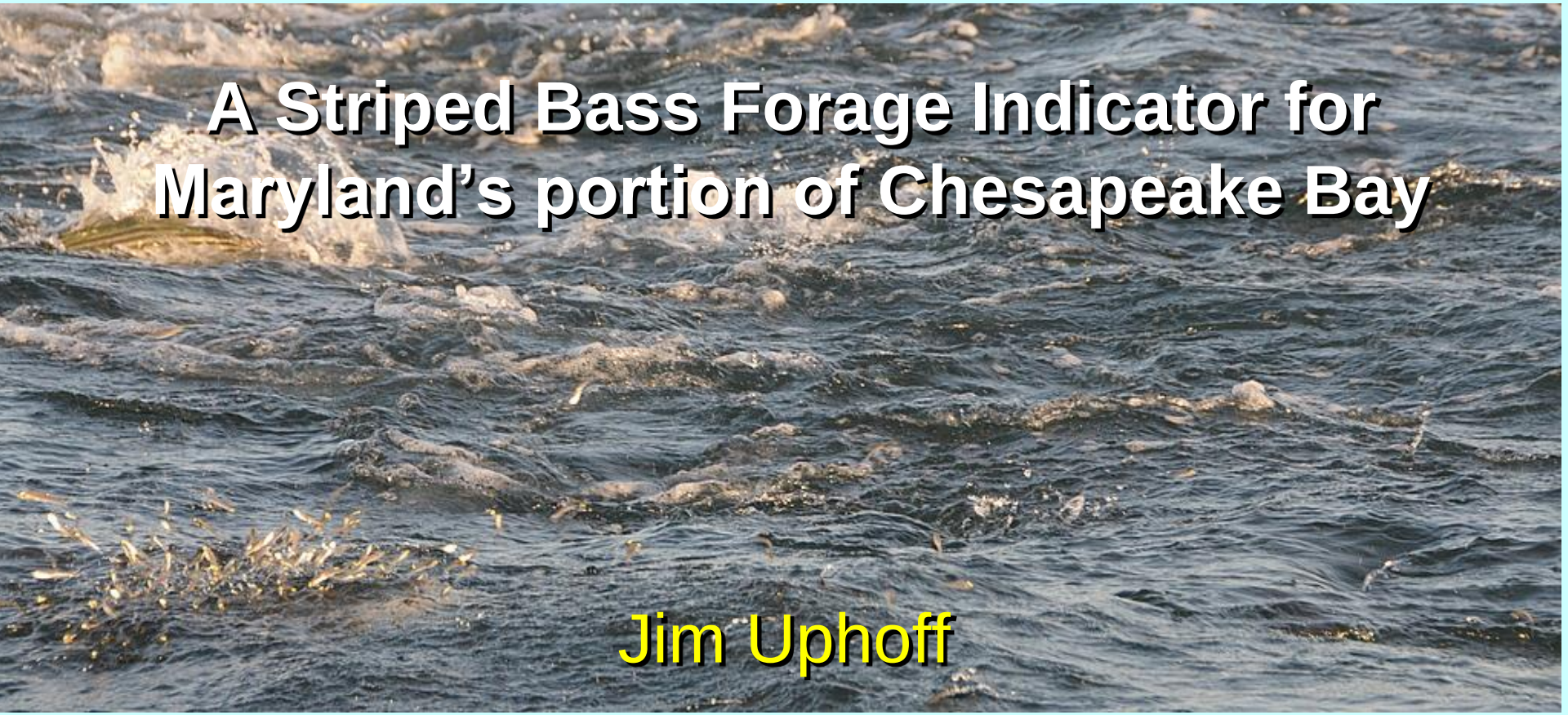

A Striped Bass Forage Indicator for Maryland's portion of Chesapeake Bay

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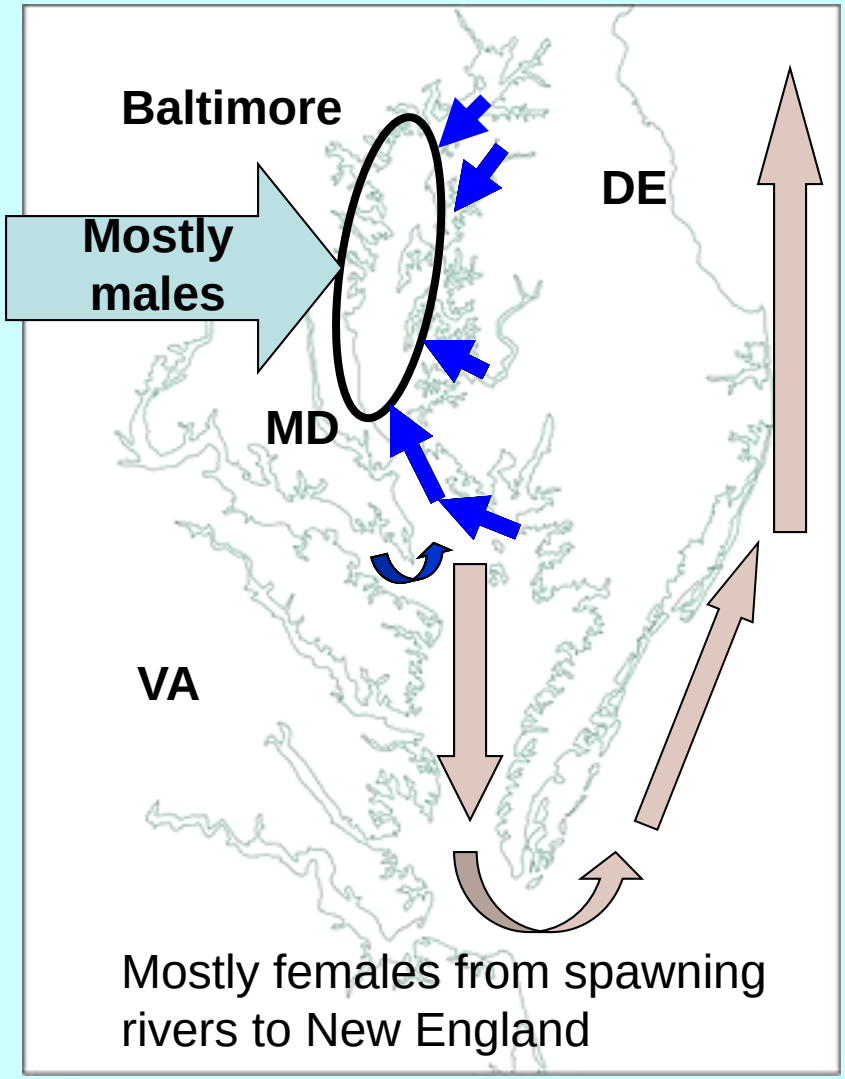
Maryland's 2014 Chesapeake Bay Agreement Forage Goal

By 2016, develop a strategy for assessing the forage base available as food for resident Striped Bass in MD's portion of Chesapeake Bay

Resident striped bass



- After spawning, most males & some immature females stay in MD mid-Bay (residents)
- Important fishery
- Main year-round large predator

Maryland's fisheries managers want practical guidance on….

(1) What forage is eaten?
(2) Is there enough?
(3) Can 1 & 2 be answered at low cost?

MD striped bass indicator approach

- **Forage availability + bass well-being. (How much forage and is it enough?)**
- **Use existing data and surveys**
- **Indicators linked biologically and statistically (not going into that today)**
  - **Not etched in stone**
  - **Can be modified and-or improved**

Bass forage Indicator – keep it simple, inexpensive, and (hopefully) meaningful

- Tractable for available staff
- Understandable to public, managers
  - (Human brain processes about 7 items without shutting down)
- Targets (good) and limits (bad) for indicators to judge status
- Summarize with a combined score

Previous Bay diet studies indicate important prey

Age 0

Age 1

Ages 3+

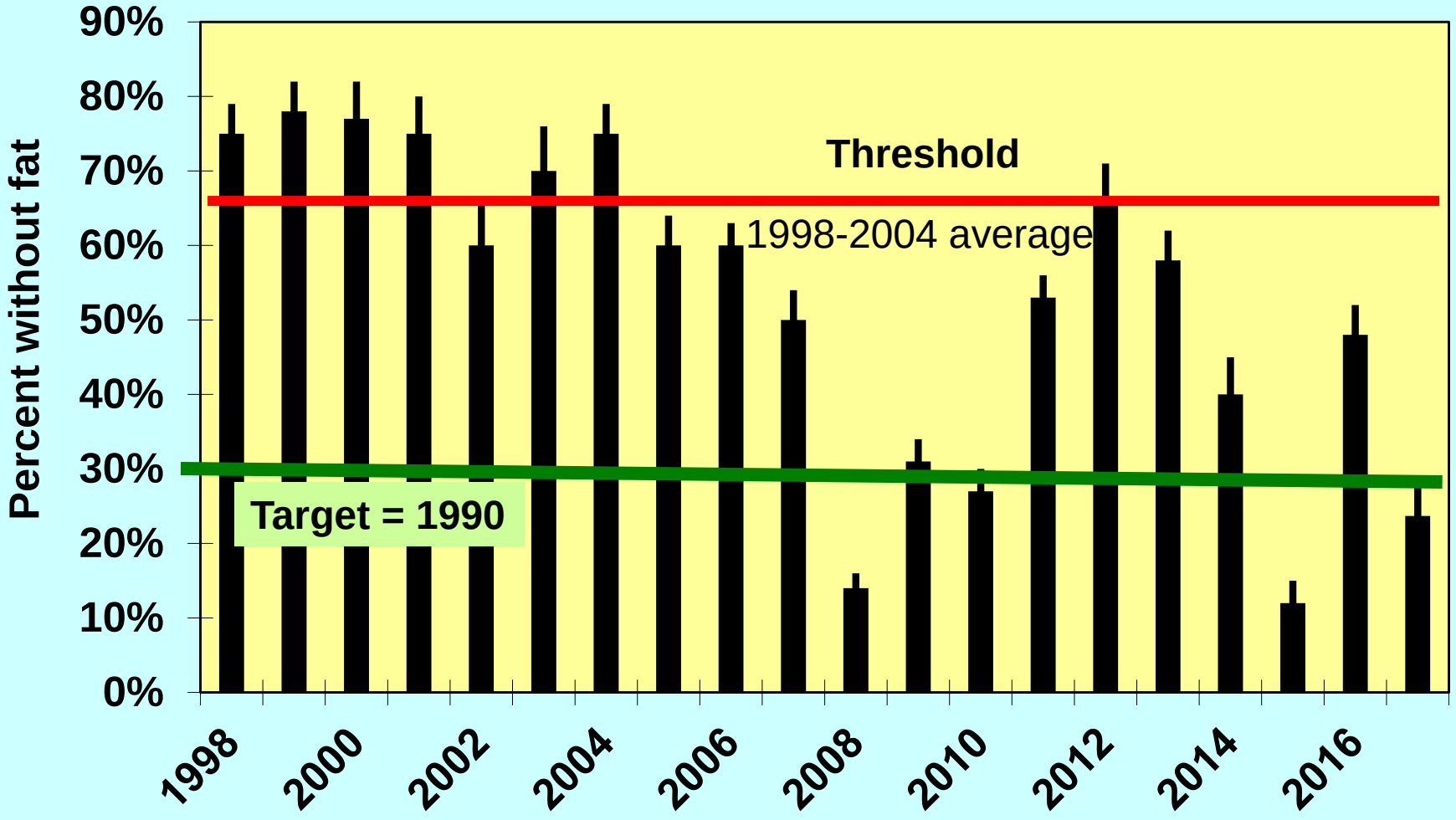
Forage and striped bass metrics

Factor	Metric
Resident bass abundance	Catch per recreational boat trip (Sept-Oct)
Potential attack success	Forage index / bass abundance index
Forage availability	Proportion of bass in fall with empty guts
Bass Condition	Proportion in fall without visible body fat
Bass Survival	Age 3 index / juvenile index 3 years earlier

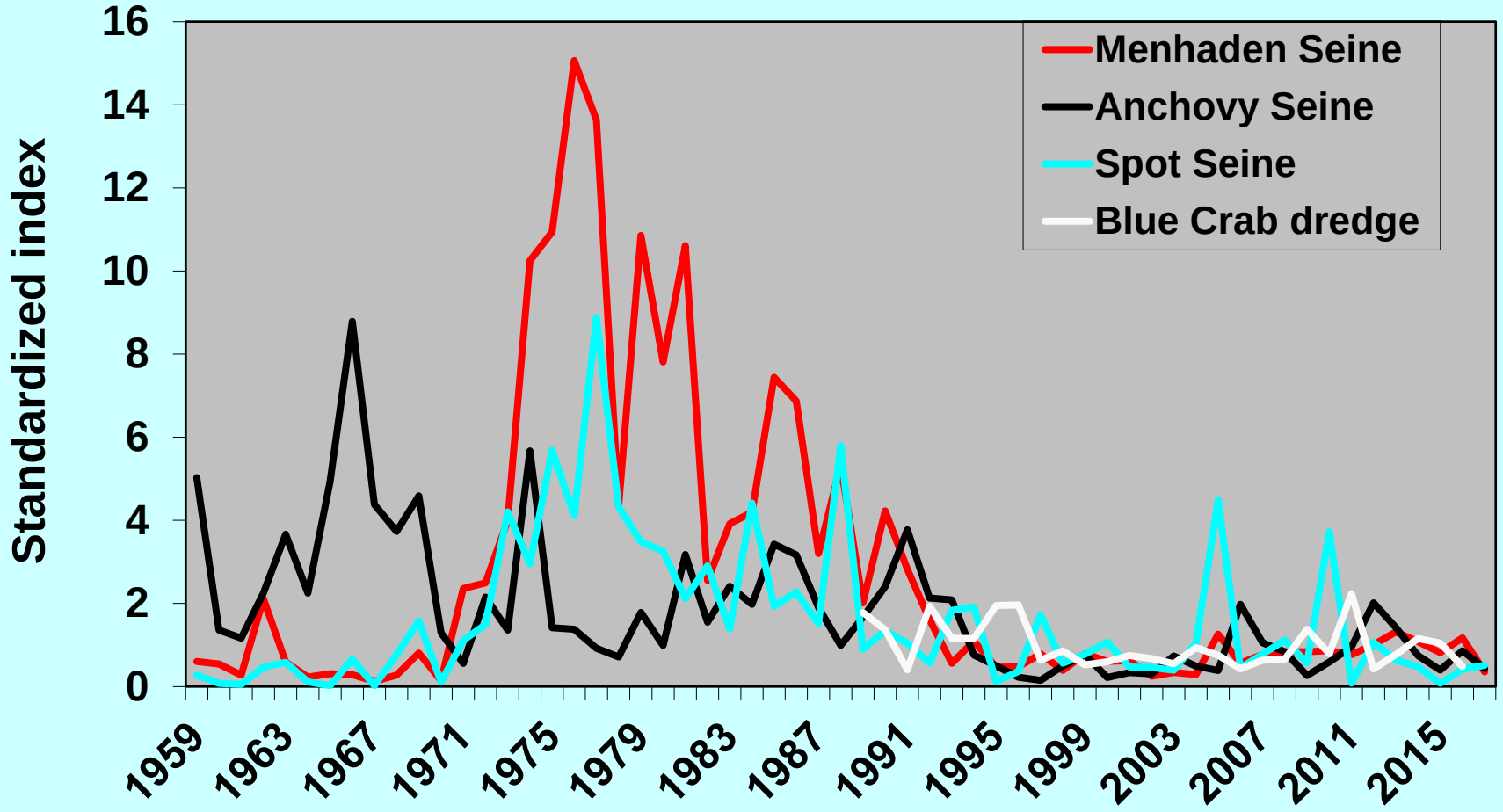
Proportion with visible body fat (fish condition) is key metric

- **Other indicators' targets and thresholds calibrated to body fat**
- Visible body fat index compared well to "gold standard" nutrition analysis (Jacobs et al. 2013)
- Fat index indicates overall food intake & potential for starvation
- Body fat responds fairly quickly (weeks)
- Longest body fat time-series in fall (Fish Health Program)

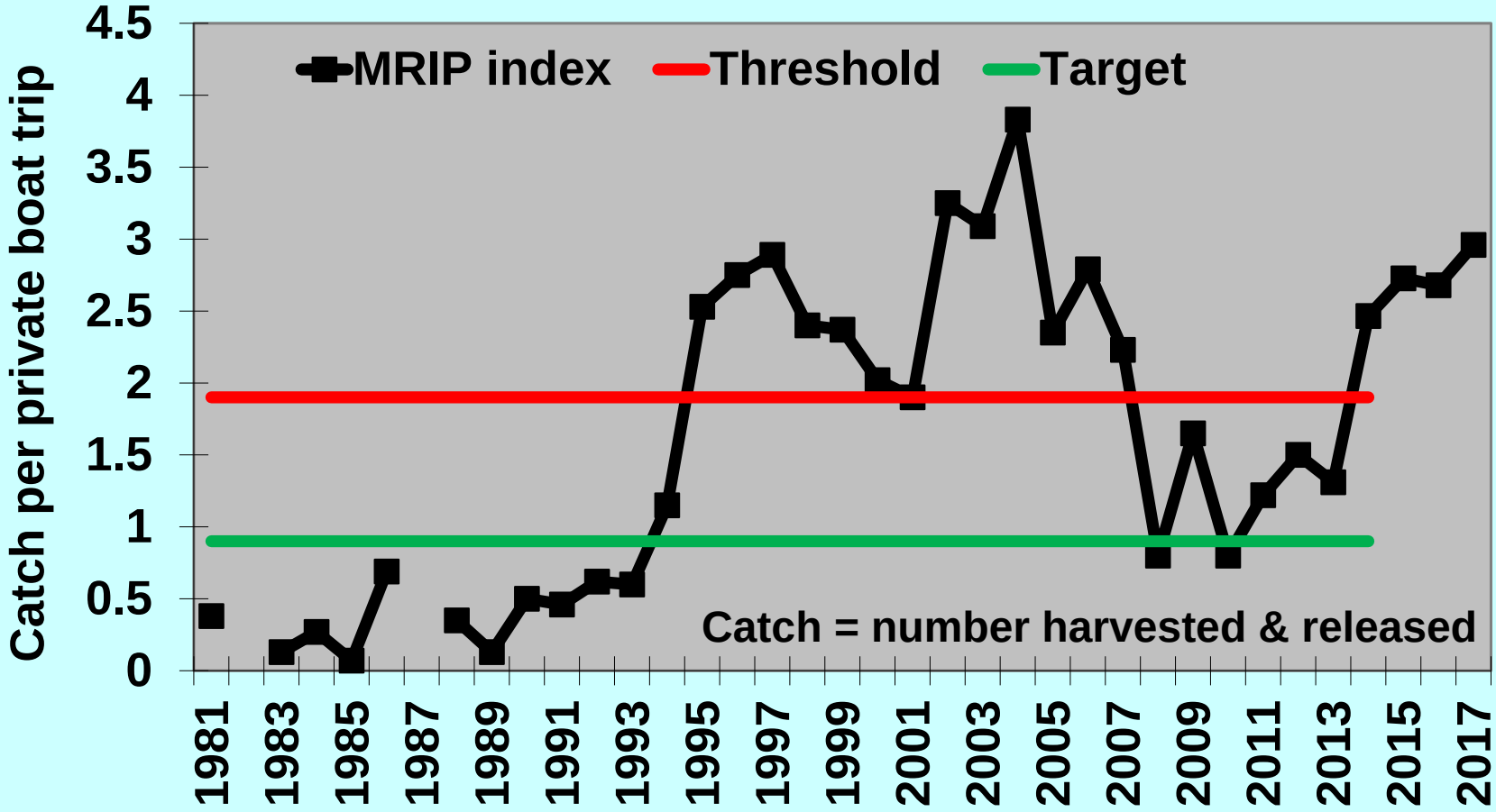
Condition: percent of Striped Bass (11 - 34 inches) without body fat during October-November (MD DNR's Fish and Wildlife Health Program).



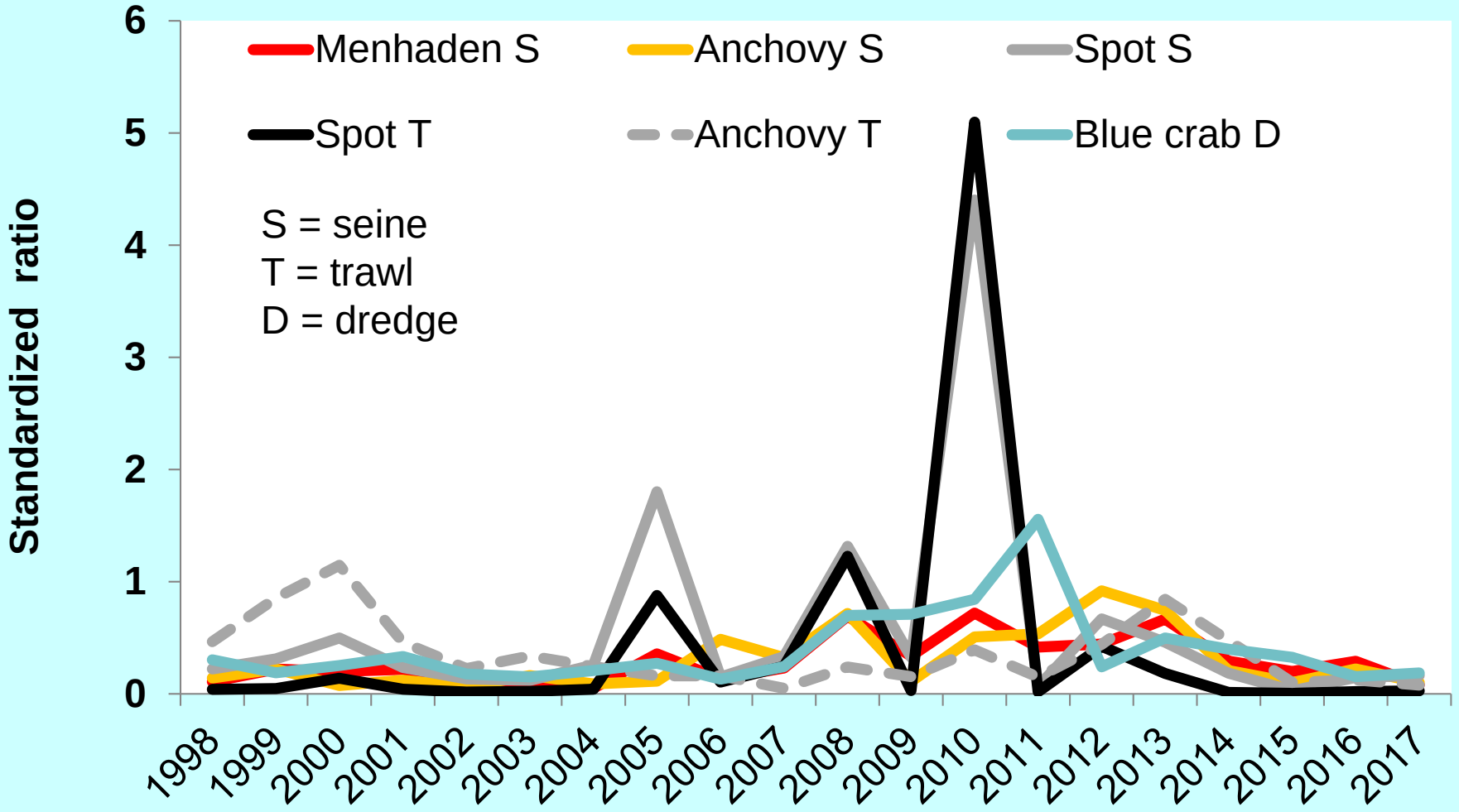
Long-term major prey trends, 1959-2017. Indices were standardized to common years (1 = 1989-2017 average).



Predator abundance: resident Striped Bass abundance index with target (best body fat) and threshold (poorest body fat)
Catch per MD private boat trip, Sept – Oct.



Potential attack success: standardized forage to Striped Bass ratios when body fat indices were available (1989-2017 mean = 1)



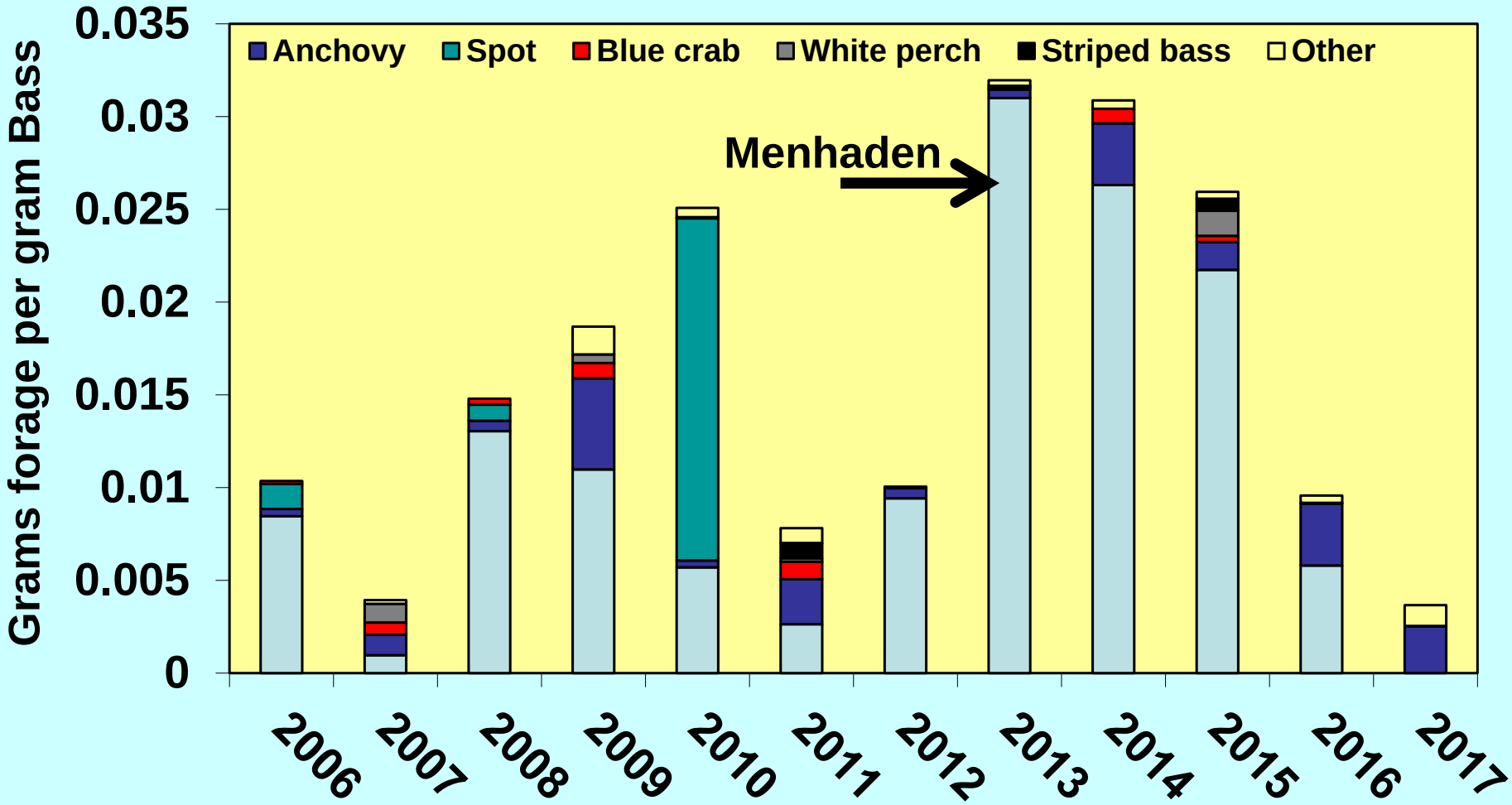
Use fall diet as indicator of prey availability

- Striped bass & forage well mixed
- What did striped bass feed on?
- How well did they feed?
- CBEF diet study (2006-2013)
- Fall diet from health sampling since 2014
- Other seasons require new effort ($$$$)

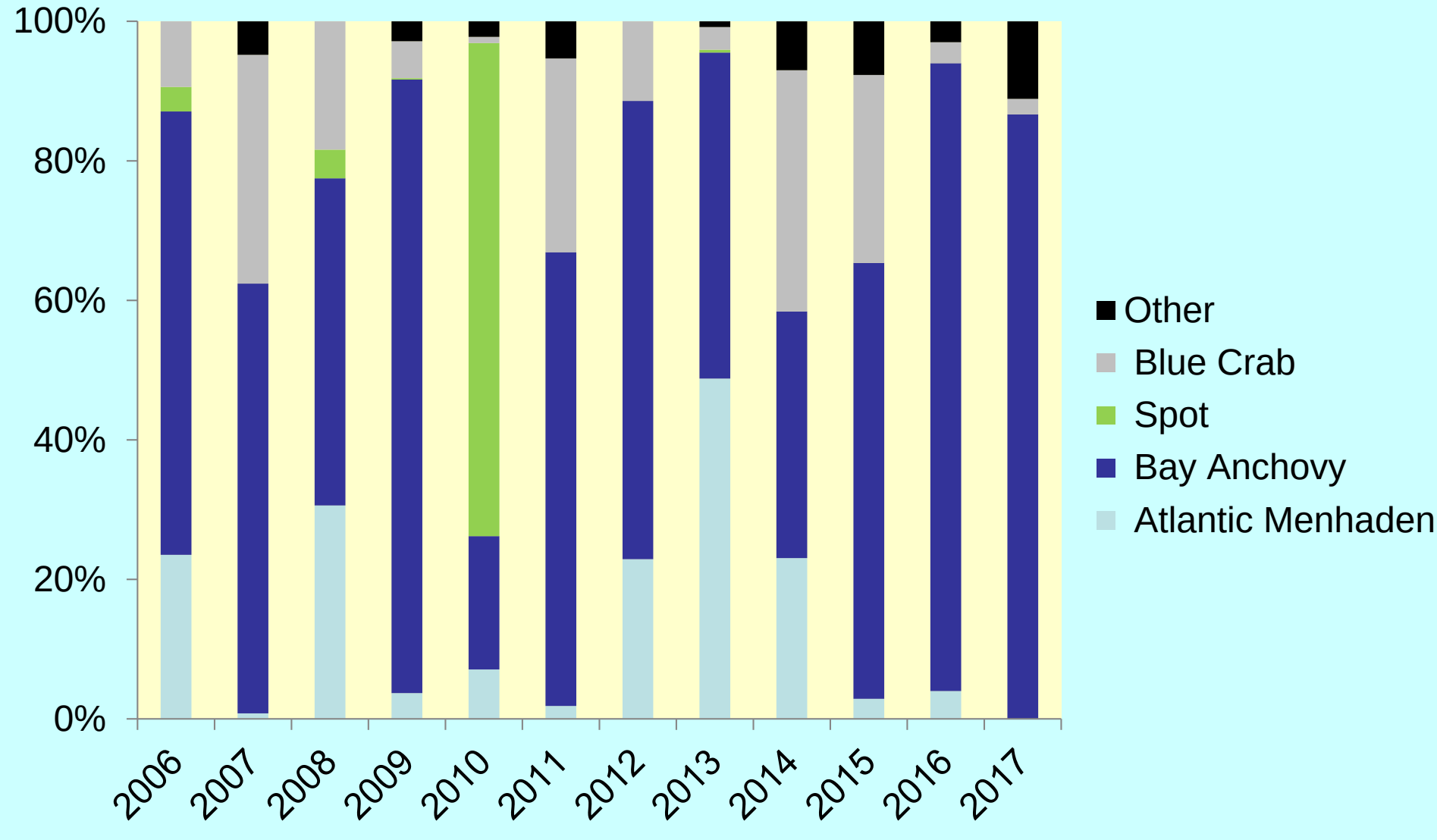
Availability index: fall diet of "small" striped bass

- **11 to 18 inches**
- **Varied diet compared to larger fish**
- **Important they survive to legal size (fishery based on this)**
- **We don't ignore "large" rockfish (> 18 in)**
- **Size break necessary for analysis due to CBEF permit restriction (Jim Price), 2006-2015**

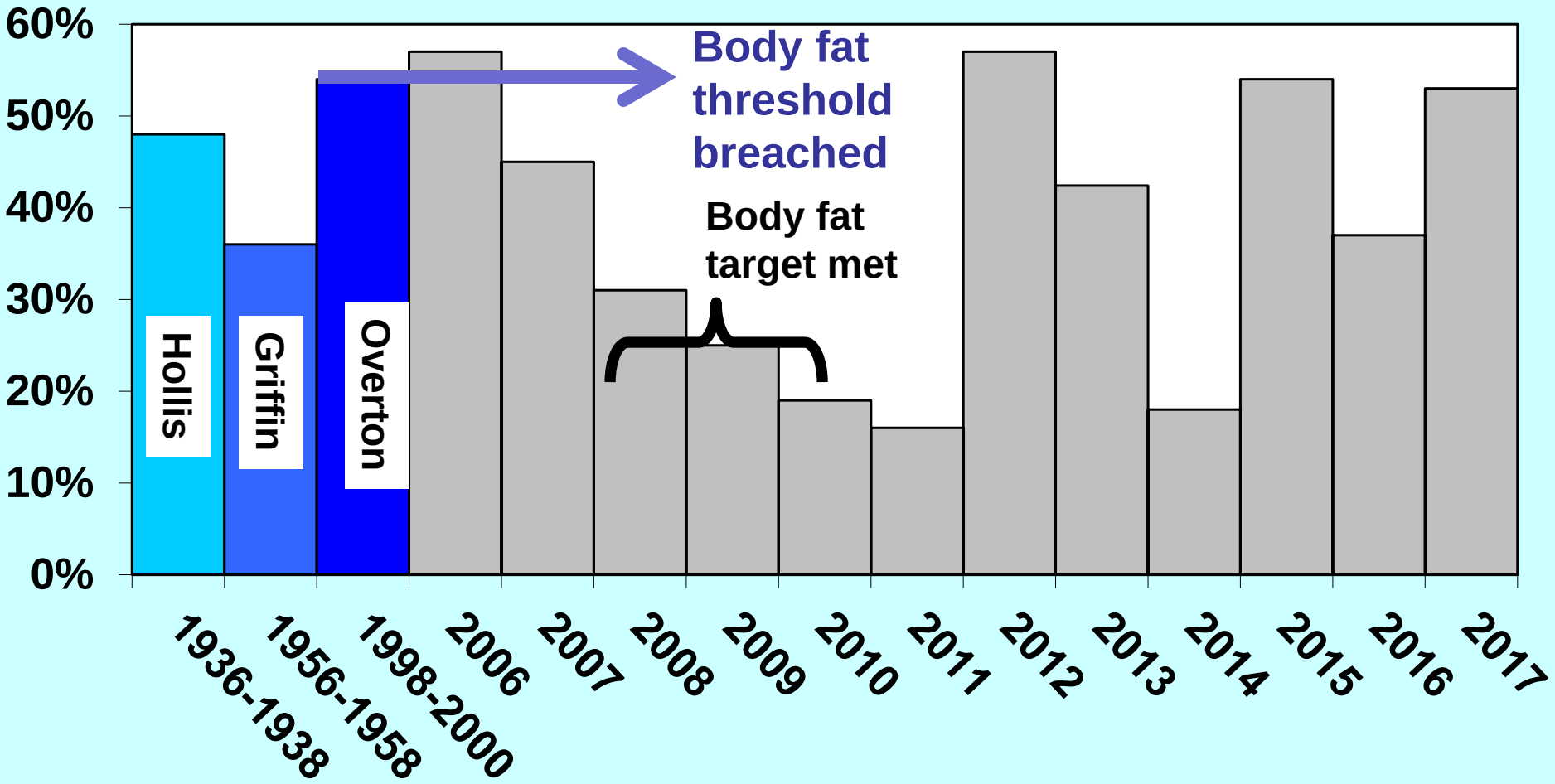
Grams prey consumed per gram of small (11-18 in) Striped Bass in fall hook-and-line samples. Age-0 forage dominates.



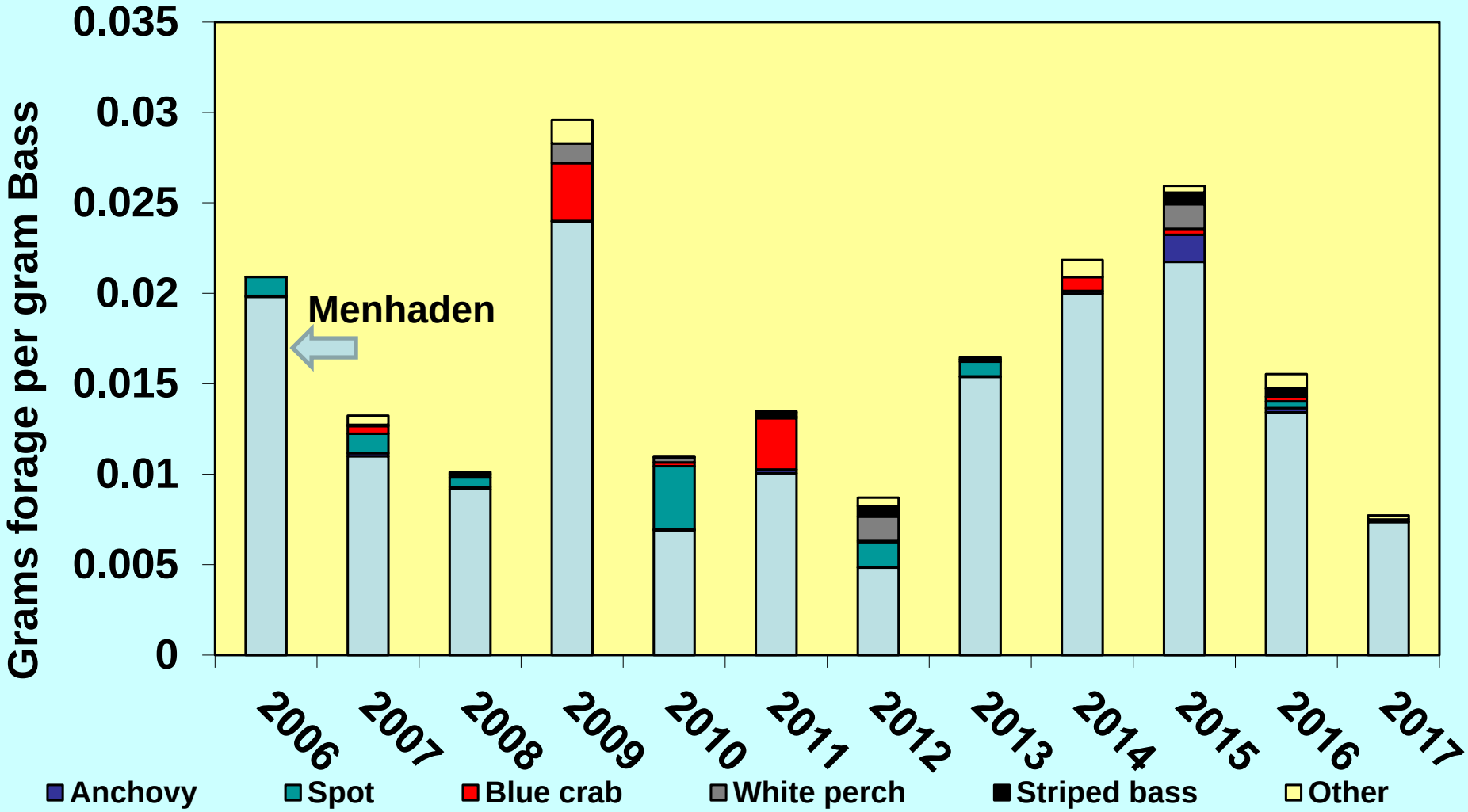
Percent of small (<18 in) Striped Bass diet represented by major forage groups, by number, in fall.



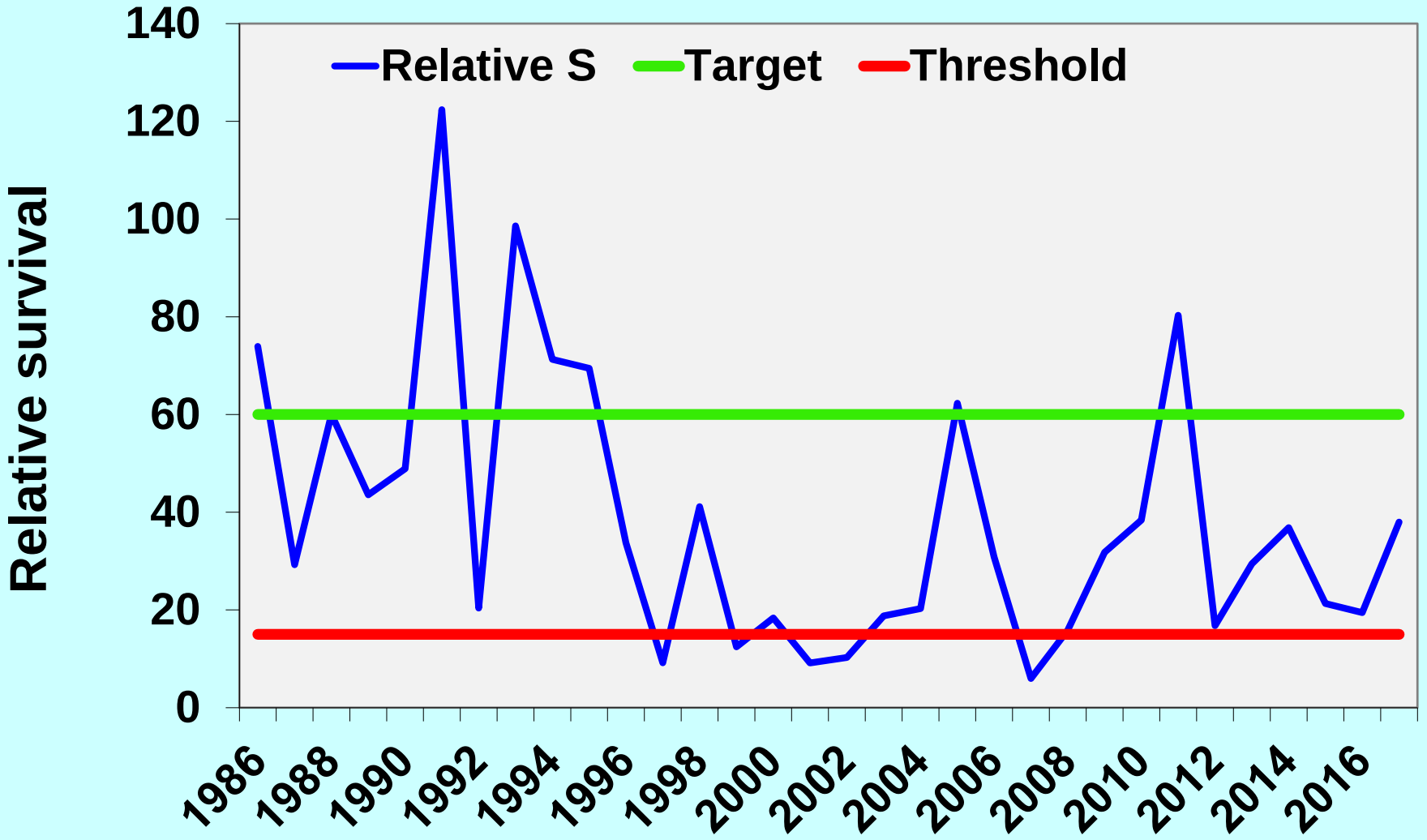
Forage availability: percent of small Striped Bass (<18 in) with empty stomachs in fall . Spot and menhaden size is an important influence.



Grams of prey consumed per gram of large (18-34 in) Striped Bass during October-November. Fall consumption dominated by YOY forage.



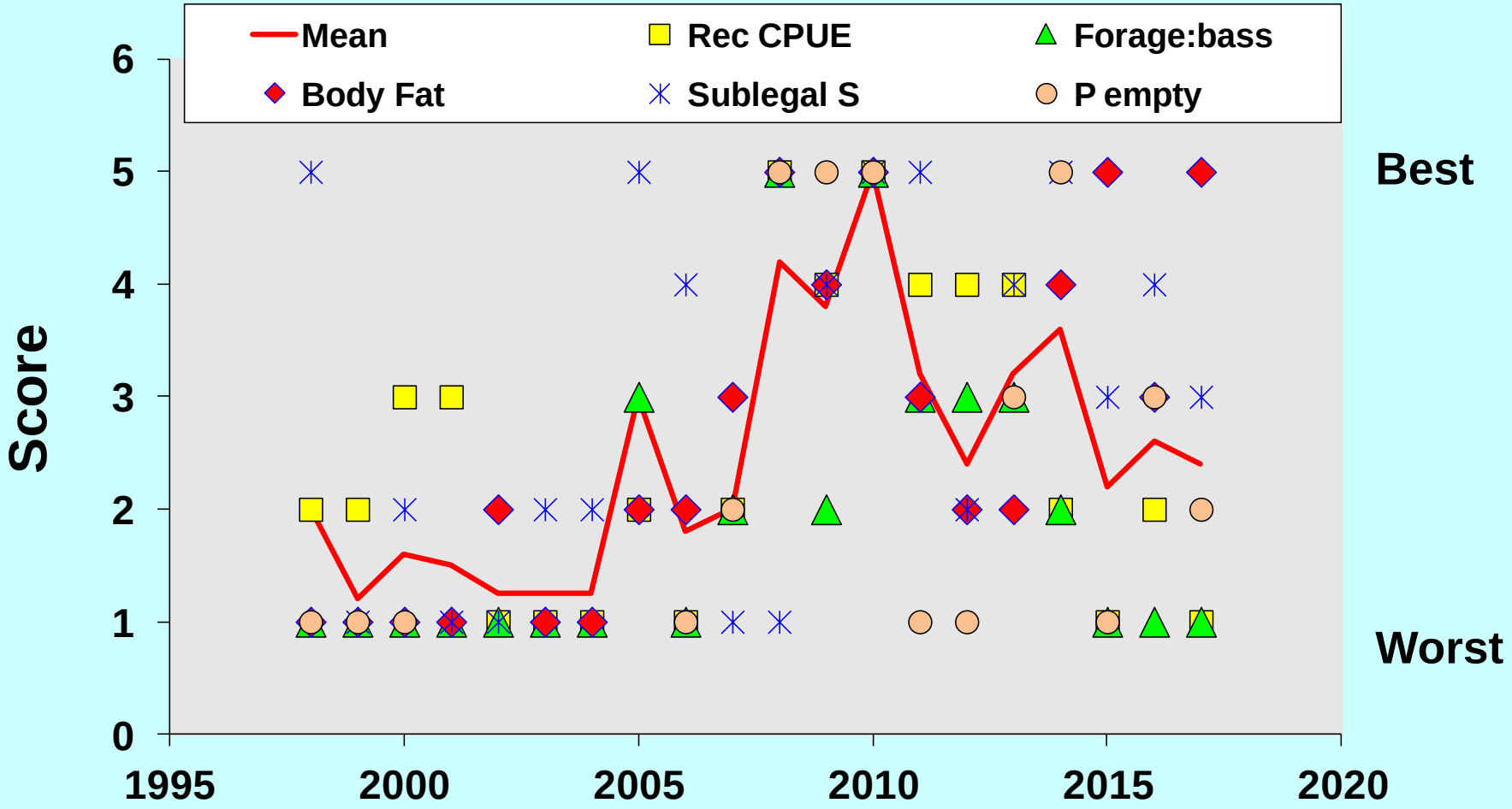
Natural mortality: relative survival of male Striped Bass to age-3 (spring gill net index / JI in yr-3). Y-axis scale is arbitrary.



Status summary for each indicator

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

Mean score summarizes all indices. Individual scores indicate uncertainty



Indicator Issues (1)

- **Forage availability ≠ relative abundance**
  - **Menhaden consumption varies more than JI**
  - **More abundant menhaden than index indicates and-or feeding efficiency changes? Sampling issue with menhaden JI or diet?**
  - **Small bass: Ratio of menhaden and spot size to bass size seems to influence feeding success (Small menhaden and spot easier to catch and handle)**
  - **Older bass may become more efficient at obtaining prey (behavior and learning?)**

Indicator Issues (2)

- Low data contrast? – Low forage, bass vary
- Mix of linear, abrupt (threshold), and lagged condition and survival responses to forage
- Indicators sometimes contradictory
- Diet and condition not sampled over the year
- Fall diet may miss other episodes

Indicator Issues (3)

- **Convenience vs designed sampling**
- **Statistical vs biological & management significance**
- **Working on including benthic invertebrate index (MD biomass density from BIBI)**

Management Thoughts 1

- **Coastal assessments may miss regional issues**
- **Natural mortality not constant as assumed (relative survival and ASMFC tag-based estimates for Bay's legal fish)**
- **Expected bass outcomes from low fishing mortality in Bay may not be realized**
  - **Escapement of young females**
  - **Yield from Bay fisheries**

Management Thoughts 2

- **Benthic and pelagic prey in low regime**
- **High rockfish population popular idea, but may not be good for Bay balance**
- **Manipulating harvested forage for better recruitment may be ineffective because of weak influence of spawning stock**
- **Harvest of more and-or smaller bass (if allowed and accepted) may not entirely balance prey**
- **Worst conditions may be avoidable, best hard to meet**


Questions, comments?
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