A bay wide oyster stock assessment

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A bay wide oyster stock assessment

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- *N.B. Partners* (end users) are included as cooperating investigators.

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- *Rationale*: A bay wide effort to restore ecosystem services by and manage fisheries for the oyster *Crassostrea virginica* is proceeding in an environment of limited critical quantitative data.
- *Overall objective*: Design, implement, and complete an oyster stock assessment that, using cross-calibrated methods, allows a statistically defensible estimate of the bay-wide population, location specific growth rate and disease status, age-specific estimates of M and F, and the vital rate measurements required to build estuary-specific and bay-wide shell substrate budgets.
- The *Overall objective* evolved into a first benchmark assessment with 11 Terms of Reference (ToR's).

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ToR's 1 through 6 and 11 (in the original scope of work).

1. Characterize commercial catch: landings, effort, CPUE, discards; describe uncertainty sources of data.
2. *Characterize the survey data (e.g., indices of abundance, recruitment, age-length data, etc.).
3. Cross-calibrate Maryland dredge with Virginia patent tong methods.
4. *Evaluate status of shell substrate on public reefs Bay wide.
5. Quantify disease prevalence and intensity Bay wide. Compare age-specific mortality against disease prevalence and intensity. Retrospective application to develop a single Bay wide time series on disease.
6. *Estimate annual F, R, and biomass for the time series.

11. Identify, review, and prioritize future research needs.

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ToR's 7 through 9 (not in the original scope of work).

7. Update or redefine biological reference points (BRPs; estimates or proxies for BMSY, BTHRESHOLD, and FMSY; rebuilding thresholds, and estimates of their uncertainty). Comment on the scientific adequacy of existing and redefined BRPs.
8. Evaluate stock status with respect to the existing BRPs, as well as with respect to updated or redefined BRPs (from TOR 7).
9. *Identify potential environmental, ecological, and fishing-related factors that could be responsible for low recruitment in future years.

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ToR's 10 (not in the original scope of work).

- *Develop and apply analytical approaches for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch).
  - Provide numerical short-term projections (1-5 years; through 2015). Each projection should estimate and report annual probabilities of exceeding threshold BRPs for F, and probabilities of falling below threshold BRPs for biomass.
  - Comments on which projections seem most realistic, taking into consideration uncertainties in the assessment.
  - Describe the oyster stock's vulnerability to becoming overfished, and how this could affect the choice of ABC.

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- *Approach*: Two major annual assessment survey + sanctuaries:
- MD DNR employs dredge swept area based assessment: 316 sites on 262 bars, with 43 sentinels for both assessment and disease status.
- VMRC/VIMS employs patent tong: 1600 sites on 174 bar with sentinels for disease status.
- UMD sanctuaries employs patent tongs.
- Cross calibrate gear to obtain a single estimator of population
- Cross calibrate historical disease surveys to a single scale
- Estimate abundance, age structure, mortality (M and F), disease impact on M, shell habitat budget
- Develop reference points and management options

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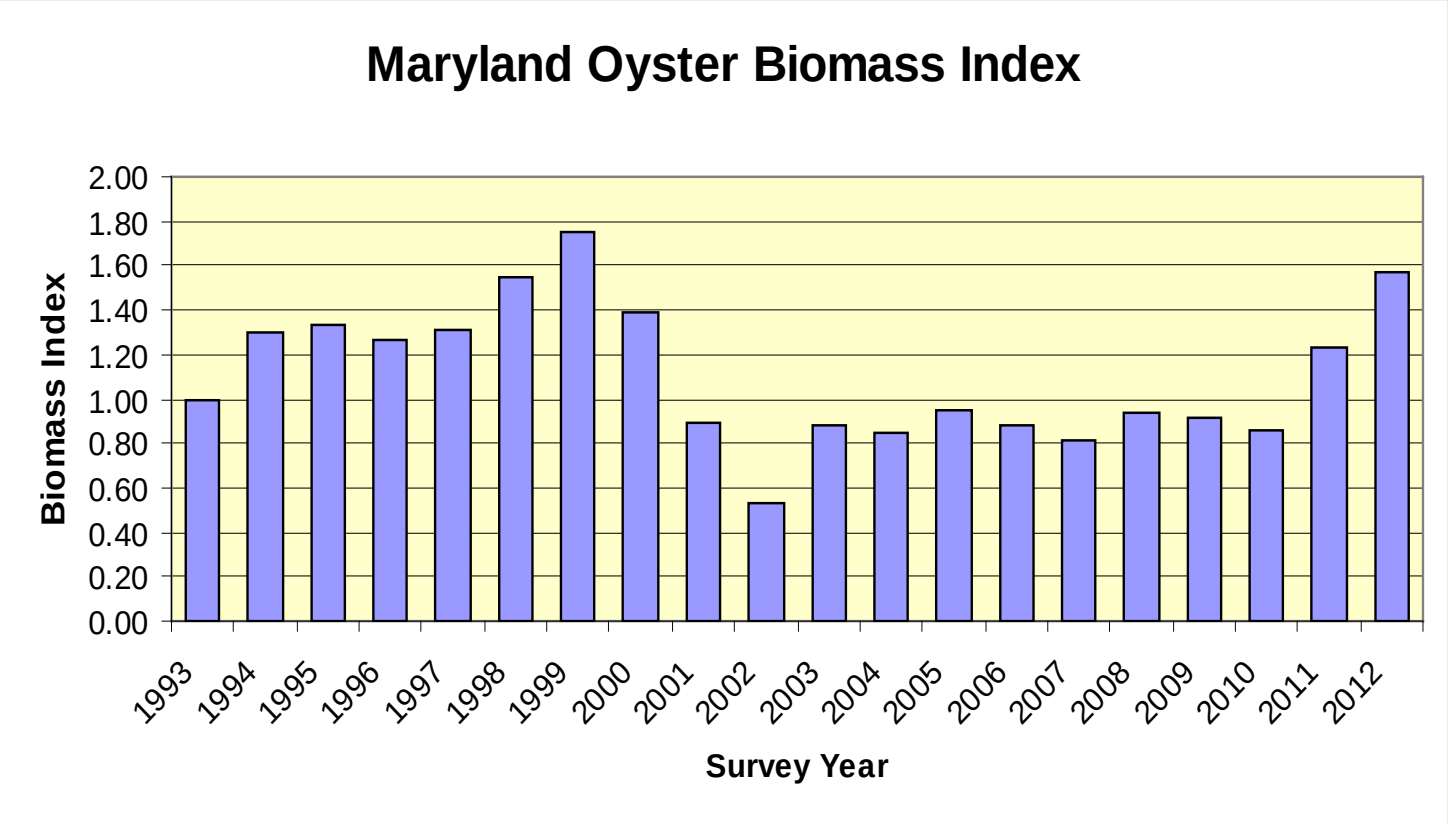
- *Results: ToR 2 and 6:Temporal changes in oyster abundance (MD)*



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- *Results: ToR 2 and 6: Spatial changes in abundance (VA, Fall 2011)*

location	area	spat	small	market	total
CHESAPEAKE BAY	3.16E+05	1.38E+06	3.59E+06	1.13E+06	6.10E+06
ELIZABETH & LAFAYETTE RIVERS	1.19E+05	5.54E+05	2.25E+06	2.13E+05	3.01E+06
GWR PUBLIC REEFS	4.38E+05	6.50E+06	1.23E+07	1.85E+06	2.06E+07
JAMES RIVER	2.75E+07	1.59E+08	1.53E+09	1.46E+08	1.83E+09
LYNNHAVEN	2.01E+05	2.64E+06	2.49E+06	1.14E+06	6.27E+06
PIANKATANK RIVER	8.31E+05	7.94E+06	5.83E+07	3.15E+06	6.94E+07
POCOMOKE SOUND	7.54E+05	9.30E+06	1.87E+07	2.74E+06	3.07E+07
RAPPAHANNOCK ALL AREAS	2.17E+06	6.77E+06	2.42E+07	3.28E+06	3.42E+07
TANGIER SOUND	4.93E+05	1.83E+06	5.57E+06	1.64E+06	9.04E+06
MOBJACK BAY AND YORK RIVER	9.38E+05	1.17E+07	1.24E+07	8.19E+05	2.49E+07
GRAND TOTAL	3.60E+07	2.08E+08	1.67E+09	1.62E+08	2.03E+09

SUMMARY

2.03 BILLION OYSTERS

832 METRIC TONNES DRY TISSUE BIOMASS

35,500 METRIC TONNES LIVE OYSTERS

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- *Results: ToR 4: Spatial changes in shell abundance (VA, 2011)*

location	area	brown	black	total
CHESAPEAKE BAY	3.16E+05	2.72E+06	1.47E+06	4.20E+06
ELIZABETH & LAFAYETTE RIVERS	1.19E+05	9.70E+05	3.24E+05	1.29E+06
GWR PUBLIC REEFS	4.38E+05	4.21E+06	1.59E+06	5.80E+06
JAMES RIVER	2.75E+07	1.16E+08	4.53E+07	1.62E+08
LYNNHAVEN	2.01E+05	1.40E+06	6.87E+05	2.09E+06
PIANKATANK RIVER	8.31E+05	7.83E+06	3.07E+06	1.09E+07
POCOMOKE SOUND	7.54E+05	7.22E+06	2.73E+06	9.95E+06
RAPPAHANNOCK ALL AREAS	2.17E+06	1.21E+07	9.04E+06	2.12E+07
TANGIER SOUND	4.93E+05	3.52E+06	1.65E+06	5.16E+06
MOBJACK BAY AND YORK RIVER	9.38E+05	7.90E+06	7.09E+06	1.50E+07
GRAND TOTAL	3.60E+07	1.64E+08	7.30E+07	2.37E+08
SUMMARY	164 MILLION LITERS BROWN SHELL			
	3.28 MILLION BUSHELS (@ 50L/BUSHEL			
	96,300 METRIC TONNES WET BROWN SHELL			

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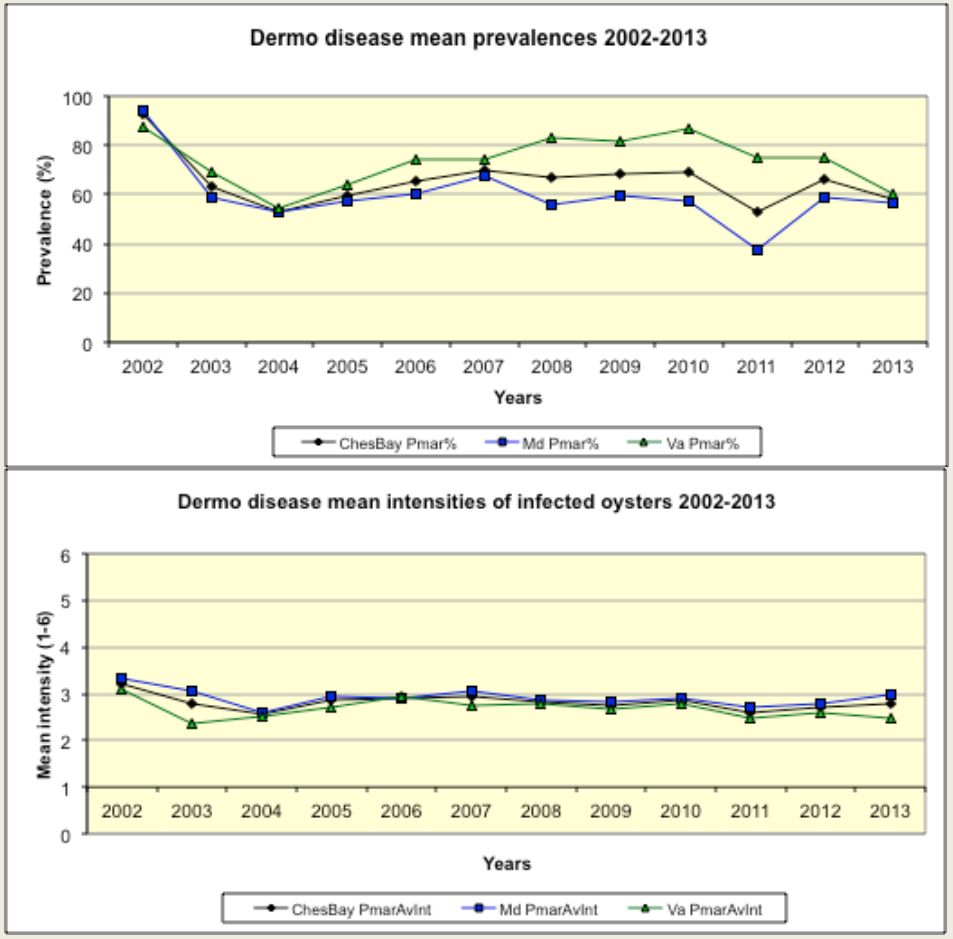
- *Results: ToR 5: oyster disease "calibration"*



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- *Results: rate functions (ToRs 2,6 and 9),*
- *R = M + F at equilibrium*
- *Length demographic to age demographic*
- *M from age sequence in successive years*
- *L v fecundity for population egg production*
- *Develop a population profile, example Piankatank*

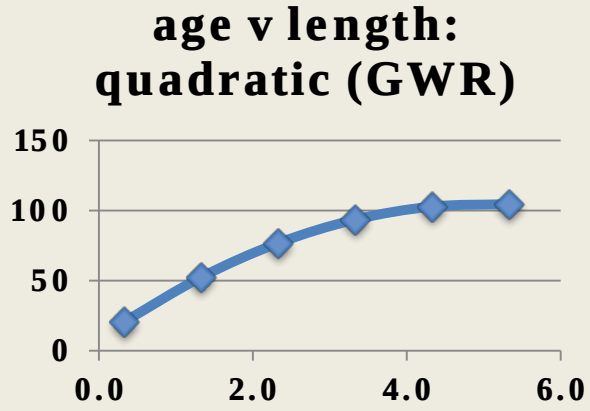

TABLE 5.

Mean oyster density and egg production, corrected for sex ratio by age class from the 2012 fall survey (see text).

	Age class (y)					
	1.3	**2.3**	**3.3**	**4.3**	**> 5.3**	**All**
Size class (Lmax)	40	65	85	95	>95	
Average density	6.2	19.4	10.8	1.5	0.8	38.7
Total oysters (*n*)	6.20E + 06	1.93E + 07	1.08E + 07	1.45E + 06	7.61E + 05	3.85E + 07
Percentage	16.1	50.2	28.0	3.8	2.0	
Sex ratio (% female)	36.0	60.0	75.4	83.6	100.0	
Egg production	1.18E + 13	1.58E + 14	2.20E + 14	5.16E + 13	4.33E + 13	4.85E + 14
Egg production (%)	2.4	32.7	45.3	10.6	8.9	

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Are we on track, by ToR number?

Black = original scope of work, blue = addition for benchmark:

1. Characterize commercial catch - yes
2. Characterize the survey data - yes
3. Cross-calibrate MD v VA methods -yes
4. Evaluate status of shell substrate - yes
5. Disease mortality and retrospective - yes
6. Estimate annual F, R, and biomass - yes
7. Update or redefine BRPs – progressing on 10-20 year time frame
8. Evaluate stock status with respect to the existing BRPs – progression from 7
9. *Identify potential environmental, ecological, and fishing-related factors that could drive low recruitment in future years - see following and text*
10. *Develop and apply analytical approaches for conducting single and multi-year stock projections and for computing candidate ABCs (Acceptable Biological Catch) – partial, also see following and text.*
11. Identify, review, and prioritize future research needs - yes.

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- *A consistent trend in the VA disease and survey data for 3 rivers – James, Piankatank, Great Wicomico.*
- *We OBSERVE:*
  - *Change in the phenotype of Perkinsus since the 1980's*
  - *No change in Perkinsus weighted prevalance*
  - *Change in demographics and truncated reproductive periodicity in selected VA populations*
  - *Increased men spat size in the fall survey (survival implications)*
- *We HYPOTHESIZE*
  - *Selection resulting in a changing reproductive strategy – spawning prior to disease mortality*
- *We PROPOSE:*
  - *Examine hypothesis bay wide using generated dataset*

Three summary slides to illustrate the data and the concern.

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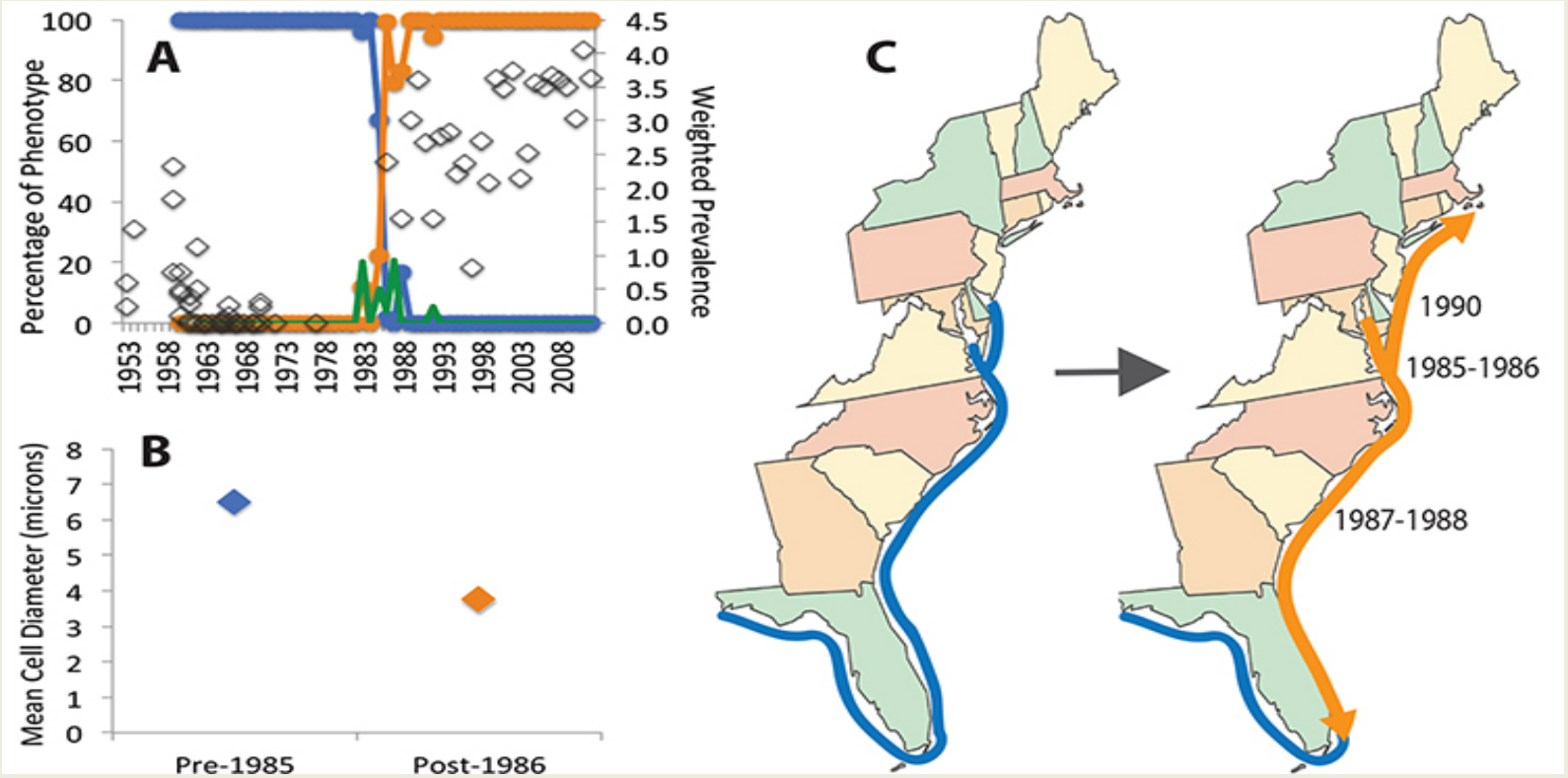
- *ToR 9 and 10:* Change in weighted prevalence and phenotype (by mean cell diameter as illustrated in B) in *Perkinsus* from 1953-2010. C: geographic changes in phenotype pre-1983 to present.



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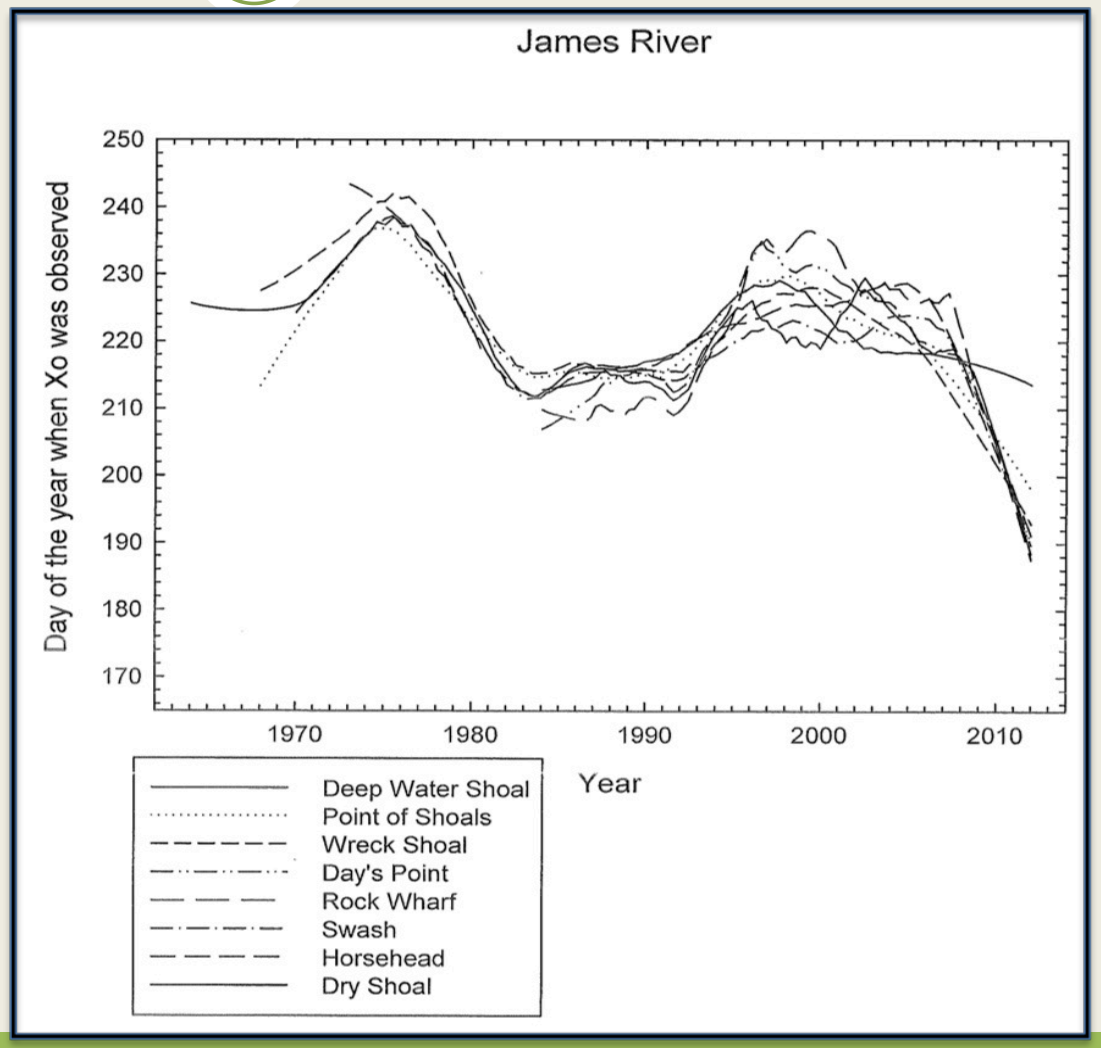
- *ToR 9 and 10:* Julian day of the year corresponding to the 50% percentile of the recruitment (Xo) to shell strings at 7 stations in the James River, VA. Note (i) long-term oscillations between days 210 and 240, probably corresponding to NAO, El Nino and similar cycles, and (ii) change since 2000 at all stations with current Xo values approximating 190.



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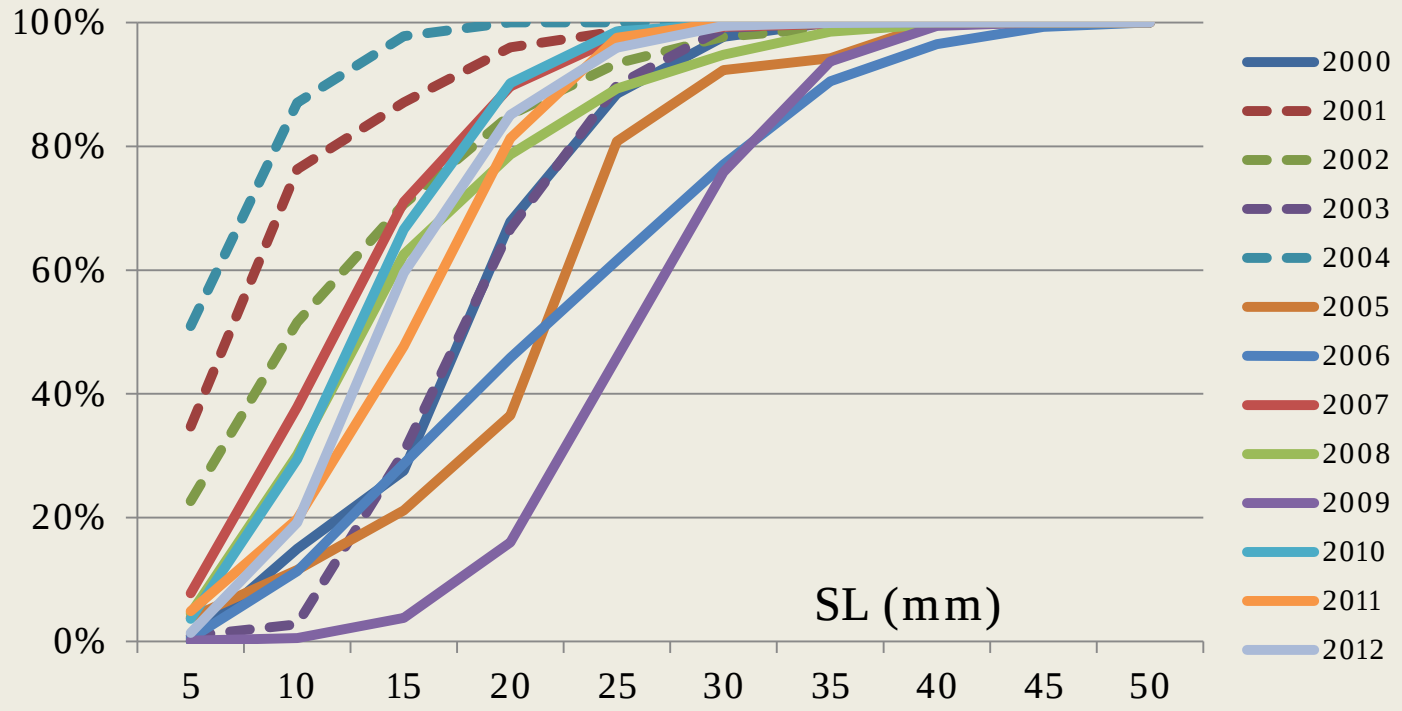
- *ToR 9 and 10*: YOY cumulative frequency size distribution: SL (mm), years 2000-2011 for Point of Shoals, James River (this station also in above Figure). Data emphasizes years 2001-2004 with broken lines. Note increasing size over 2000-2011 period indicative of earlier spawning.



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- *ToR 9 and 10: Potential concerns and impacts*
- If the hypothesis is correct
  - This selection response is very quick- arguably not climate driven
  - Is it graded spatially (local or baywide)?
  - What is the end point? Additional truncation of spawning - consider 10y life span at 4 spawning/yr v 4 y life span at 2 spawning/y. When does this drive recruitment failure (iterparity to semelparity boob or bust analog)
- If the hypothesis is not correct
  - Are the causative factor(s) biological (e.g., HAB), physical, water column or watershed?
  - What is the end point and is it reversible?
- In either case – there are no management models with intrinsic moving baselines
- The above options can be discriminated with the assembled data
- We have prepared an explanatory document “Moving baselines in oyster reproductive periodicity in the Chesapeake Bay: a localized or bay wide phenomenon?” for GIT consideration as a one year follow proposal on (i) data mining and analysis study with (ii) a wrap up workshop with bay modelers and managers. We invite discussion.