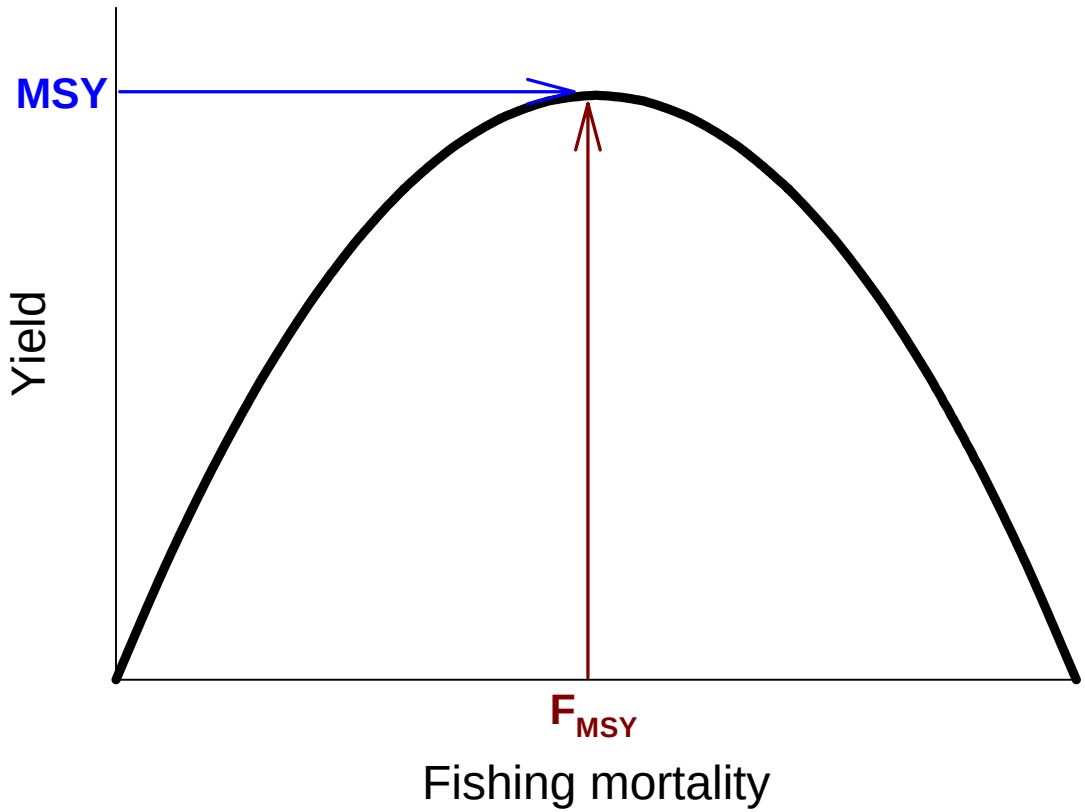
What is MSY for U.S. Atlantic Sea Scallops?

Dvora Hart
Northeast Fisheries Science Center
Woods Hole MA

MSY (Maximal Sustainable Yield) originated as an idealized concept, and was defined as the maximum yield that can be obtained at equilibrium.



A simple analogy: Suppose you have $10,000 in a bank account, earning 5% compounded annually.

Then the “maximal sustainable yield” for this account is $500. Constant withdrawals of more than $500 would decrease your principal, and thus would not be sustainable in the long run. Withdrawals of less than $500 are sustainable, but not maximal.

In such simple situations, where there is perfect information and no variability or uncertainty in productivity (interest rates), the appropriate strategy is clear.

Since fisheries are normally not in equilibrium, MSY is more properly defined as the maximum average long-term yield.

Thus, calculating MSY requires estimating the long-term productivity of the resource. This is difficult because productivity is highly variable and good scientific information is available for only a relatively short time period

In terms of the bank analogy, suppose that

(1)The bank gave interest rates (productivity or recruitment) that were highly variable and not explicitly known

(2)Your bank balance (biomass) is known only approximately

Calculation of "MSY" in this situation would require estimating the long-term mean interest rate, based on the past observations, and would be highly uncertain

Basic yield equation

Yield = Recruitment X Yield per recruit

Sea scallop recruitment is highly variable. It is unclear whether management can affect recruitment

Yield per recruit (the average yield obtained from an individual scallop recruit) is better understood, and strongly depends on management. The average scallop landed today (10-20 count or 25-30 g) is over twice as heavy as that which occurred 15-20 years ago (35-40 count, or 11-13 g). This suggests that the yield per recruit obtained today is about twice that which occurred historically.

Yield per recruit analysis shows only modest uncertainty, with optimal fishing mortality rates near the present overfishing threshold of F = 0.24

Georges Bank – Y_{max} = 17.4 g, range 14.5-18.6g

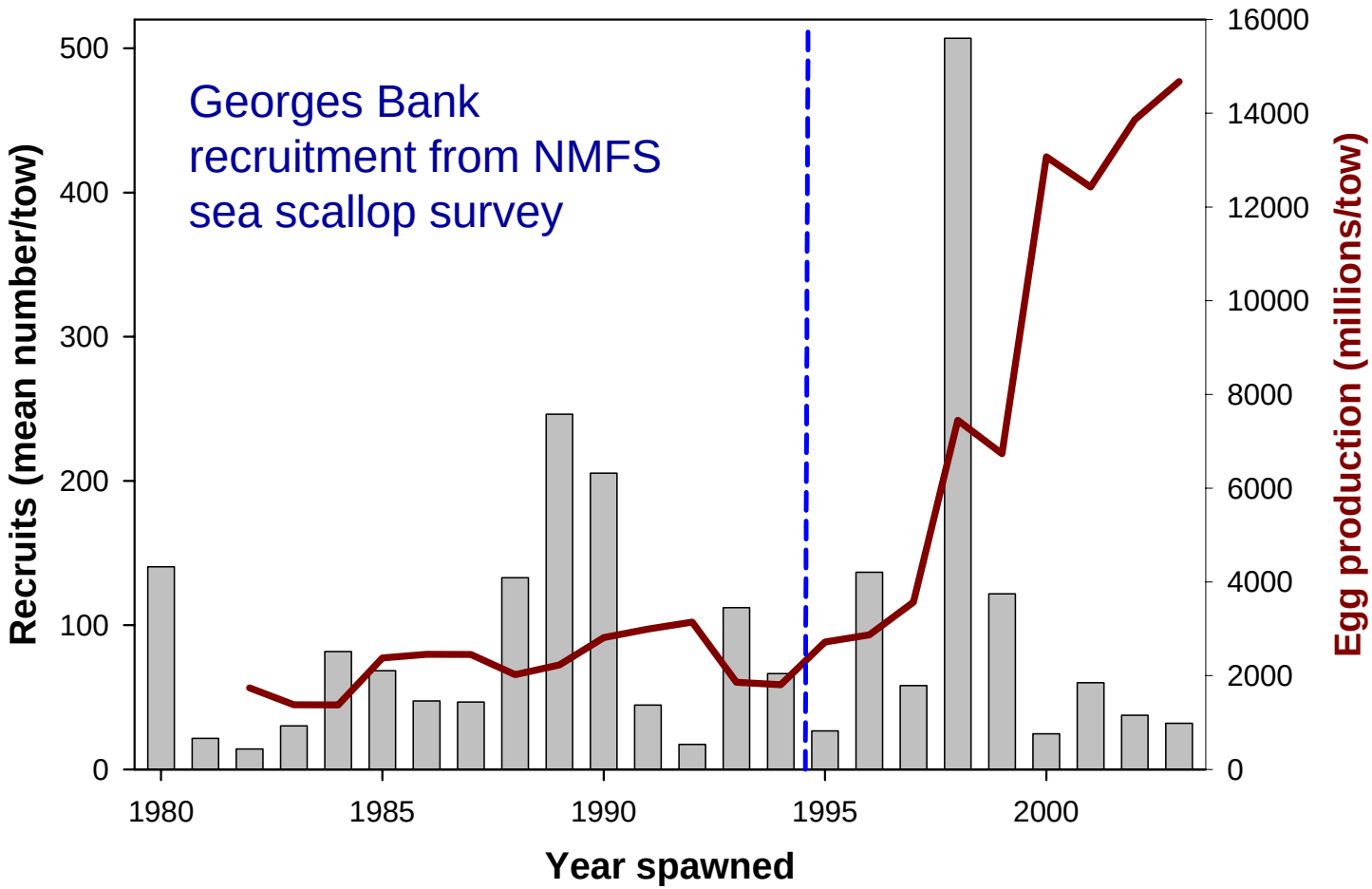
F_{max} = 0.242, range 0.22-0.40

Mid-Atlantic - Y_{max} = 18.2g, range 14.7-19.3g

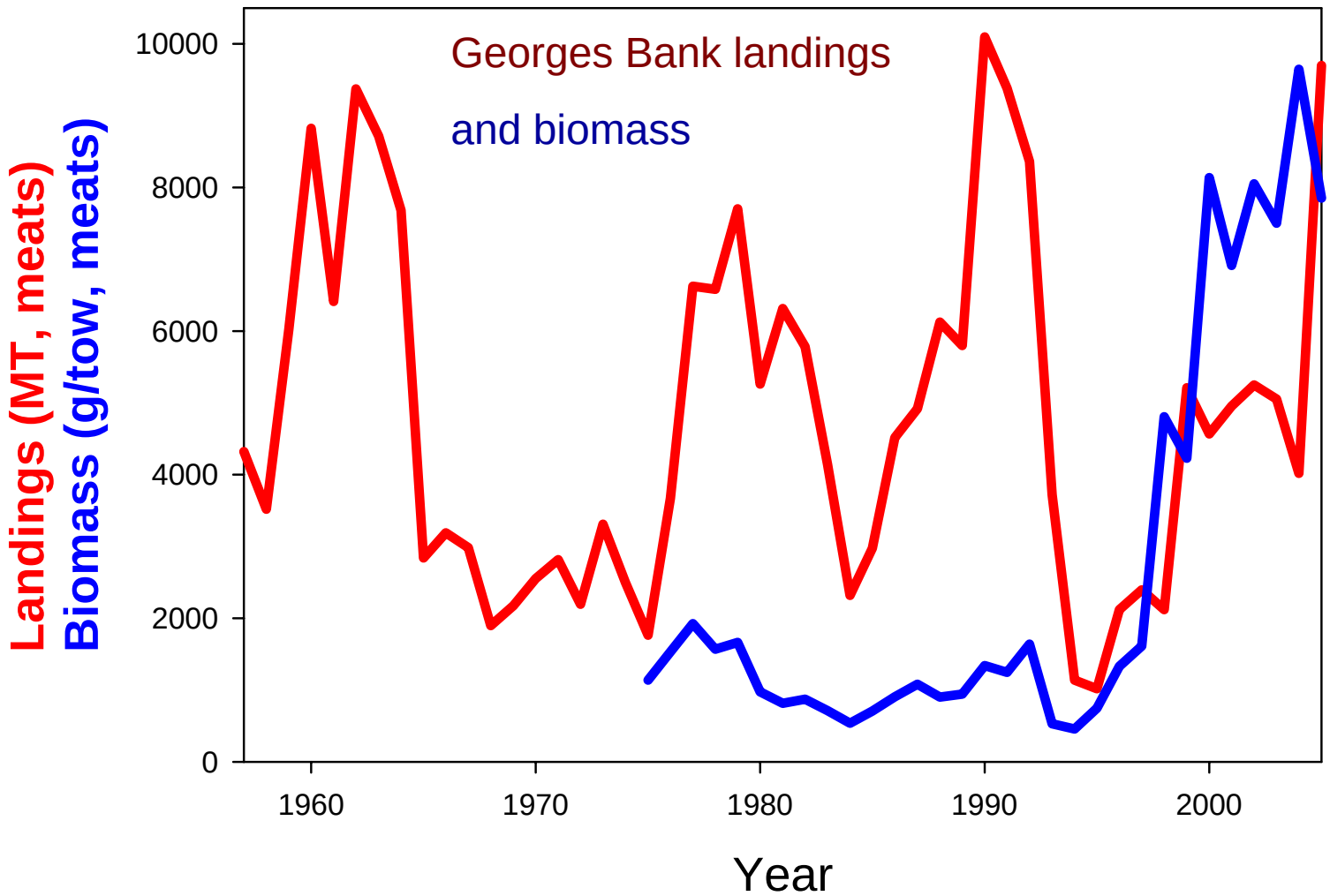
F_{max} = 0.250, range 0.22-0.41

The YPR obtained 15 years ago was about 8-9 g, about half the optimal values above

Recruitment on Georges Bank is highly variable, and does not appear to be related to egg production nor is there any trend in recruitment

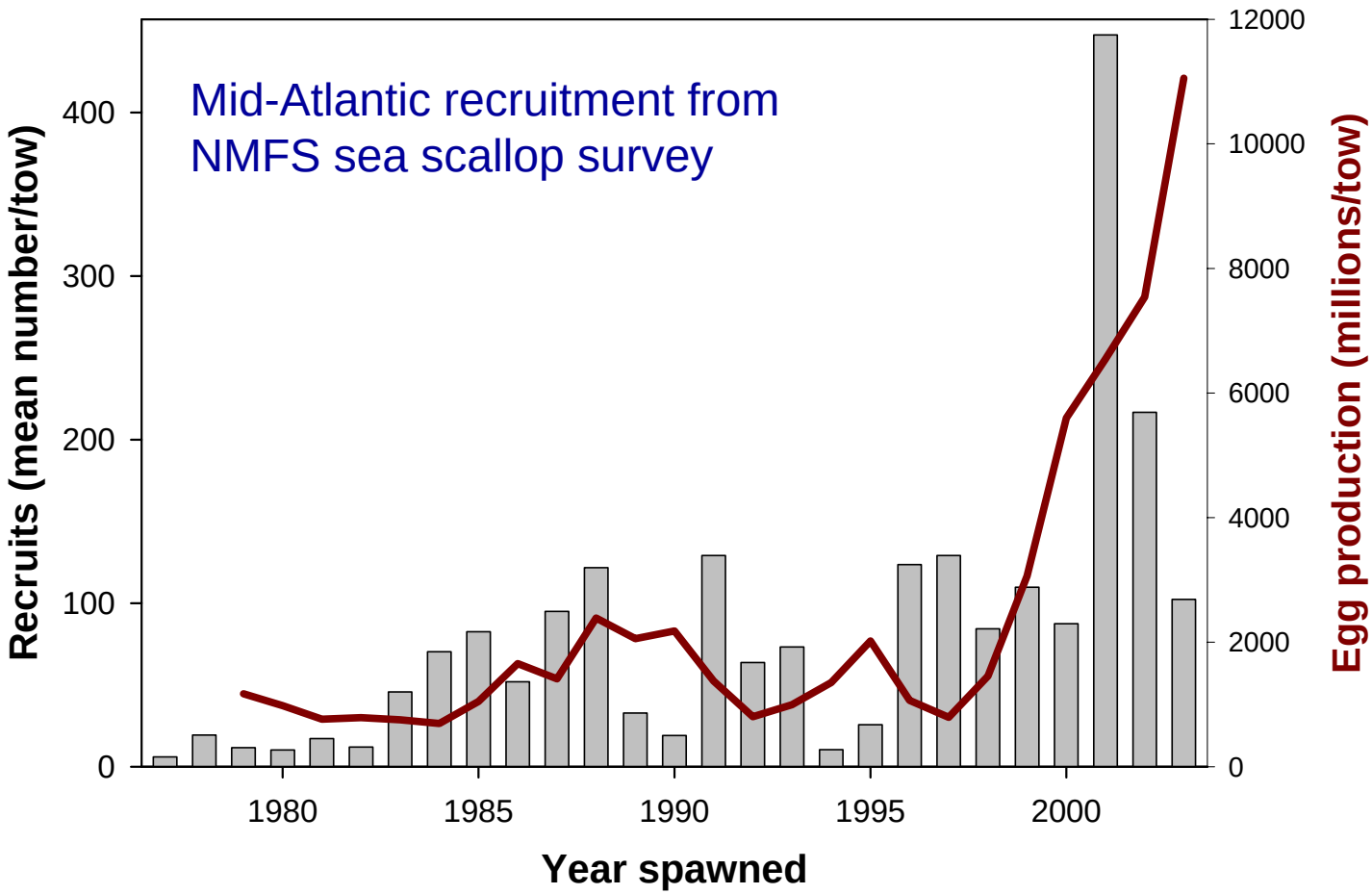


Georges Bank landings also suggest highly variable, but trendless, recruitment.



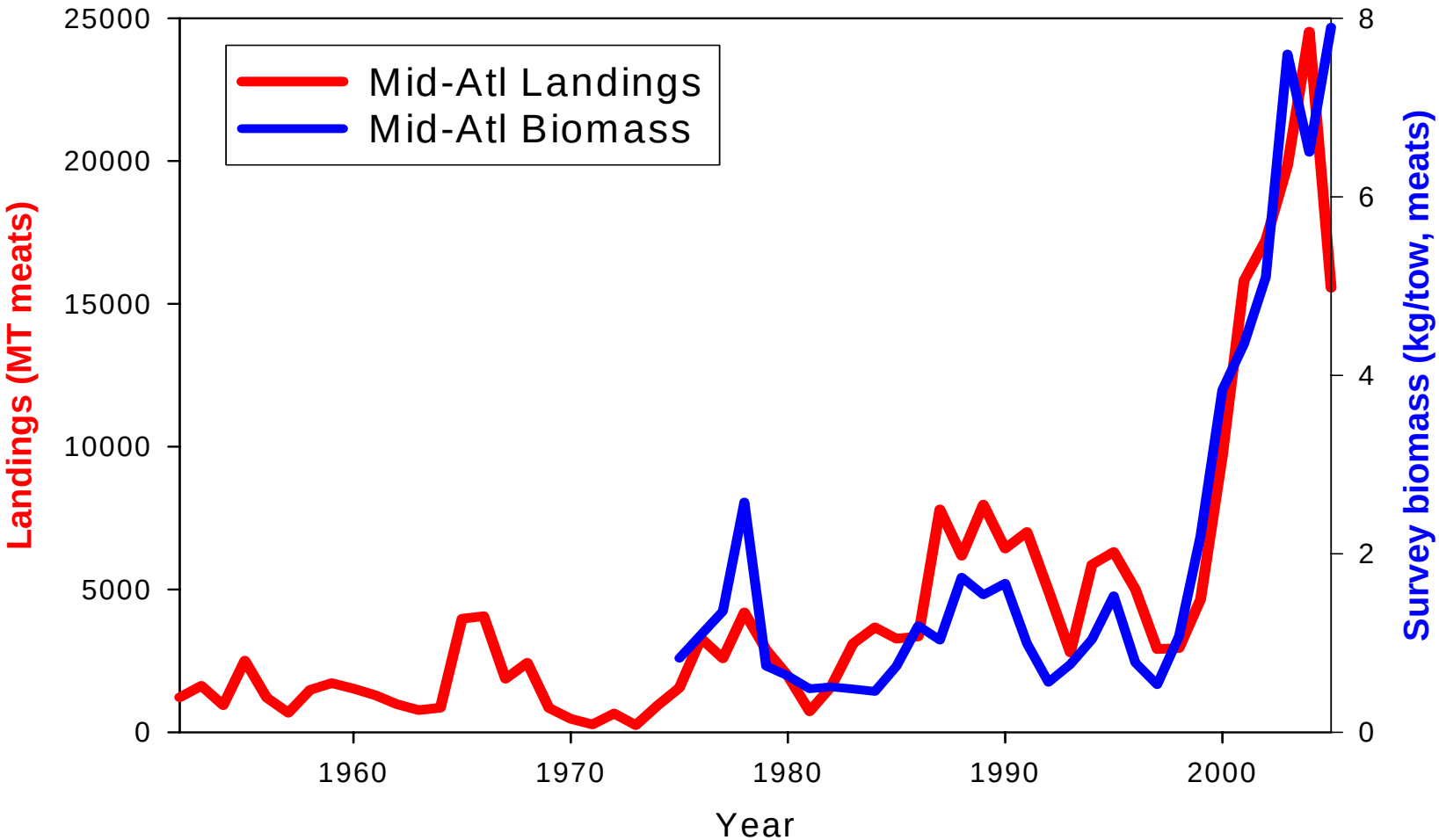
Recruitment in the Mid-Atlantic has been increasing since the mid-1980s

Recent strong recruitment may (or may not) be related to the increase in egg production



Landings in the Mid-Atlantic have also been trending upwards since the mid-1980s, and are consistent with the observed recruitment

The current high landings are due to the combination of increased yield per recruit and very high recruitment

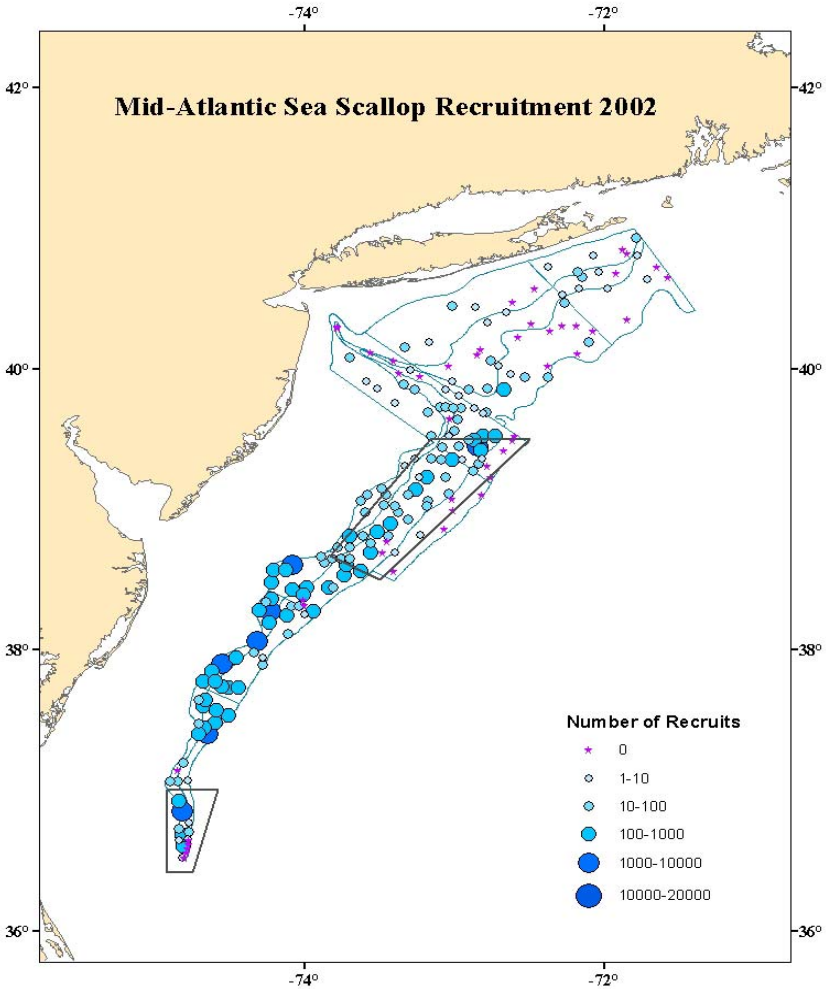


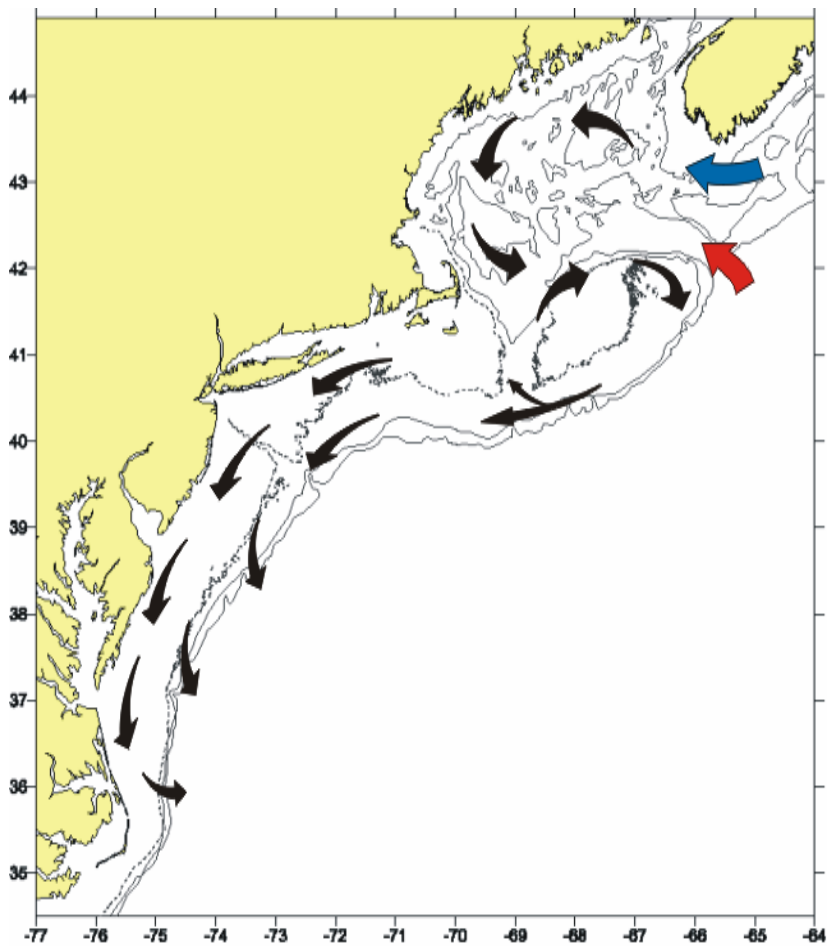
The $200 million question: Will recruitment in the Mid-Atlantic continue to be strong, or will it revert to the low levels seen prior to the mid-1980s?

In the short to medium term, yields will remain high due to recruitment already observed. However, in the long-term, there is no guarantee that the strong recruitment will continue

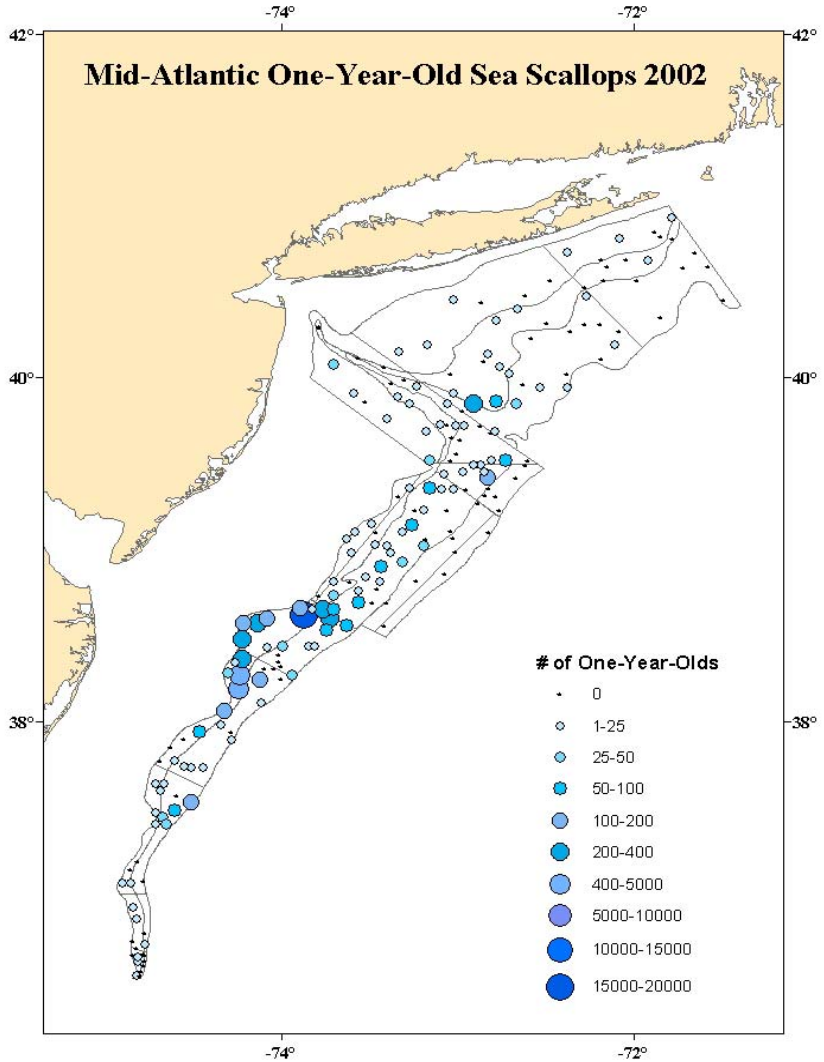
Could management measures such as rotational closures be in part responsible for the increased recruitment?

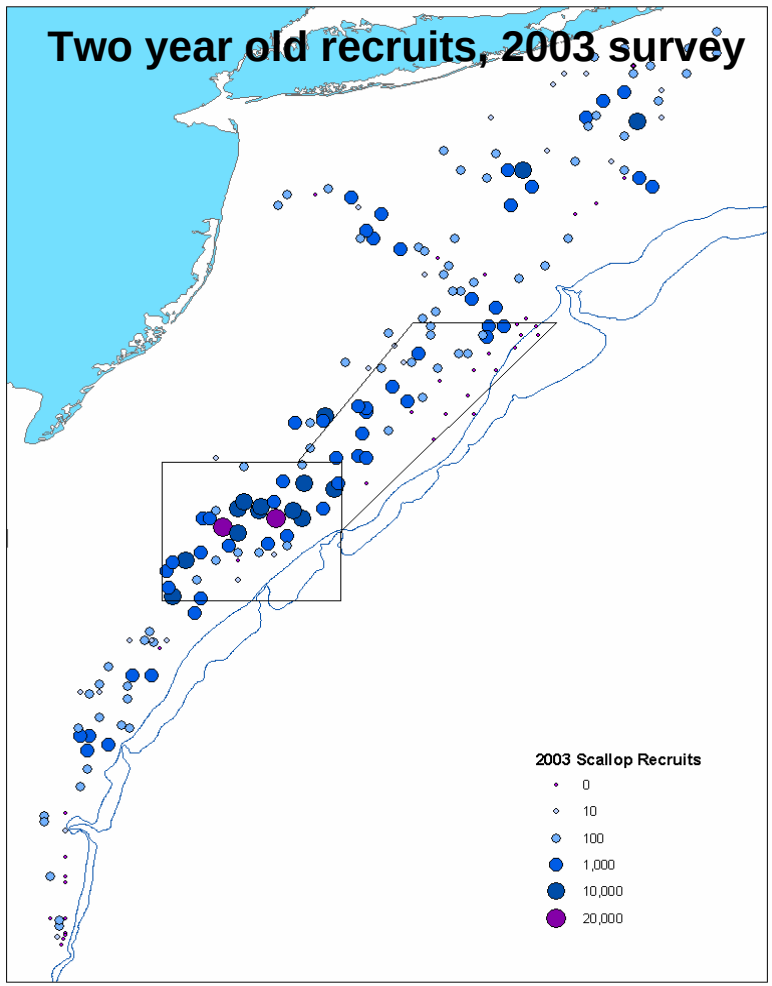
In each survey since 2002, recruitment has been stronger south of the Hudson Canyon closed area than “upstream” of it





The 2001 year class, as observed as one year olds in 2002 and two year olds in 2003, was exceptionally large, especially downstream of Hudson Canyon





Large numbers of 1 year old scallops observed south of the Hudson Canyon closed area in the 2002 NMFS sea scallop survey (2001 year class)

Huge number of two-year old recruits (2001 year class) observed south of Hudson Canyon closed area on the 2003 NMFS survey

MSY estimates

Georges Bank: 9000-15,000 MT

Mid-Atlantic: 11,000 – 20,000 MT

Total: 20,000 – 35,000 MT

Even these ranges do not fully reflect true uncertainty, especially in the Mid-Atlantic

There have been long periods of poor recruitment in both Georges Bank and the Mid-Atlantic

MSY is an idealized concept

Actual yield will likely be less

Effect	Approx. increase/decrease on yield
EFH closures	- 10%
Spatial heterogeneity in effort	- 5%
Overfishing of open areas	- 5%
Adaptive rotation	+ 5%