

Analysis of blue crab survey data and reproductive output to assess causes of population variability

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Objectives

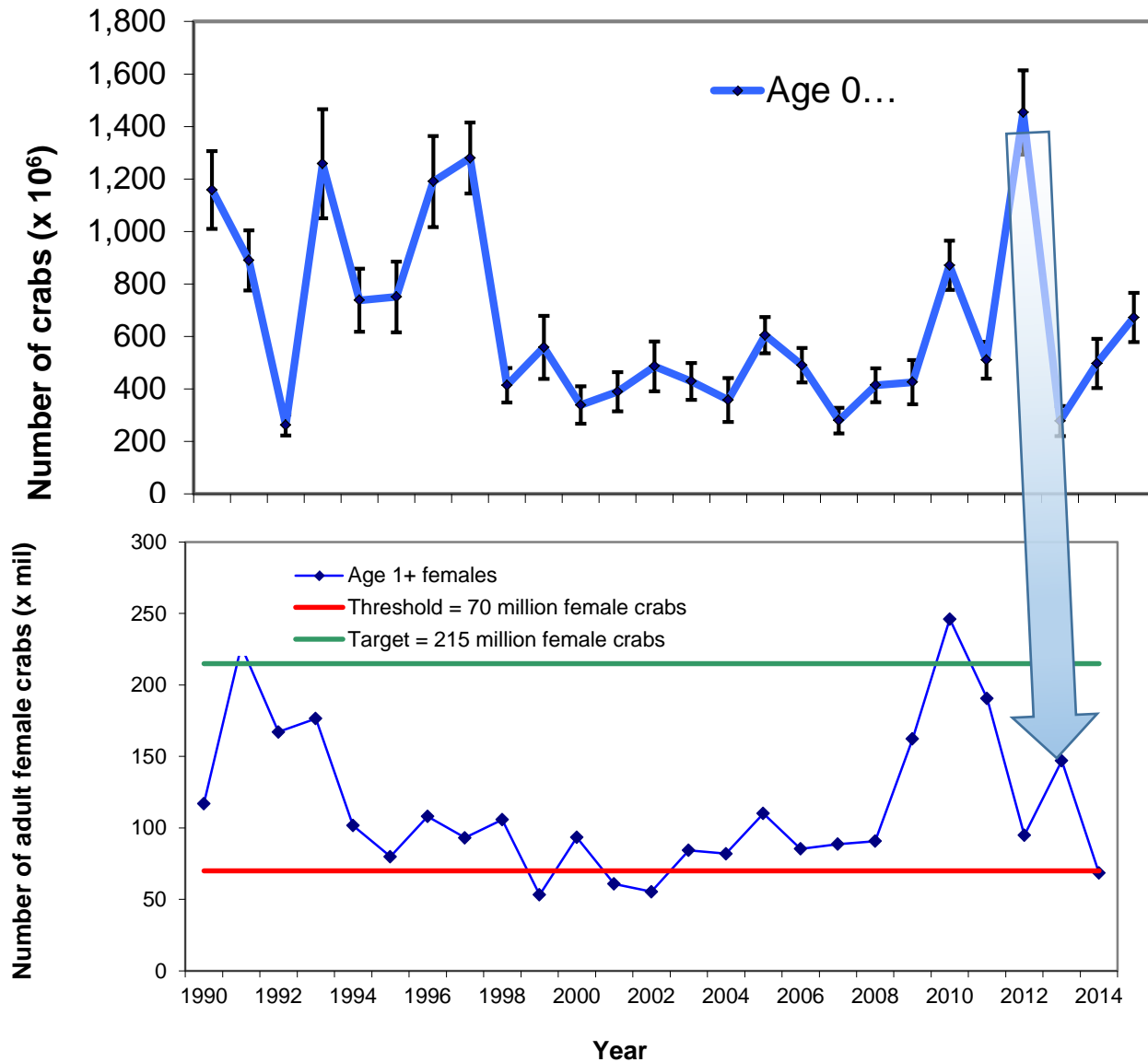
Task A) Analysis of the summer survey data from the VIMS trawl

- **Analysis of all available survey data for blue crab in Chesapeake Bay**

Task C) Assess how many broods each adult female can produce over a lifetime

- **Integrate existing data with estimates of survival to estimate expected female lifetime reproductive output**

Why analyze survey data



Hypotheses for 2011 year class failure

- H1: The WDS in 2012 was biased and over-estimated the “true” abundance of juvenile blue crab
 - H1A: More small crabs in survey
 - H2A: Spatial distribution biased statistical weighting
- H2: The 2011 year class was very abundant, but experienced unusual levels of mortality
 - H2A: Particularly cold year
 - H2B: Something (aka red drum, striped bass) ate them

Data sources

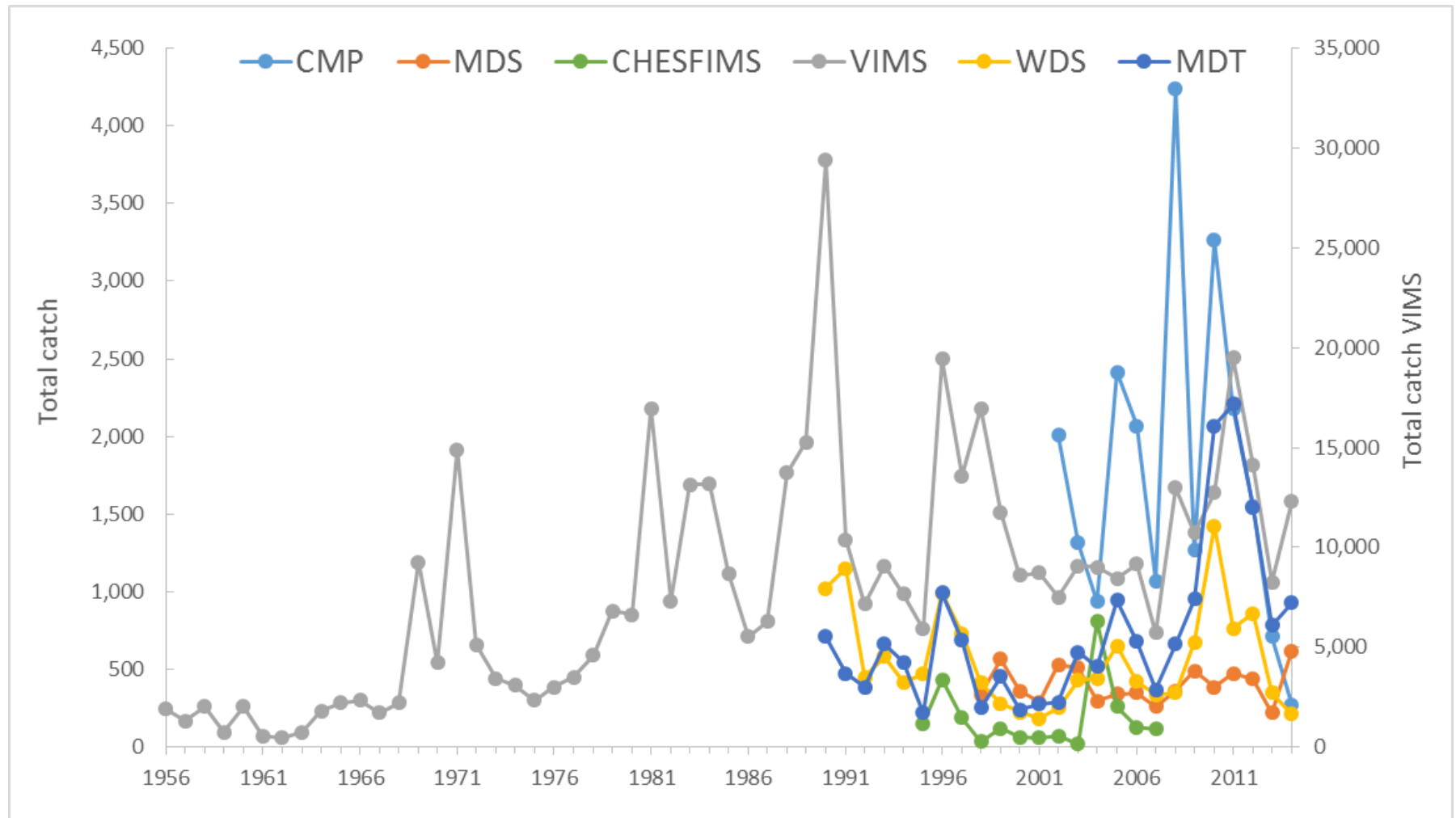
Baywide

- Winter dredge survey
 - Baywide -- 1990 – 2014 -- 41, 531 stations – count, size, sex, maturity
- ChesMAPP
 - Baywide – 2002 – 2014 – 4,752 stations – count, size, sex, maturity
- ChesFIMS
 - Baywide – 1996 – 2007 – 3,309 stations - count, size, sex, maturity

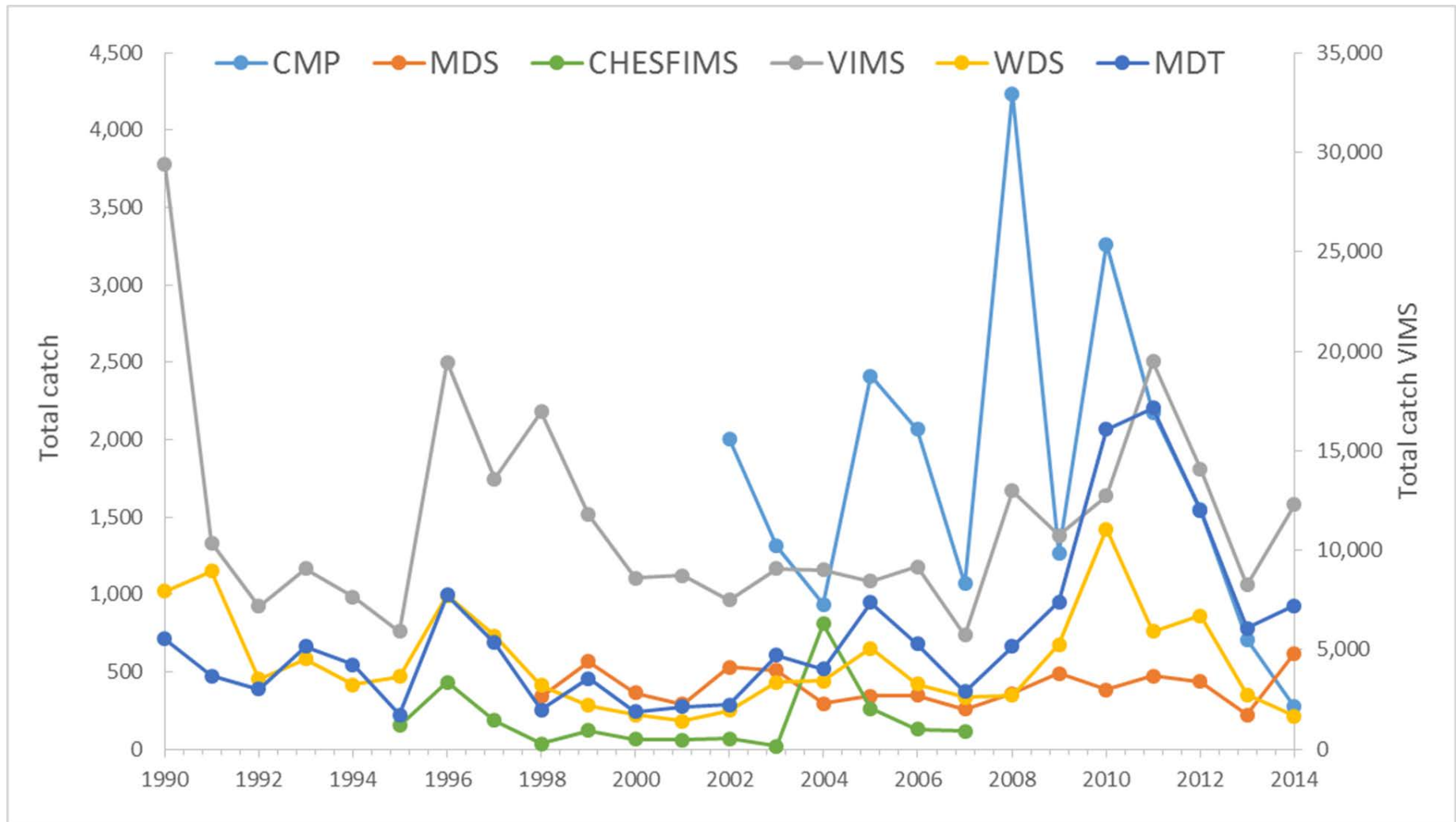
Regional

- VIMS Trawl
 - VA tribs and mainstem -- 1955 – 2014 -- 41, 096 stations – count, size, sex, egg stage
- MD trawl
 - MD tribs and mainstem – 1990 – 2014 – 5,507 stations - count, size, sex, maturity

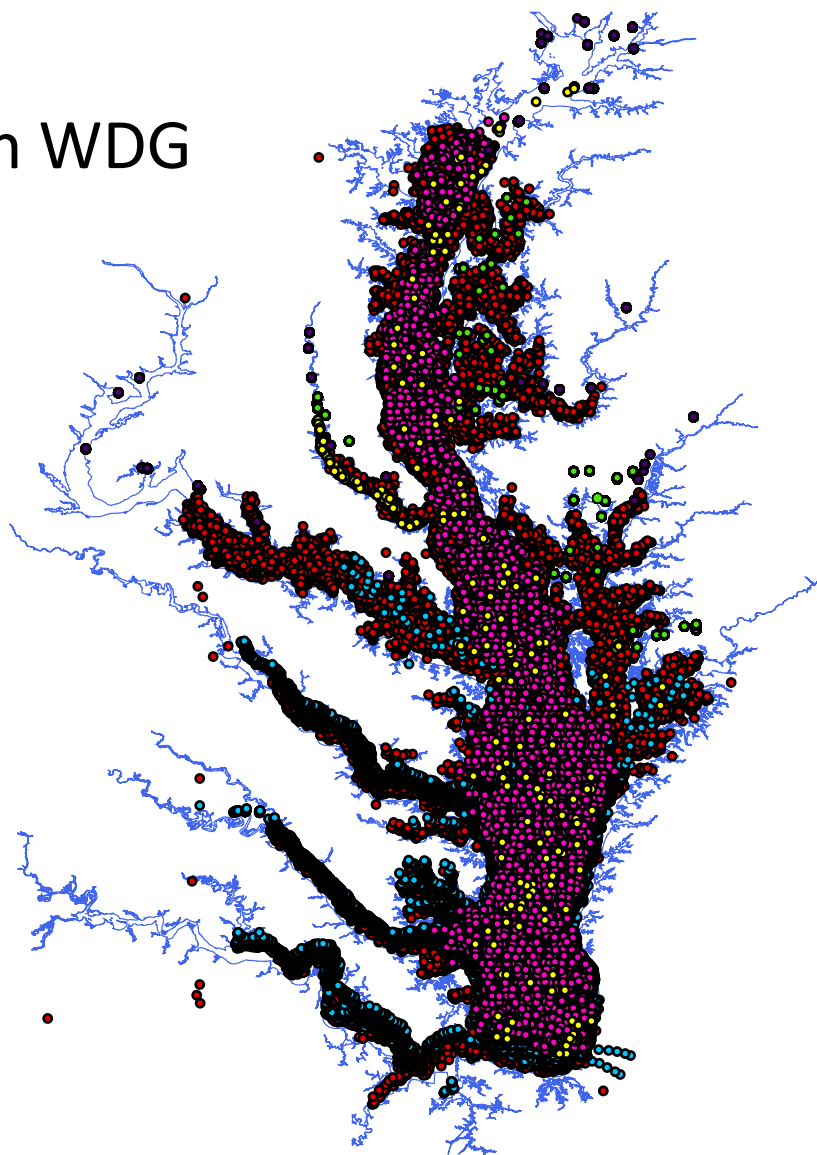
Survey comparisons – full time span



Survey comparison – recent years



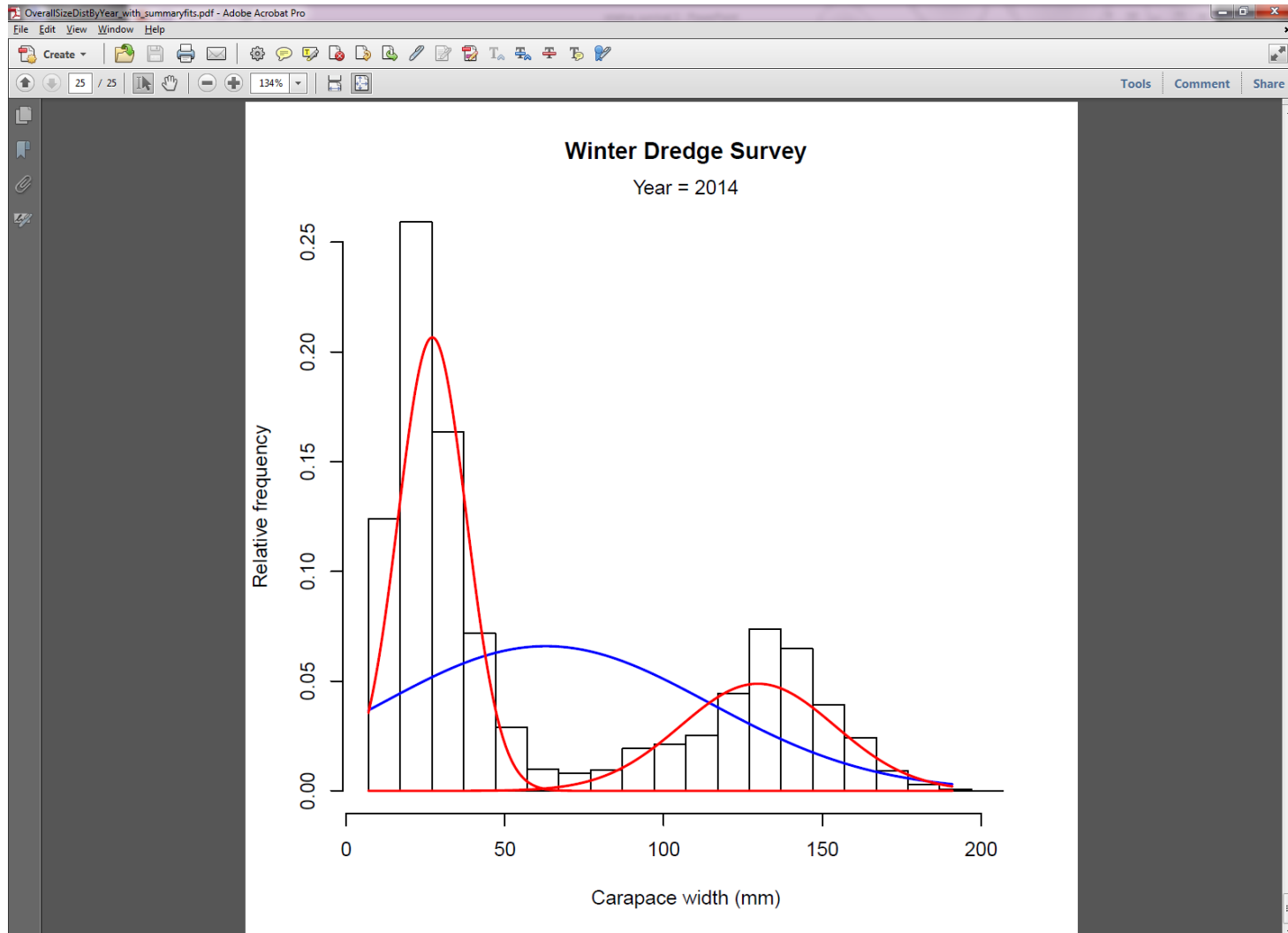
2000-2014 with WDG



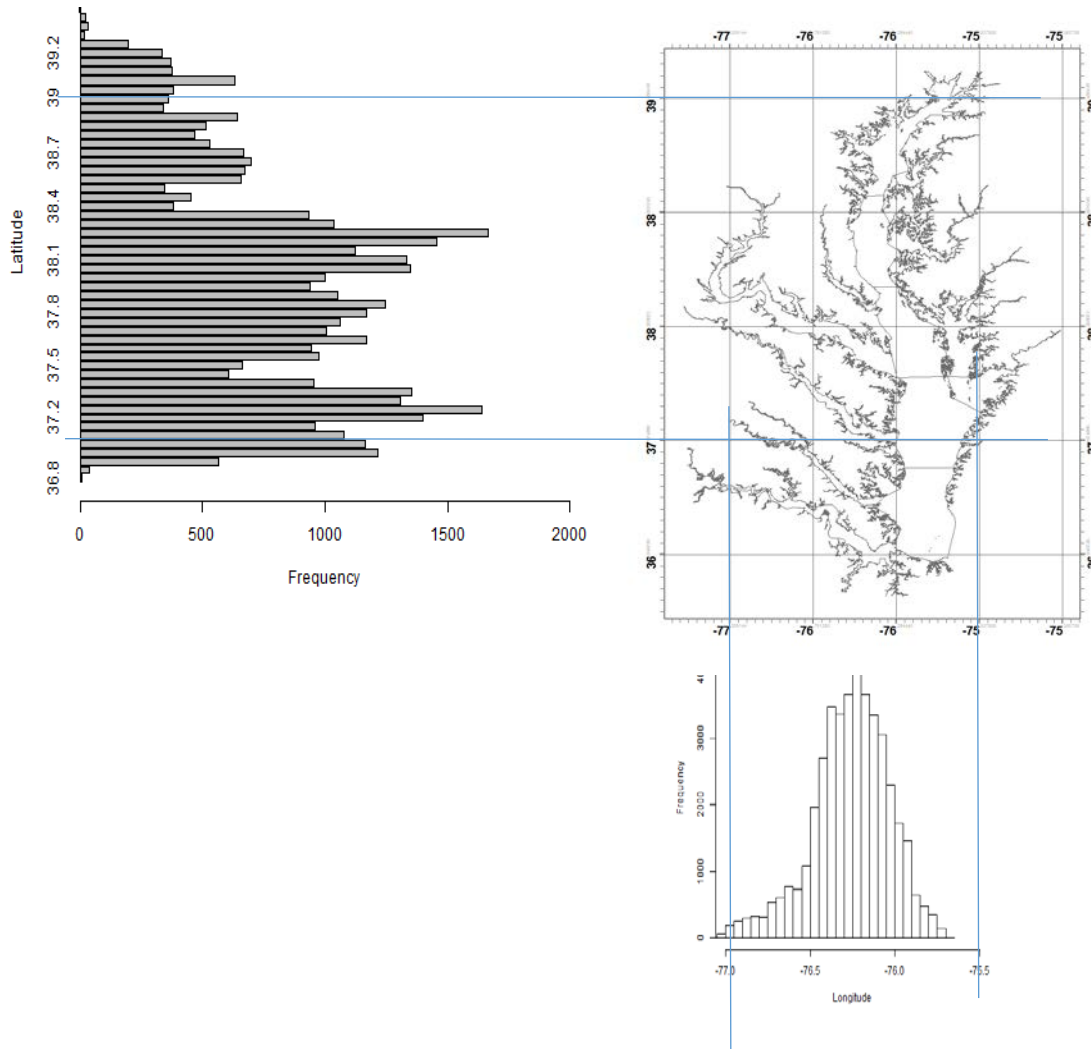
Database

- Defined consistent geographic regions and depth strata
- Extensive QA/QC
 - Consistent lat/long coding
 - Consistent date coding
 - Consistent missing data coding
 - Corrected obvious errors in station locations (where possible)
- Plea for consistency and openness

H1A: More small crabs in 2012?

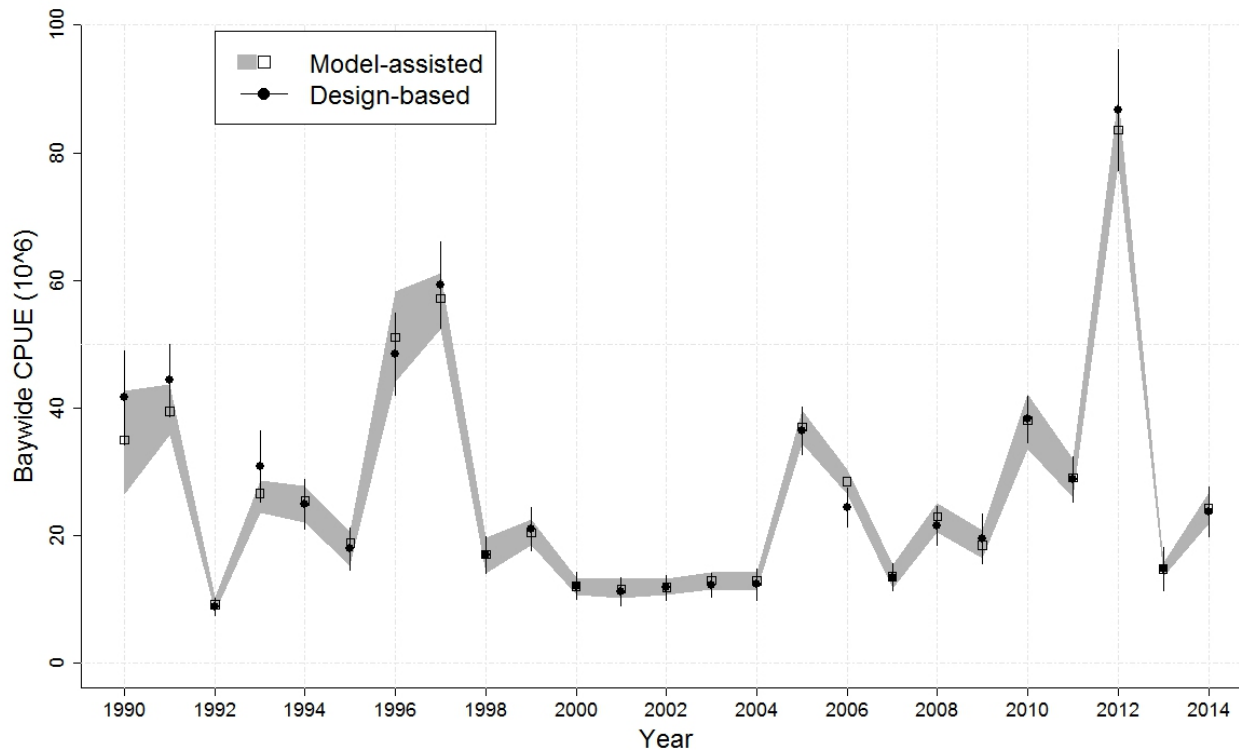


H1B Spatial distribution of crab altered



H1B: Spatial distribution of crabs altered

- Used a geostatistical model to estimate abundance (e.g., Jensen and Miller 2005)



H1: 2012 WDS was biased

- No evidence of substantial change in size distribution of small crabs in the WDS
 - But we cannot determine if the same fraction of the age-0 recruits were in the survey area
 - Juvenile distribution survey
 - Preliminary variance estimators obtained, \$\$\$
- Geostatistical model provides no evidence of bias in the design-based estimator, indicating that broader changes in spatial distribution is not a likely explanation
- 2011 year class was likely extremely strong

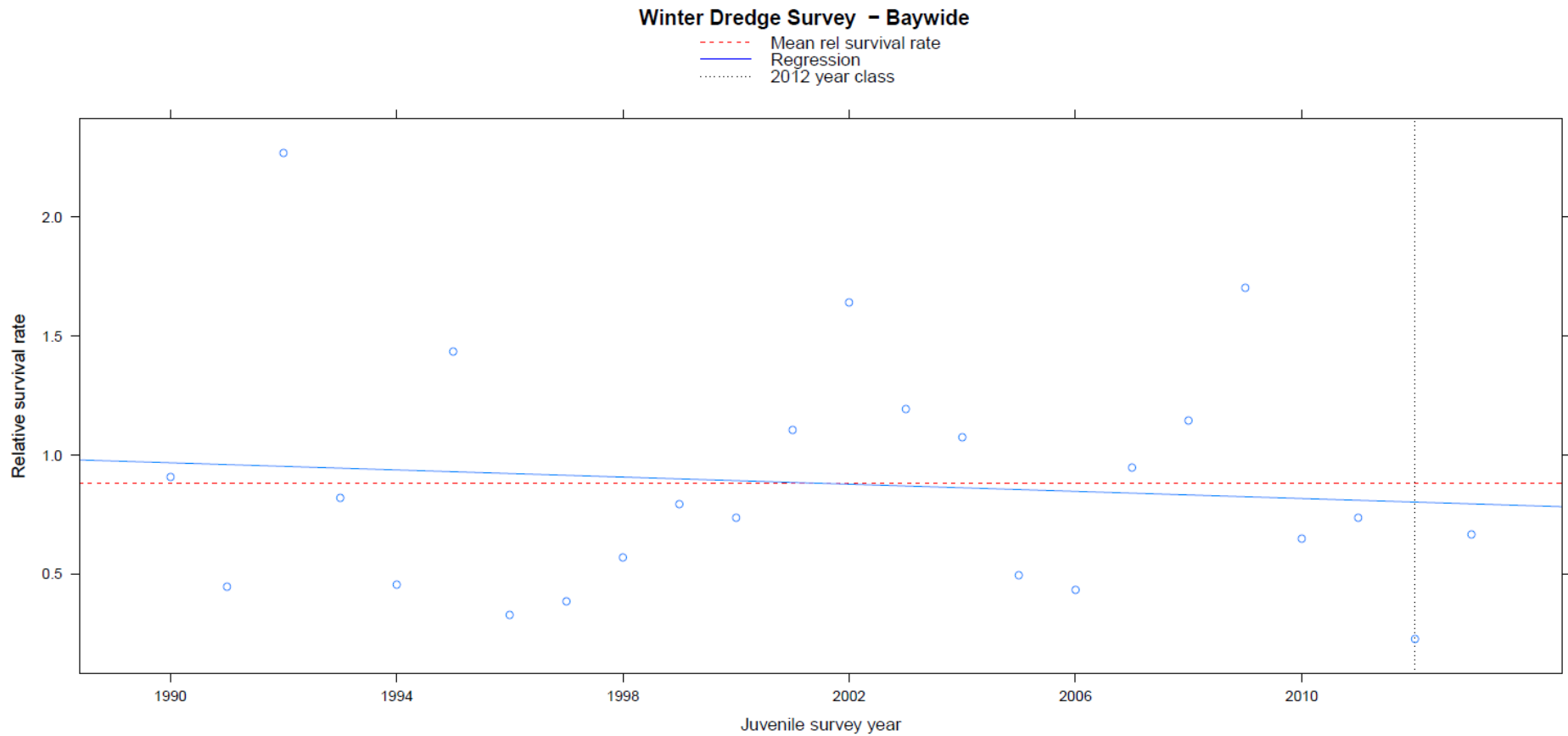
H2: Unusual mortality

- Calculated relative survival – ratio of adults next year to juveniles this year, so

$$Rel\ Surv_{2012} = \frac{Adult\ CPUE_{2013}}{Juv\ CPUE_{2012}}$$

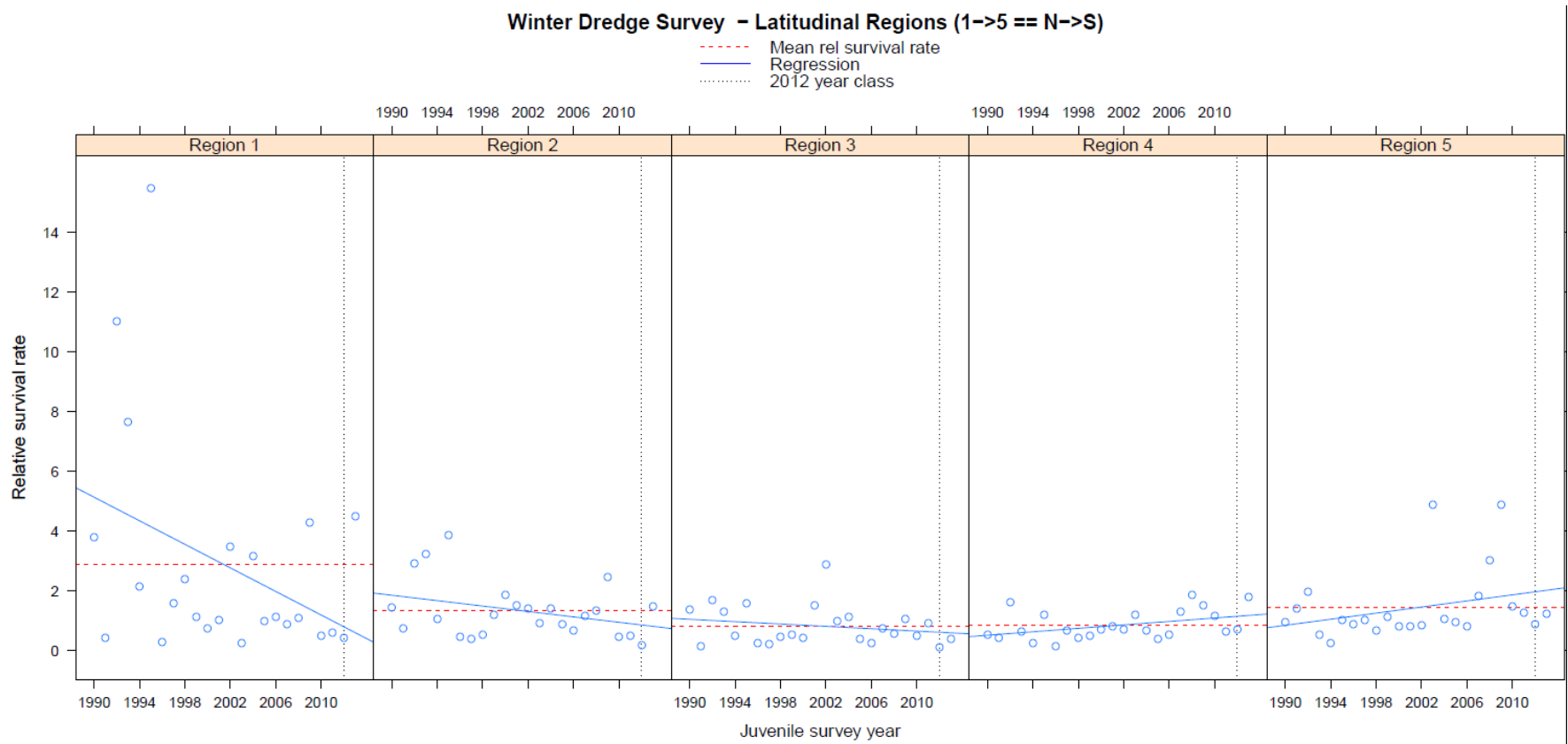
- Compared rel. surv. by year and region, paying particular attention to the pattern of 2012

Relative survival trends

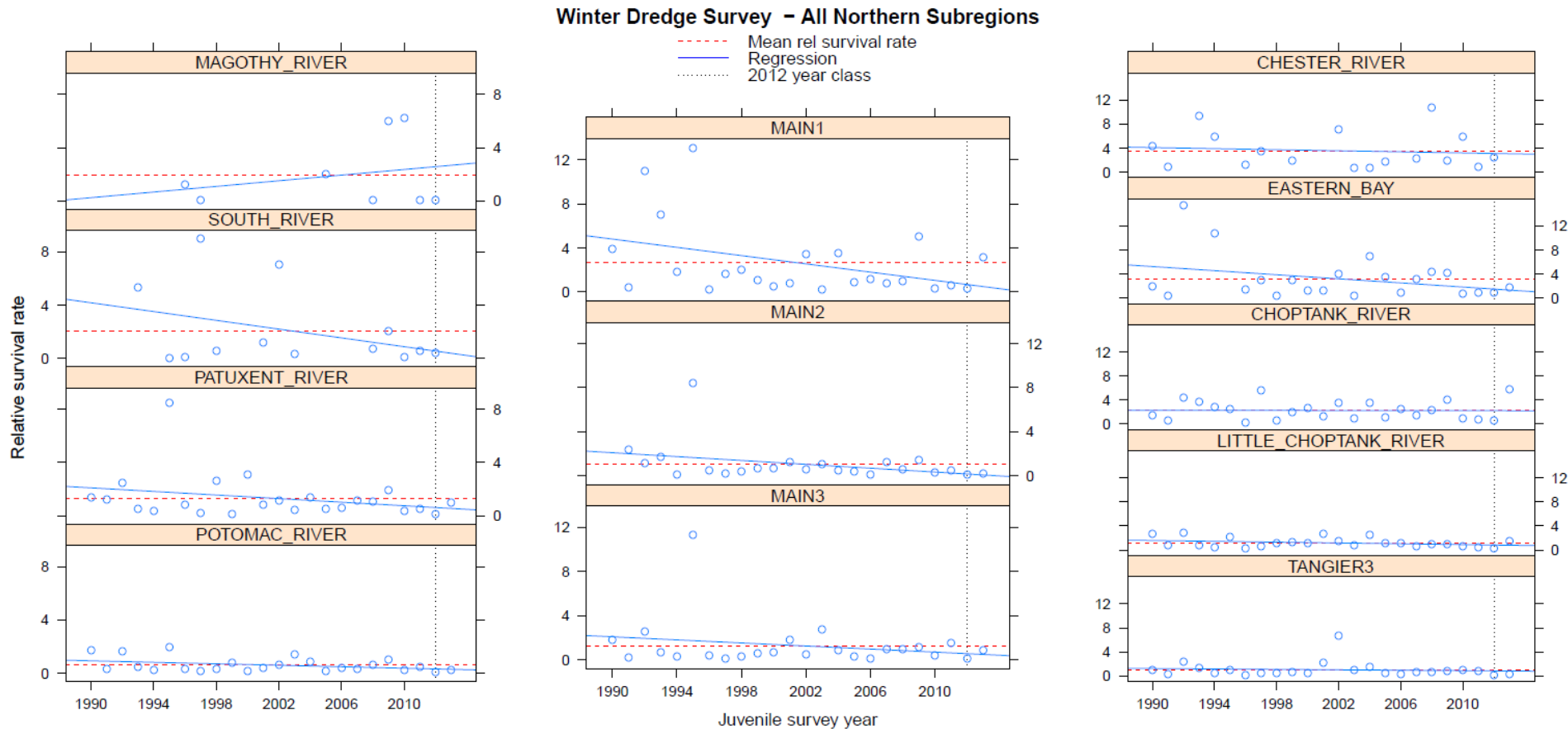


Relative survival trends

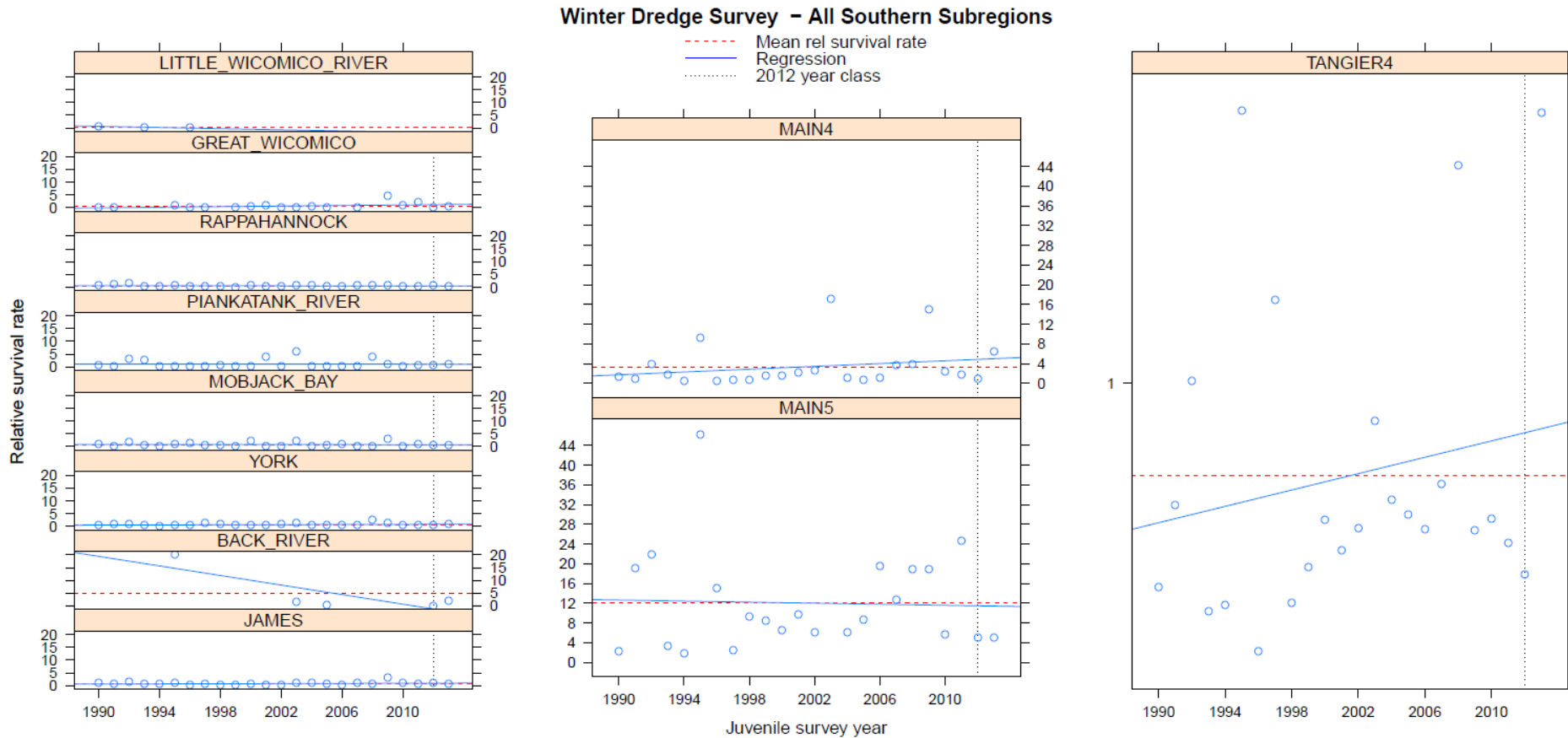
- If we assume adults are randomly distributed, we can calculate regional rel. surv. estimates



Relative survival – northern regions



Relative survival – southern regions



H2: 2011 year class experienced extreme mortality

- Relative survival of 2011 year class in 2012 (rel. surv_{2012} , i.e. from age-0 to age-1) was the lowest on record, based on WDS
- Extremely low relative survivals were more evident in northern regions than in southern regions
 - In southern regions rel. surv_{2012} was one of the 5 lowest years, but not the lowest
 - In northern regions , rel. surv_{2012} was often the lowest
- Any proposed mortality source must be more prevalent in northern regions

H2: 2011 year class experienced extreme mortality

- Latitudinal differences were evident in trends of rel. surv., such that rel. surv. has declined in northern regions, but appears to have increased in southern regions – particularly Tangier Sound

To do

- Link surveys to provide temporal resolution to determine if low relative survival occurred at a particular time and/or location
- Correlation with abundance of key fish species and SAV

Lifetime reproductive output

- Used a monthly life-table approach to estimate reproductive output ($\ell_x m_x$)
 - Assumed Darnell et al. (2009) brood production schedule
 - Assumed Prager et al. (1990) fecundities
 - Assumed Miller (2001) egg & megalop survival from
 - Assumed current M and F from Miller et al. 2011
- Expected number of broods per individual female recruit to Chesapeake ~ 1.42
 - Expected number of broods given a female survives to produce a first brood ~ 3.30
- Expected number of female eggs per individual female recruit to Chesapeake $\sim 2.27 \times 10^6 \rightarrow 2.708$ individual females per recruit. Implies $r \sim 0.375$