

Scallop growth in archive specimens (1982-1999) and 2017 Nantucket Lightship survey

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Project objectives: 2016-2018

Describe growth of scallops from both archive collections and recent field collections. Scallops examined from:

- (1) Collections from 1982-2000 period (mostly NEFSC, occasionally commercial vessels) and archived at NEFSC Woods Hole;
- (2) Collections from 2013 and 2014 surveys in hand at VIMS.
- (3) Collected from 2016 and 2017 assessment surveys completed during project activity – include survey of Nantucket Lightship.

Source material in archive (Pocasset warehouse)

- Material sorted 3/31/2016, transported 4/1/2016 to VIMS (part 1 of 2), and sorted 12/22/2016, transported 12/23/2016 to VIMS (part 2 of 2).
- Years 1977, 1982, 1983, 1984, 1985, 1987, 1988, 1989, 1992, 1993, 1995, 1996, 1997, 1998 and 1999.
- The scallop shells are still in the original, clear plastic bags with station tags (one in the bag, typically one attached externally) as used at sea.
- Most bags appear not to have been opened in the intervening period.
- Bag varied from a few (2-3) scallop shells to ~20 scallop shells.
- Even though the total number of stations represented was high (e.g., 1977 $n = 45$ of which 41 were labeled; 1984 $n = 33$; total counts on next slide) the total number of scallop shells in many instances was modest.
- Bags are in poor condition and the content varies from simply dusty to, in some instances, covered in black mold. Careful cleaning and re-bagging was required.

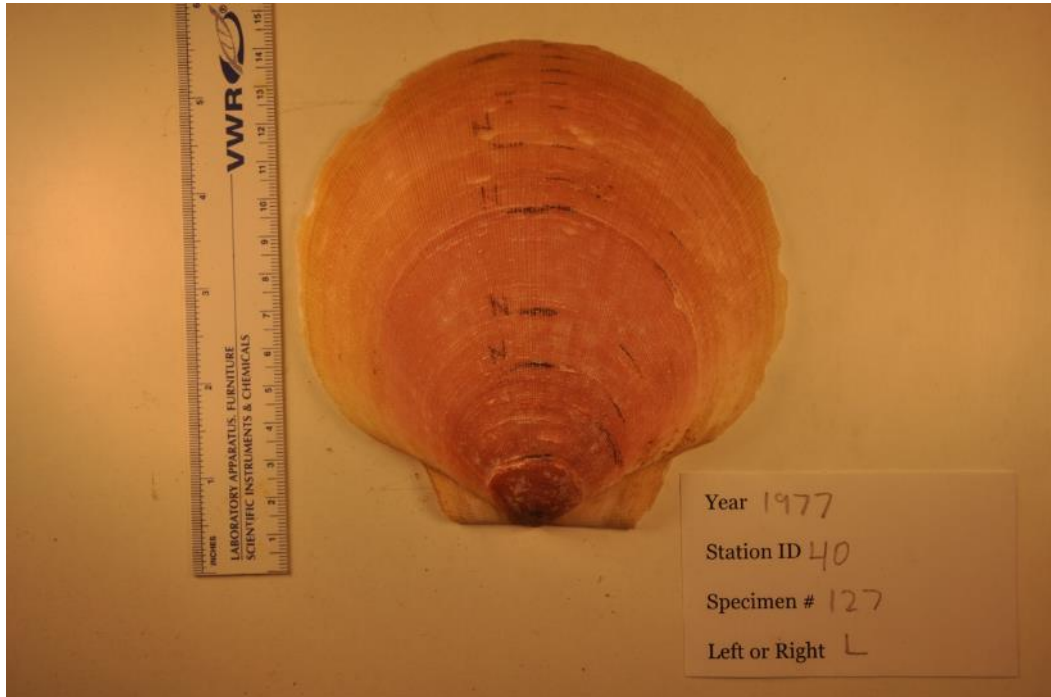
Source material in archive (Pocasset warehouse): stations represented by year

- 1977: 45 stations.
- 1982: (cruise 82-06) 13 stations.
- 1983: (cruise 83-07) 26 stations.
- 1984: 33 stations.
- 1985: (cruise 85-07) 53 stations.
- 1987: 16 stations.
- 1988: 33 stations.
- 1989: 23 stations.
- 1992: 7 stations.
- 1993: 16 stations.
- 1995: (cruise 95-09) 12 stations.
- 1996: (cruise 96-09) 11 stations.
- 1997: (cruise 97-09) 14 stations.
- 1998: (cruise 98-09) 11 stations.
- 1999: (cruise 99-09) 18 stations.

Growth estimation methods

- Hart and Chute (2009). Estimating von Bertalanffy growth parameters from growth increment data using a linear mixed-effects model, with an application to the sea scallop *Placopecten magellanicus*. – ICES Journal of Marine Science, 66: 2165–2175 based on external signatures with focus on larger specimens.
- This approach uses external shell signatures (lines) and thus discounts collections with only small scallops (typically <40mm shell length, SL) or specimens that have multiple disturbance lines.
- The requirement is a series of increment measures from the valve surface, from which is generated a plot of L_t v L_{t+1} (a Ford Walford).
- All scallops were photographed for archive when measured (next slide).

Examples of marked scallops: in a limited number of instances scallops had been previously marked by NEFSC investigators (no data records were found) and were thus re-examined and measured by VIMS investigators).

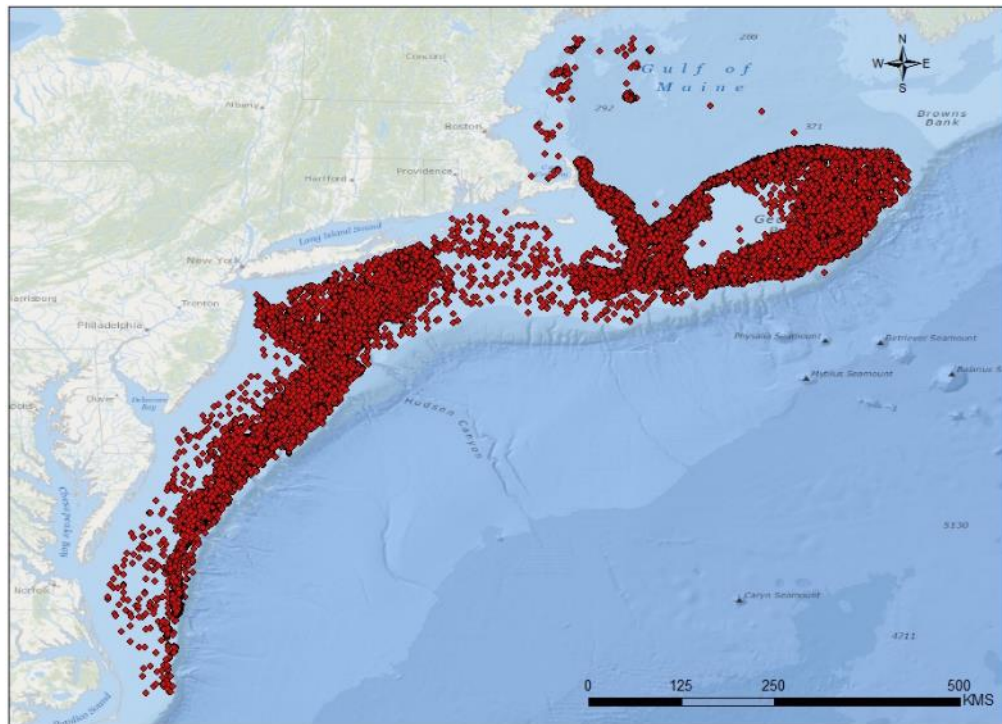


Standard image format for *Placopecten magellanicus* specimen 127, station 40, year 1977 with both NEFSC and VIMS markings

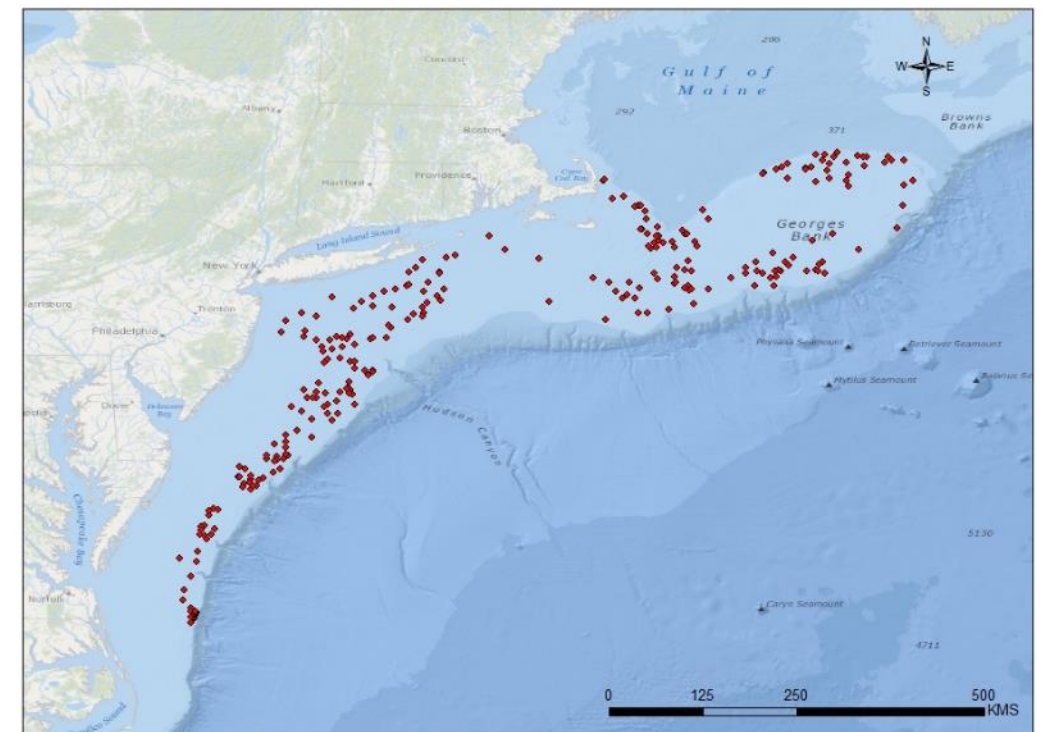


Standard image format for *Placopecten magellanicus* specimen 1001, station 14, year 1977 with both NEFSC and VIMS markings

How did we choose stations? The locations of all stations occupied by NEFSC surveys 1977-1999 are given in the lower left panel. The archive does not include specimens from many of these stations. The lower right panel shows locations of all stations from 1977-1999 in VIMS material. Note loss of Gulf of Maine stations, but otherwise good coverage by latitude and with depth for both Mid Atlantic and Georges Bank.

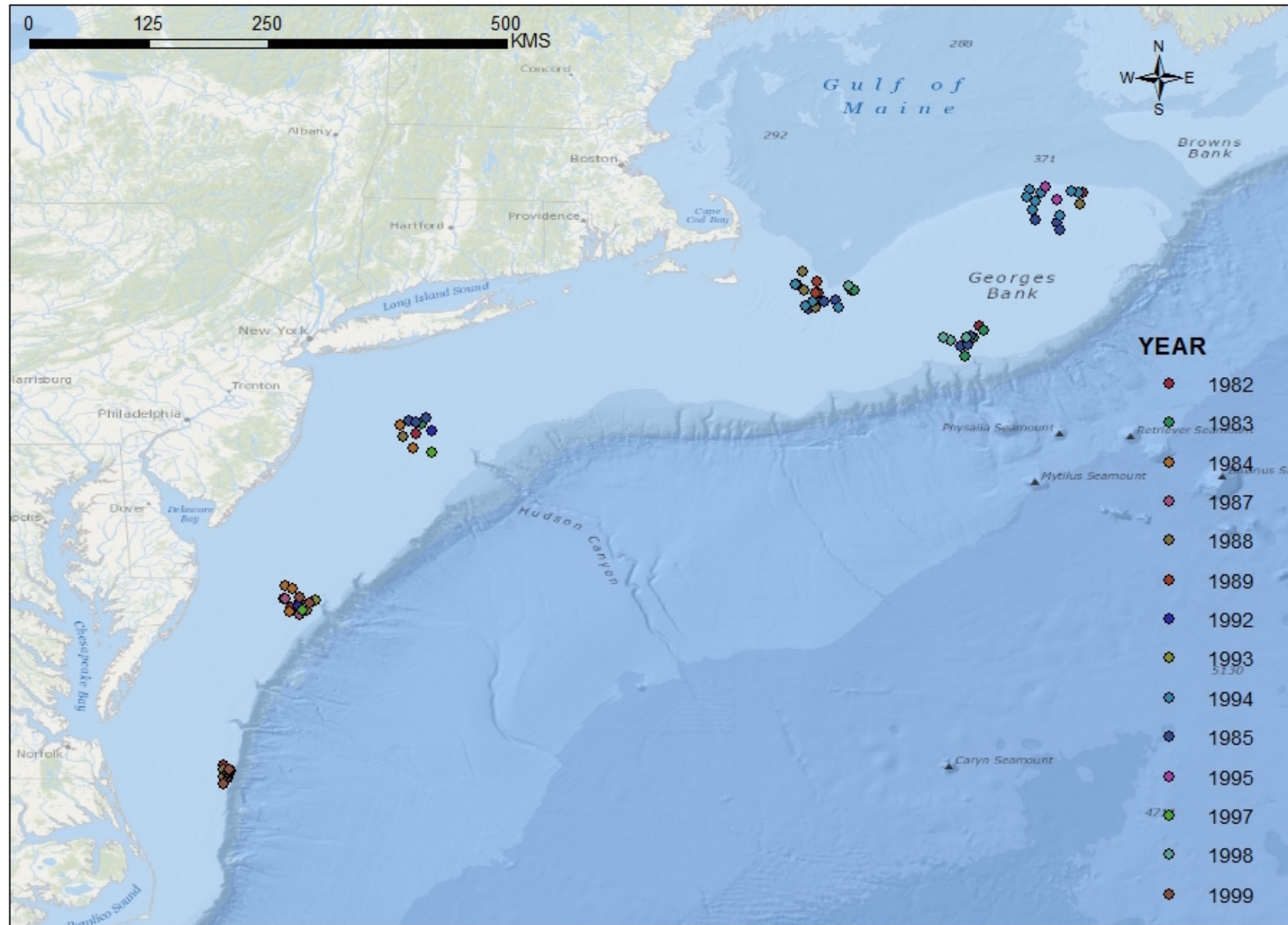


All stations in 1977-1999 NEFSC data records



All stations represented in VIMS collections

Final distribution of stations by year included in the analysis



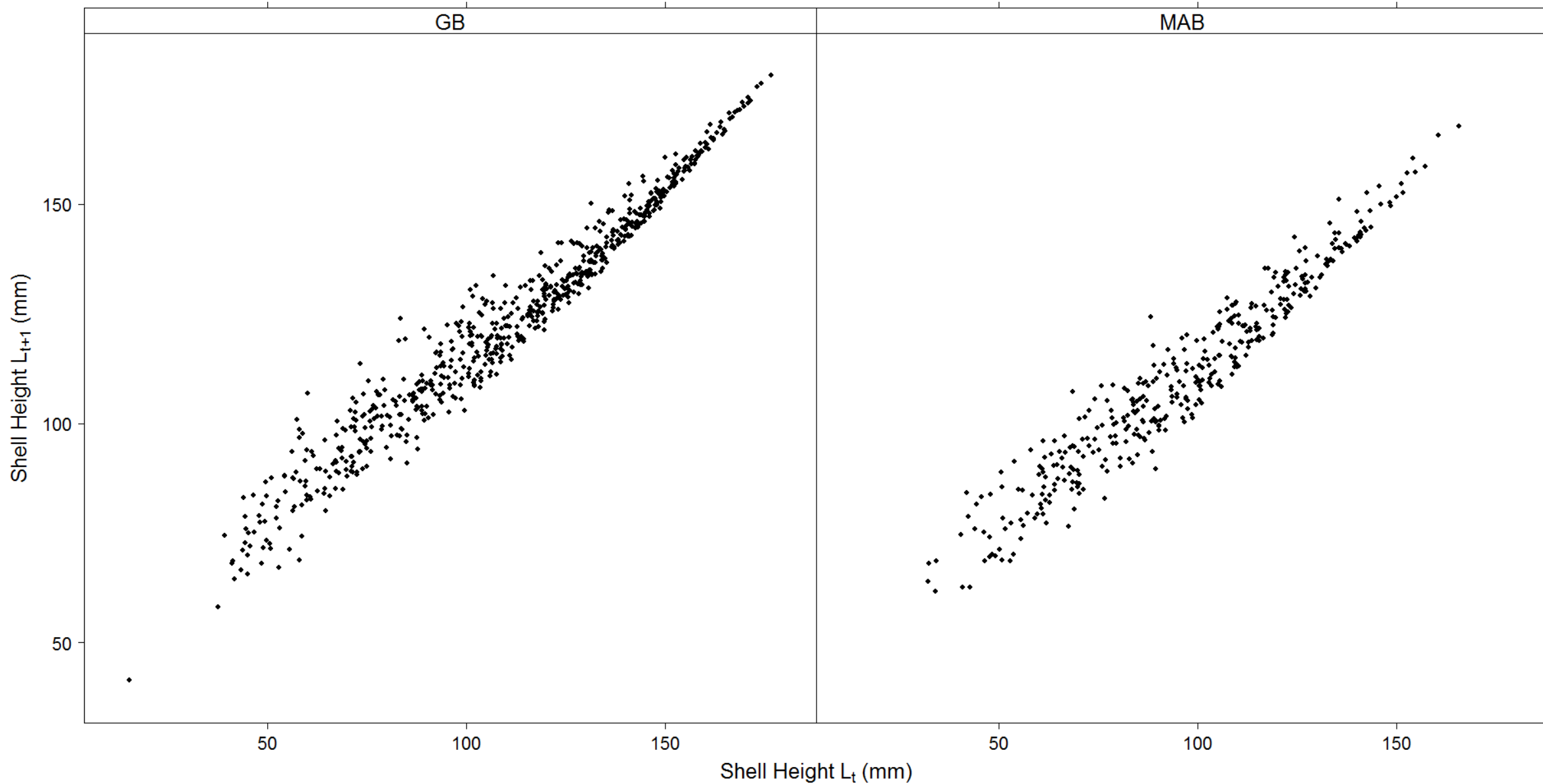
Analysis

- 227 Shells
- All but one scallop ≥ 40 mm
- Data divided into MAB and GB areas based on Hart and Chute (2009) description

Area	Discrete Area	Number	Total
MAB	VA/NC Border	25	97
	DelMarVa	41	
	Hudson Canyon	31	
GB	Nantucket Lightship	55	130
	NE GB	42	
	SW GB	33	
Total		227	227

- Number of years with scallops sampled by area was variable

Ford-Walford plots by area



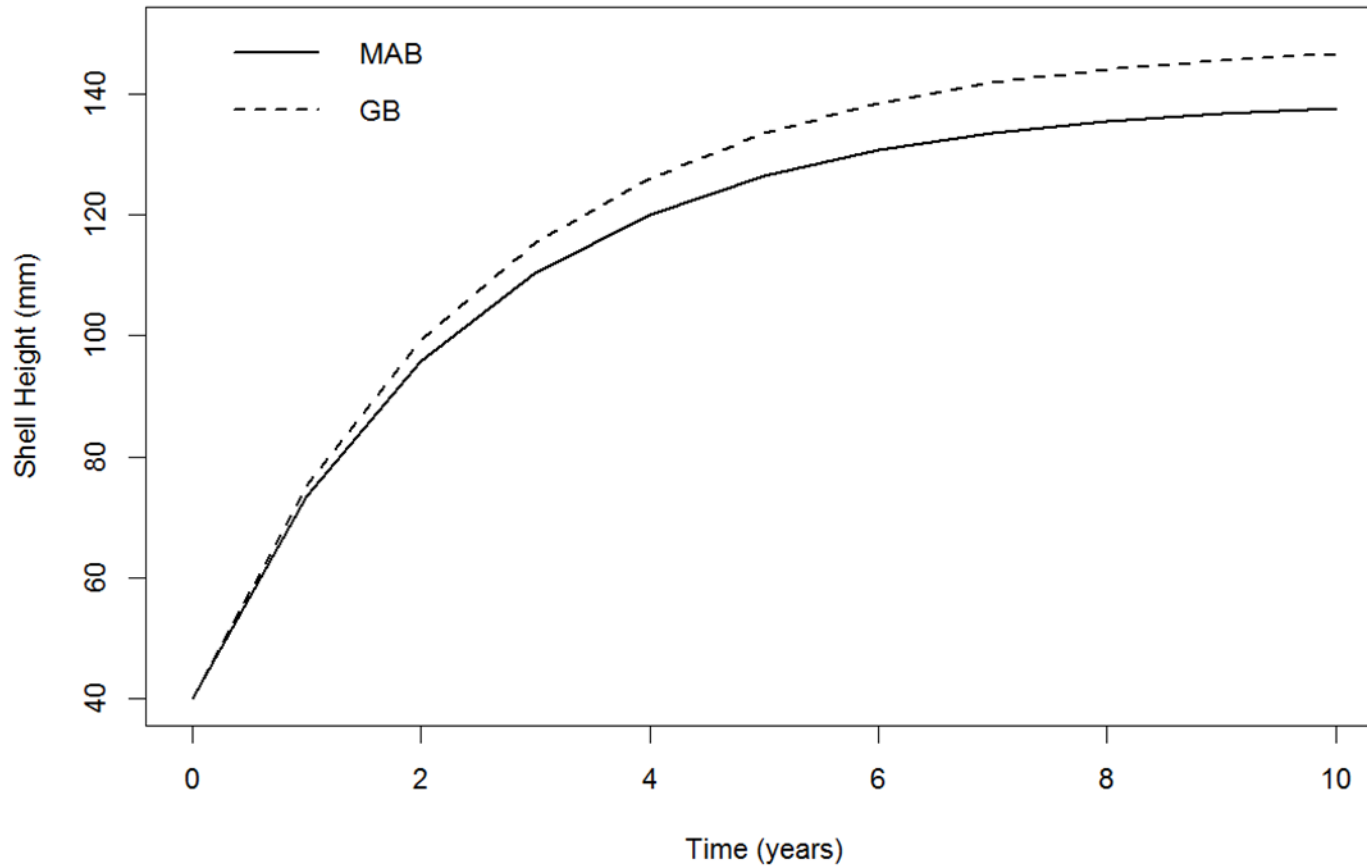
Mixed effect growth models

- Random intercept (variation in L_∞) and random intercept/slope (variation in L_∞ and K) models
 - $K = -\ln(m)$ $L_\infty = b/(1-m)$
- Mean K and L_∞ values were used to predict growth of 40 mm scallop by area

Area	\bar{K}	\bar{L}_∞	σ_k	σ_{L_∞}	SD K_i	SD $L_{\infty,i}$	Number of Shells	Number of Intervals
MAB	0.413	139.086	0.015	1.879	0.141	13.896	97	393
GB	0.392	148.764	0.011	1.450	0.136	12.823	130	683
							227	1,076

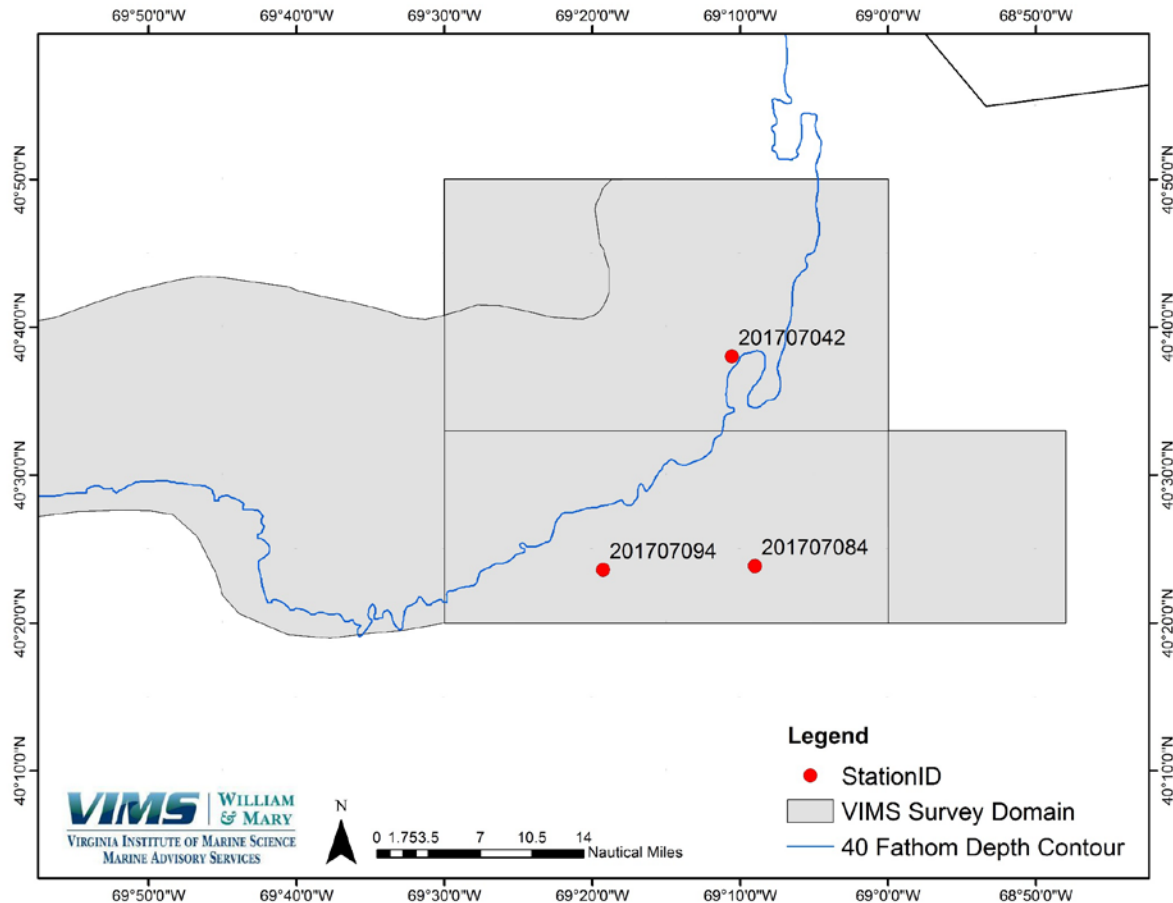
- Results showed similar trends compared to results from Hart and Chute
 - MAB higher K and lower L_∞ $K = 0.508$, $L_\infty = 133.3$ (Hart and Chute)
 - GB lower K and higher L_∞ $K = 0.427$, $L_\infty = 143.9$ (Hart and Chute)
- Estimates for earlier time period for both areas had greater L_∞ and lower K

Growth of 40 mm scallop by area



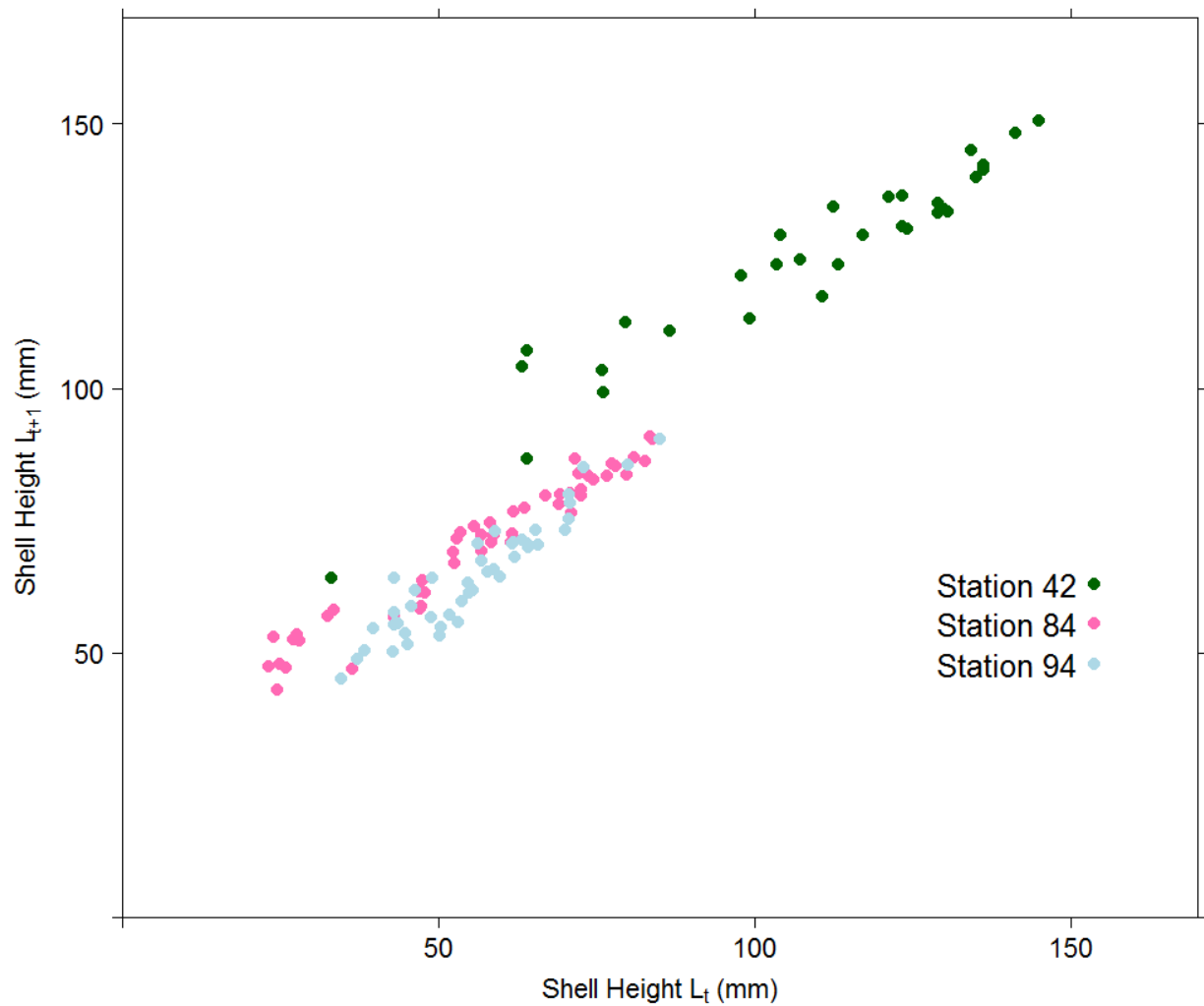
- Greater and faster growth in GB beginning ~ 80 mm but larger differences observed beginning ~ 100 mm
- Hart and Chute results indicated growth began to differ at 100 mm

Nantucket Lightship



- 3 stations
 - Station 42 – 7 scallops
 - Station 84 – 14 scallops
 - Station 94 – 15 scallops
- Used similar approach to estimate K and L_{∞} by station with an random intercept only model

Ford-walford plot by station



K and L_∞ estimates for random intercept model

Station	\bar{K}	\bar{L}_∞	σ_k	σ_{L_∞}	SD $L_{\infty,i}$	Number of Shells	Number of Intervals
42	0.46	151.25	0.05	5.14	7.8	7	31
84	0.37	101.1	0.03	3.29	5.6	14	52
94	0.42	81.37	0.05	3.76	10.48	15	45

Alternative approaches

- The described approach works well where shells are large and grow lines distinctive. Sufficient stations were available to complete by year and by region (MA v GB) comparisons. But many stations were not included because shells were either too small or compromised by many disturbance lines.
- We also investigated the use of hinge ligament structures as age recorders based on a old report by Merrill, A. S., J. A. Posgay & F. E. Nichy. (1966). Annual marks on shell and ligament of sea scallop (*Placopecten magellanicus*). Fish Bull. 65:299–311.



Figure 1. Banding pattern on the inner valve resilium surface of *Placopecten magellanicus* after removal of the ligament.

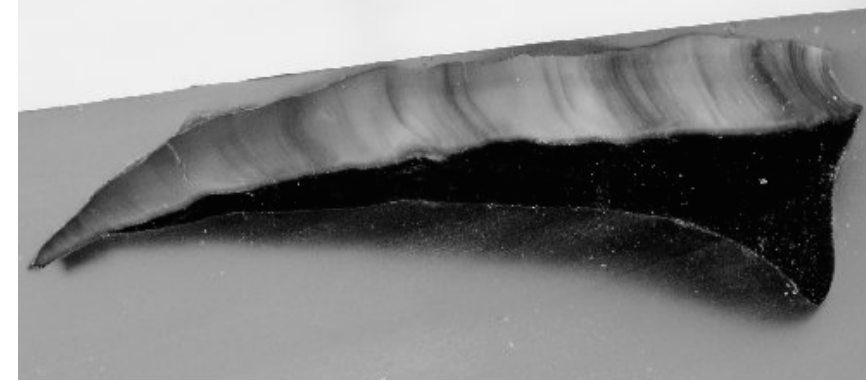


Figure 2. Embedded polished section through resilium (light upper portion) and ligament (dark lower portion) of *Placopecten magellanicus* illustrating internal growth signatures.

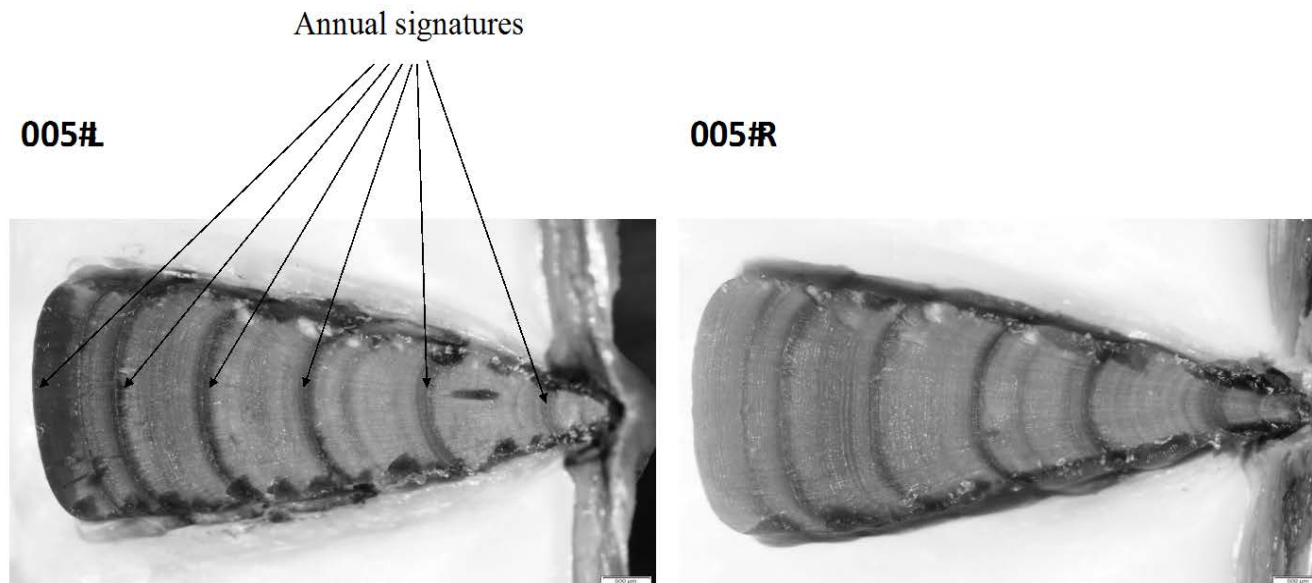
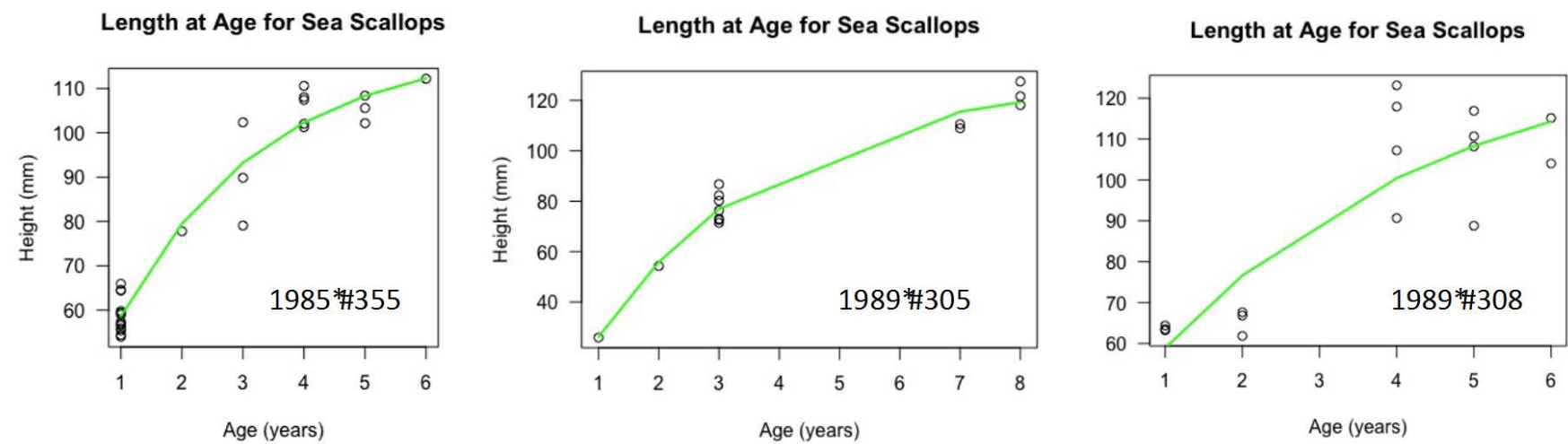


Figure 3. Resilia from left (L) and right (R) valve hinge structures of one scallop indicating annual growth signatures – both valves provide information.

A compilation of von Bertalannfy data from resilia and external rings. Age versus height plots are from resilia: year 1985 #355, 1989 #305, and 1989 #308. L_{∞} and K values are given for both resilia and external ring (Ford-Walford) methods.



year (station)	1985 #(355)		1989 (#305)		1989 (#308)	
n	26	3	14	7	10	4
method	resilia	external	resilia	external	resilia	external
k	0.42	0.46	0.34	0.39	0.27	0.45
s.e. of k	0.13	0.28	0.05	0.1	0.28	0.2
Linf	119.9	148	128.6	136.6	133.5	140.8
s.e. of Linf	9.2	25.8	5.7	8.8	42.1	30.2