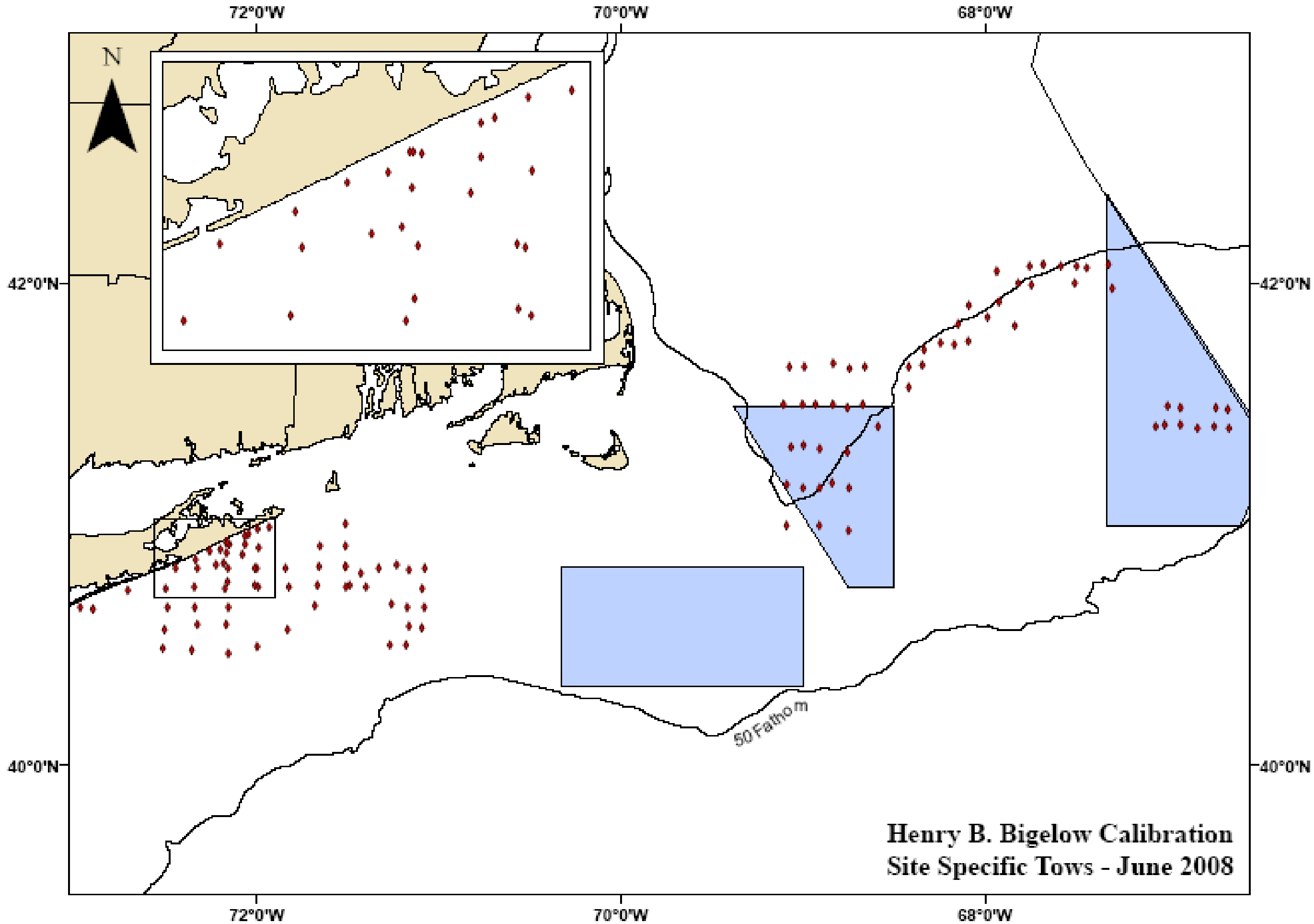
June Calibration Station Locations

- **June 2008**
- **124 usable pairs**
- **all site specific**



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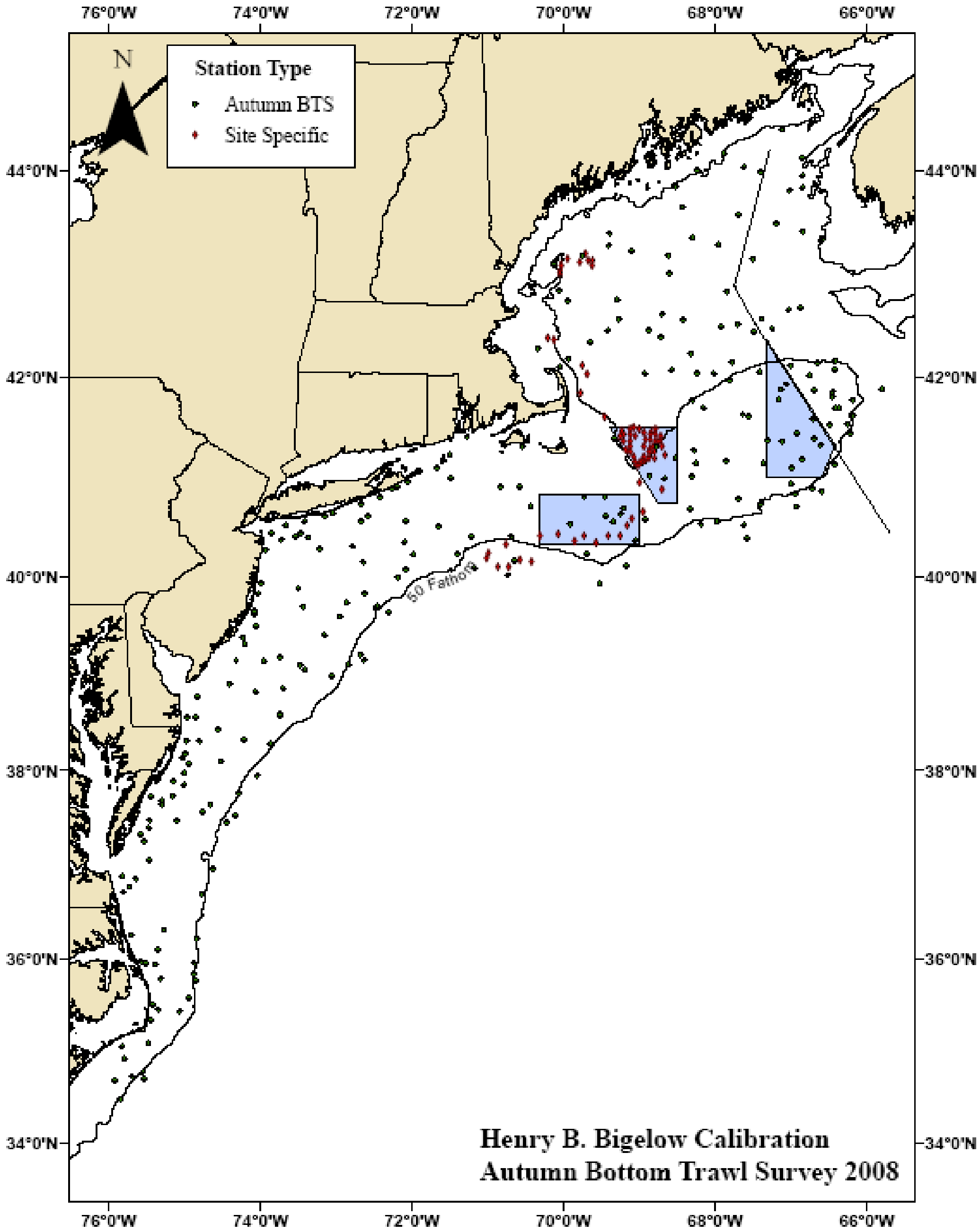
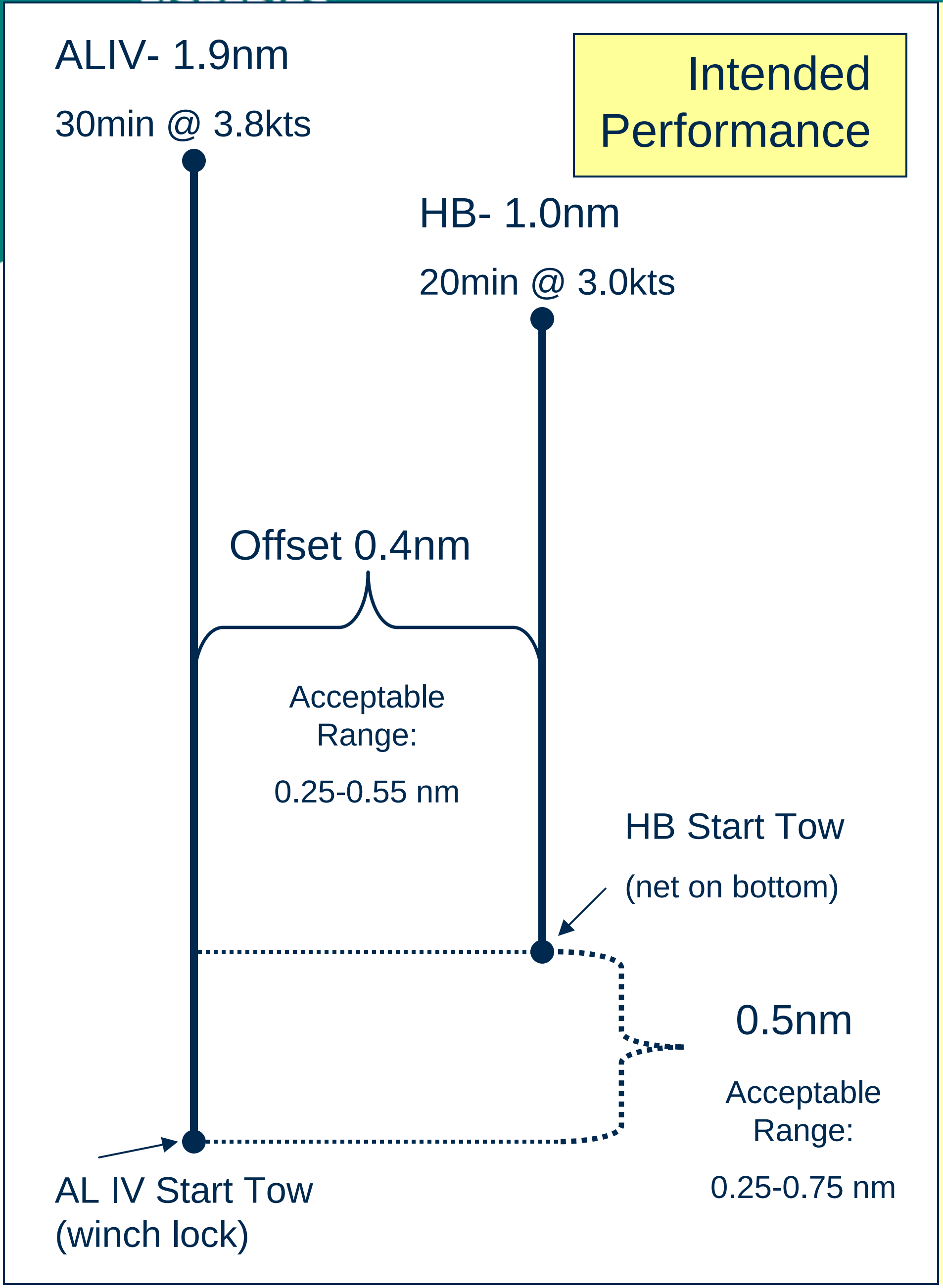
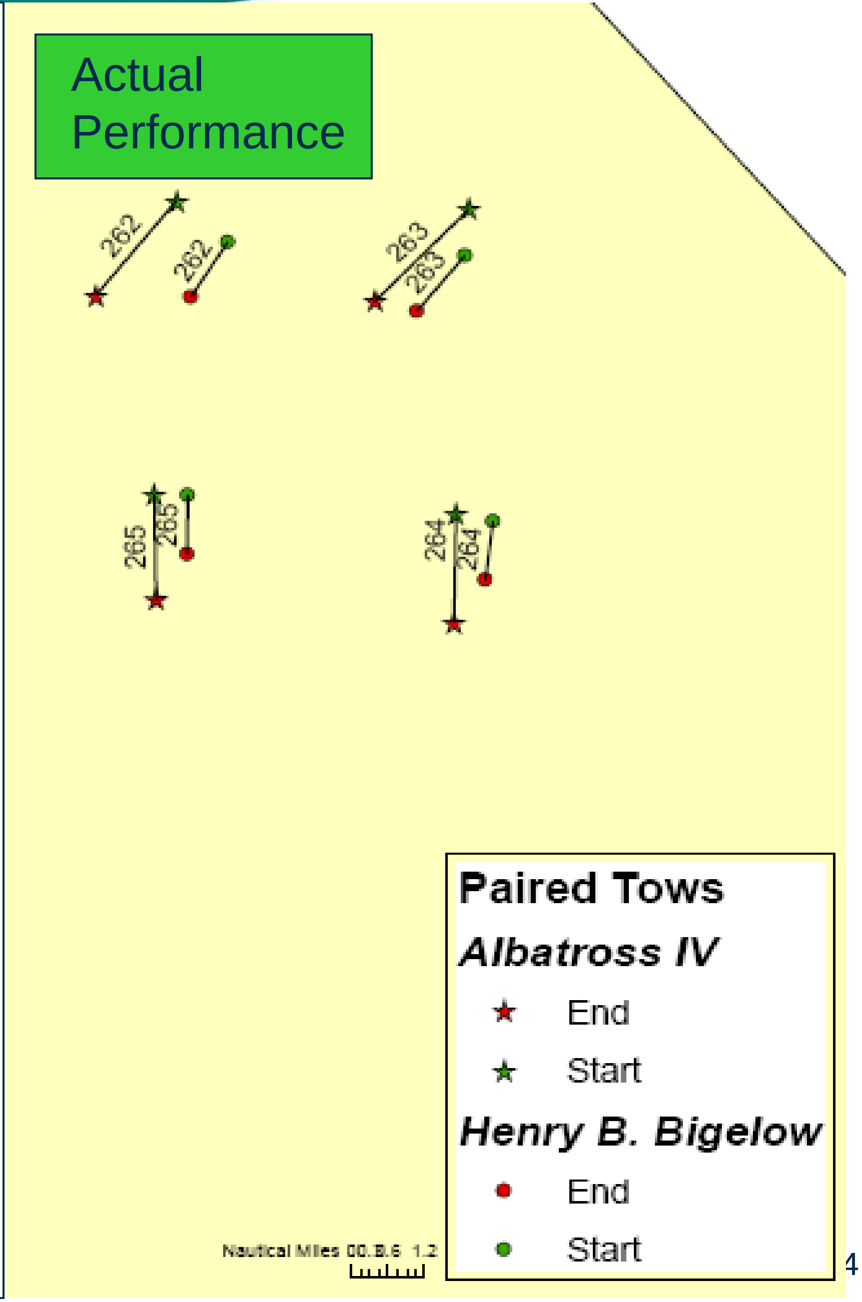
Autumn Calibration Station Locations

- Autumn 2008
- 322 usable pairs
  - 251 stratified random
  - 71 site specific
- plotted based on Bigelow start tow location



Spatial Offset





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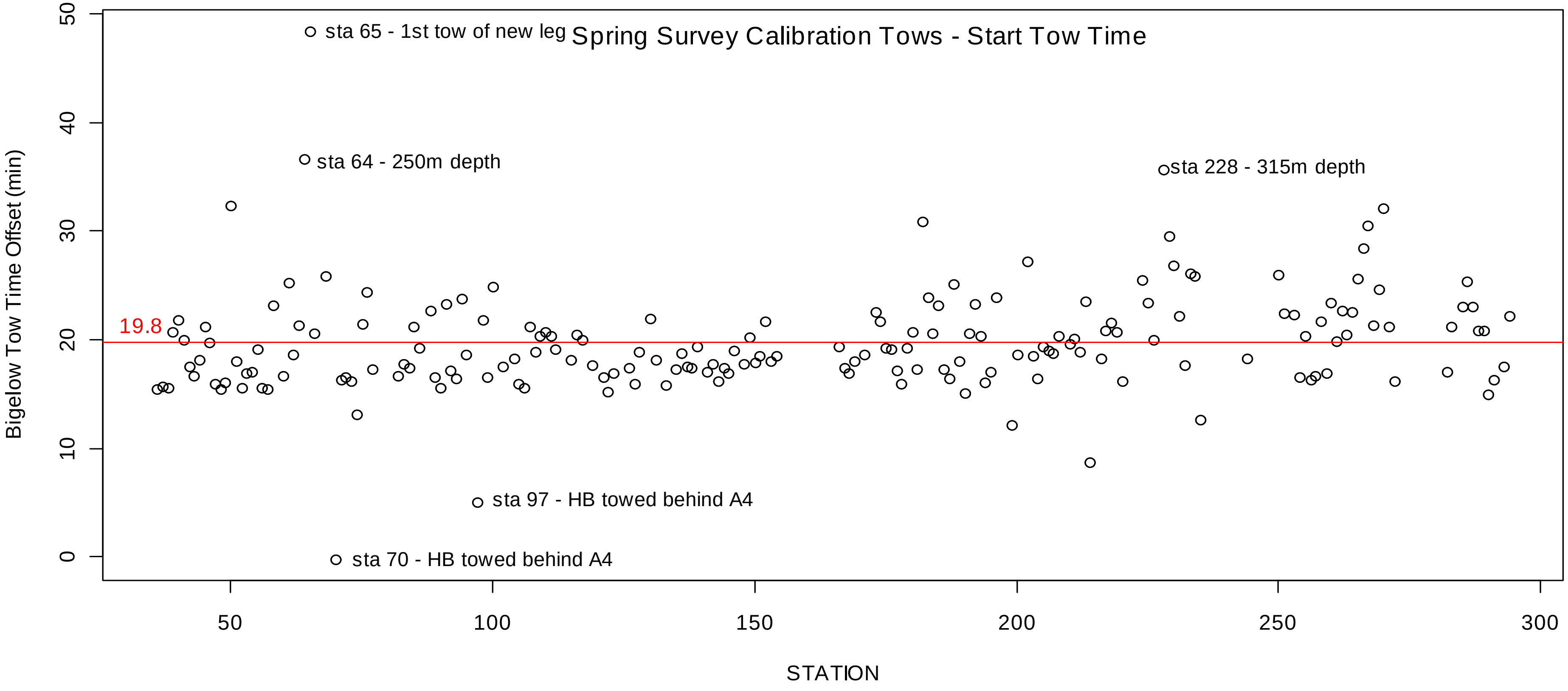
Data Screening

Paired tow performance

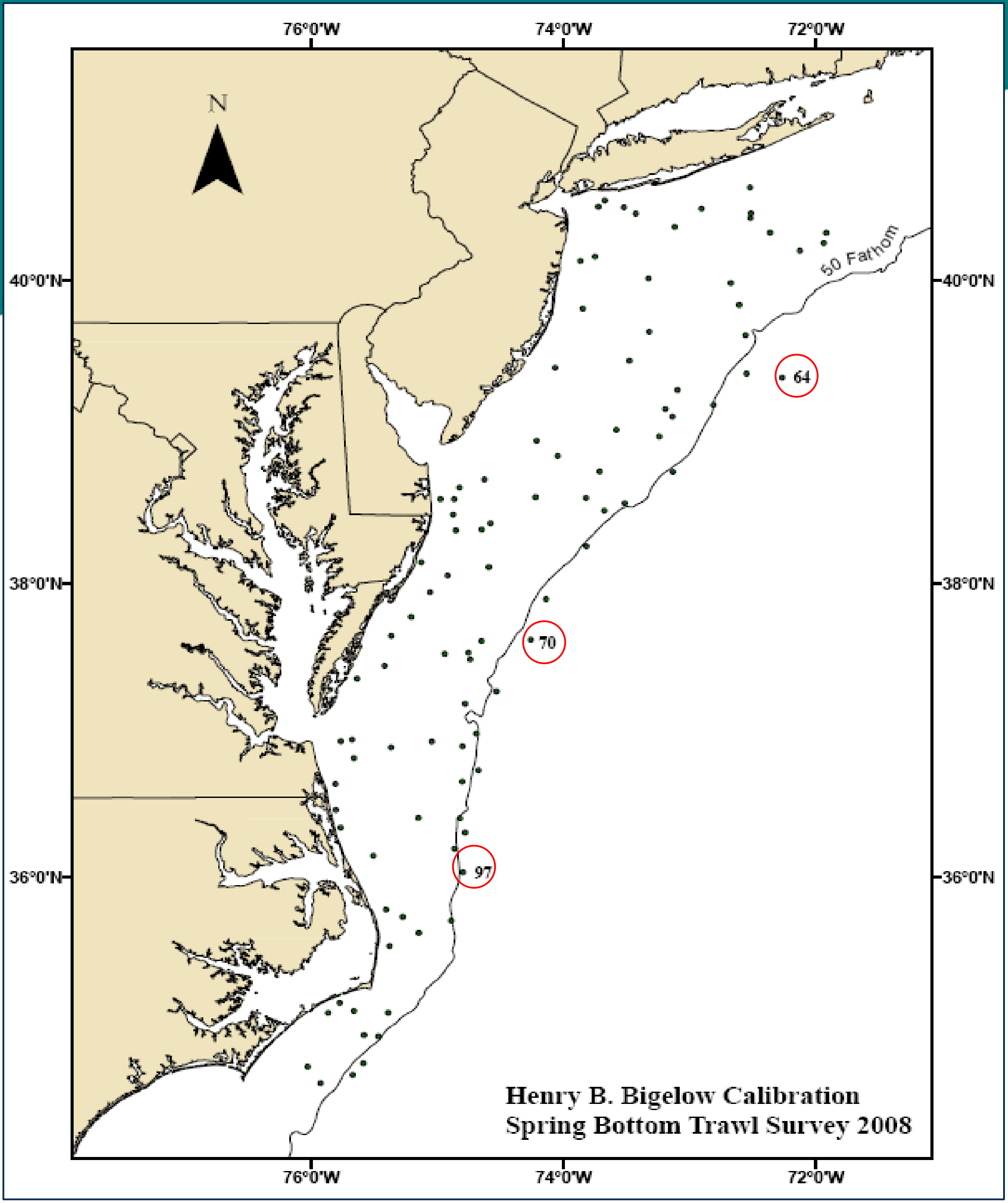
- Headings; temporal, spatial offsets

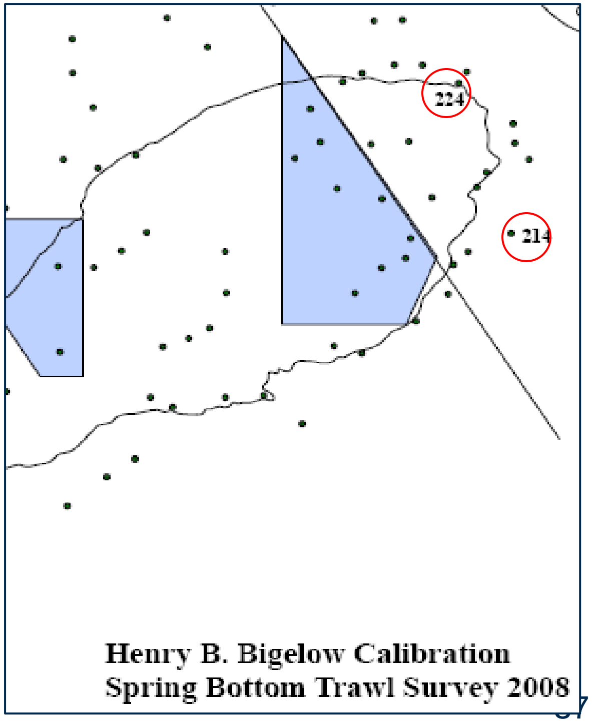
Gear performance

Temporal Offset



Identifying Outliers





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Tow Evaluation Criteria

Historical (Albatross IV)

—Station, Haul, Gear (SHG)

- Fairly liberal tow acceptance criteria
- Matched historical data before tows were coded

Current (FSV Henry Bigelow)

—Tow, Operations, Gear, Acquisition (TOGA)

- Tow Type: stratified randow, non-random, comparison, etc.
- Operational: tow duration, vessel speed, stratum boundaries, scope ratio, trawl geometry
- Gear Condition: No damage, representative tow, non-representative tow
- Acquisition of data: vessel and sensor data quality

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3a. Descriptive Results

Sample sizes by species

Length frequency distributions

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Results: +/+, +/0 and 0/+ Tows by Species

Species	$+_{Big}$ / $+_{Alb}$	$+_{Big}$ / 0_{Alb}	0_{Big} / $+_{Alb}$
Silver Hake	407	81	11
Loligo Squid	346	63	13
Spiny Dogfish	342	52	39
Red Hake	283	95	18
Butterfish	278	78	31
Little Skate	252	137	3
Sea Scallop	204	99	12
Atlantic Herring	198	76	32
Illex Squid	195	98	39
4-Spot Flounder	143	46	14

+/+, +/0 and 0/+ Tows by Species

Species	$+_{Big}$ / $+_{Alb}$	$+_{Big}$ / 0_{Alb}	0_{Big} / $+_{Alb}$
Winter Skate	177	104	11
Longhorn Sculpin	167	61	5
Spotted Hake	161	92	13
Haddock	160	27	20
American Plaice	152	45	13
Summer Flounder	146	53	13
Yellowtail Flounder	143	46	14
Winter Flounder	131	38	15
White Hake	128	56	16
Redfish	117	18	8

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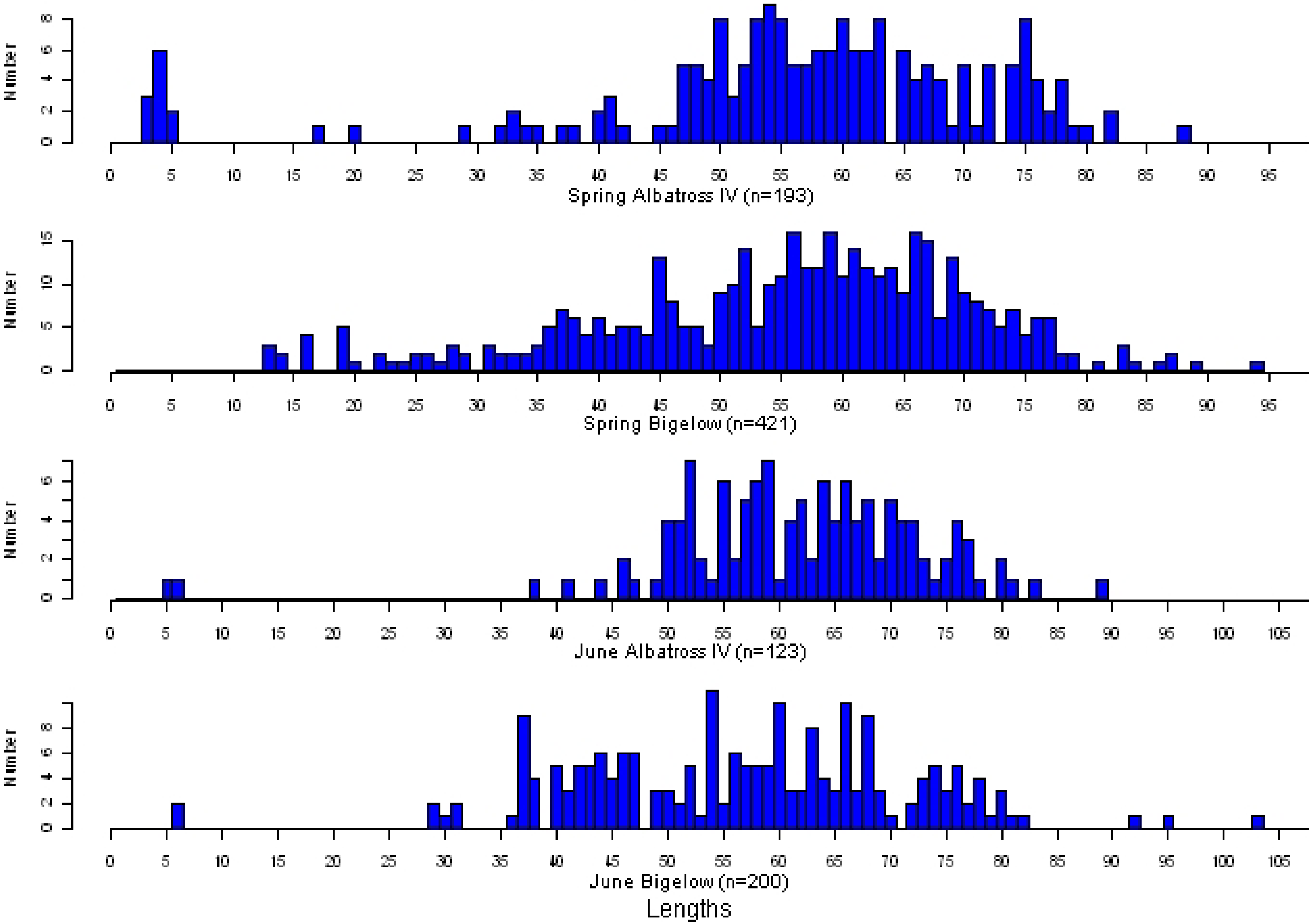
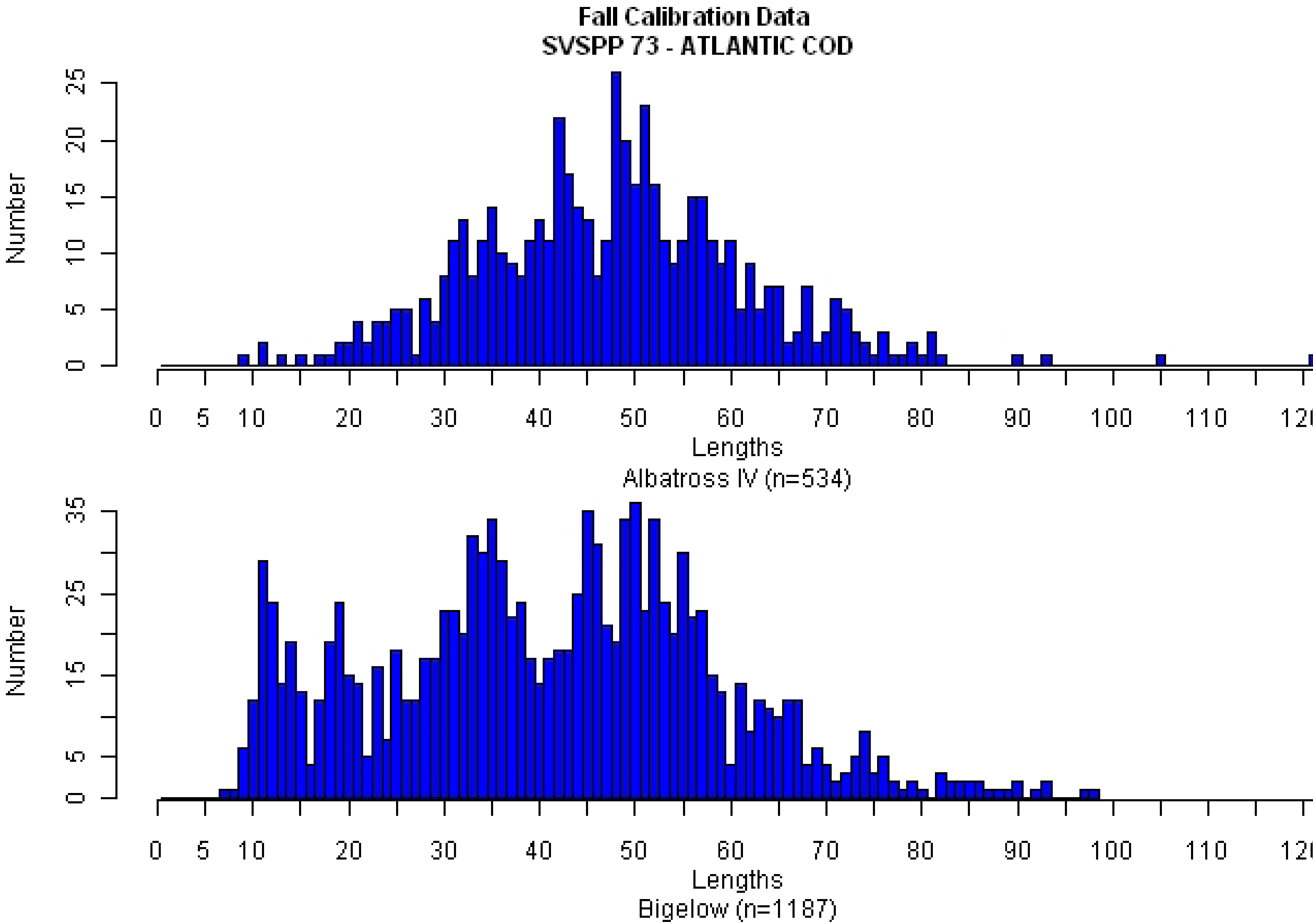
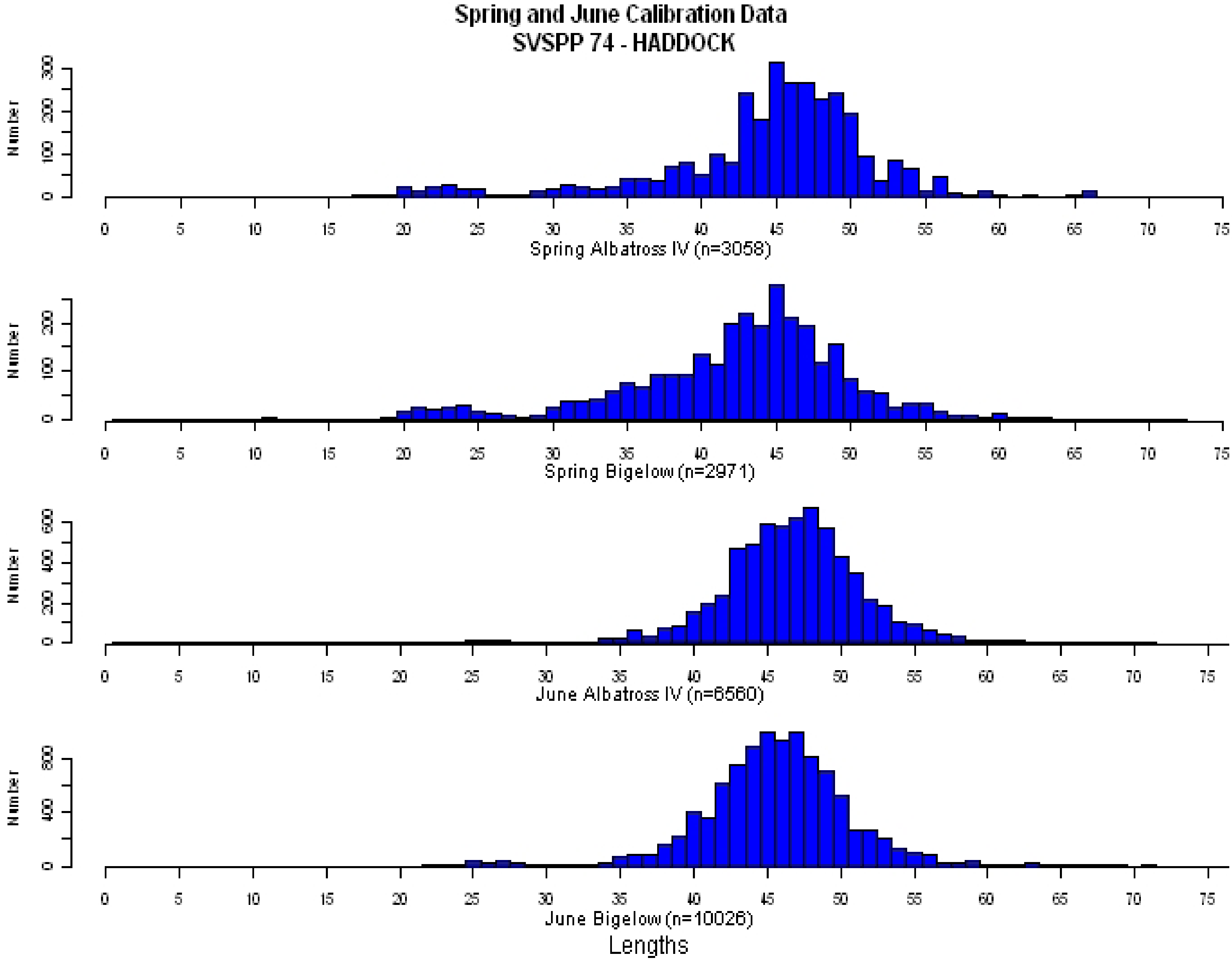
Problematic Species
+/+, +/0 and 0/+ Tows by Species

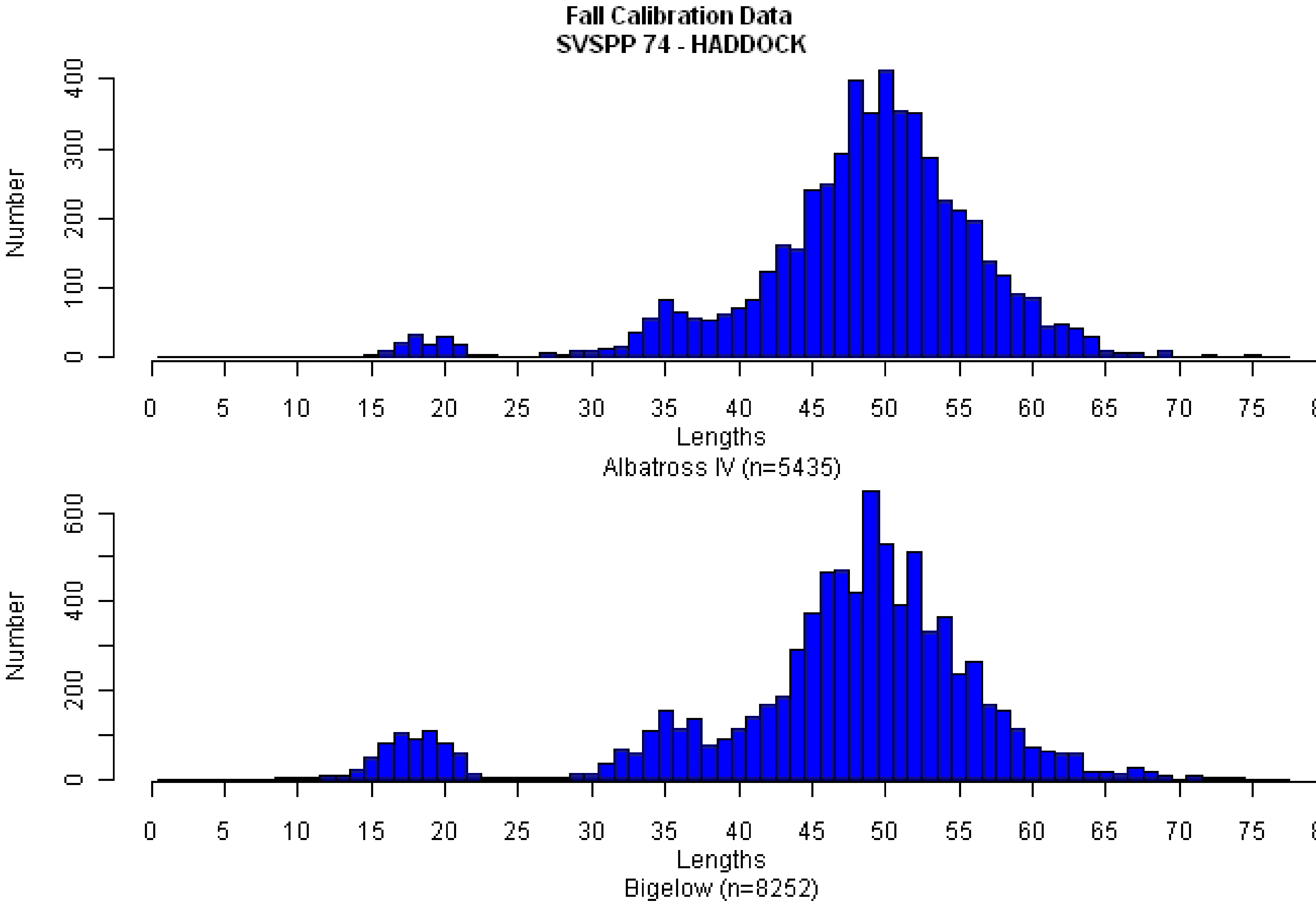
Species	$+_{Big}$ / $+_{Alb}$	$+_{Big}$ / 0_{Alb}	0_{Big} / $+_{Alb}$
Goosefish (Monkfish)	76	209	9
Thorny Skate	49	61	5
Pollock	29	15	29
Rosette Skate	12	19	2
Offshore Hake	7	4	1
Striped Bass	6	9	13
Atlantic Halibut	5	7	10
Cusk	4	15	5
Wolfish	3	14	2
Tautog	1	3	3

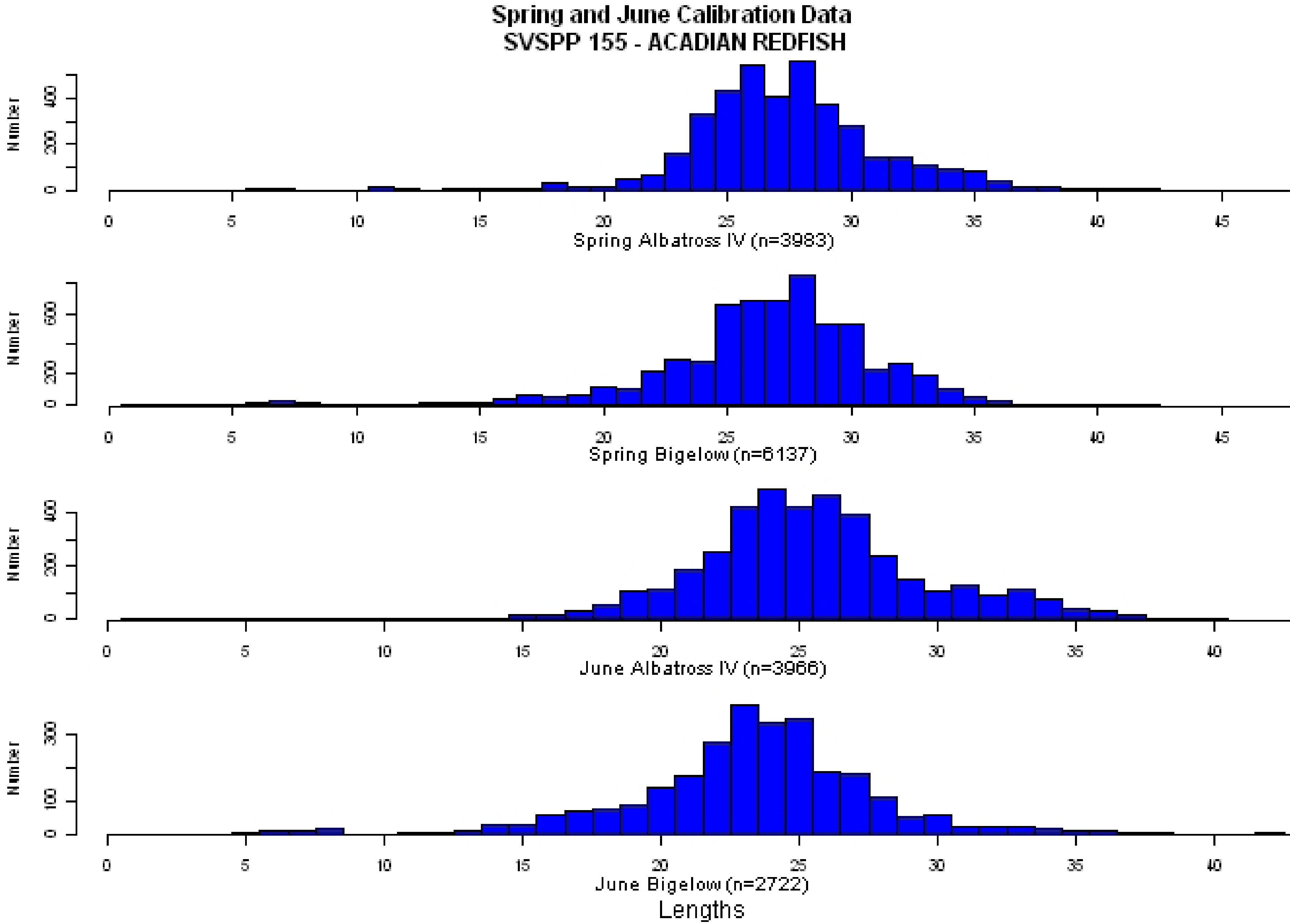
Spring and June Calibration Data
SVSPP 73 - ATLANTIC COD

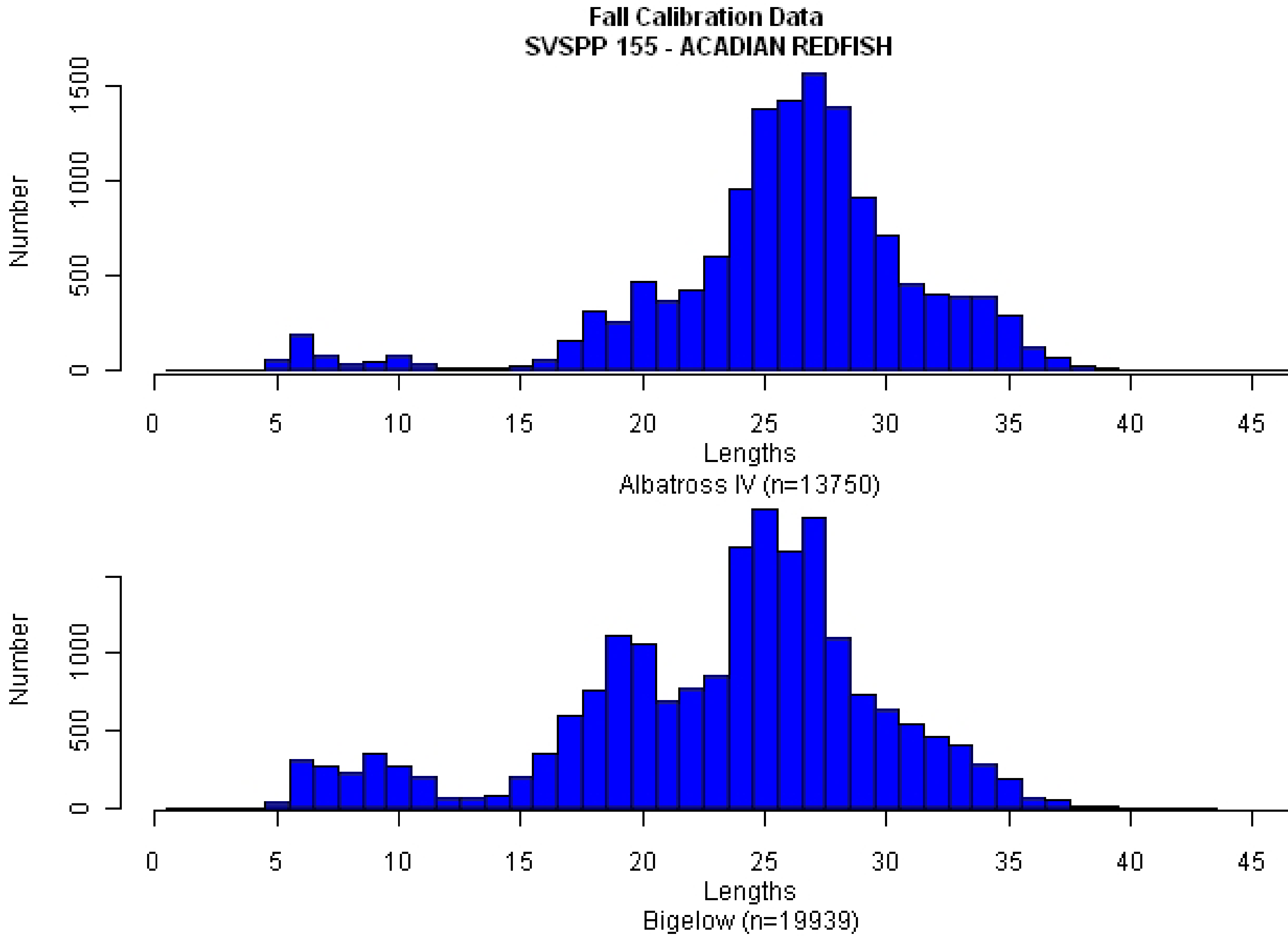



Fall Calibration Data
SVSPP 73 - ATLANTIC COD
Number
0
5
10
15
20
25
0
5
10
20
30
40
50
60
70
80
90
100
110
Lengths
Albatross IV (n=534)
Number
0
5
15
25
35
Lengths
Bigelow (n=1187)

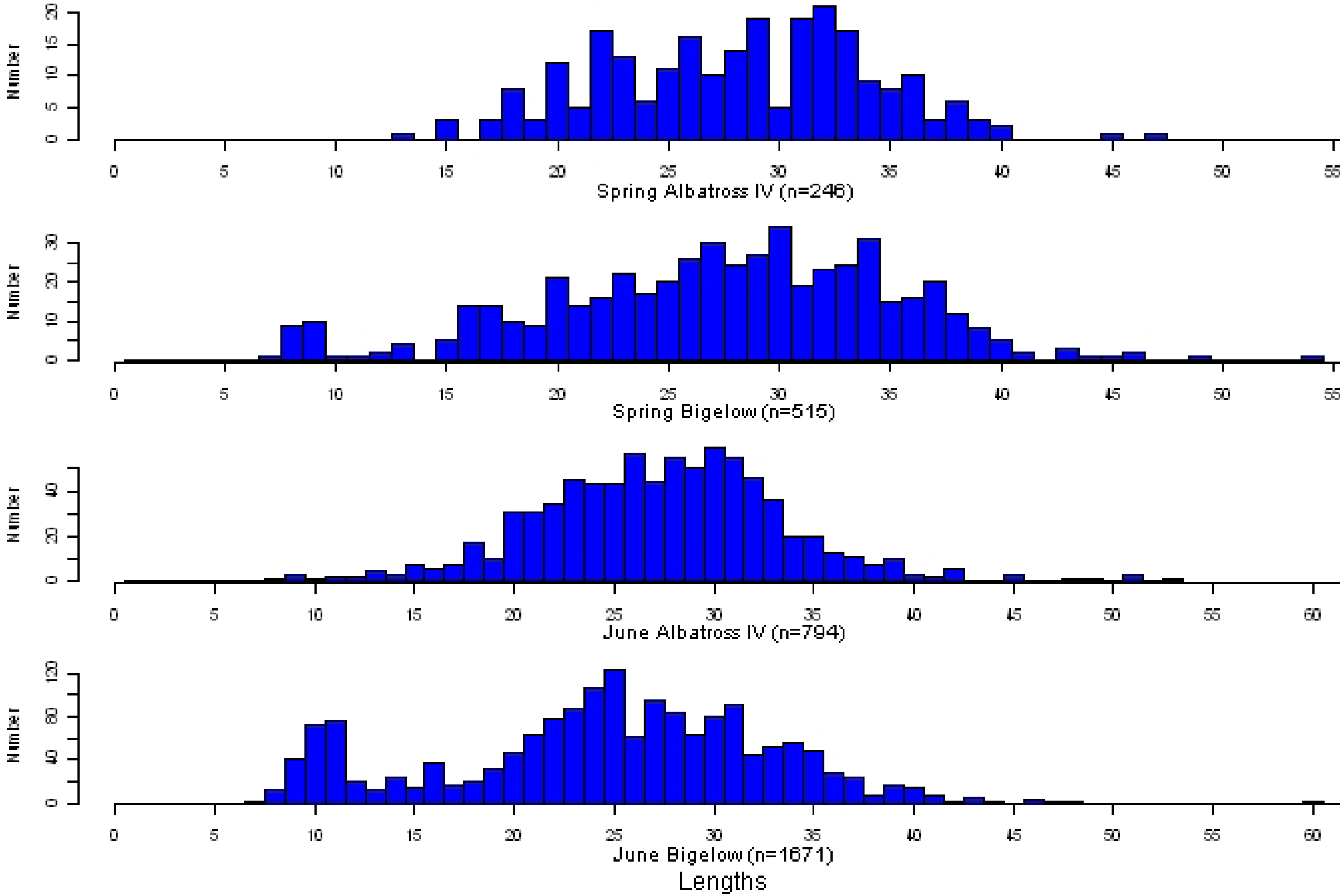

Spring and June Calibration Data
SVSPP 74 - HADDOCK
Number
Spring Albatross IV (n=3058)
Spring Bigelow (n=2971)
June Albatross IV (n=6560)
June Bigelow (n=10026)
Lengths

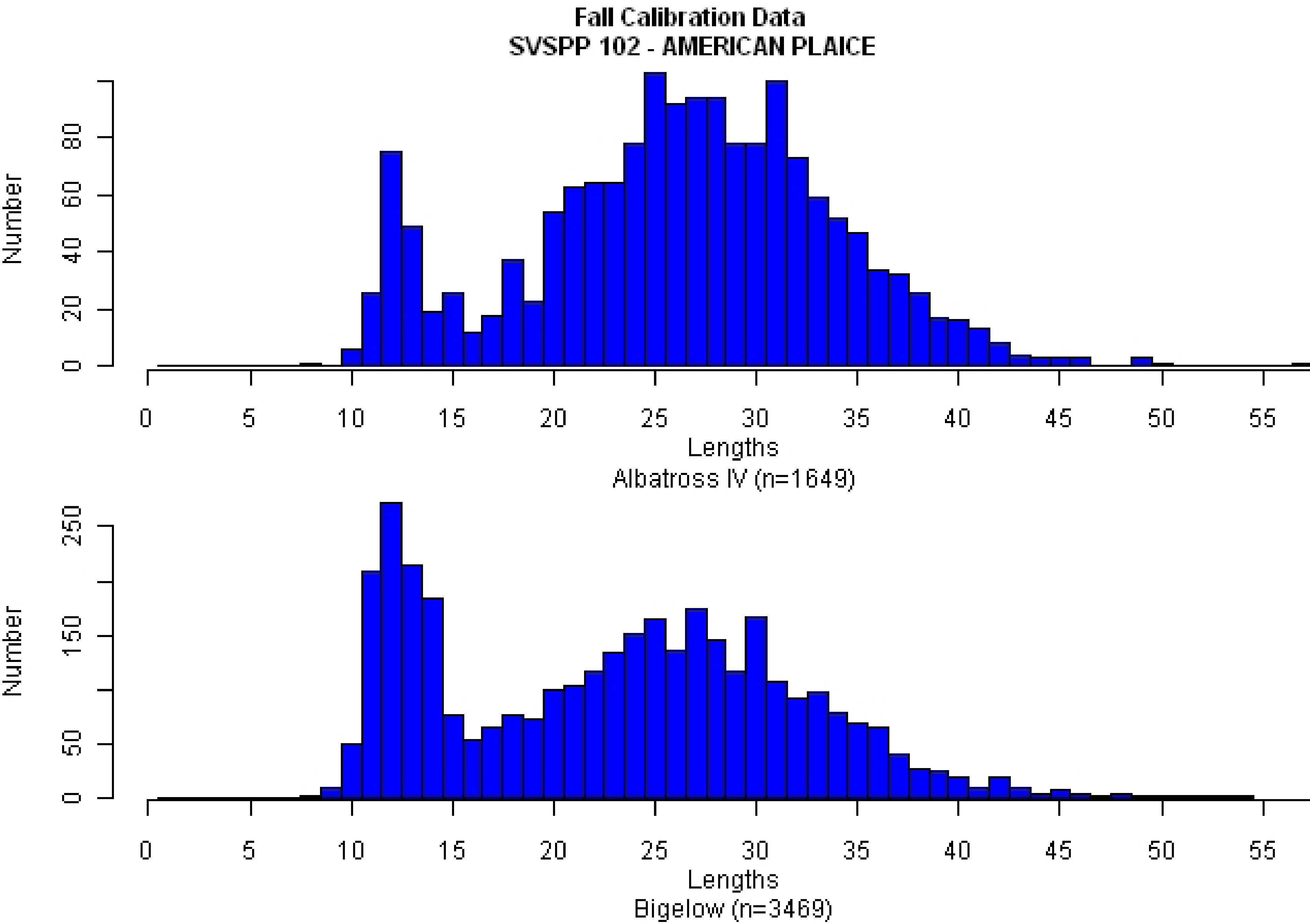

Fall Calibration Data
SVSPP 74 - HADDOCK
Number
0
100
200
300
400
0
5
10
15
20
25
30
35
40
45
50
55
60
65
70
75
Lengths
Albatross IV (n=5435)
Number
0
200
400
600
Lengths
Bigelow (n=8252)


Spring and June Calibration Data
SVSPP 155 - ACADIAN REDFISH
Number
Spring Albatross IV (n=3983)
Spring Bigelow (n=6137)
June Albatross IV (n=3966)
June Bigelow (n=2722)
Lengths

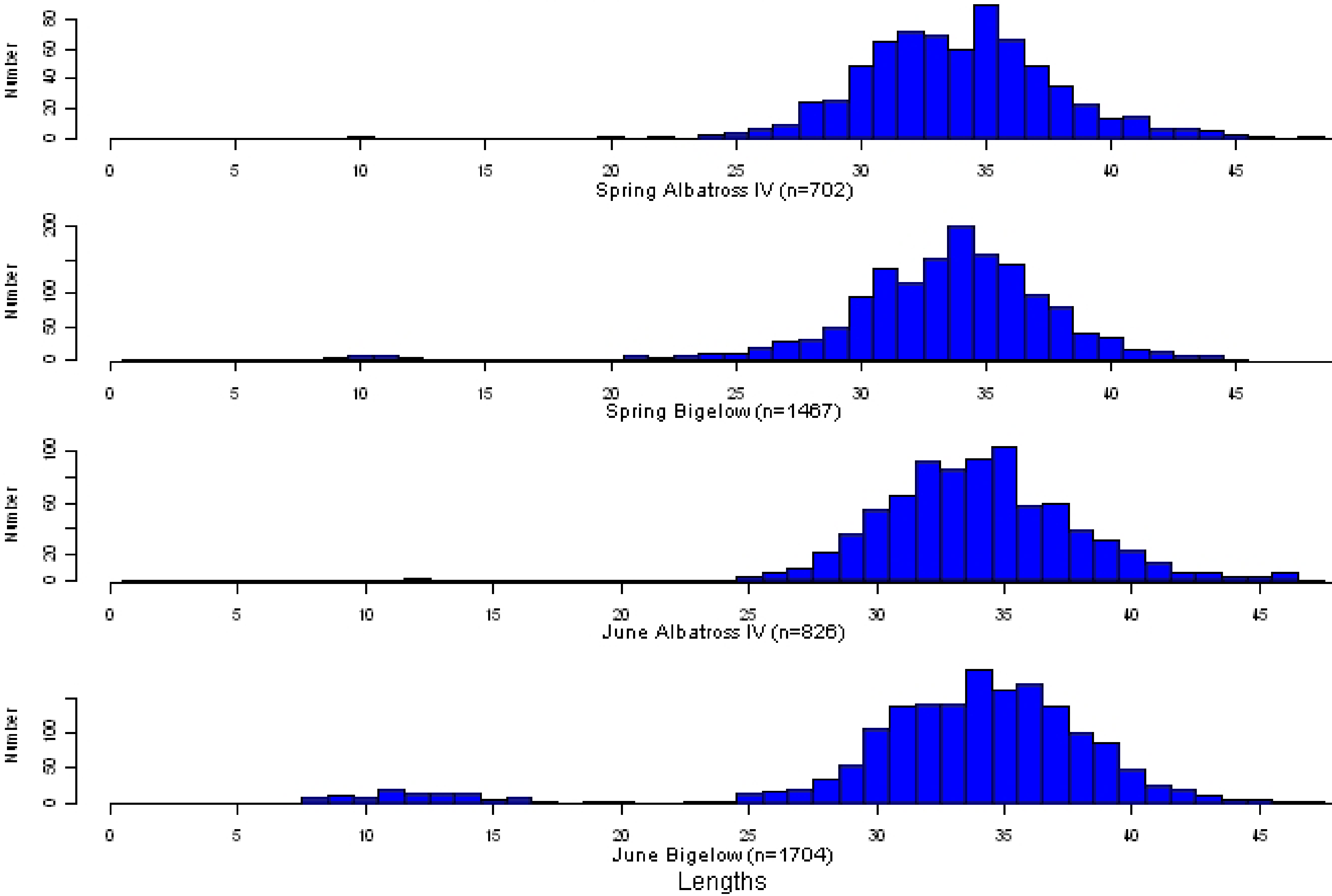

Fall Calibration Data
SVSPP 155 - ACADIAN REDFISH
Number
0
500
1000
1500
0
5
10
15
20
25
30
35
40
45
Lengths
Albatross IV (n=13750)
Number
0
500
1000
0
5
10
15
20
25
30
35
40
45
Lengths
Bigelow (n=19939)

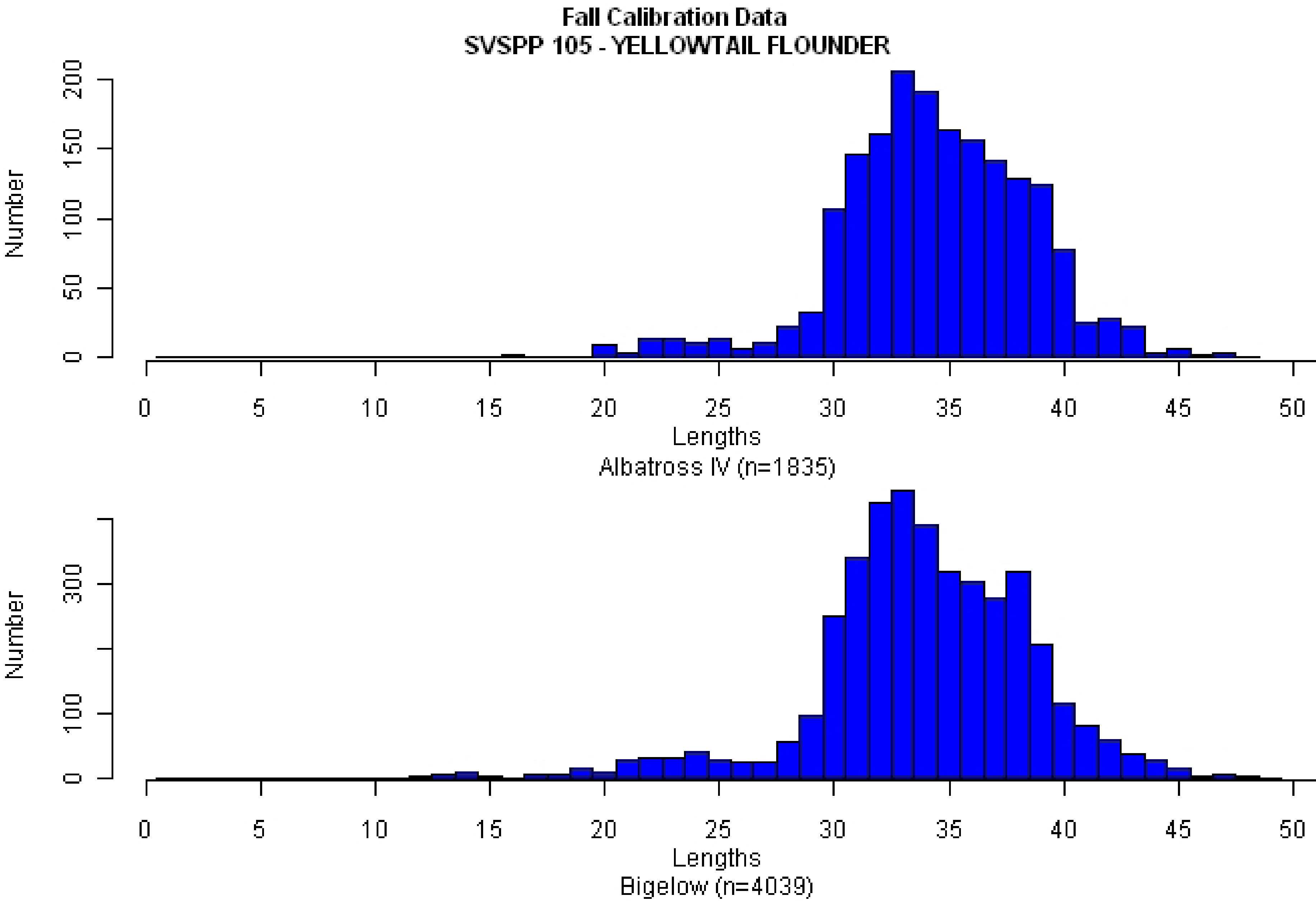
Spring and June Calibration Data
SVSPP 102 - AMERICAN PLAICE

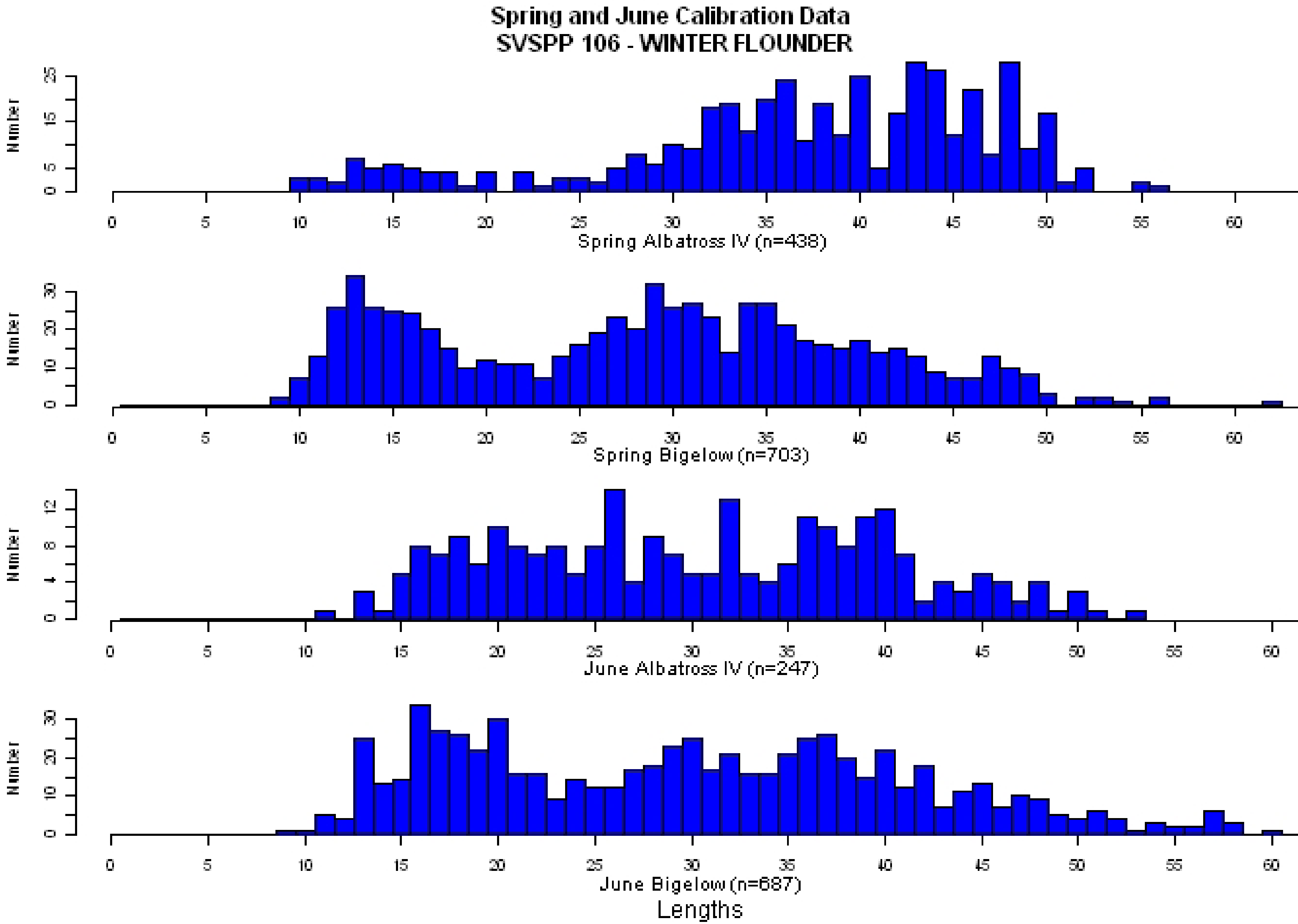


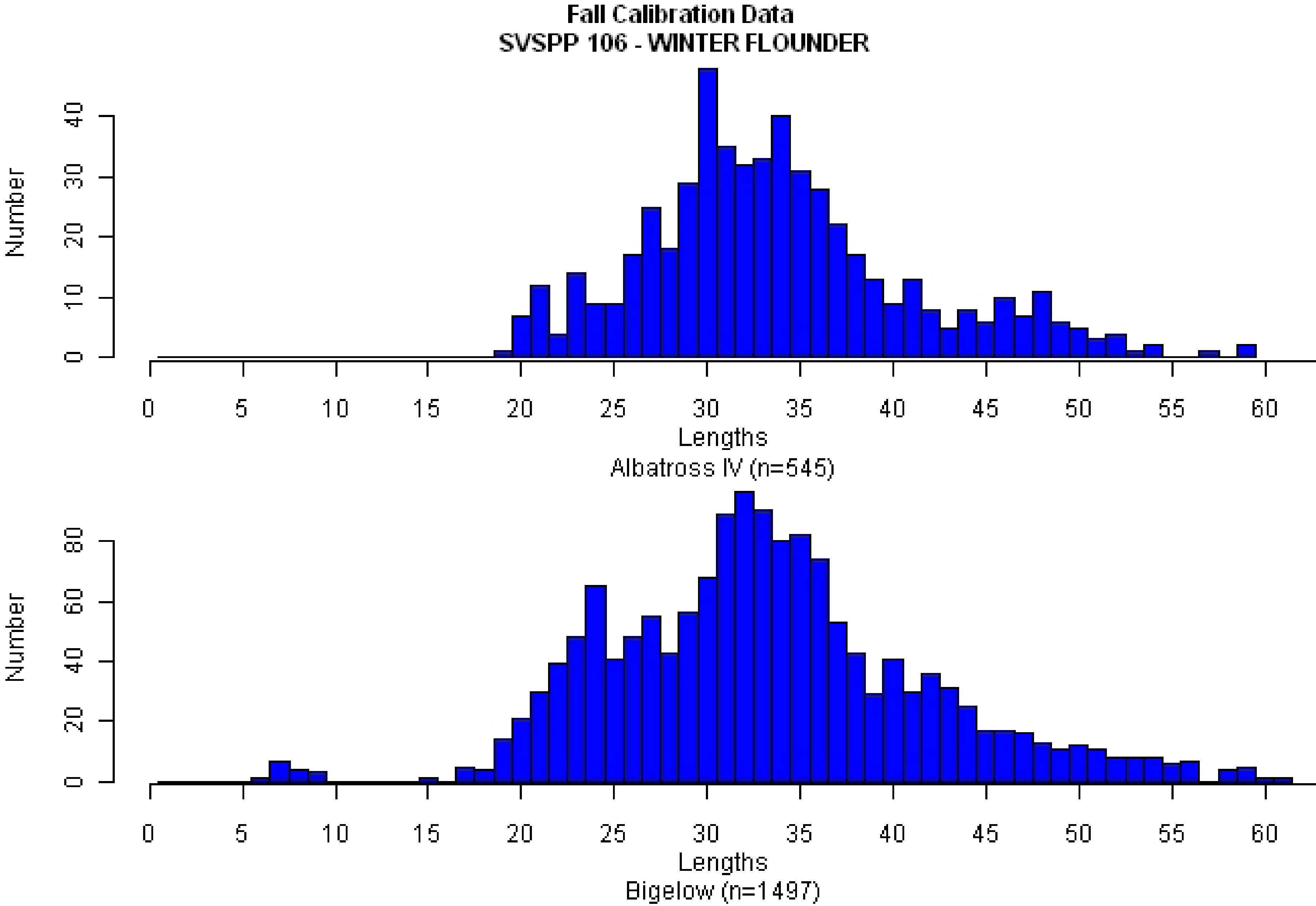

Fall Calibration Data
SVSPP 102 - AMERICAN PLAICE
Number
0
20
40
60
80
0
5
10
15
20
25
30
35
40
45
50
55
Lengths
Albatross IV (n=1649)
Number
0
50
150
250
0
5
10
15
20
25
30
35
40
45
50
55
Lengths
Bigelow (n=3469)

Spring and June Calibration Data
SVSPP 105 - YELLOWTAIL FLOUNDER




Fall Calibration Data
SVSPP 105 - YELLOWTAIL FLOUNDER
Number
0
50
100
150
200
0
5
10
15
20
25
30
35
40
45
50
Lengths
Albatross IV (n=1835)
Number
0
100
300
0
5
10
15
20
25
30
35
40
45
50
Lengths
Bigelow (n=4039)


Spring and June Calibration Data
SVSPP 106 - WINTER FLOUNDER
Number
Spring Albatross IV (n=438)
Spring Bigelow (n=703)
June Albatross IV (n=247)
June Bigelow (n=687)
Lengths


Fall Calibration Data
SVSPP 106 - WINTER FLOUNDER
Number
0
10
20
30
40
0
5
10
15
20
25
30
35
40
45
50
55
60
Lengths
Albatross IV (n=545)
Number
0
20
40
60
80
0
5
10
15
20
25
30
35
40
45
50
55
60
Lengths
Bigelow (n=1497)

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3b. Analytic Results

Identification of candidate estimators

Evaluation of performance of estimators

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Model Candidates (Catch in Numbers)

- Ratio estimator
- Independent Poisson Maximum Likelihood Estimator and binomial MLE
- Negative binomial MLE
- Quasi-likelihood MLE
- Beta-binomial MLE
- Independent negative binomial MLE

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Model Candidates

Each model had different assumptions about distribution of density of fish, distribution of calibration factor, and whether abundance in paired tows was correlated.

Model Candidates

Based on simulation models, beta binomial estimator behaved best

—Lowest bias, and exhibited better goodness of fit than binomial estimators.

I.e., when data were generated from a non-beta binomial distribution, the beta-binomial estimator performed well.

It was robust to a variety of different assumptions about distributions.

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Model Candidates

Beta-binomial model reflects variation in catchabilities of each vessel (and so variation of calibration factors) across stations.

I.e., each tow is providing a measure of the random variable of catchability. This could be a function of substrate, tide, time of day, etc.

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Model Candidates

Different forms of beta-binomial models performed better for different species : including variability in one or two parameters due to station type (site-specific vs. shadow tow) and/or season (spring vs. fall)

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Model Candidates

Ratio estimator reflects the ratio of averages

— total catch, Albatross/total catch, Bigelow

—((5+2+3)/(10+15+10))

Beta-binomial is closer to the average of the ratios

—average of catch by Albatross/catch by Bigelow over tows 1, 2, 3..)

—((5/10)+(2/15)+(3/10))/3

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Model Candidates: Catch in Weight

- Develop a mean weight calibration factor (MLE).
- Multiply this by the beta-binomial calibration factor for number.
- Individual and total weight is distributed gamma (2 parameters).
- Parameters could vary by
  - —Vessel
  - —Vessel, station type
  - —Vessel, station type, season
- A preferred model form was identified for each species

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Model Candidates: Catch in Weight

26 species showed no difference in parameters for season or station type.

16 species showed no only a difference for station type.

95 species showed a difference for season.

When mean weight calibration factor not equal to 1, may imply different length compositions between vessels.

Model Candidates: Length-Specific Factors

Extremes:

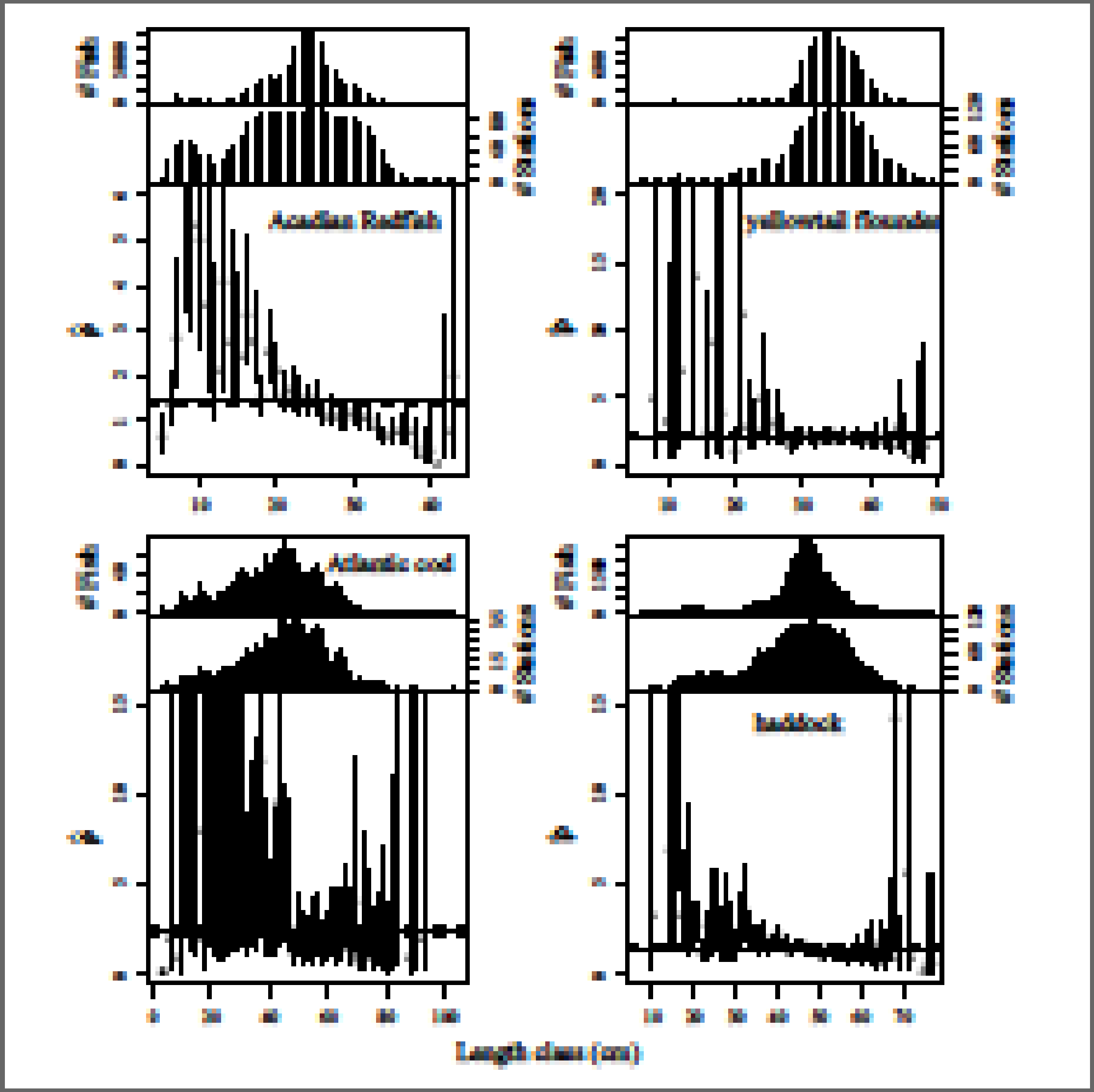
- —Separate calibration factors for each size interval (beta binomial)
- — A single factor across all length classes?

Constant factor may not work for some example species.

Functional alternative varies by species

Calibration factors at length

Refer to handout!



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Reviewers' Comments: Estimator Choice

Primary output: A set of protocols to choose between application of ratio estimator vs. beta-binomial estimator.

If both estimators give same result, use the beta-binomial. Add length to the model as a continuous covariate, where appropriate

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Reviewers' Comments: Estimator Choice

If ratio estimator > beta-binomial estimator, (due to large, patchy catches by Bigelow e.g., schooling pelagics), use beta-binomial, because it is less influenced by large catches on one vessel.

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Reviewers' Comments: Estimator Choice

If ratio estimator < beta-binomial estimator (both vessels get large catches, but Bigelow gets small catches when Albatross gets zero) use ratio estimator. (Beta-binomial prone to be over-influenced.) Large catches contain more information about calibration factor

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Reviewers' Comments: General Guidelines

If number of positive paired tows <30, do not attempt conversion

If number of positive paired tows <30 in a season, seasonal conversions are inappropriate.

If number of positive paired tows between 31-50 in a season, consider conversion only if required and with caution.

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Reviewers' Comments: General Guidelines

If catches by both vessels low, derived estimates will be unreliable (pollock – one large catch, striped bass, Atlantic halibut, Atlantic hagfish, cusk, Atlantic wolffish).

Reviewers' Comments: Additional recommendations

Data from site-specific surveys should have been analyzed separately for more information on estimator performance.

Modelling of zero frequencies should be further evaluated.

A hierarchical approach should be considered for the long-term (Kaiser).

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Reviewers' Comments: Additional recommendations

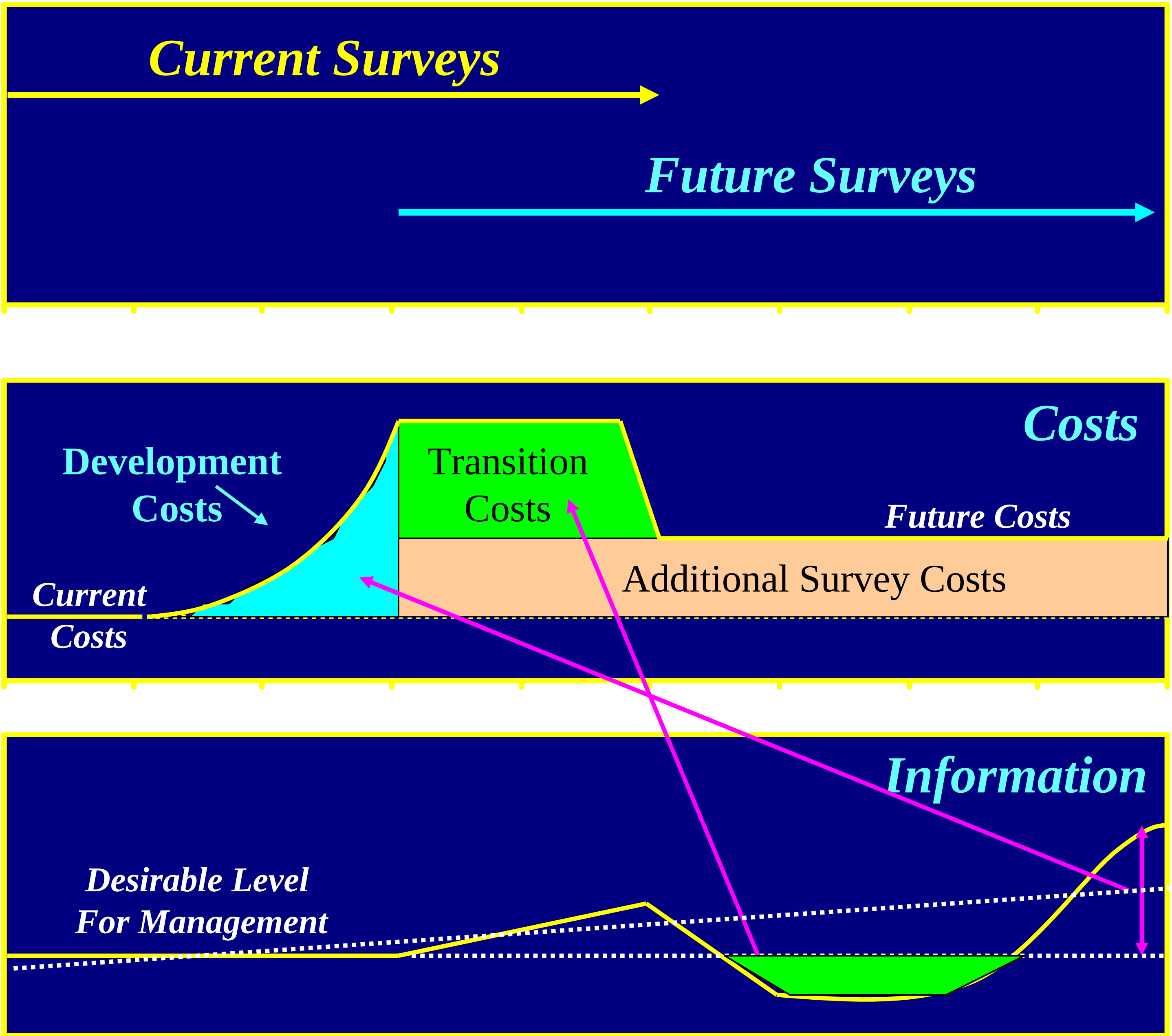
Some improvements to analysis of age frequency comparisons could be made.

The review was time-limited.

Individual Comments

Standardize counts for area swept before analyzing.

Catches of small fish by Bigelow will be down-weighted by converting to Albatross equivalents, but may provide important recruitment data to assessments. Evaluate incorporation of this aspect into assessment models.



Current Surveys
Future Surveys
Costs
Development
Costs
Transition
Costs
Future Costs
Current
Costs
Additional Survey Costs
Information
Desirable Level
For Management