Indicators of Major Forage Status and Well-Being of Striped Bass in Maryland's portion of Chesapeake Bay

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Forage Action Team, February 2017

Ecosystem-based Fisheries Management could be a foundation of Bay sustainability, but...

Agencies' resources limited.
Demands of single-species very high.
Concern about ecosystem management's "extra" information needs & expense.
Goals and pathway unclear.
Broad approaches (EWE, Sea Grant) not embraced.
Try building ecosystem approach in steps?

Resident striped bass and its forage as MD indicator

Baltimore

Mostly males

DE

MD

VA

Mostly females from spawning rivers to New England
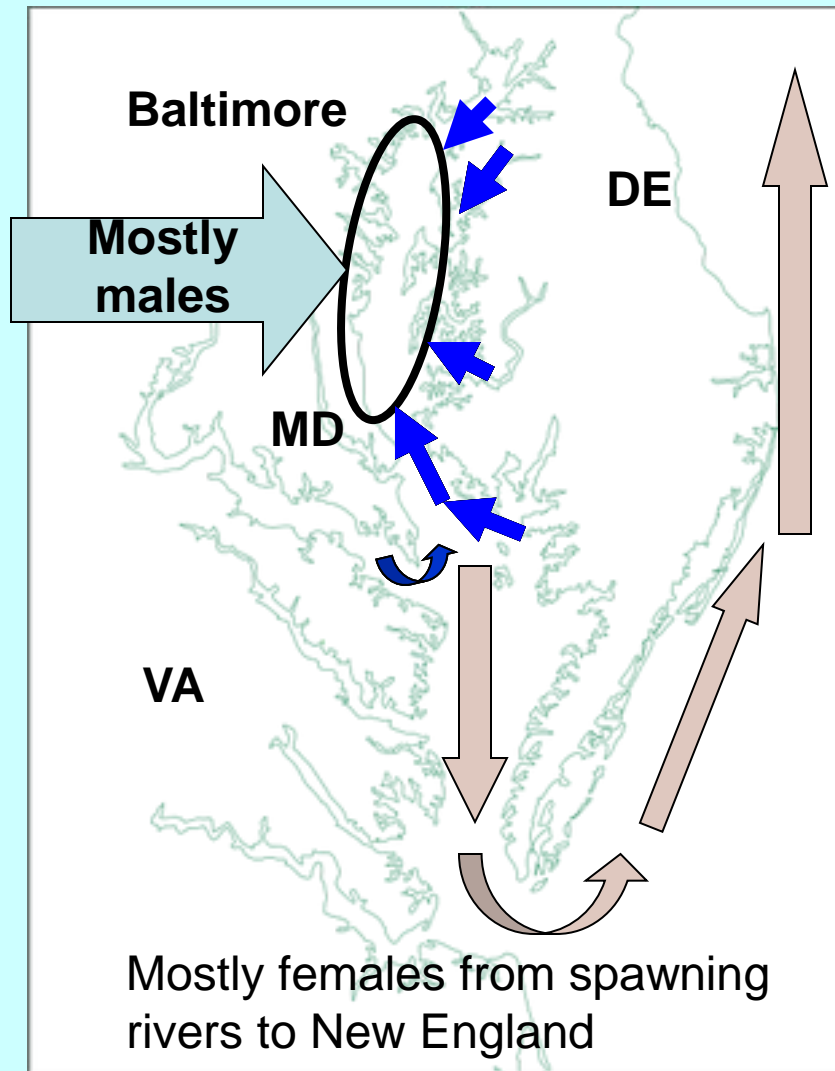
- After spawning, most males & some immature females stay in MD mid-Bay (residents)
- Important fishery in MD
- MD's main year-round predator
- Data available
- Easy to update
- Forage a concern

Regulations had unconsidered forage implications. Relative lifetime demand for menhaden by striped bass year-classes in past and present.
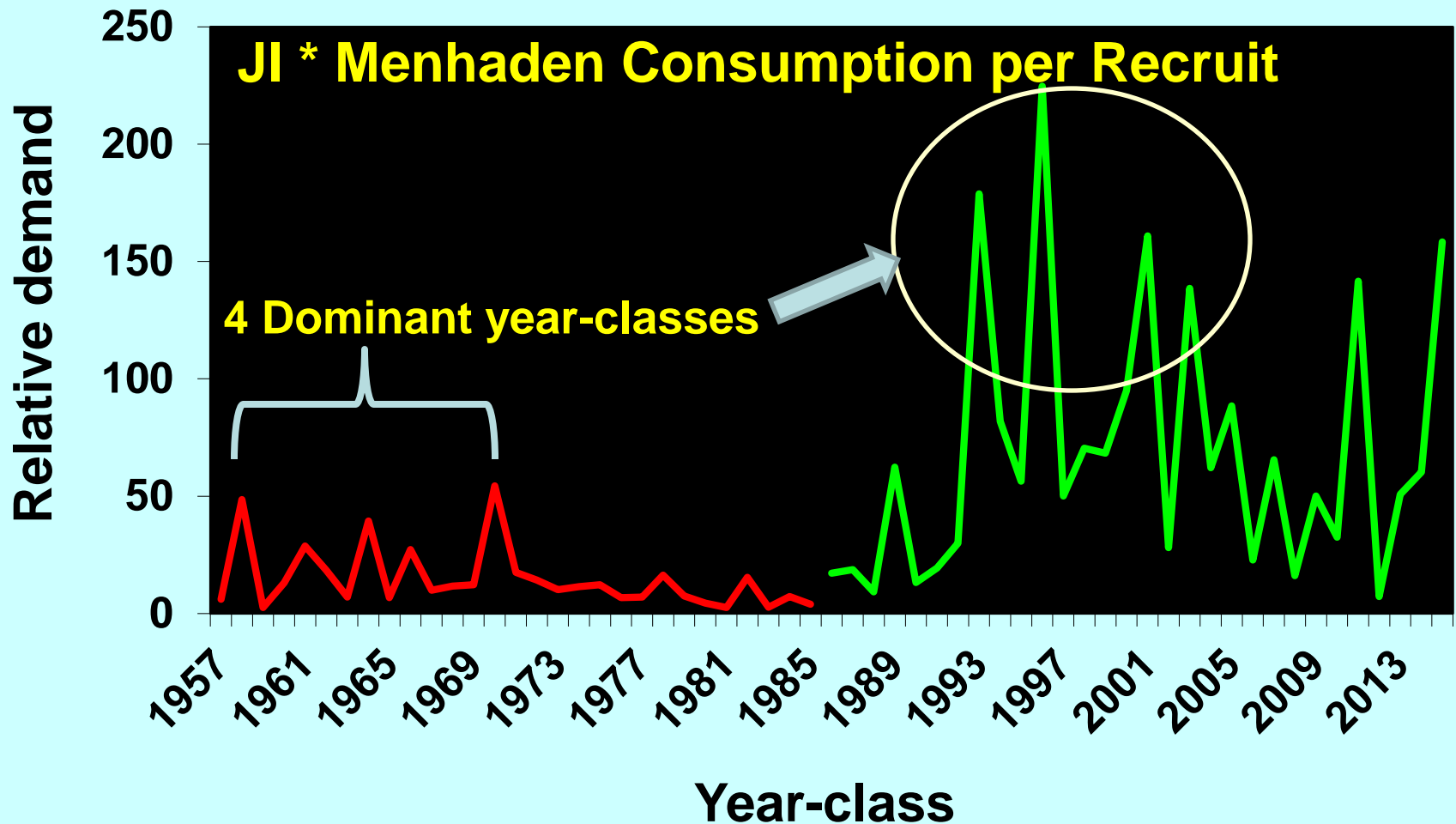
Bass overfishing ends; abundance rises, weight drops, emaciation, lesions, and disease follow in Bay

- **Forage hypotheses**
  - ❑ **Too many bass limit forage (top down)**
  - ❑ **Environment (pollution, climate, etc) limits forage (bottom up)**

  You get a forage–bass issue either way

  - ❑ **No forage issue, just pollution**
  - ❑ **No issue – (single-species default)**

Maryland's fisheries managers want practical guidance on….

(1) What forage is being eaten?
(2) Is there enough?
(3) What existing monitoring can be used or new programs inexpensively implemented?

Need for resident striped bass forage indicators

- Public concern (since late 1990s)
- MD 2008 Fisheries Management Reform Act
- 2009-2010 MD Sea Grant Briefs
- 2014 Bay Program forage goal (by 2016)
- 2014 ASMFC ecological (forage) reference points for Menhaden (by 2019?)

Bass Indicator methods – keep it simple

- Tractable for available staff
- Understandable to public, managers
- Targets and limits on 5 indicators to judge status
  - Based on historical performance
  - Decisionmakers retain 3-5 indicators (based on a paper I can't find anymore)
- Summarized with combined score (Index of Biotic Integrity approach, i.e., "Just give me a number!")

Index coverage
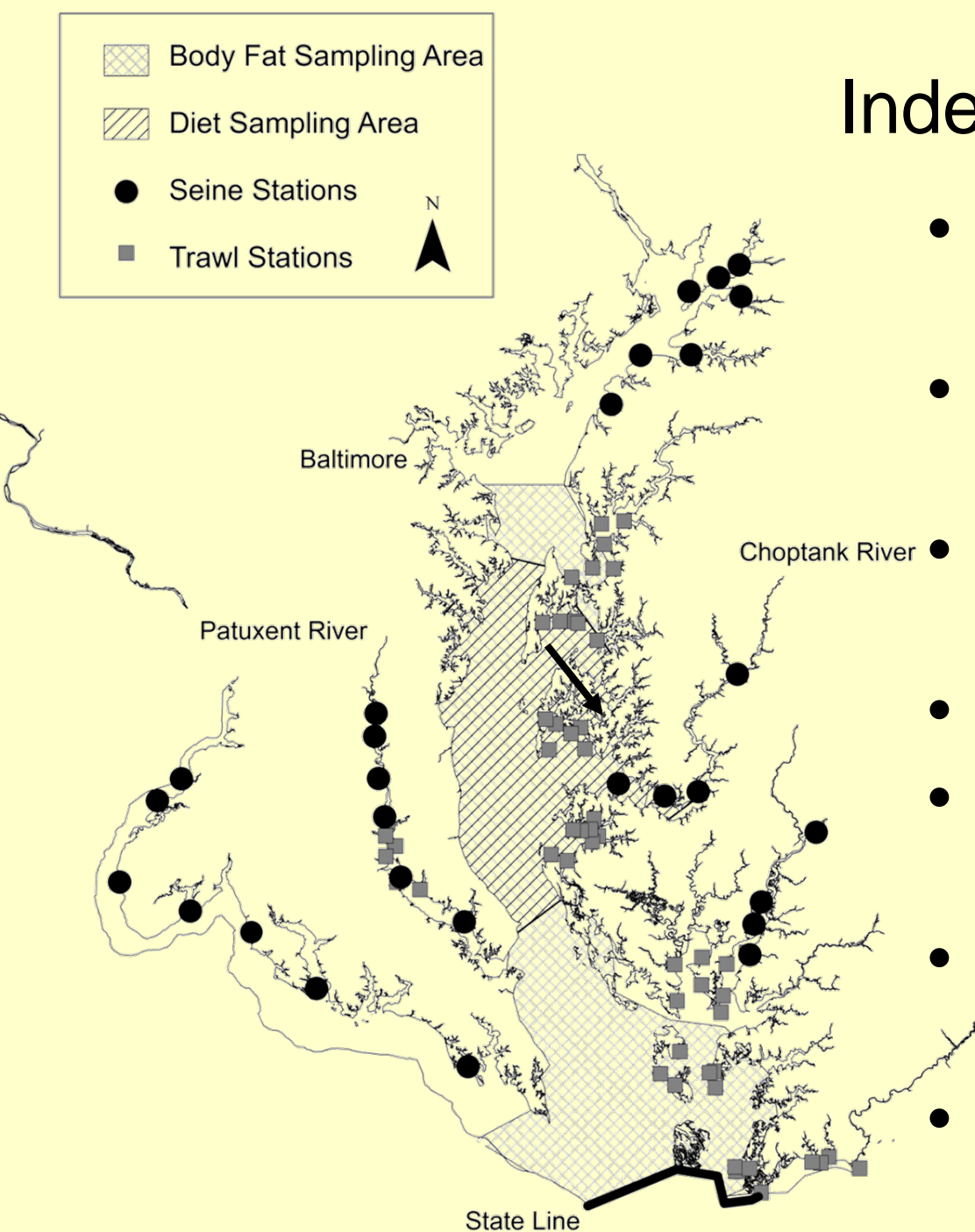
- MRIP bass index, starts 1983, MD Bay

- Seine forage indices, 1959

- Trawl forage indices, 1989

- Baywide blue crab, 1989

- FWHP Body fat, 1998 (2014-2016 diet); H & L

- CBEF diet 2006-13 & published diets; H & L

- Relative survival to age 3 (M), 1985, MD Bay

Legend:
- ⊠ Body Fat Sampling Area
- ⧄ Diet Sampling Area
- ● Seine Stations
- ■ Trawl Stations

N

Baltimore

Choptank River

Patuxent River

State Line

Targets and thresholds based on time period means
Empty guts data missing 2001-2005

Index	Time-series	Target	Threshold
Bass abundance	**1981-2015**	**2008-2010**	**1998-2004**
Major forage-to-bass	**1983-2015**	**1983-1993**	**1996-2004**
Empty stomachs	**1998-2015***	**2008-2010**	**1998-2000**
Body fat	**1998-2015**	**1990 (Jacobs)**	**1998-2004**
Age 3 relative survival	**1985-2015**	**1985-1995**	**1996-2004**

Fall diet and body fat indices

- Other seasons require new effort ($$$$)
- Sampling program (fish health) exists as platform for collections; labor manageable
- Jacobs et al. (2013) recommended measuring body fat in fall (earliest time-series)
- Striped bass & forage well mixed, available
- Fat progress indicates overall food intake & potential for starvation
- Diet indicates major (~90% wt) prey and amount

Status summary for each indicator

Score	Descriptor
1	**At threshold**
2	**Near threshold**
3	**Avoid threshold**
4	**Approach target**
5	**At target**

Mean forage score based on targets and thresholds; maximum = 5
Summarizes all indices status
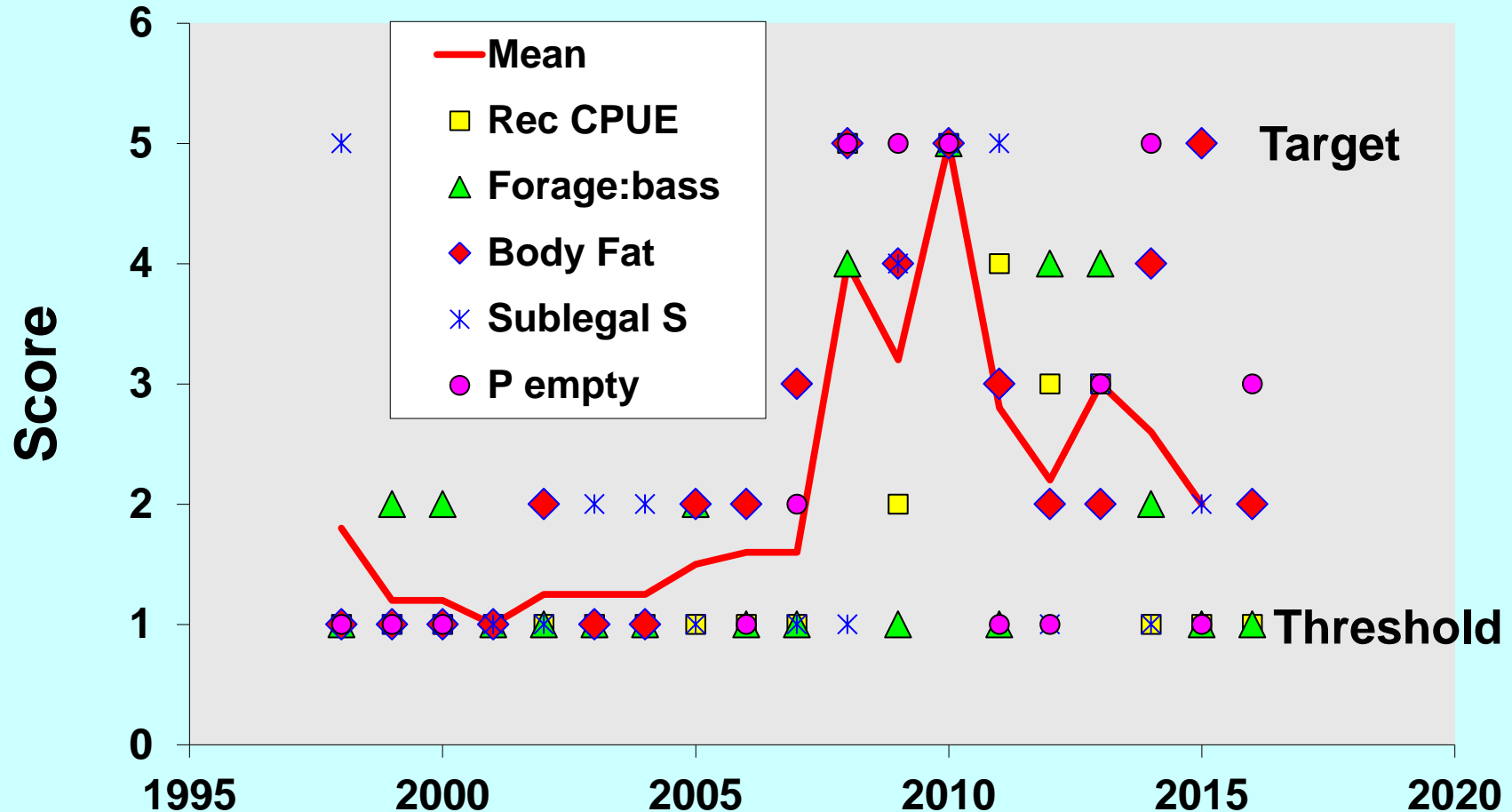
Percent of Striped Bass (280 - 800 mm) without body fat during October-November (MD DNR's Fish and Wildlife Health Program).
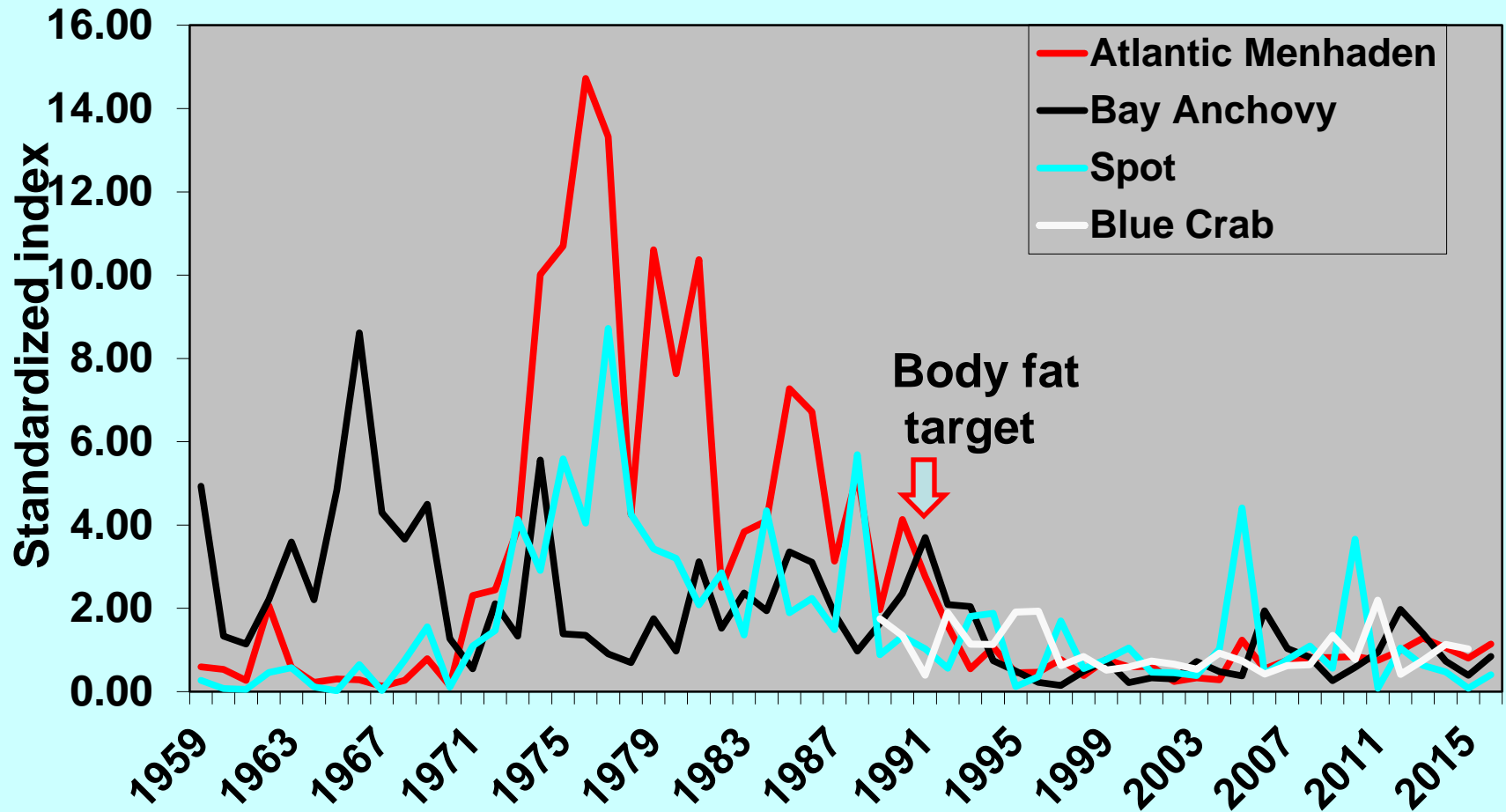## Other indicators' targets and thresholds tuned to body fat
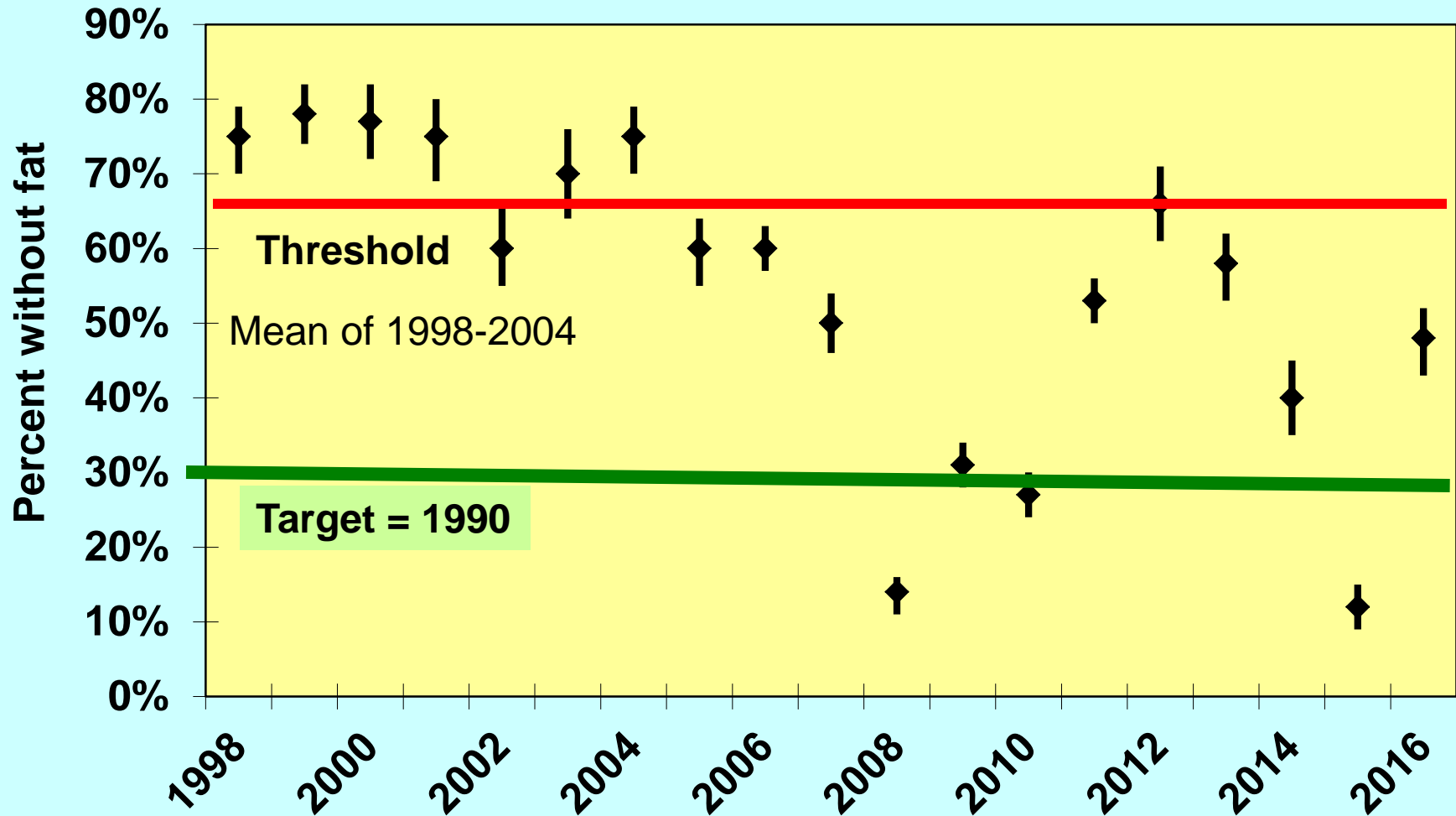
# Trends in fall body fat indices for sublegal (280-456 mm) and legal striped bass
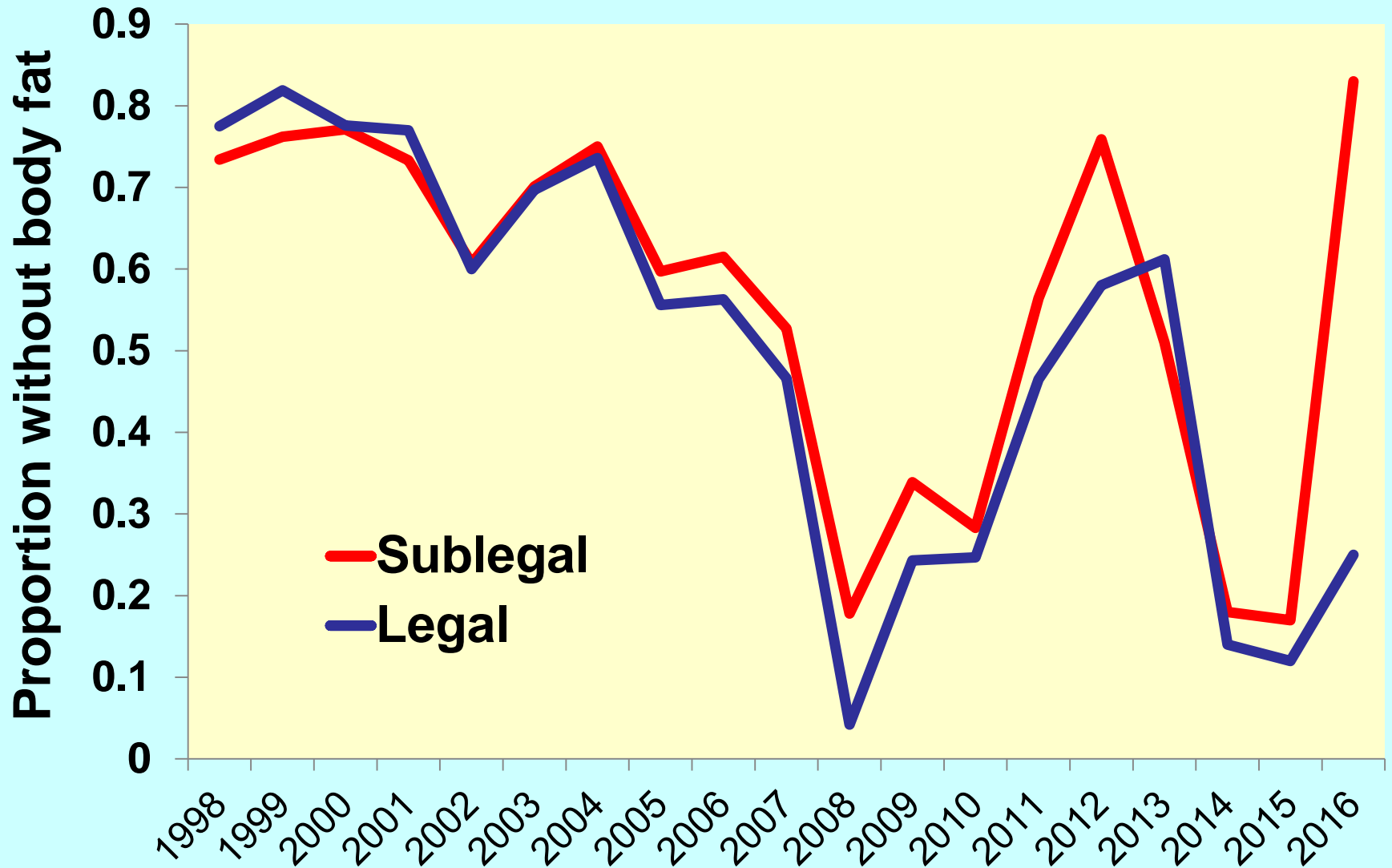
Long-term trends in major prey of Striped Bass 1959-2016. Geometric mean indices were standardized to common period (1989-2016).
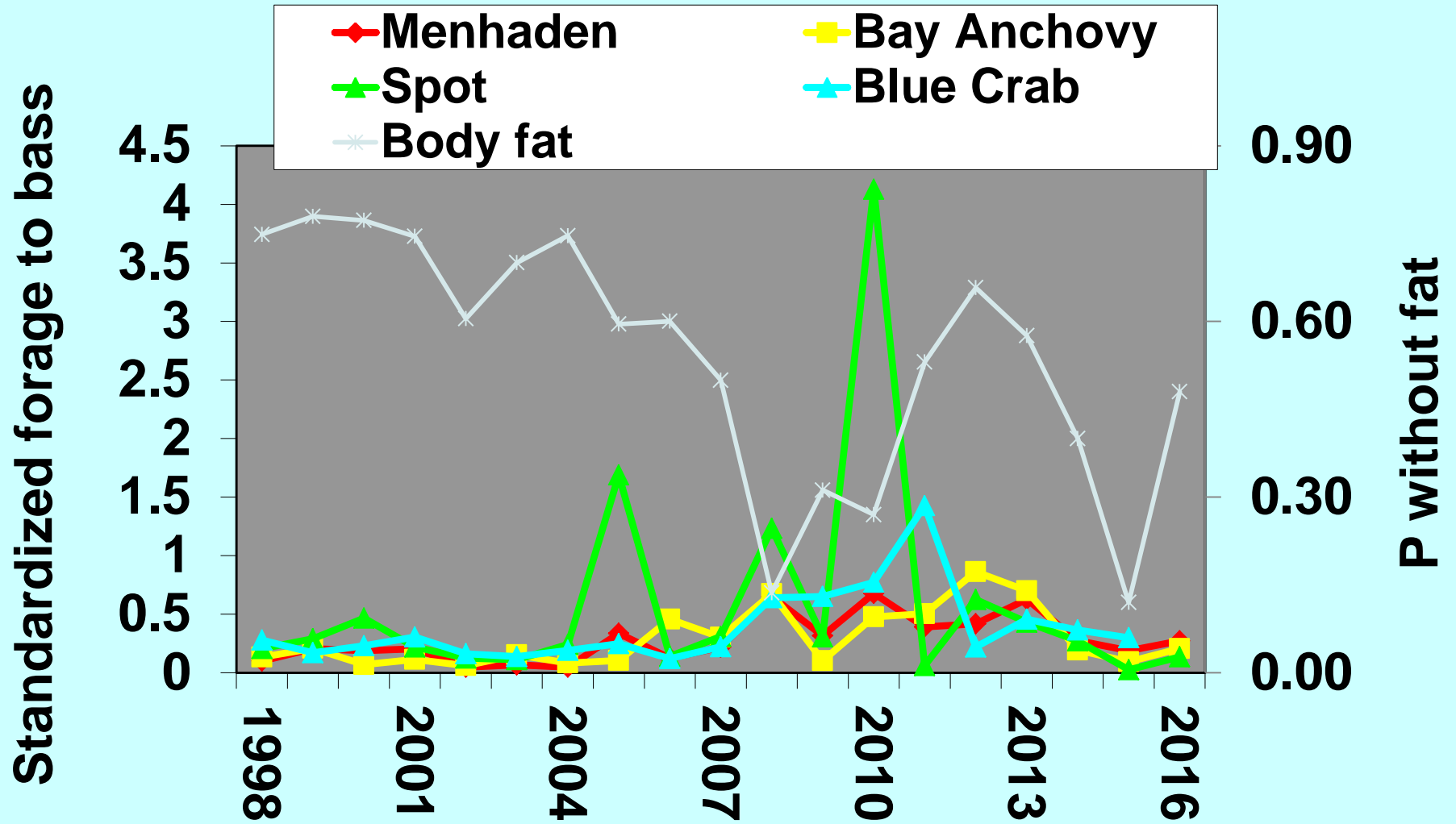
Resident Striped Bass abundance index target (best body fat) and threshold (poorest body fat) Catch per MD private boat trip, Sept – Oct.
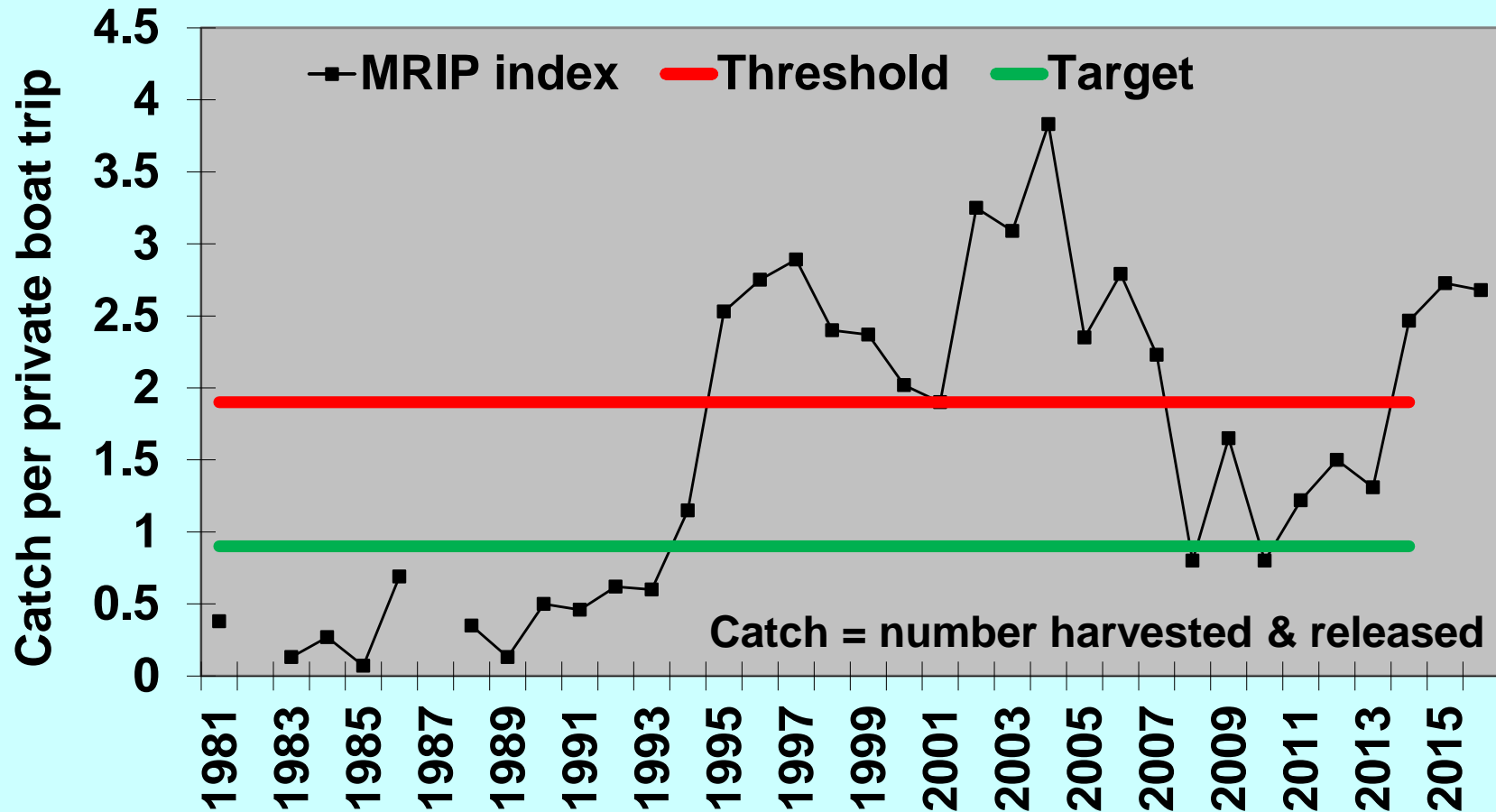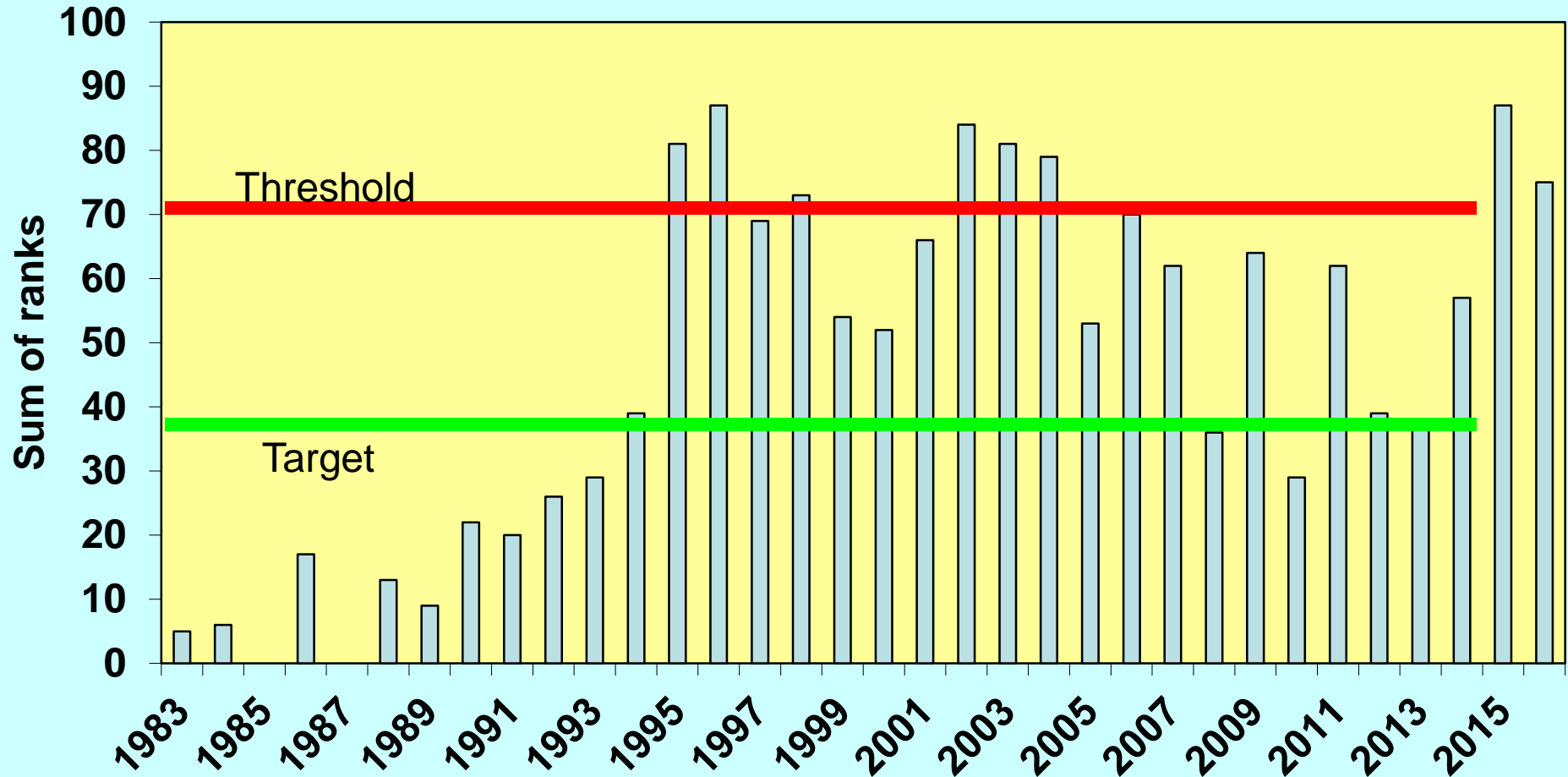
Standardized indices of bass-to-major forage
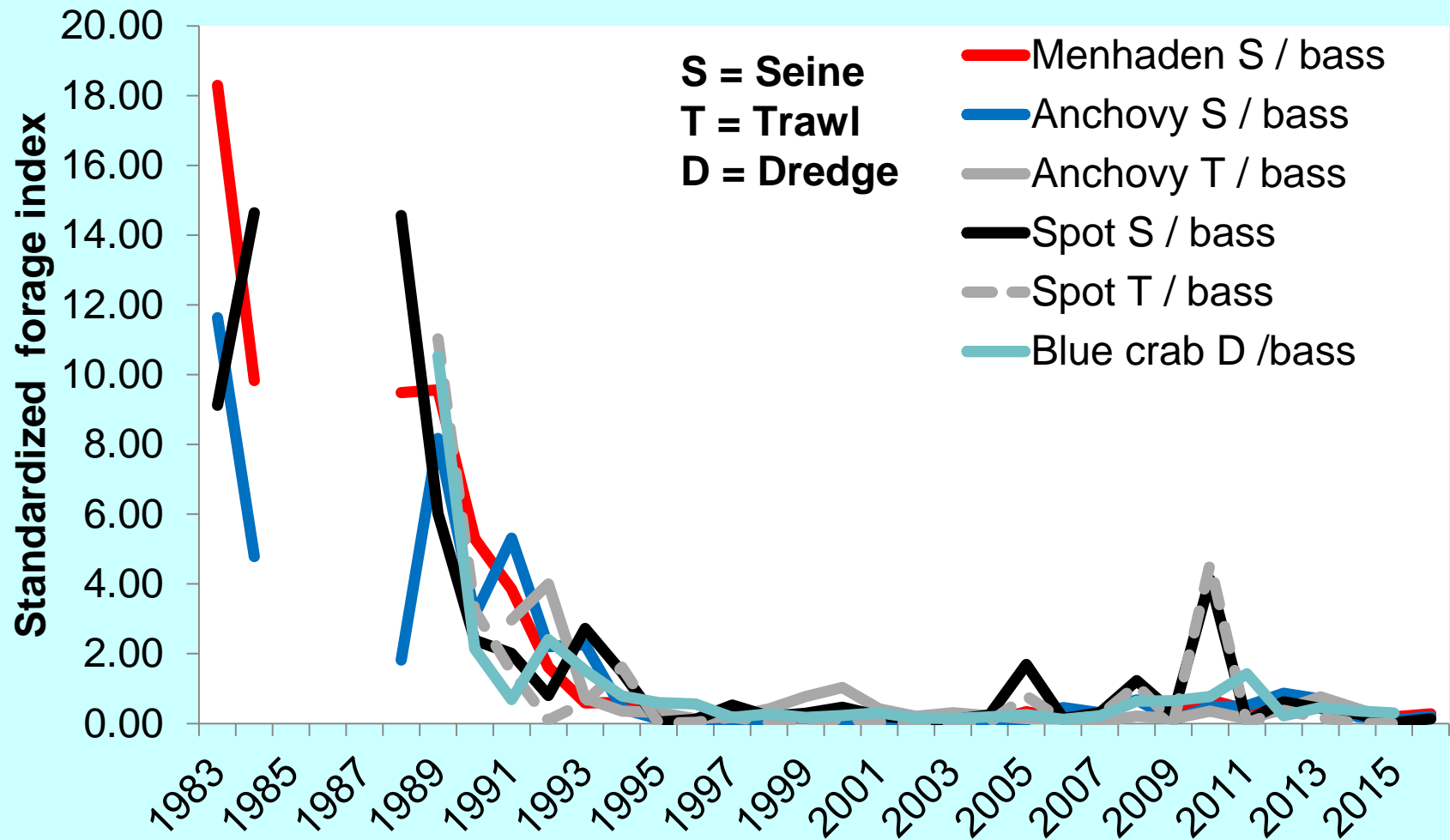
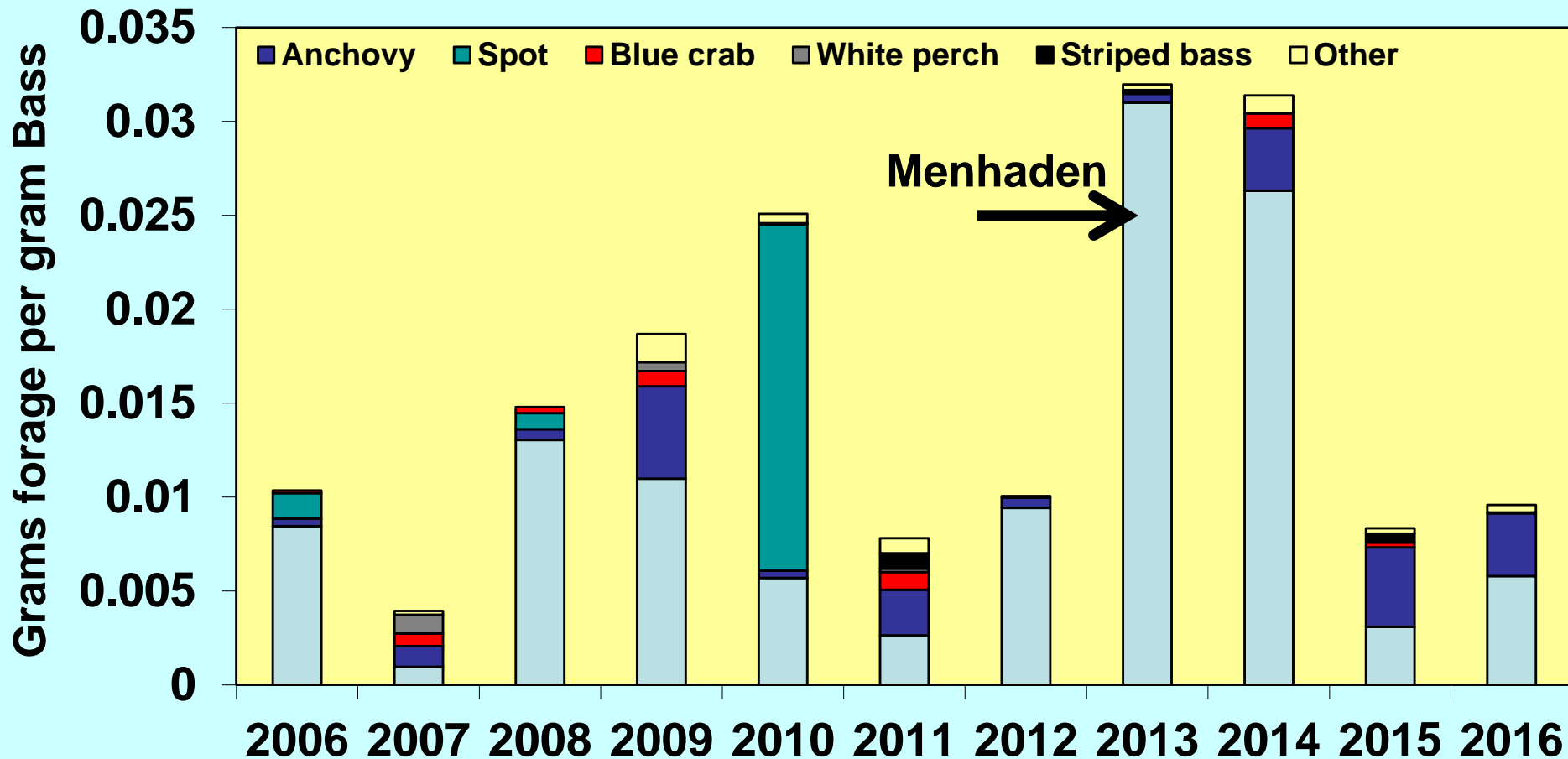Standardized major forage to Striped Bass ratios (to 1989+ mean) and proportion without body fat

Sum ranks of major forage-to-bass ratios & target or threshold status (reflect body fat indices)
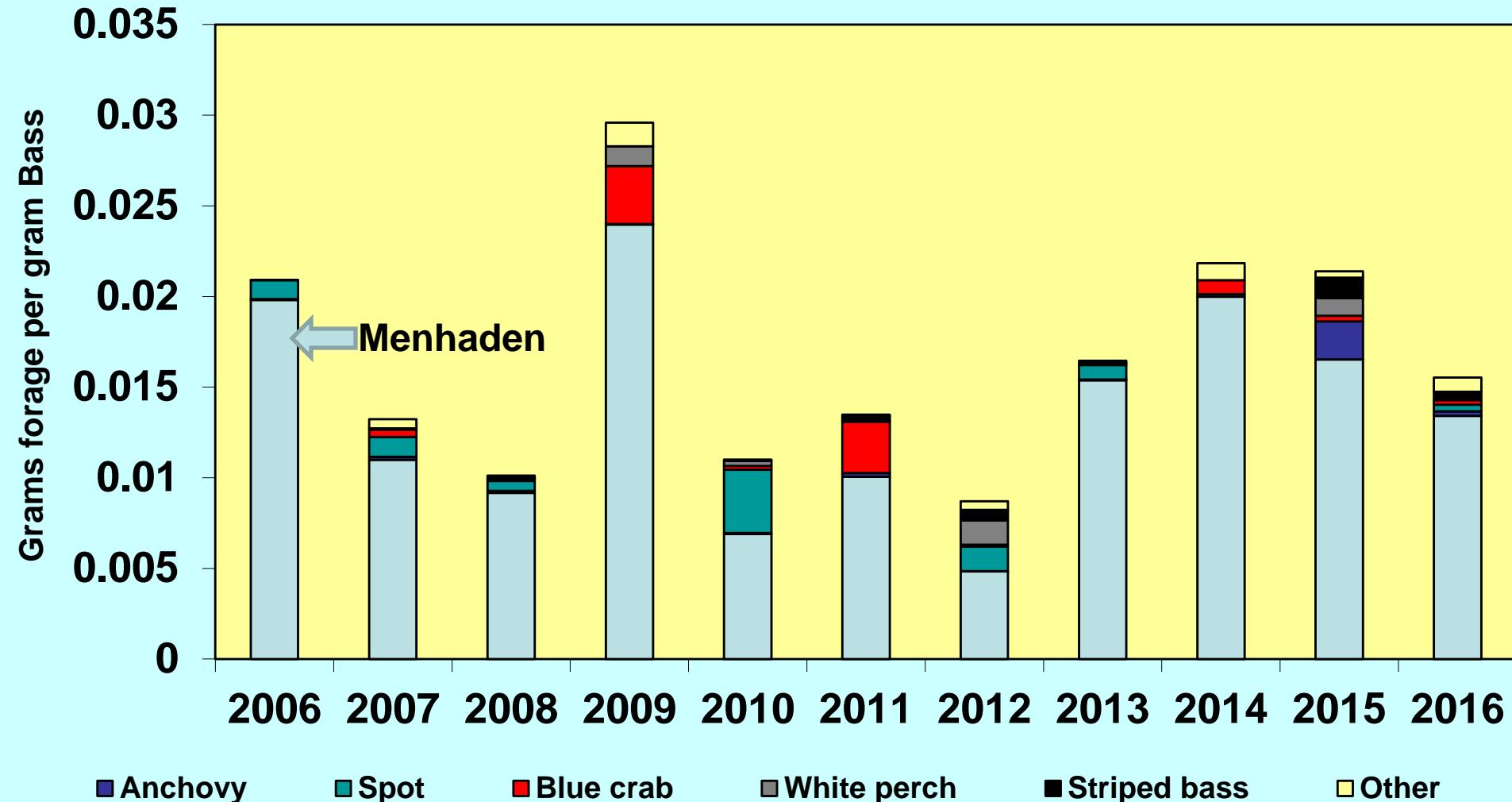
# Gram prey consumed per gram of sublegal (280-456 mm) Striped Bass in fall hook-and-line samples. Age-0 forage fish dominate.
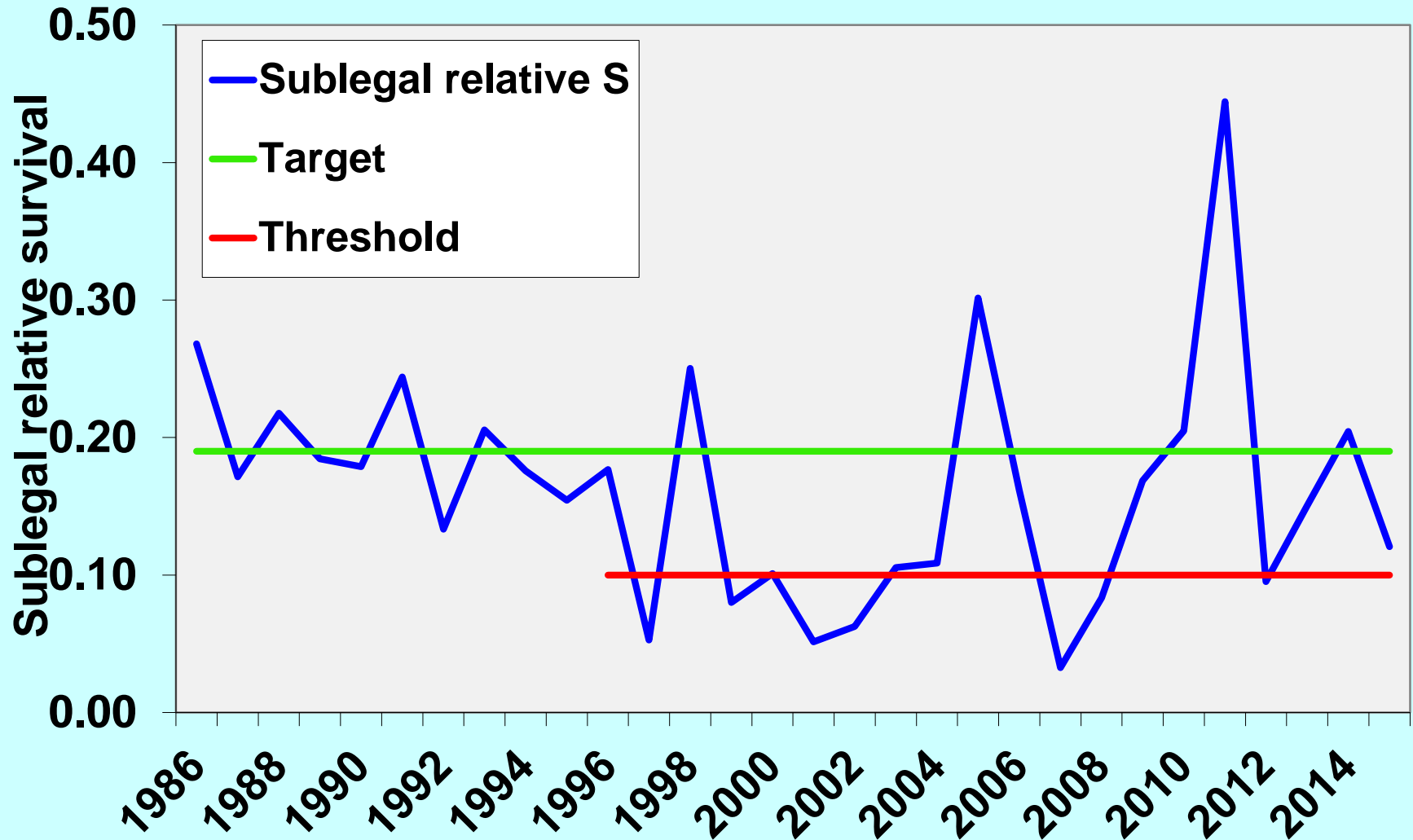
Grams of prey consumed per gram of legal (457-860 mm) Striped Bass during October-November. Fall consumption dominated by YOY forage.

Proportion of sublegal Striped Bass (280-456 mm) with empty stomachs in fall indicates forage availability / feeding success
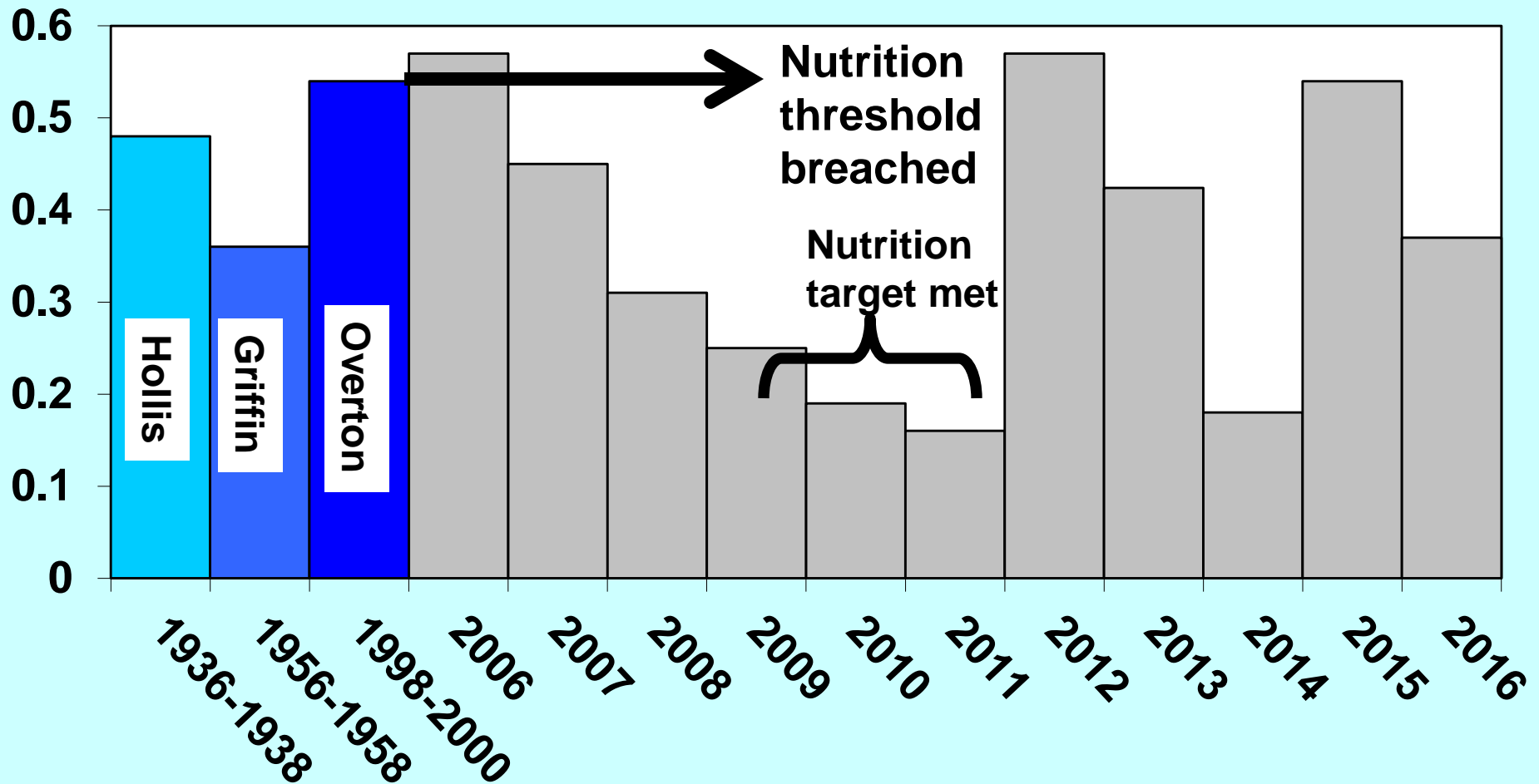
Relative survival of sublegal male Striped Bass to age-3 (spring gill net index / JI in yr-3) targets and thresholds.

Y-axis: Sublegal relative survival (0.00, 0.10, 0.20, 0.30, 0.40, 0.50)

Legend:
- Sublegal relative S
- Target
- Threshold

X-axis years: 1986, 1988, 1990, 1992, 1994, 1996, 1998, 2000, 2002, 2004, 2006, 2008, 2010, 2012, 2014

2015

- Legal fish body fat much better than other indicators

- Something missed?

- Striped bass fed heavily in late spring - early summer on clams and other benthos by feeding with Cownose Rays (based on guts collected & processed by JHU)

- Gained body fat before summer set in

- Would benthic invertebrate data have caught that?

What could MD indicators do?

- **Illustrate / quantify local forage issue for Bay managers, ASMFC, & public**
- **Considerations:**
  - **What's the decision to be made?**
    - **Bring situation forward to ASMFC? Or other? None?**
  - **How much do we pay to make it?**
    - **As little as possible**
  - **No change = current situation (Is that OK?)**
  - **Change = manage towards balance (not defined)**
    - **Reshuffle angry & happy stakeholders**
    - **Degree and longevity of success difficult to predict**
    - **Must monitor**

Indicator Issues

- Convenience sampling vs dedicated program
- Statistical vs biological / management significance
- Mix of linear, nonlinear, and lagged responses
- Indicators sometimes appear contradictory
- May not cover episodes of lots of "other" forage (Surprise!)
- Menhaden consumption varies more than JI
  - More abundant menhaden and-or feeding efficiency changes?
  - Sampling?

Management Issues 1

- Coastal single-species approach may not capture regional issues

- Non-fishing (M-based) bass survival not constant as assumed

- Expected bass outcomes from managing for low F in Bay may not be realized
  - Escapement of young females
  - Yield from Bay fisheries

Management Issues 2

– High rockfish population is popular idea, but may not be good for Bay balance

– Palatable reductions in bass (if allowed and accepted) may not entirely balance prey

– Manipulating forage may be difficult because of weak influence of spawning stock

– Older bass may become more efficient at obtaining prey (behavior and learning a factor? Not just abundance.)

– Thresholds may be avoidable, targets hard to meet

Concerns about striped bass forage and health in Bay are not new!

There was concern about the 1958 dominant year-class in 1959 (MD DNR file report, circa 1960).

…fishermen noted that some small fish were in poor physical condition and surmized that …food supply was inadequate…

…usual swarms of anchovies were not present around pound nets and this was attributed to the dearth of anchovies…due to the enormous rockfish population.…

…the emaciated condition of a few striped bass and the almost complete absence of anchovies…were observed by biologists…

Questions?

Details follow

MD striped bass indicator approach

- Forage availability + bass well-being. (How much forage and is it enough?)

- Convenience sampling – use existing surveys

- Indicators linked biologically and statistically
  - Not etched in stone
  - Can be modified and-or improved

- Calibrate other indicators to body fat indicator (condition; Jacobs et al. 2013)

MD forage trend indicators – available or developed easily without $

1. Proportion bass without body fat in fall (condition)
2. Major forage indices: menhaden, anchovy, spot, blue crab (benthic inverts?)
3. Resident bass relative abundance index (MRIP Sept – Oct CPUE)
4. Attack success ~ (forage index / bass index)
5. Fall diet as major forage availability indicator (not year-round diet and not all forage)
6. Sublegal Striped Bass relative non-F survival (Spring gill net indices of age 3 males / relevant JI)
7. ? ASMFC non-F survival estimates for 18-28 inch Striped Bass in Bay from tagging

MD striped bass indicator approach

- Ecosystem approach to fisheries management and not EBFM

- A step from single-species to ecosystem

- Build on extensive 2009 MD Sea Grant recommendations

- Looks at forage availability and adds bass well-being. (How much forage and is it enough?)

- Calibrated to body fat indicator (condition; Jacobs et al. 2013)

- Convenience sampling
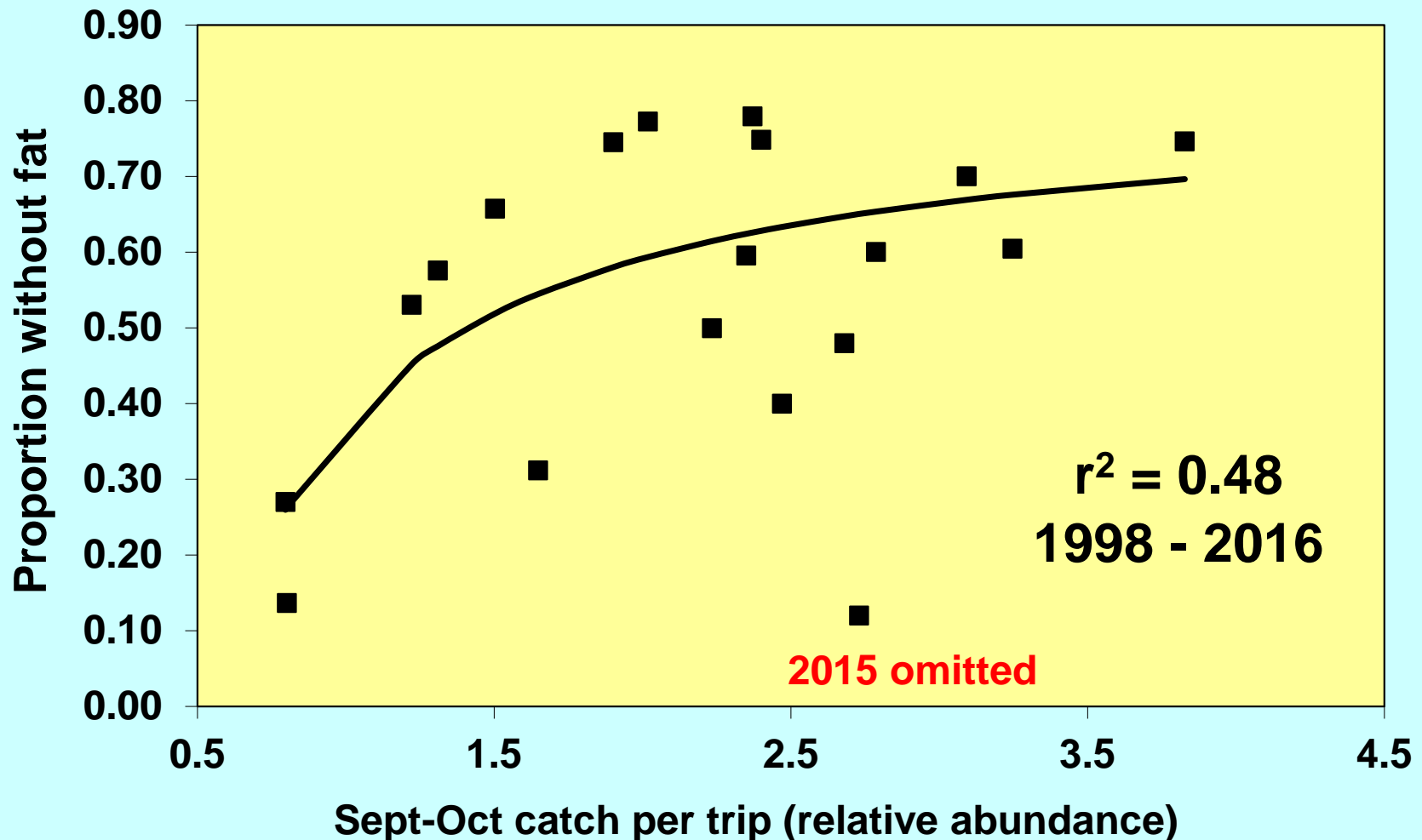
- Indicators linked biologically and statistically

Percent of striped bass without body fat in summer influences condition in fall, 1999-2012 (FWHP). Summer sampling discontinued.

Weibull fc
R^2 = 0.75
P < 0.0001
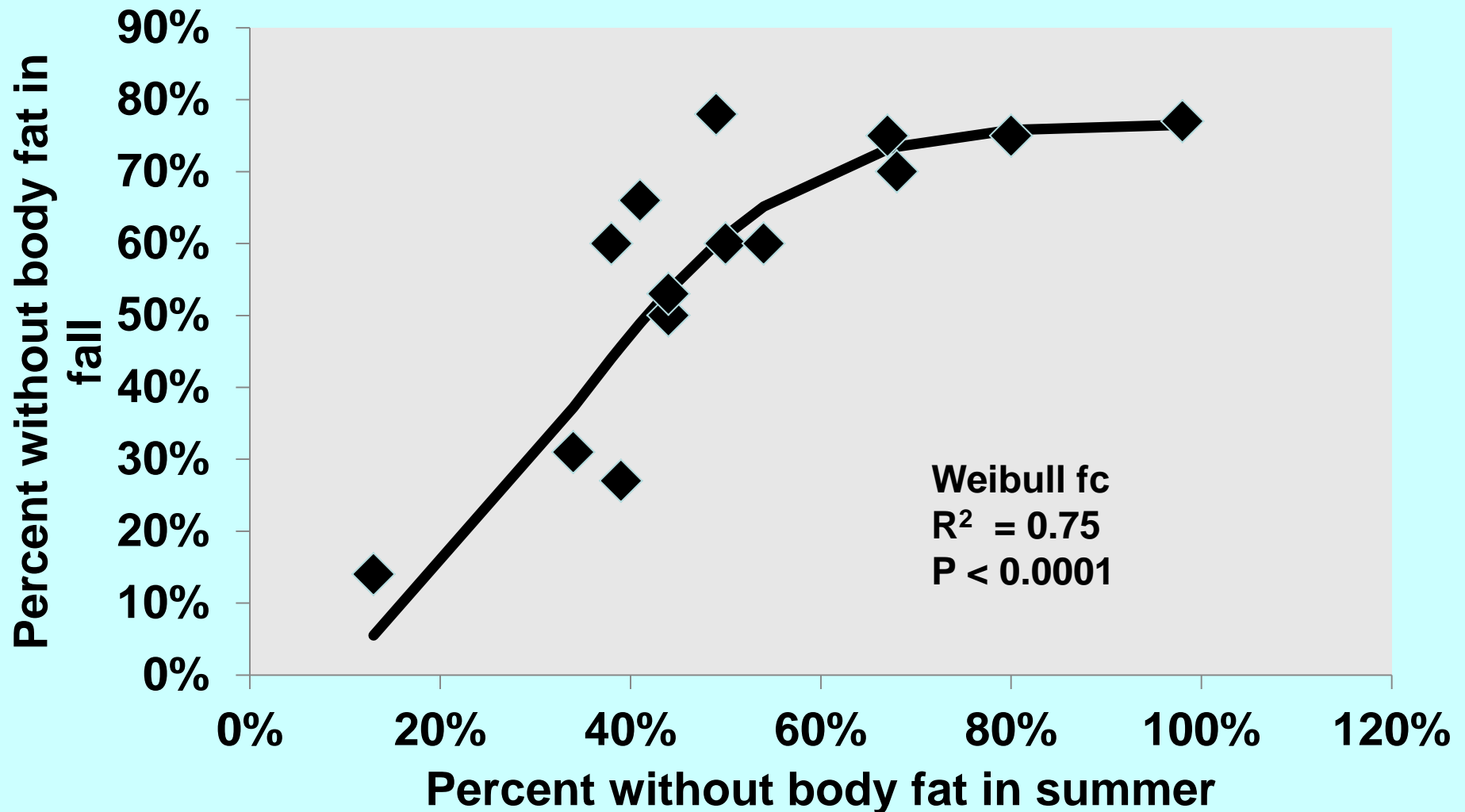
Percent of striped bass without body fat in summer may be influenced by condition in previous fall, 1999-2012 (FWHP)

$r^2 = 0.34$
$P = 0.04$

Percent without body fat in summer

Percent without body fat in previous fall
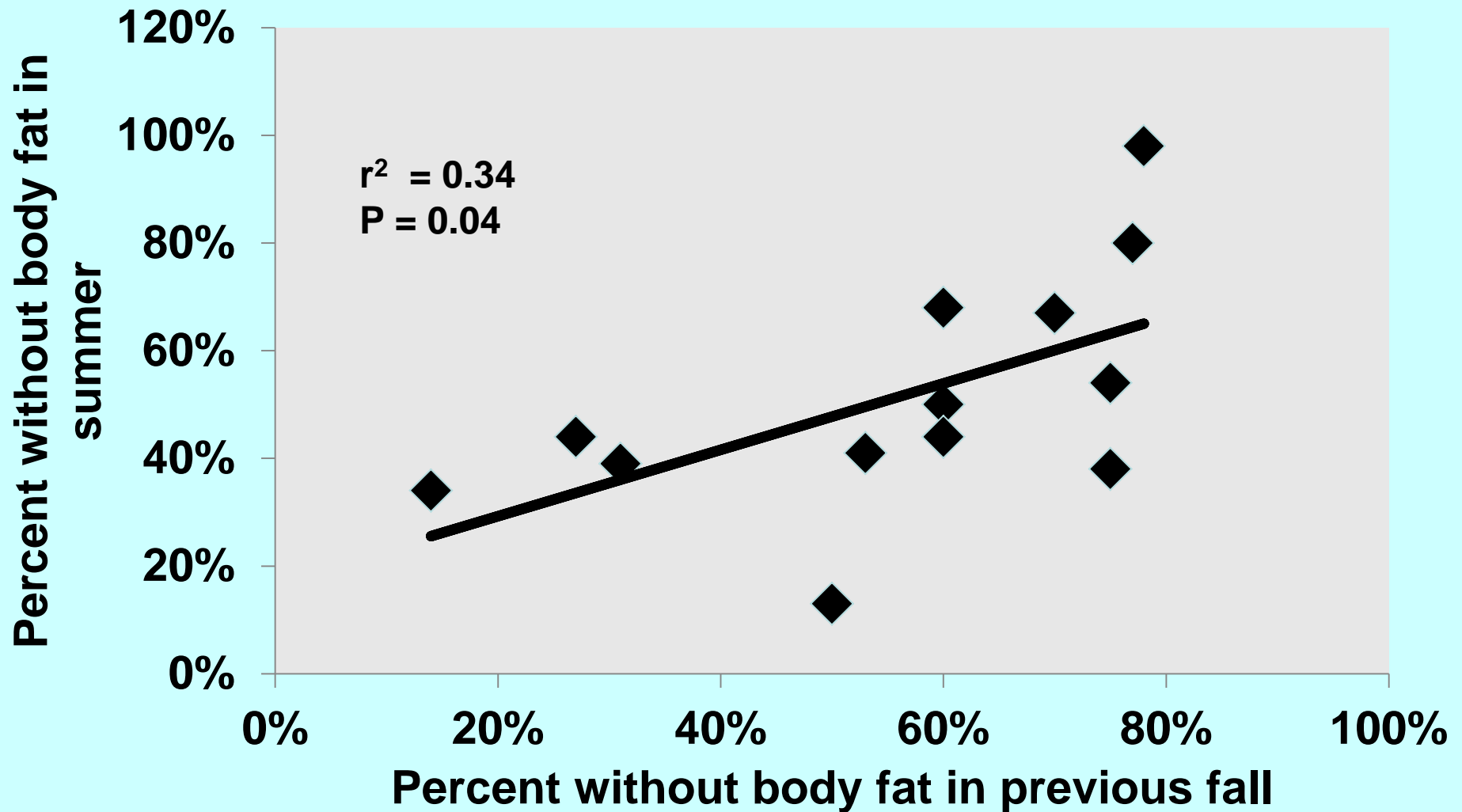
In the current low forage / high abundance / larger size limit regime, condition was usually a non-linear function of abundance

Proportion without fat (y-axis, 0.00 to 0.90)

$r^2 = 0.48$
1998 - 2016

2015 omitted

Sept-Oct catch per trip (relative abundance)

Proportion of Striped Bass with empty stomachs by size class
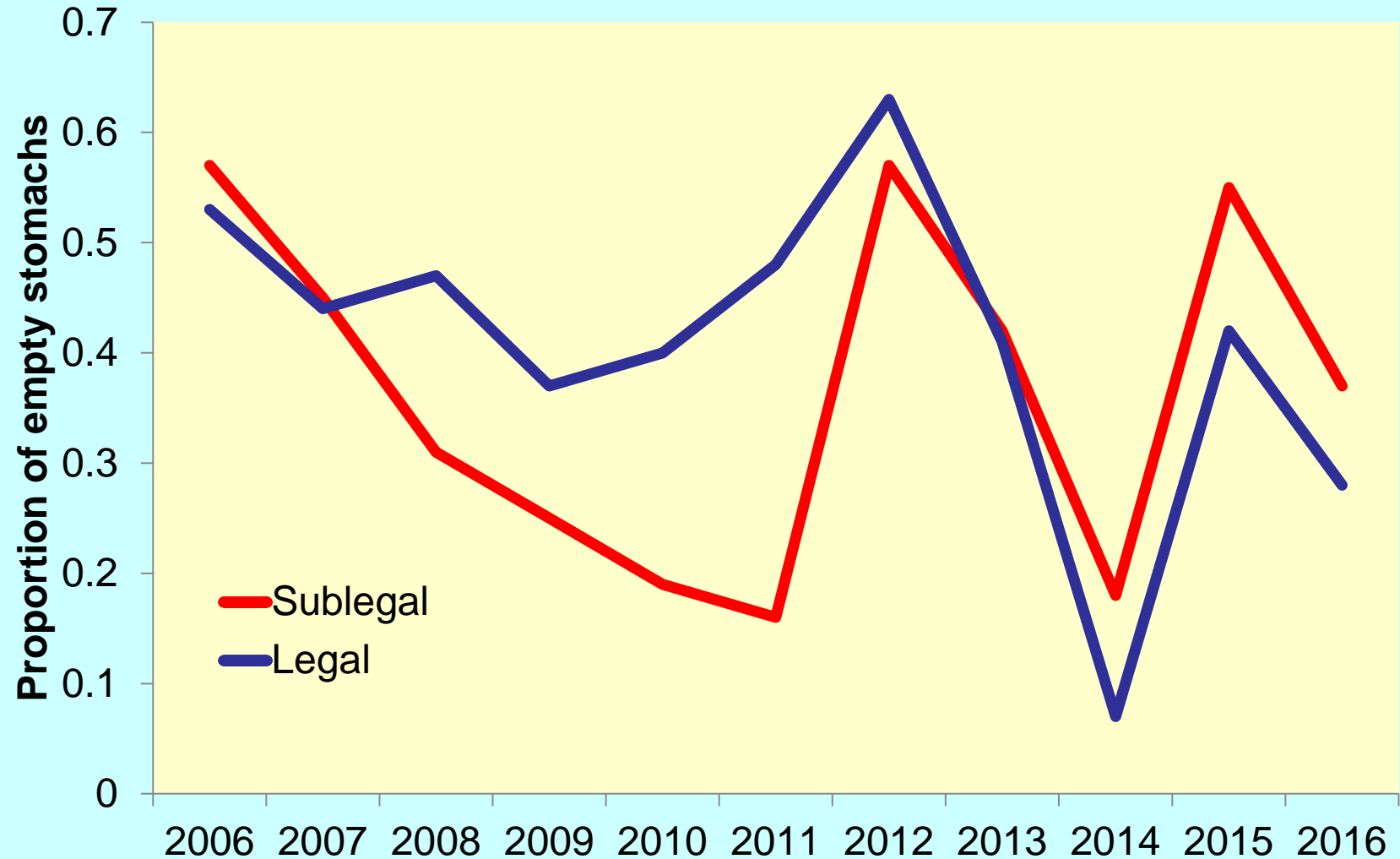
Proportion of empty stomachs versus proportion without fat
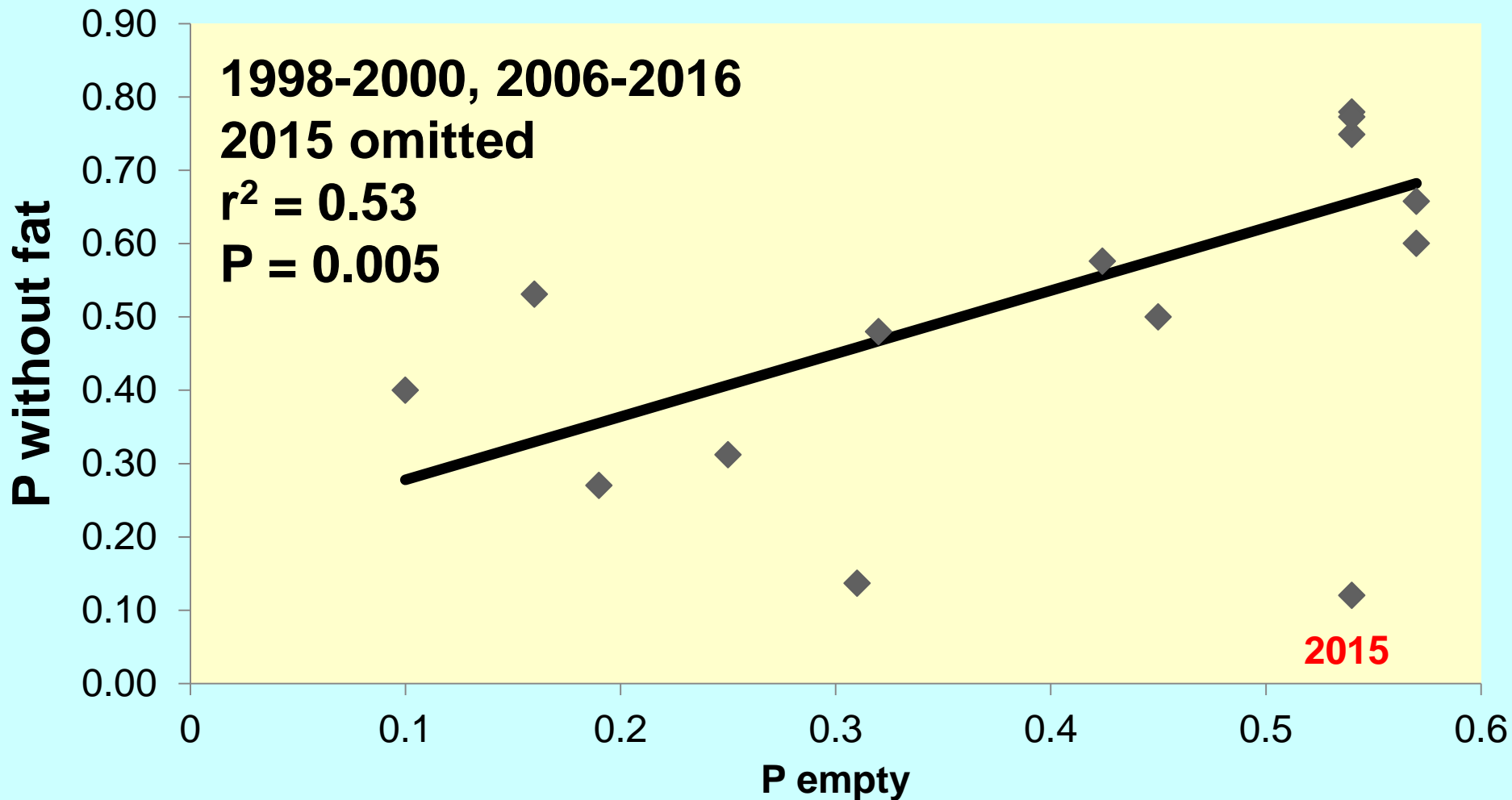
Relative survival in year t (cohort in spring; arbitrary scale) and body fat in year t-1 (all fish in fall).
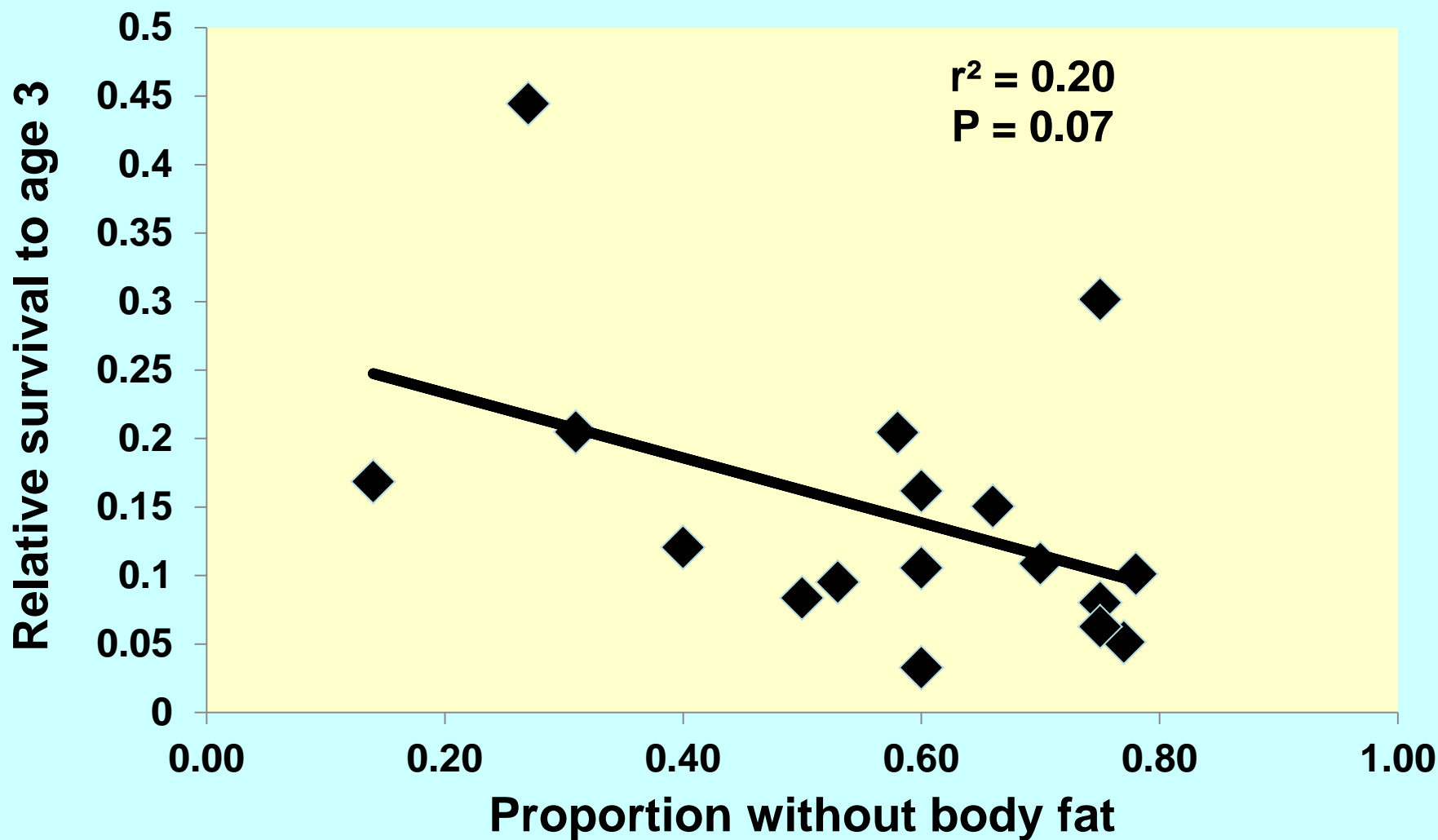
ASMFC tag-based estimates of M-related survival of legal fish in MD's Bay are available. Shorter interval would be more useful than 2 long periods.
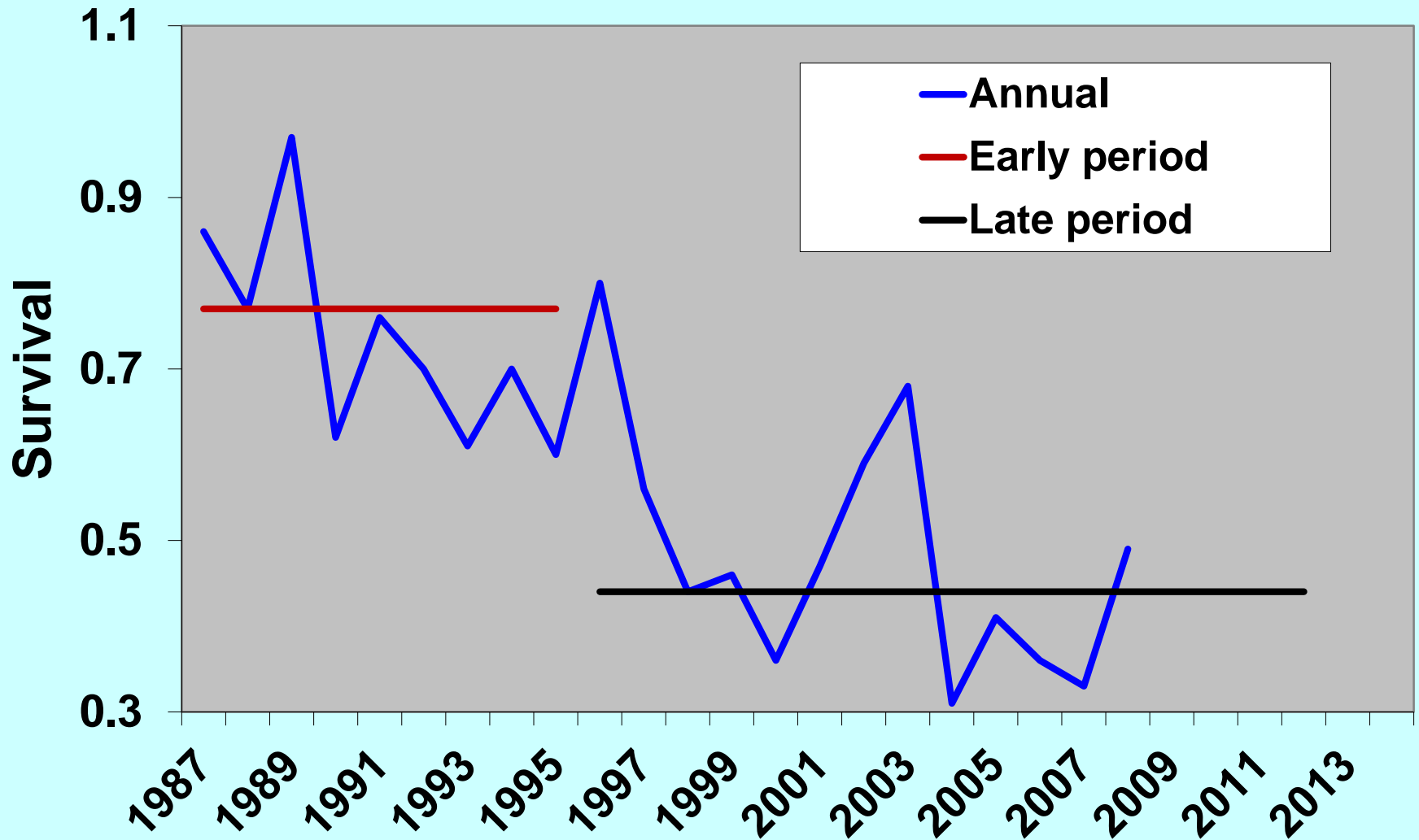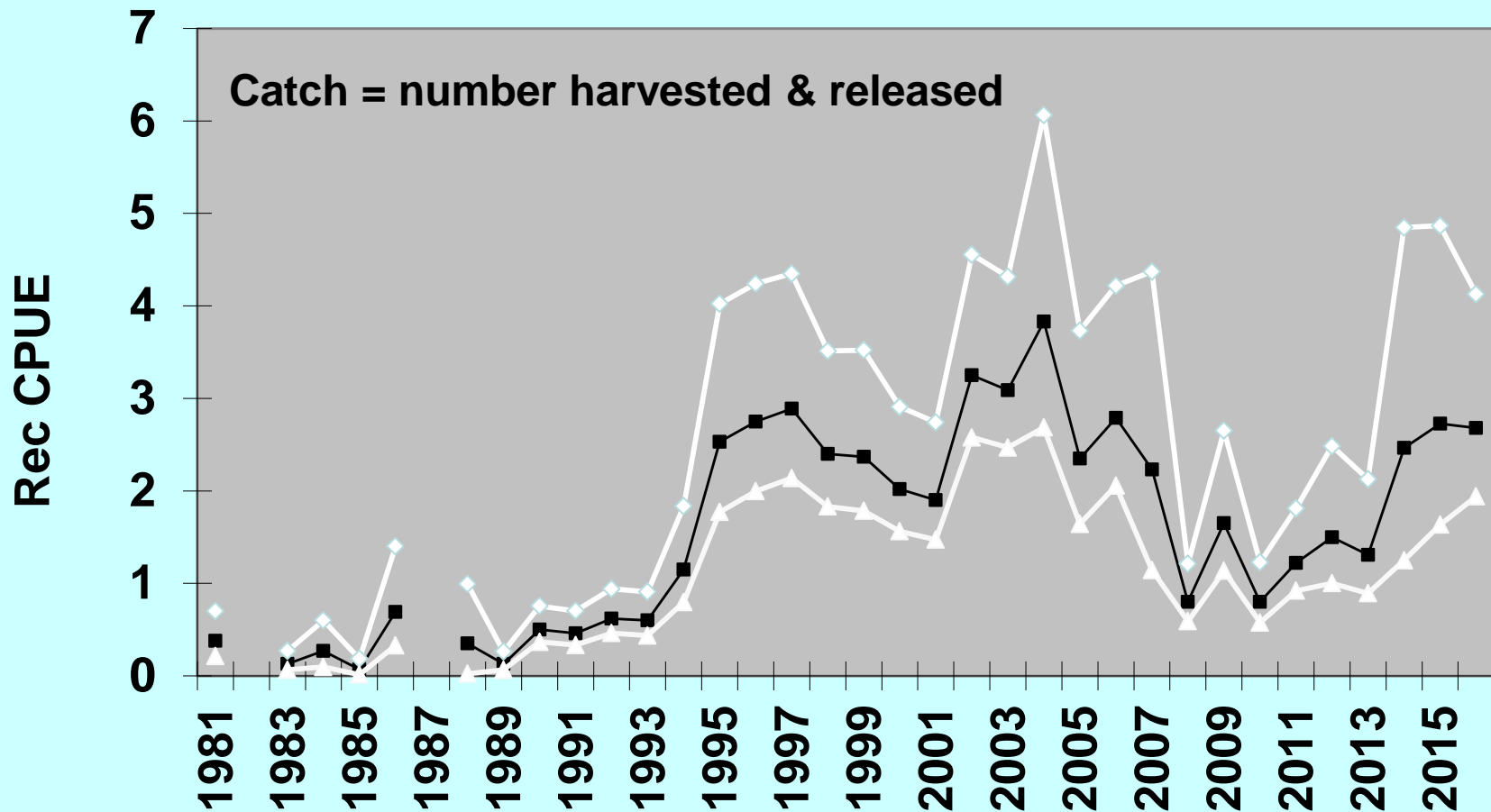
Percent of sublegal Striped Bass without food in fall.
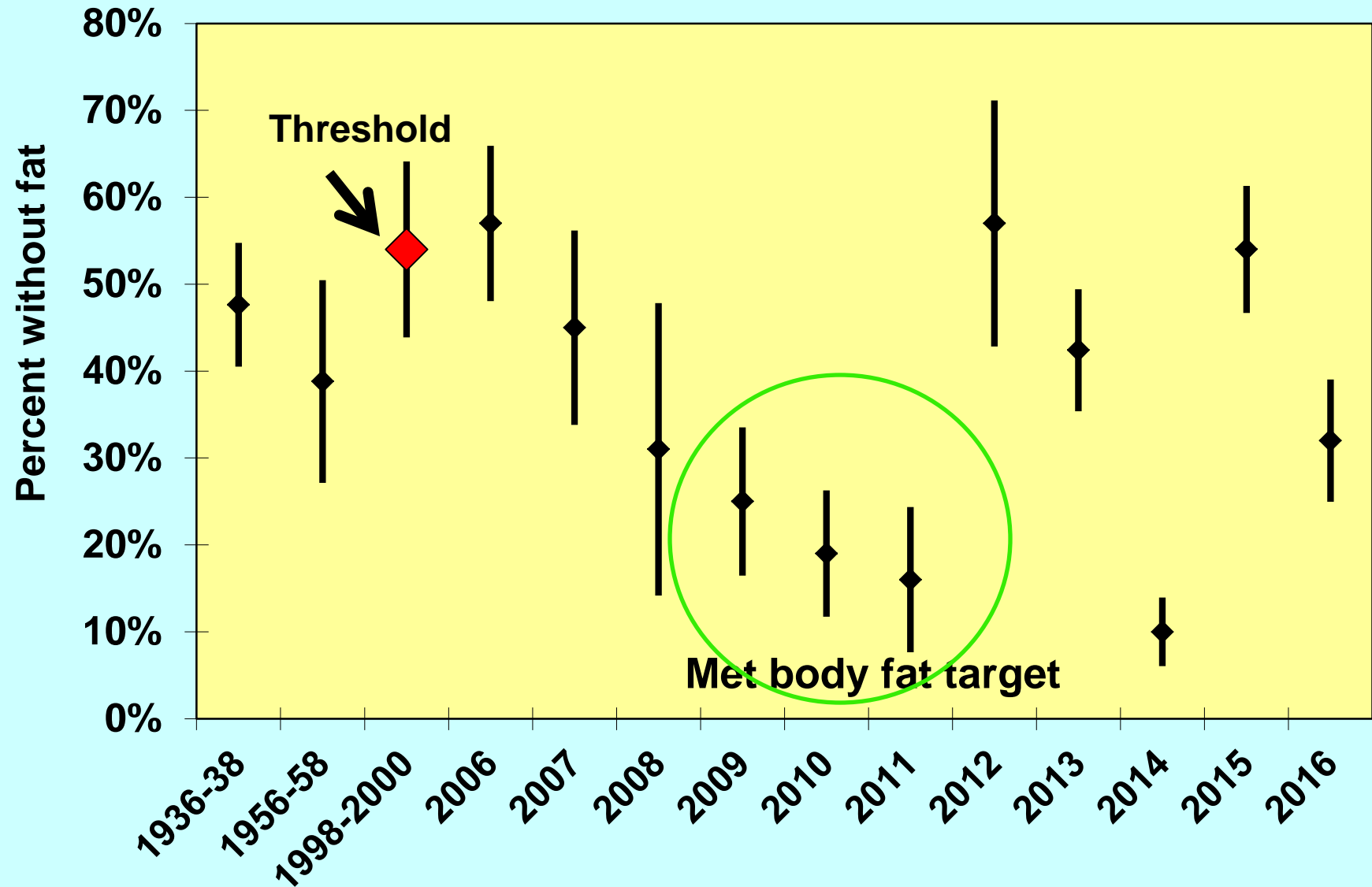
# Long-term trends in major prey of Striped Bass in Maryland's seine survey 1959-2016. Geometric mean indices were standardized to common period (1989-2016).
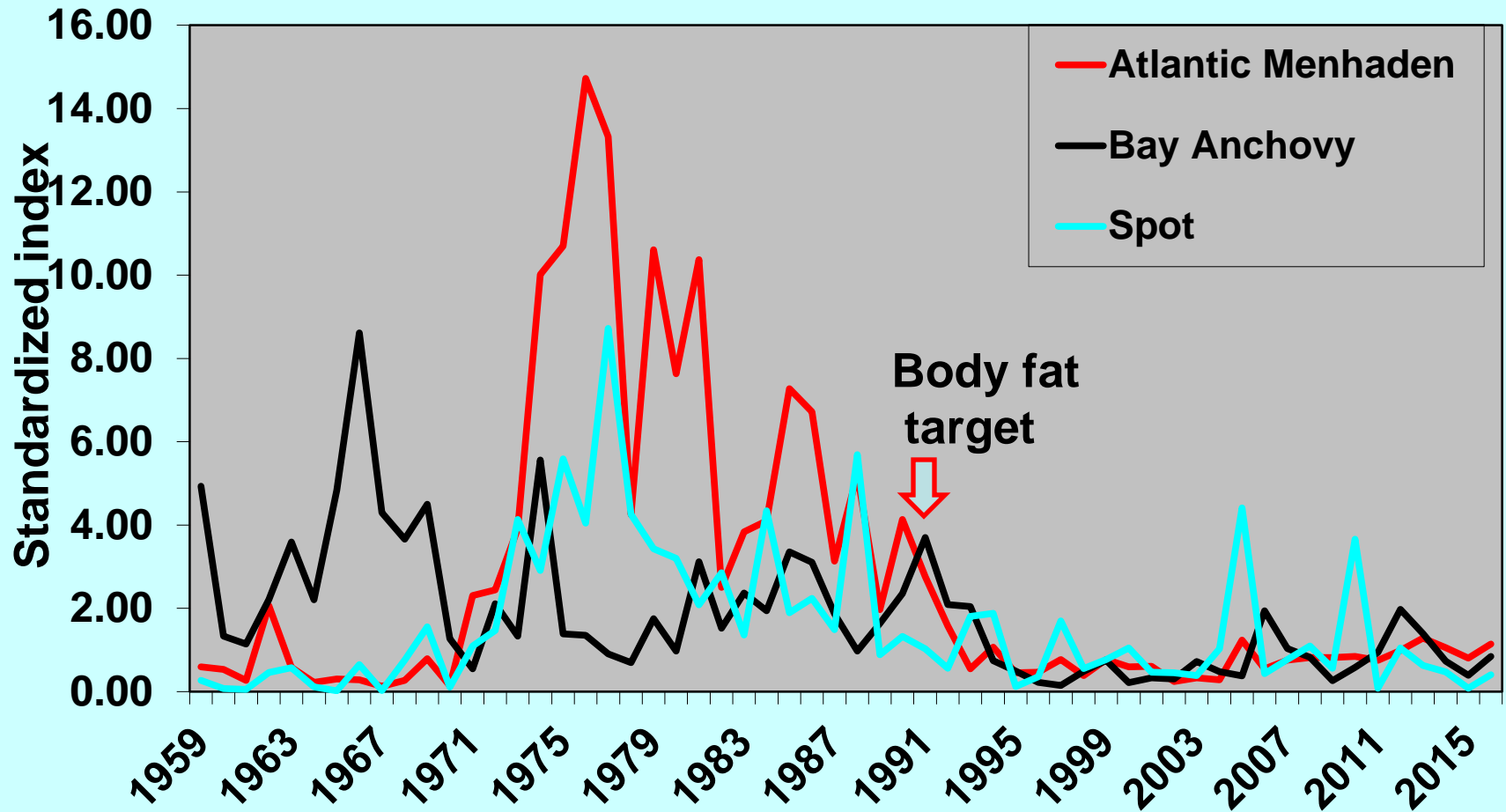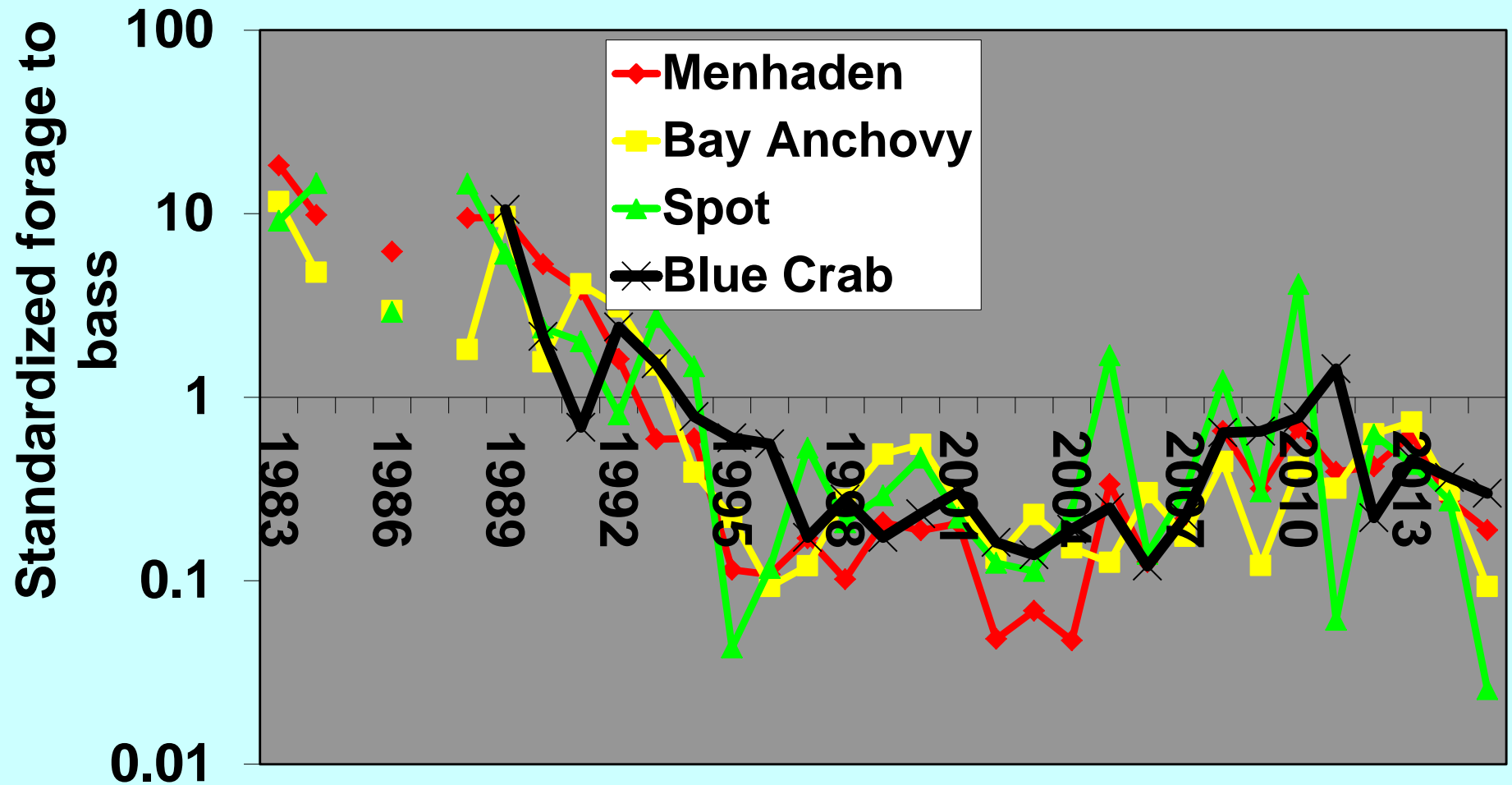
# Resident Striped Bass index (Sept-Oct MD MRIP recreational catch per private boat trip) and 95% CI

Resident Striped Bass abundance index target (best body fat) and threshold (poorest body fat) under low forage.
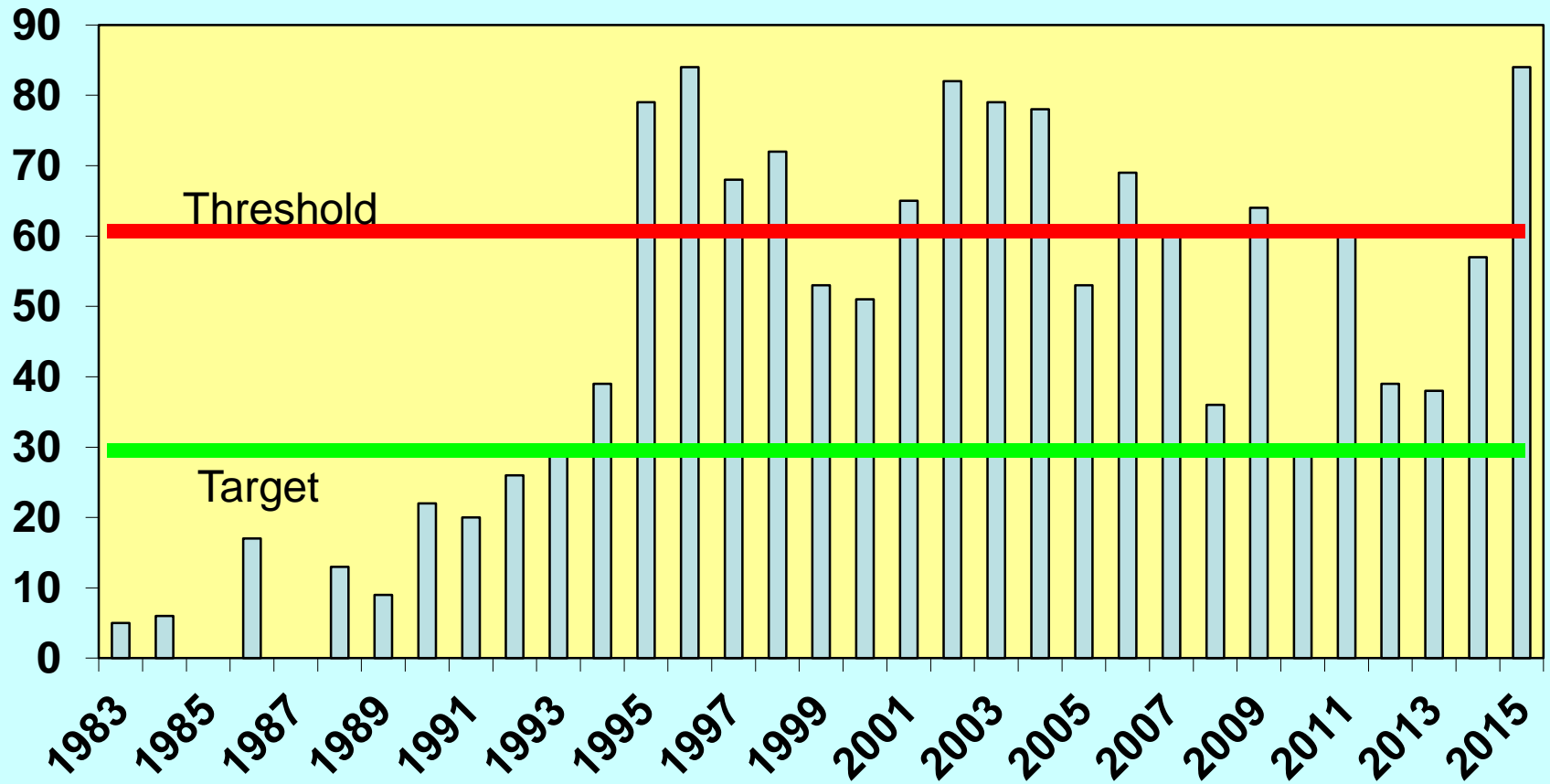
Catch = number harvested & released
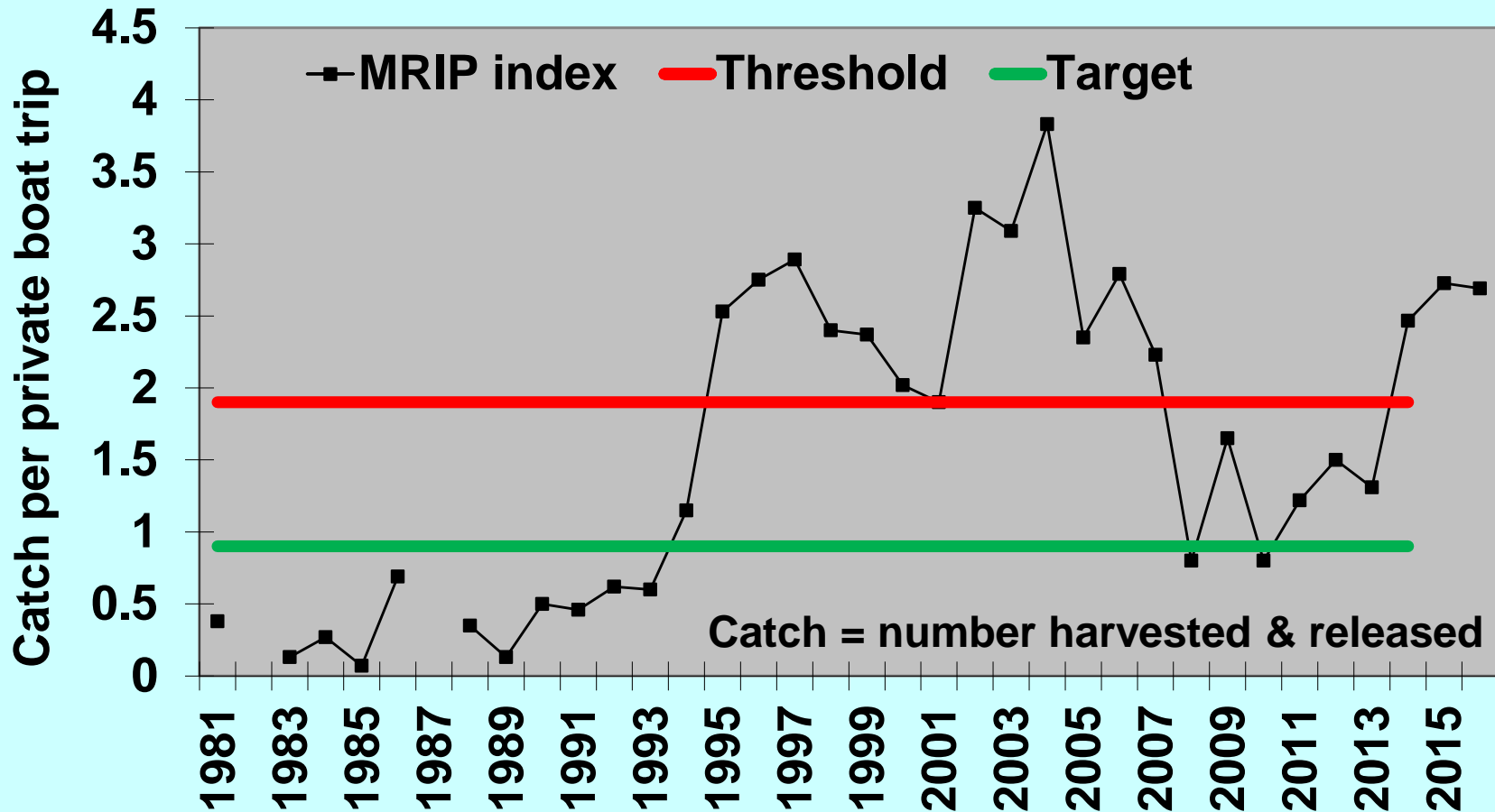
Standardized major forage to Striped Bass ratios on a log-scale (mean = 1)
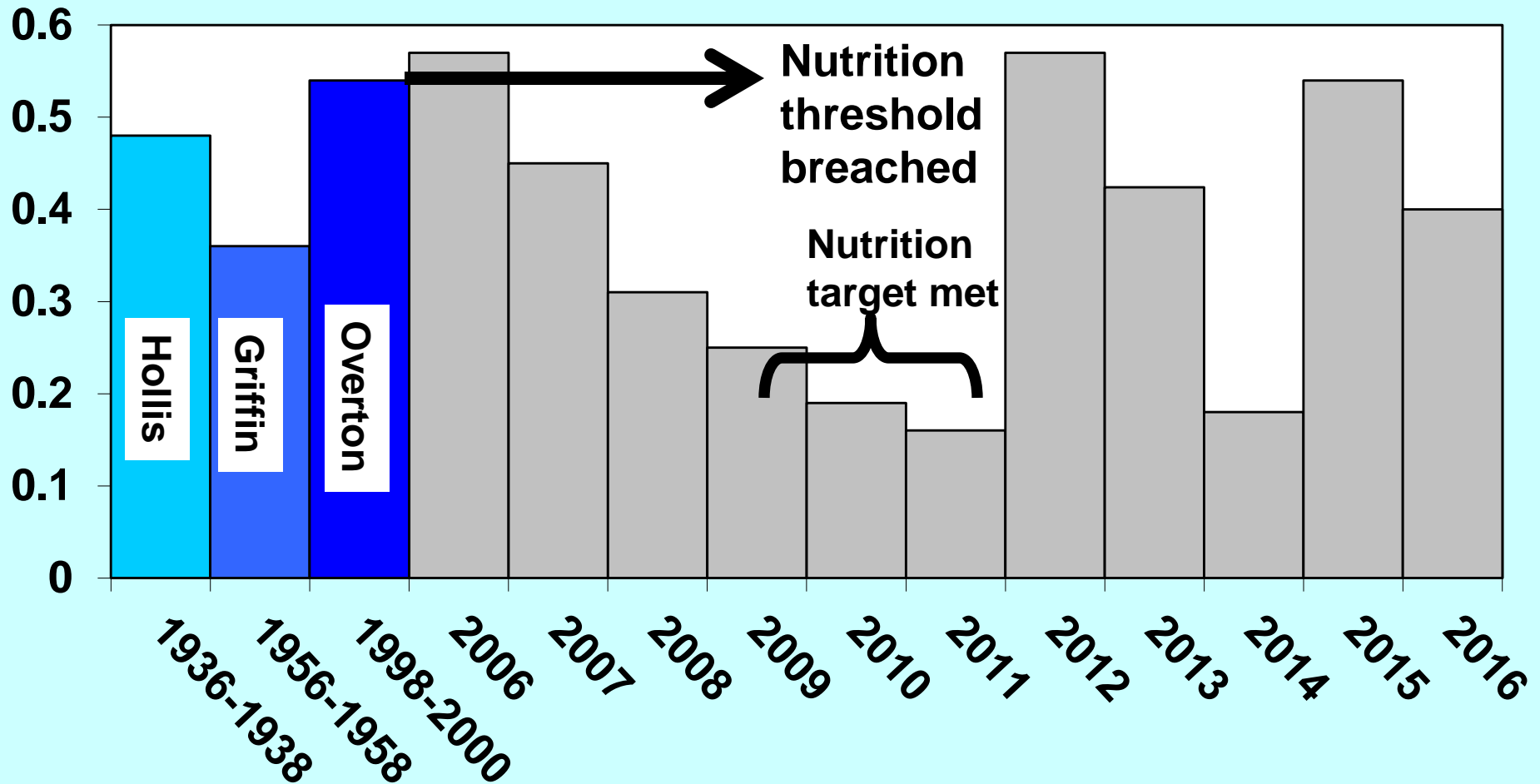
Standardized major forage to Striped Bass ratios (1 = mean) and proportion without body fat
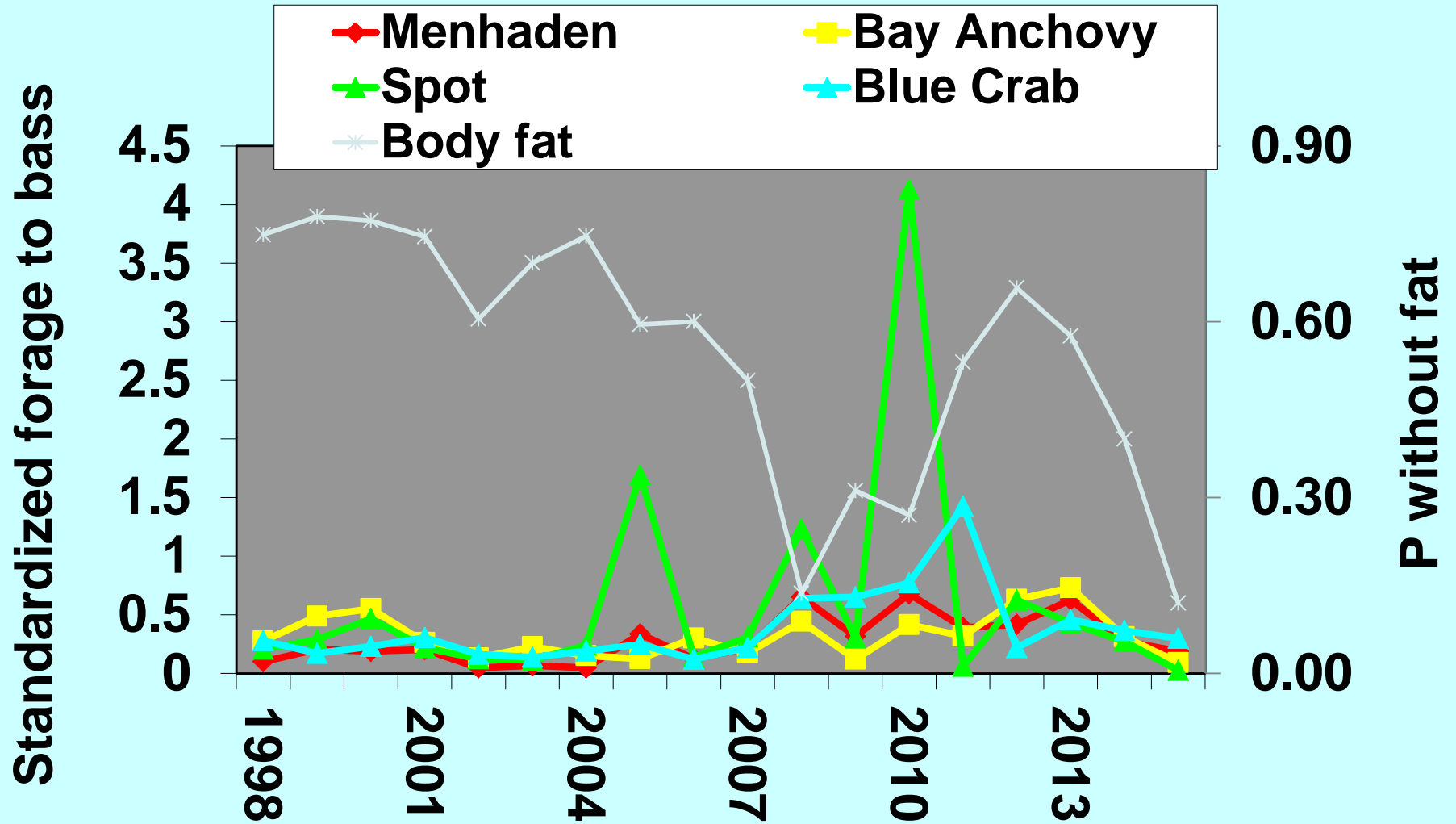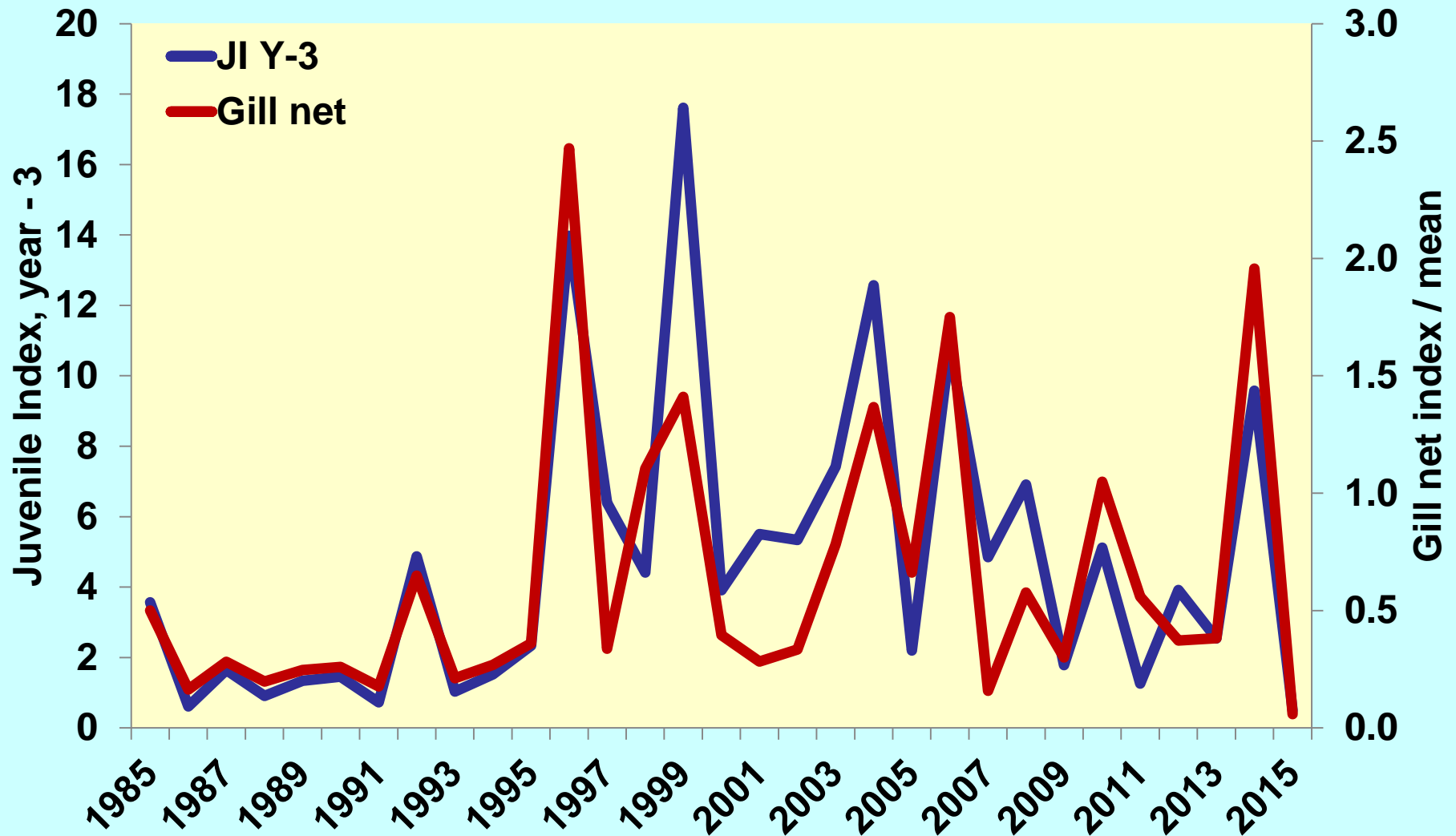
Sum ranks of forage fish ratios target-threshold status (reflect body fat indices)
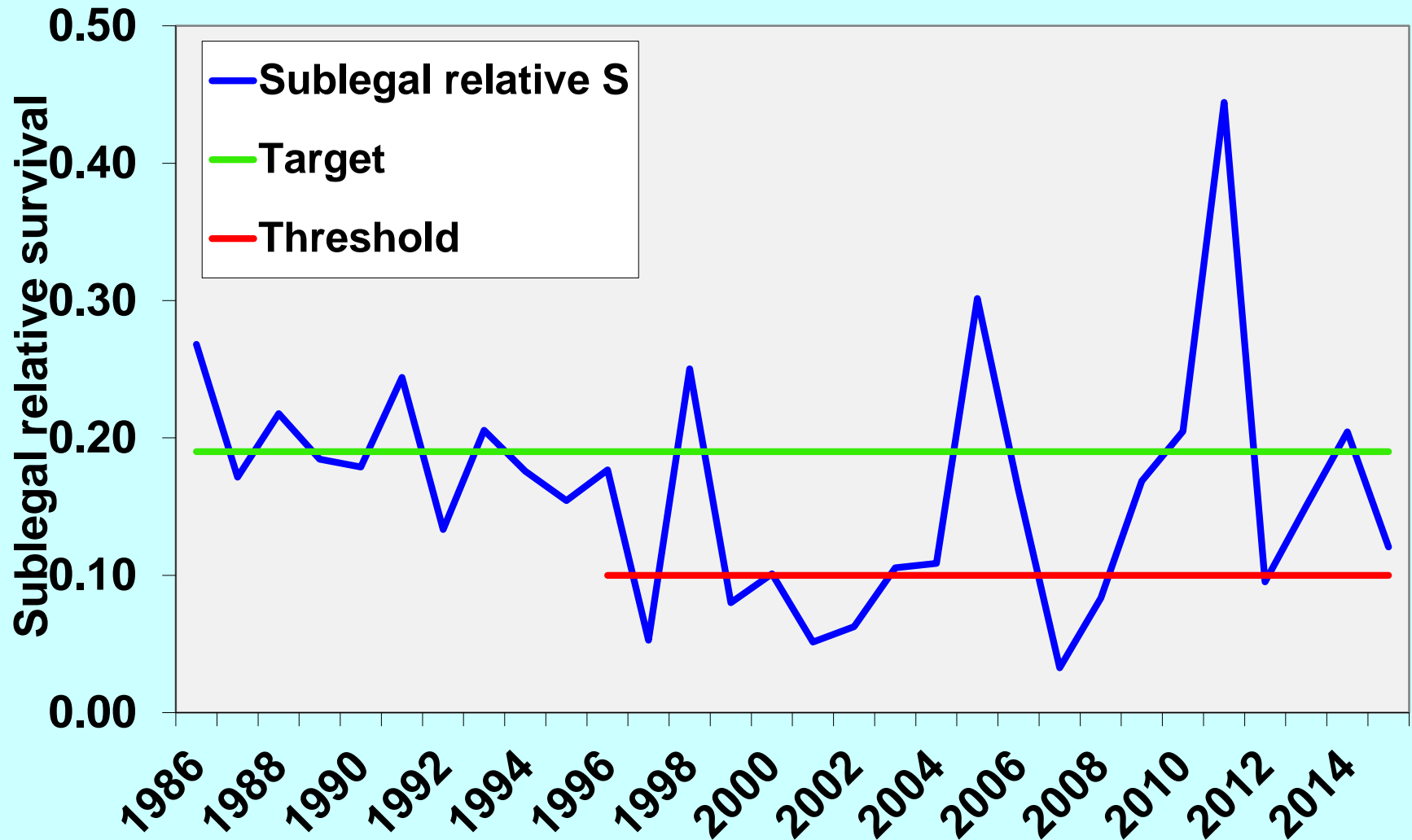
Proportion of Striped Bass 280-456 mm with empty stomachs in fall indicates forage availability / feeding success

Components of relative survival: lagged juvenile indices and corresponding spring gill net index
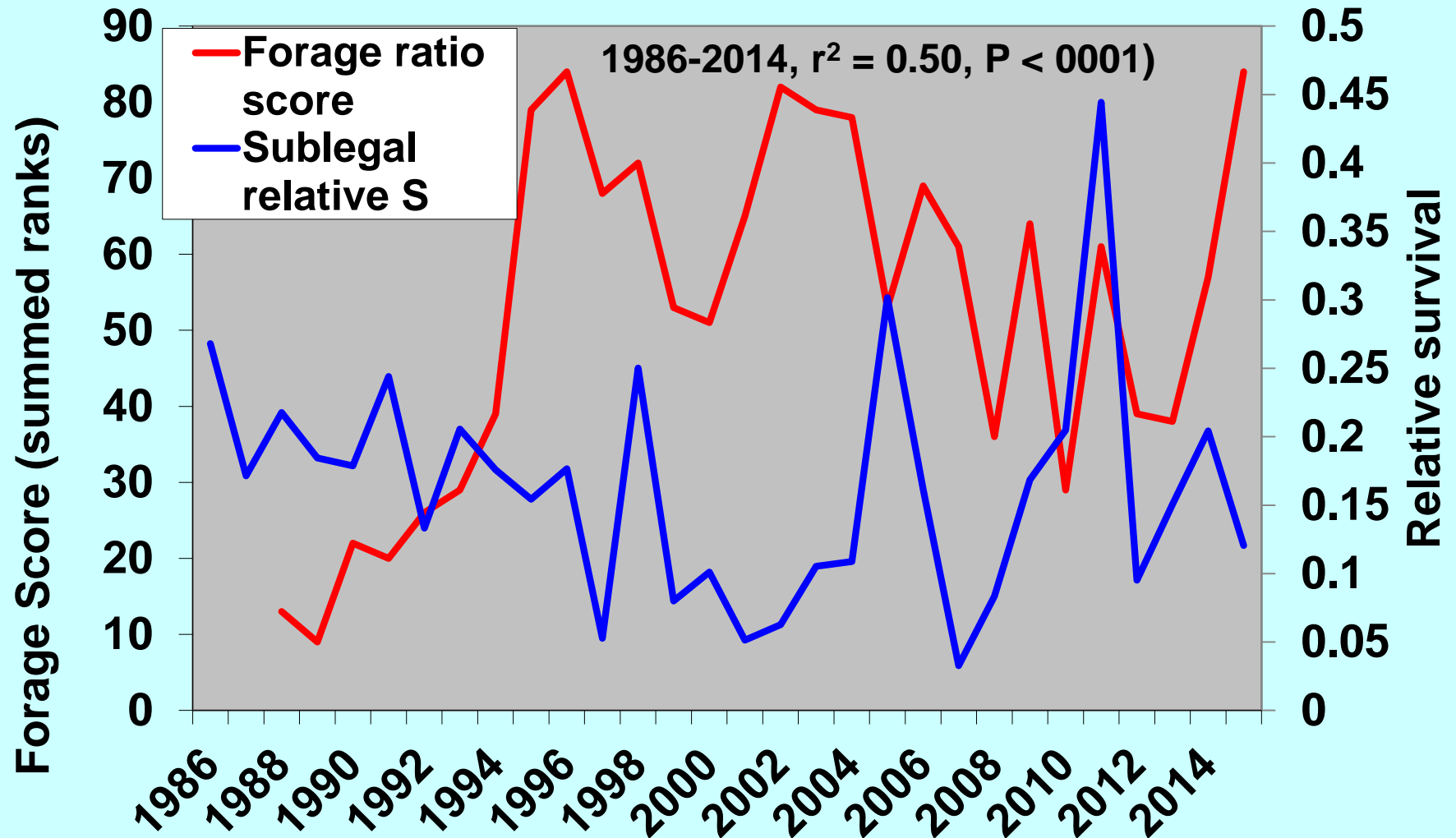
Relative survival of sublegal male Striped Bass to age-3 (spring gill net index / JI) targets and thresholds.

Relative survival of sublegal male Striped Bass to age-3 (spring gill net index / JI) and combined forage score (lower is better)

Death from causes other than harvest.

Legend:
- Forage ratio score
- Sublegal relative S

1986-2014, r² = 0.50, P < 0001)

Y-axis (left): Forage Score (summed ranks)
Y-axis (right): Relative survival
X-axis: 1986–2014

Sum ranks of ratios of menhaden, spot, and anchovy to striped bass to get single index. Here, sum is compared to body fat index.

1983-2014, r^2 = 0.36, P = 0.011
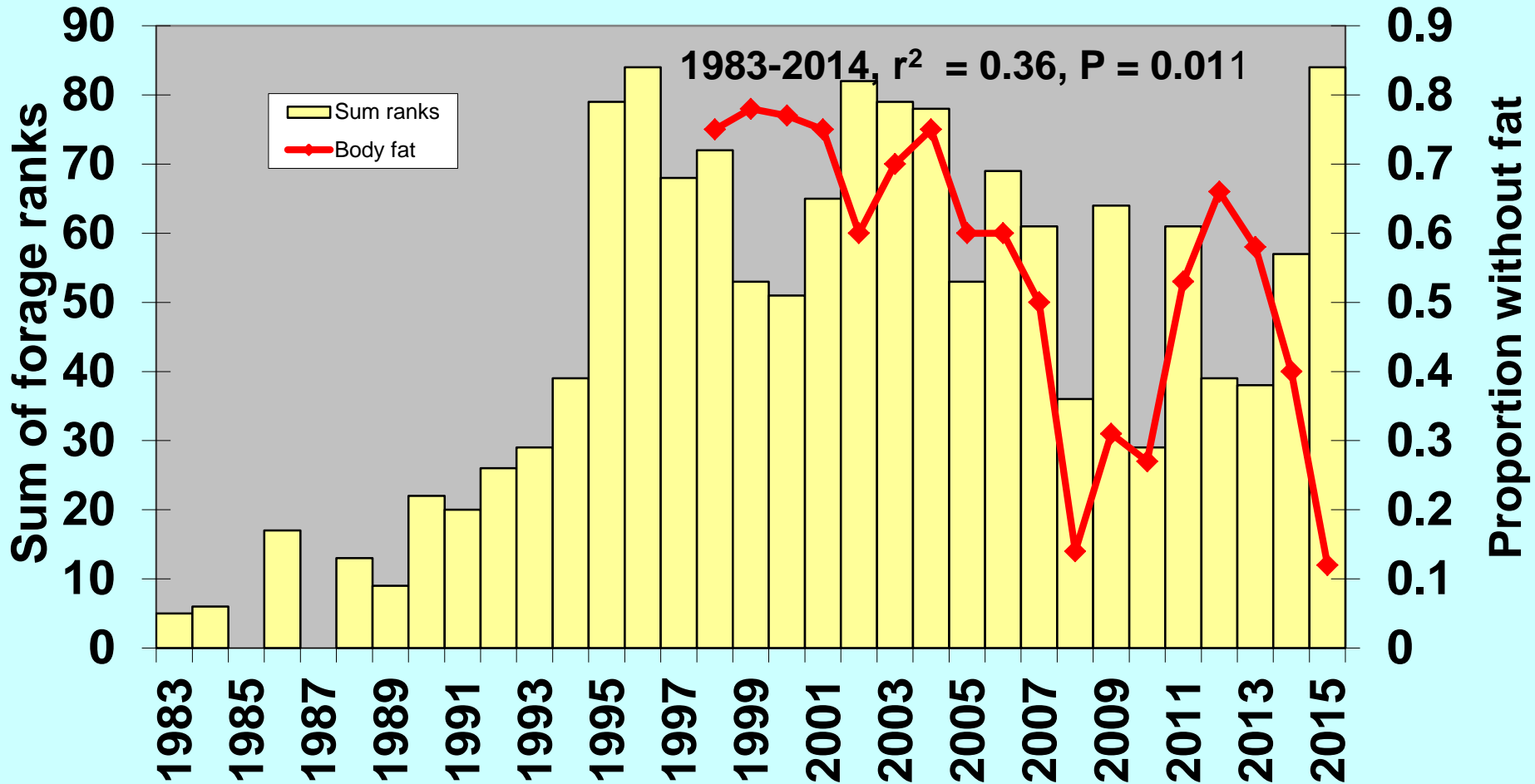
Indicators?

- Many fishermen don't like models

- Bay EWE not warmly embraced by managers

- Indicators are a try from another direction