Striped Bass Health Indicator Development

CBP – Sustainable Fisheries Goal Implementation Team – Executive Committee

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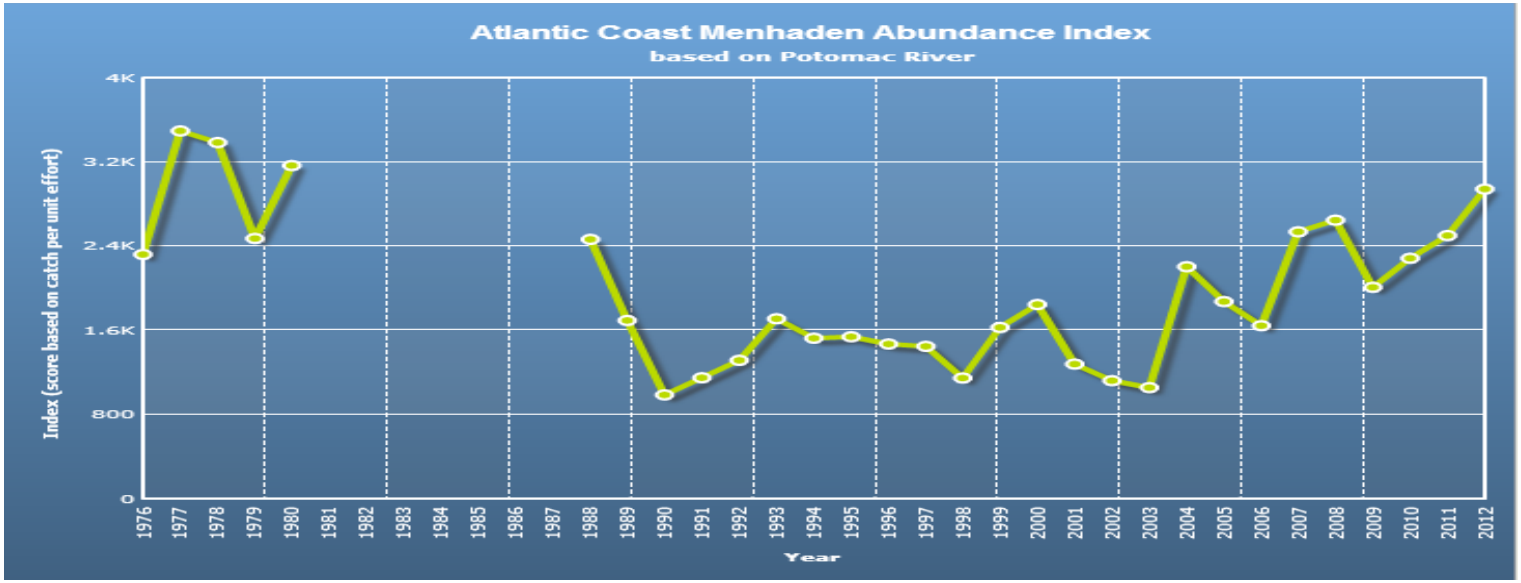
Outline

- Background on CBP Fish indicators
- Overview of Indicator development - Striped Bass Mycobacteriosis
- Potential Indicators
- Connecting Indicators to Water Quality
- Conclusions and Next Steps

Chesapeake Bay Fish Indicators

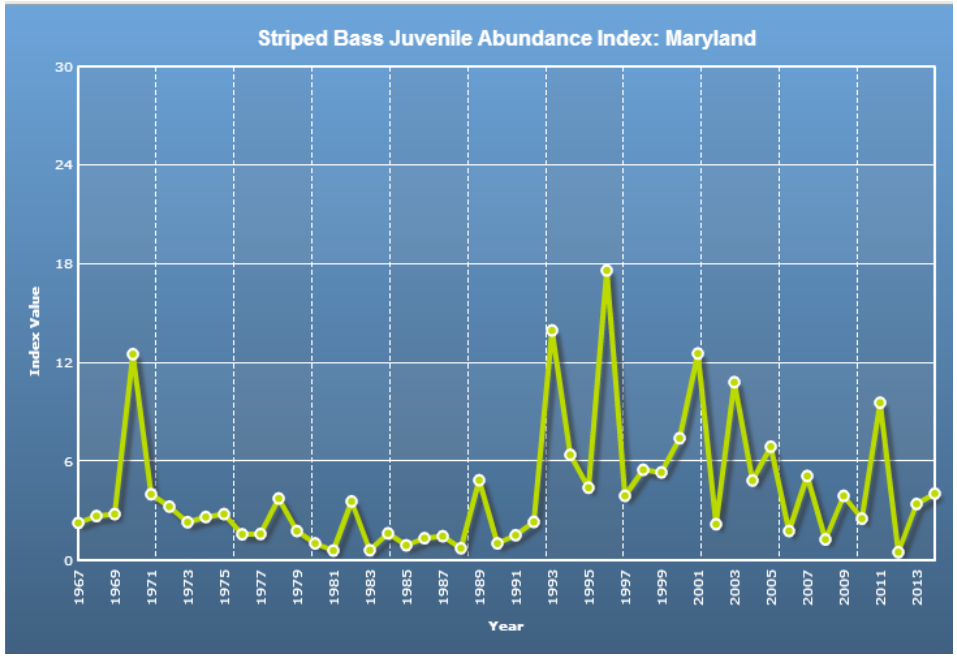
- Currently the CBP tracks the bay's health through a variety of indicators. The fish indicators tend to be based on coast-wide stock assessments or beach seine survey (e.g., Striped Bass and Atlantic Menhaden Abundance and Juvenile Indices)



http://www.chesapeakebay.net/indicators/indicator/atlantic_menhaden_abundance

Utility of Chesapeake Bay Fish Indicators

- These indicators are generally useful for publicly communicating basic patterns in key stocks, but they are not necessarily providing much information on how the bay's health is influencing fisheries stocks.



Trends in Biomass or Juvenile abundance indices can be influenced by many factors external to the Chesapeake.

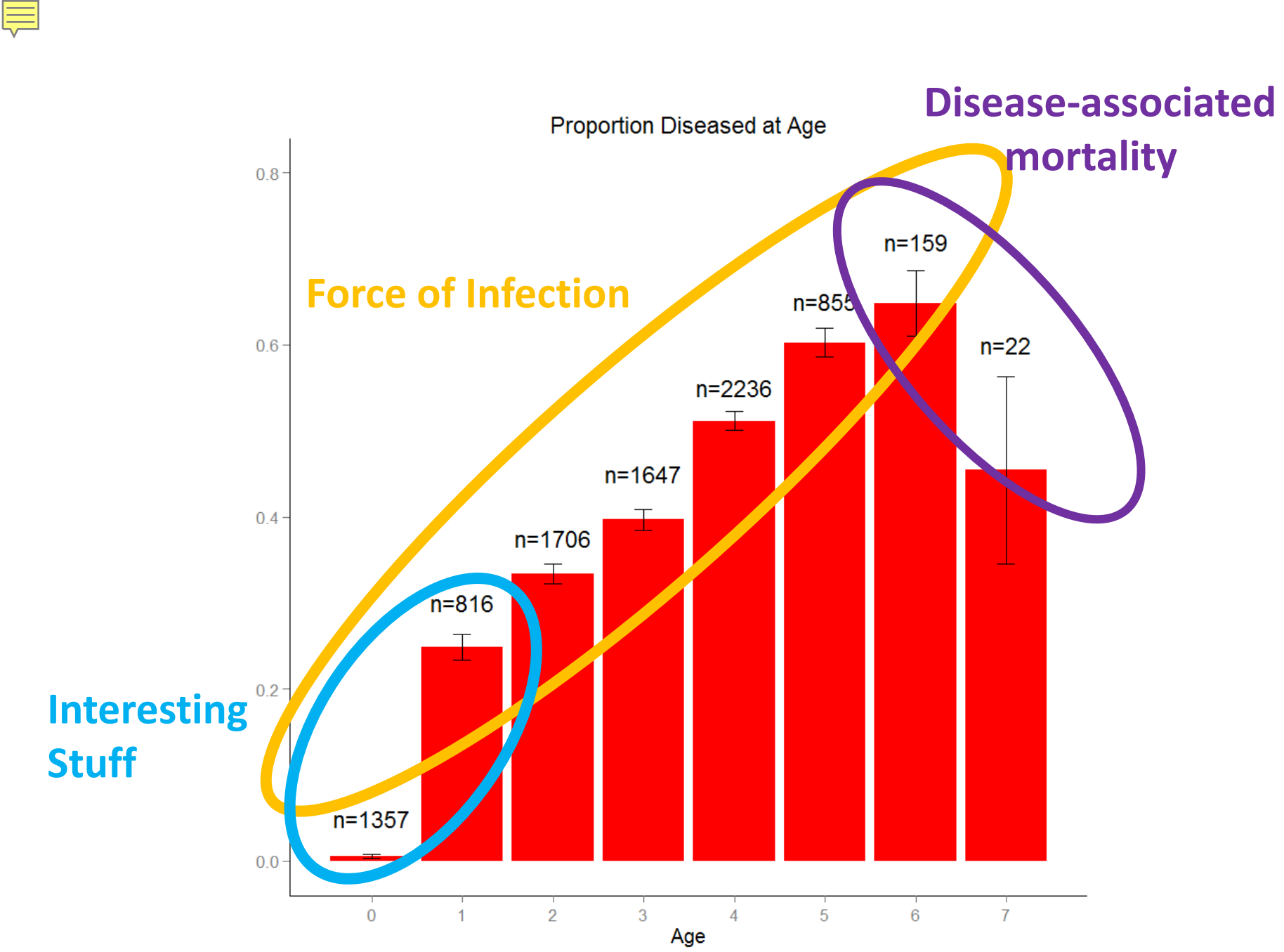
http://www.chesapeakebay.net/indicators/indicator/striped_bass_juvenile_abundance_index

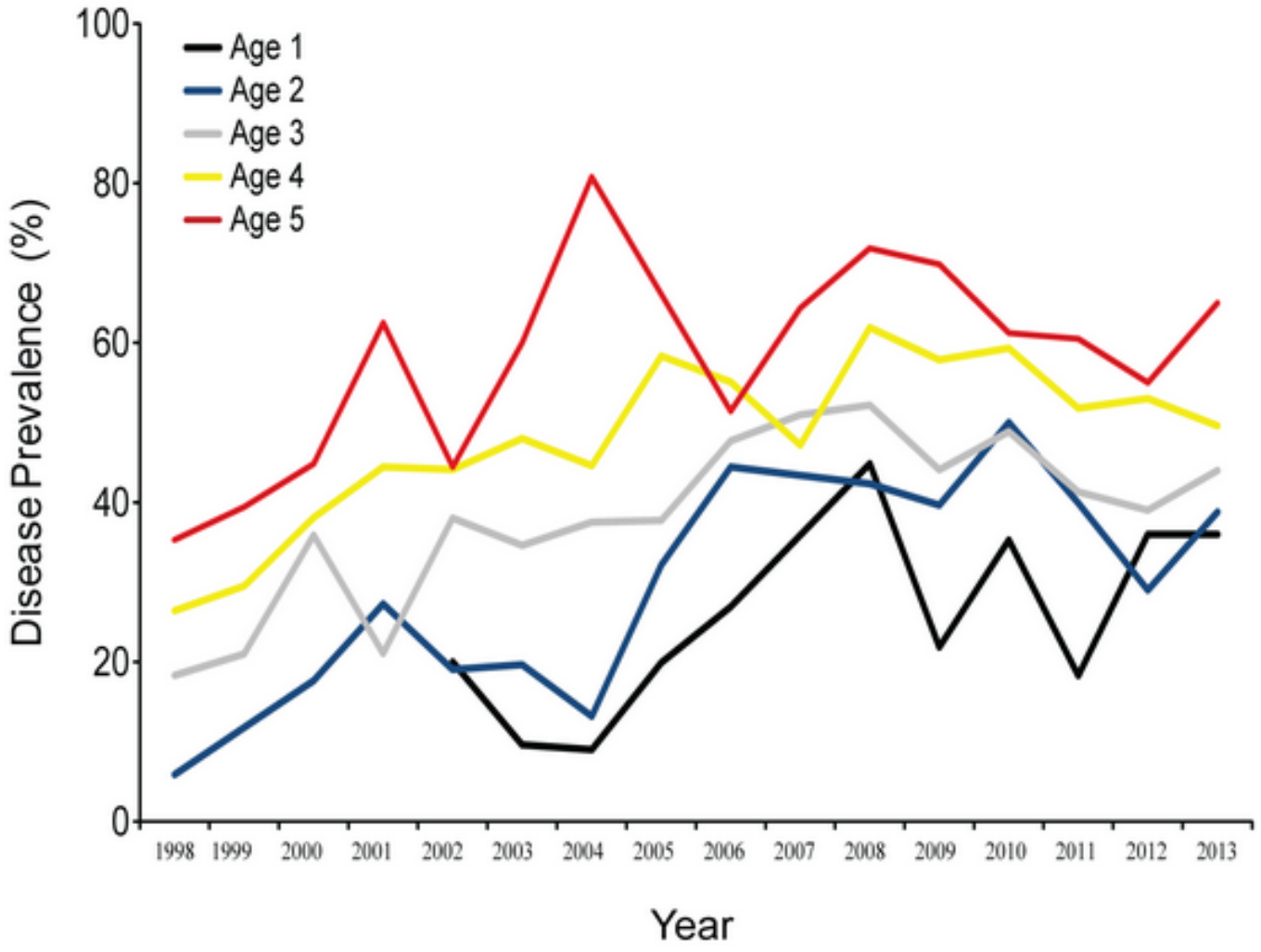
Chesapeake Bay Fish Health Indicator

- The purpose of this project was to develop an indicator of striped bass health that may be useful for fisheries and water quality managers.
- Using MD DNR – Fish Health Team's data on Mycobacterial infection (16-year time series) in Striped Bass
- Explored connections between myco infection and environmental variables (water temp, nutrients, forage fish, etc.)

Potential Fish Health Indicators

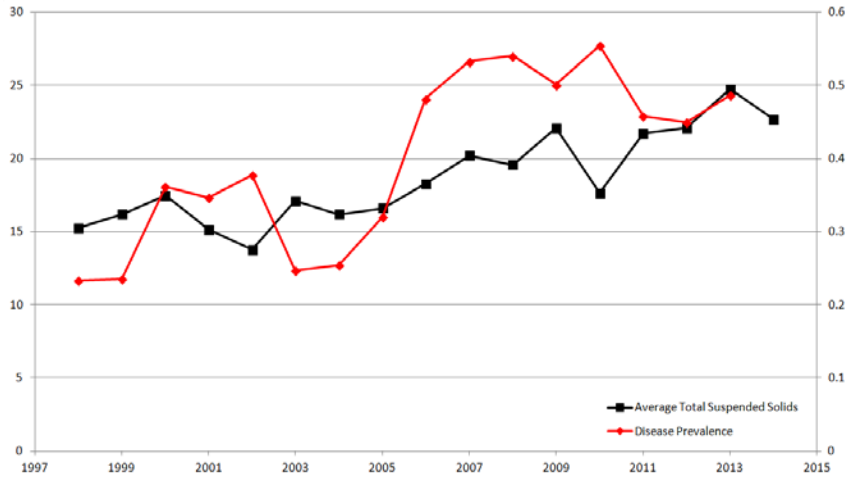
- Disease associated mortality
  - the increase in probability of death resulting from becoming infected relative to an animal that remains disease-free
- Force-of-Infection
  - the rate at which disease-free animals become infected
- Apparent Prevalence
  - the proportion of animals that have a positive test (or external indicator) for infection by the focal disease.
- Severity
  - extent of disease process


Disease-associated mortality
Force of Infection
Interesting Stuff
Proportion Diseased at Age
0.8
0.6
0.4
0.2
0.0
n=1357
n=816
n=1706
n=1647
n=2236
n=855
n=159
n=22
0
1
2
3
4
5
6
7
Age

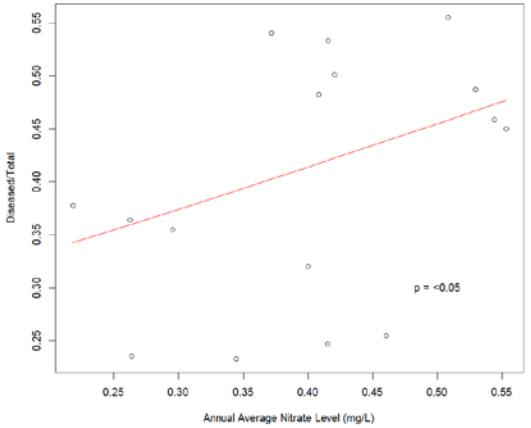

Age 1
Age 2
Age 3
Age 4
Age 5
Disease Prevalence (%)
100
80
60
40
20
0
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
2013
Year

Apparent prevalence is correlated with water quality variables

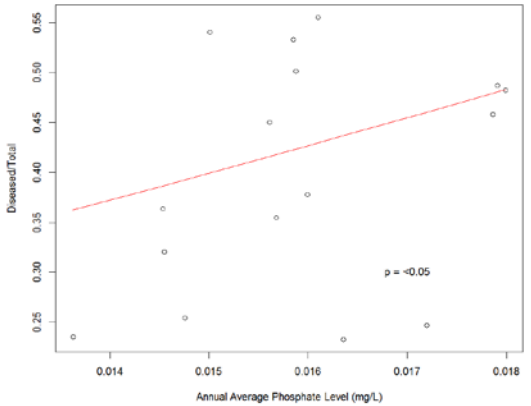
Total Suspended Solids



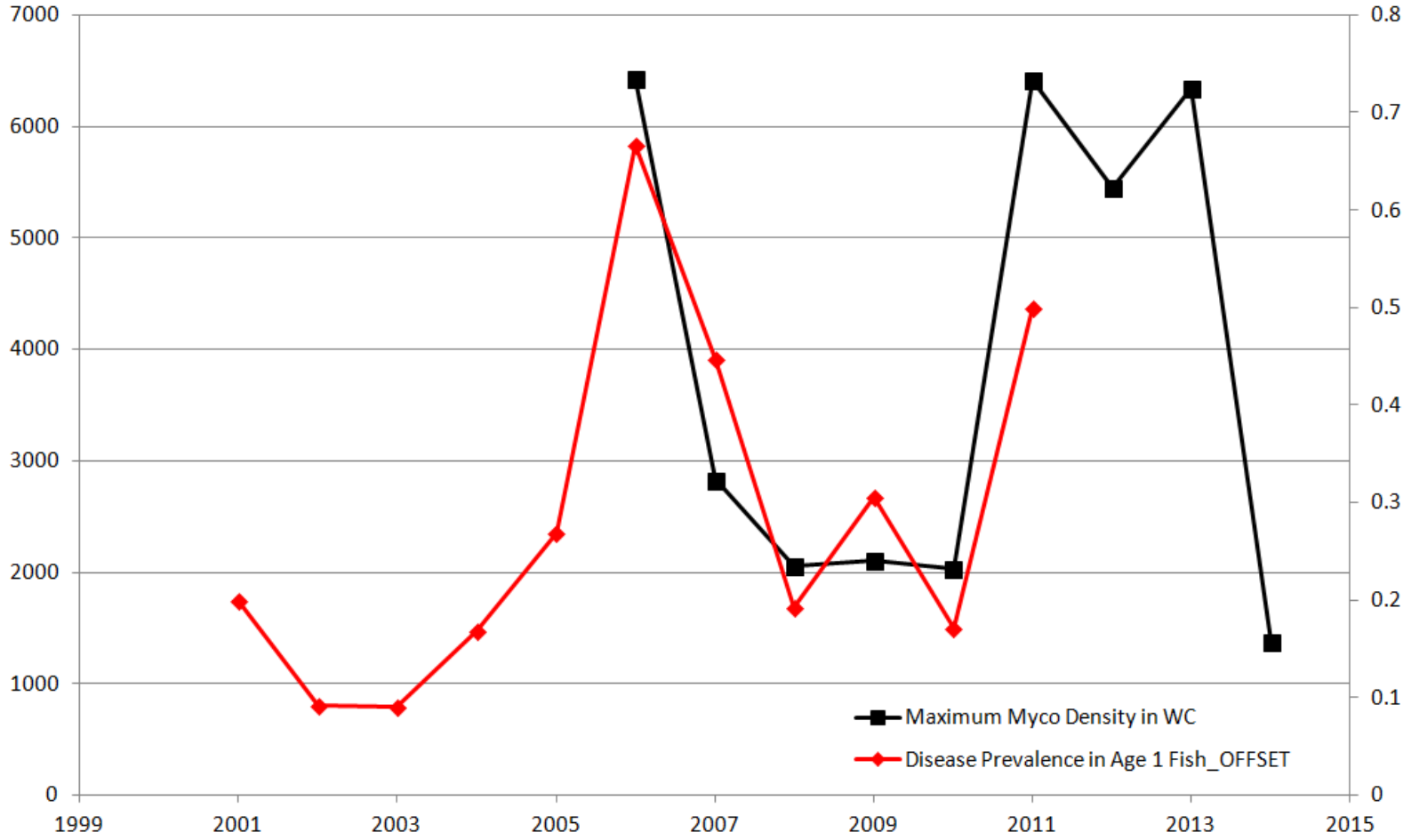
Nitrates



Phosphates



Apparent prevalence for Age-1 SB links to water column mycobacterium



Water column mycobacterium is likely associated with water quality

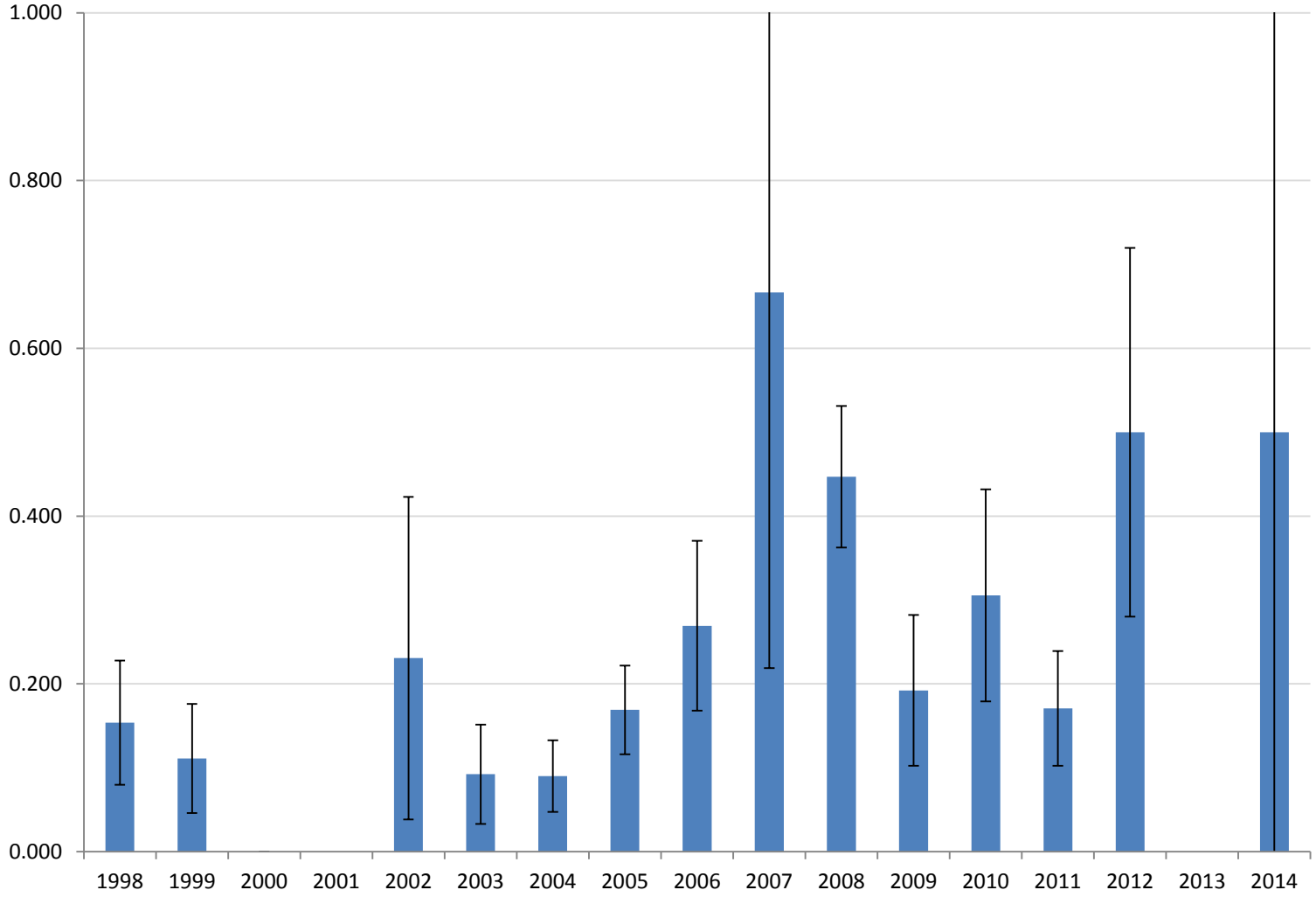
TABLE 2. Spearman's rank correlation coefficients for water quality variables and log bacterial concentrations in coastal bay water samples

Variable	r^a
N	212
Temp	0.19938*
pH	−0.12096
Salinity	−0.24622*
Dissolved oxygen	−0.31385*
Turbidity	0.46706*
Total suspended solids	0.33627*
Chlorophyll	0.23337*
NO_3+NO_2	0.37426*
TN	0.3935*
Total dissolved nitrogen	0.38888*
Particulate nitrogen	0.25357*
PO_4	0.09279
Total phosphorus	0.23955*
Total dissolved phosphorus	0.13119
Particulate phosphorus	0.26341*
Silica	0.2252*
Secchi depth	−0.39165*

[a] * indicates significance at $P = 0.05$.

Jacobs et al 2009

Age-1 Apparent Prevalence as an indicator



Preliminary Conclusions

- With current data availability, apparent prevalence is an appropriate annual indicator.
- Apparent prevalence is positively correlated with several water quality variables, thus it is **an indicator of water quality effects on a key fish stock**.
- With additional age-structured, apparent prevalence data, apparent prevalence can be used to estimate disease-mortality, which is a measure of stock productivity.
- Ultimately, apparent prevalence of myco in striped bass can **quantitatively link water quality (and land use) to fish productivity.**

Next Steps

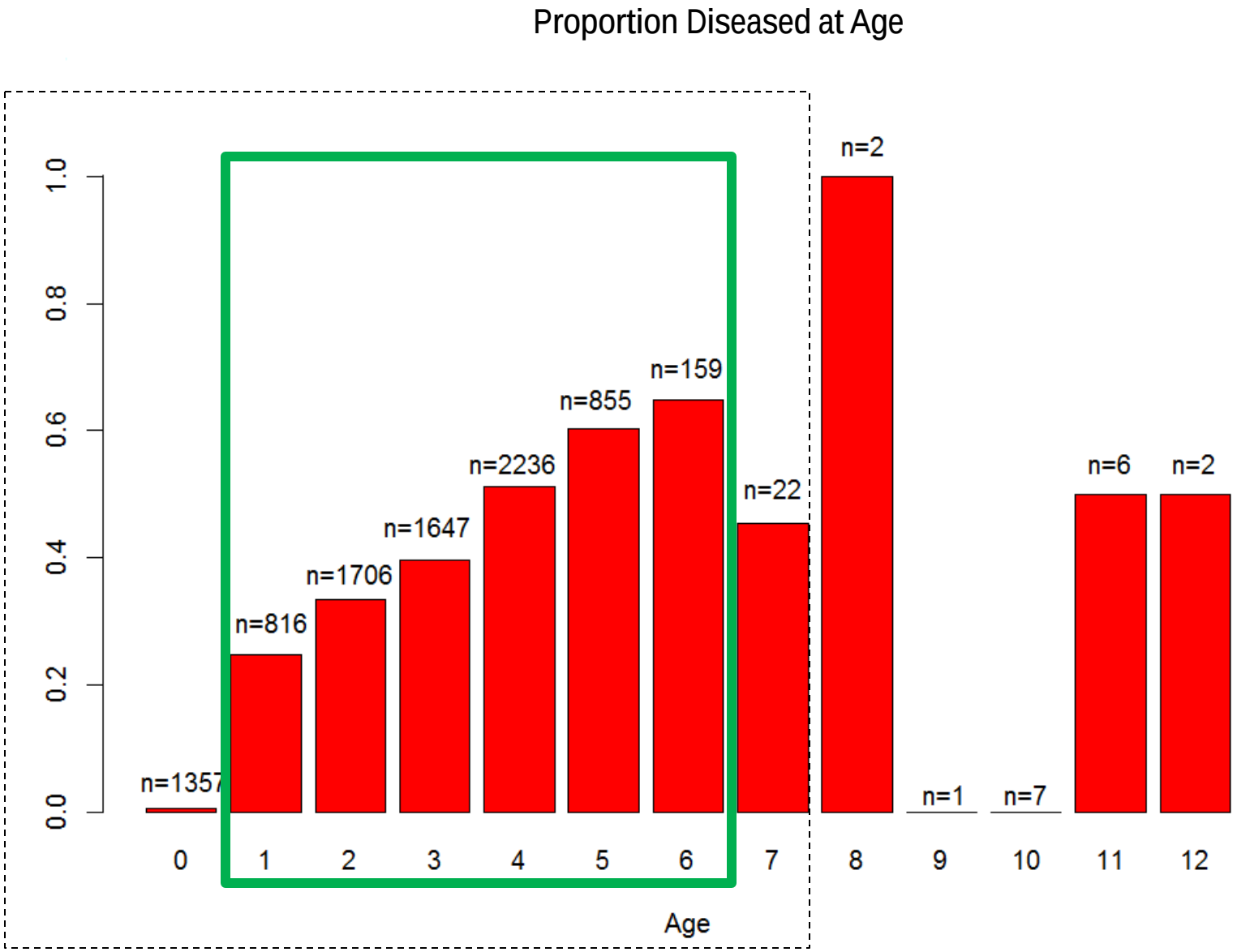
- Work with SF-GIT, STAR, and CBP Comms Team for indicator development
- Ensure adequate sampling of age-1 striped bass in MD
- Incorporate striped bass mycobacteriosis data for Virginia
- Future surveys should focus efforts on acquiring older age classes in order to more effectively capture annual trends in disease-associated mortality

Acknowledgments

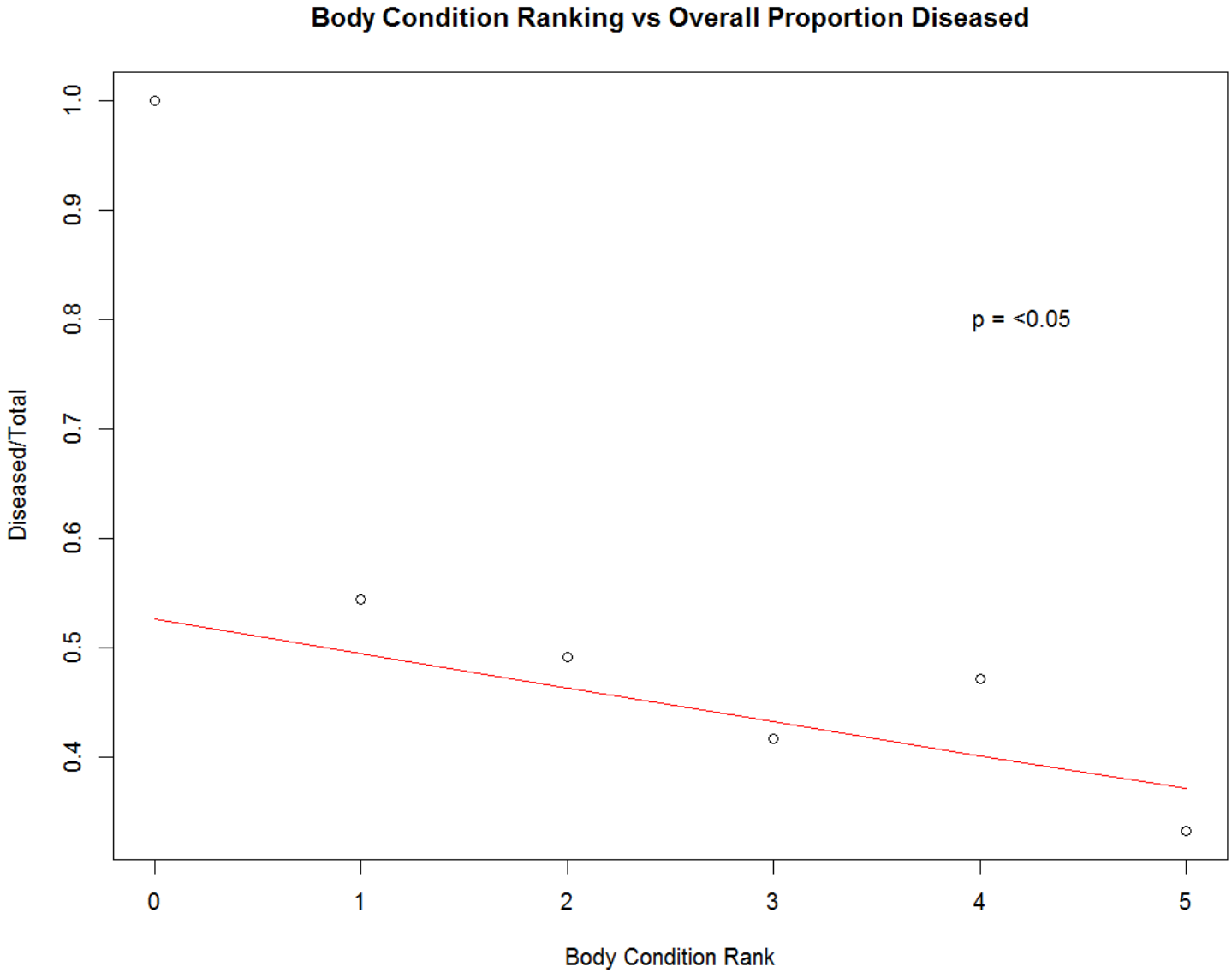
Chesapeake Bay Program

A Watershed Partnership

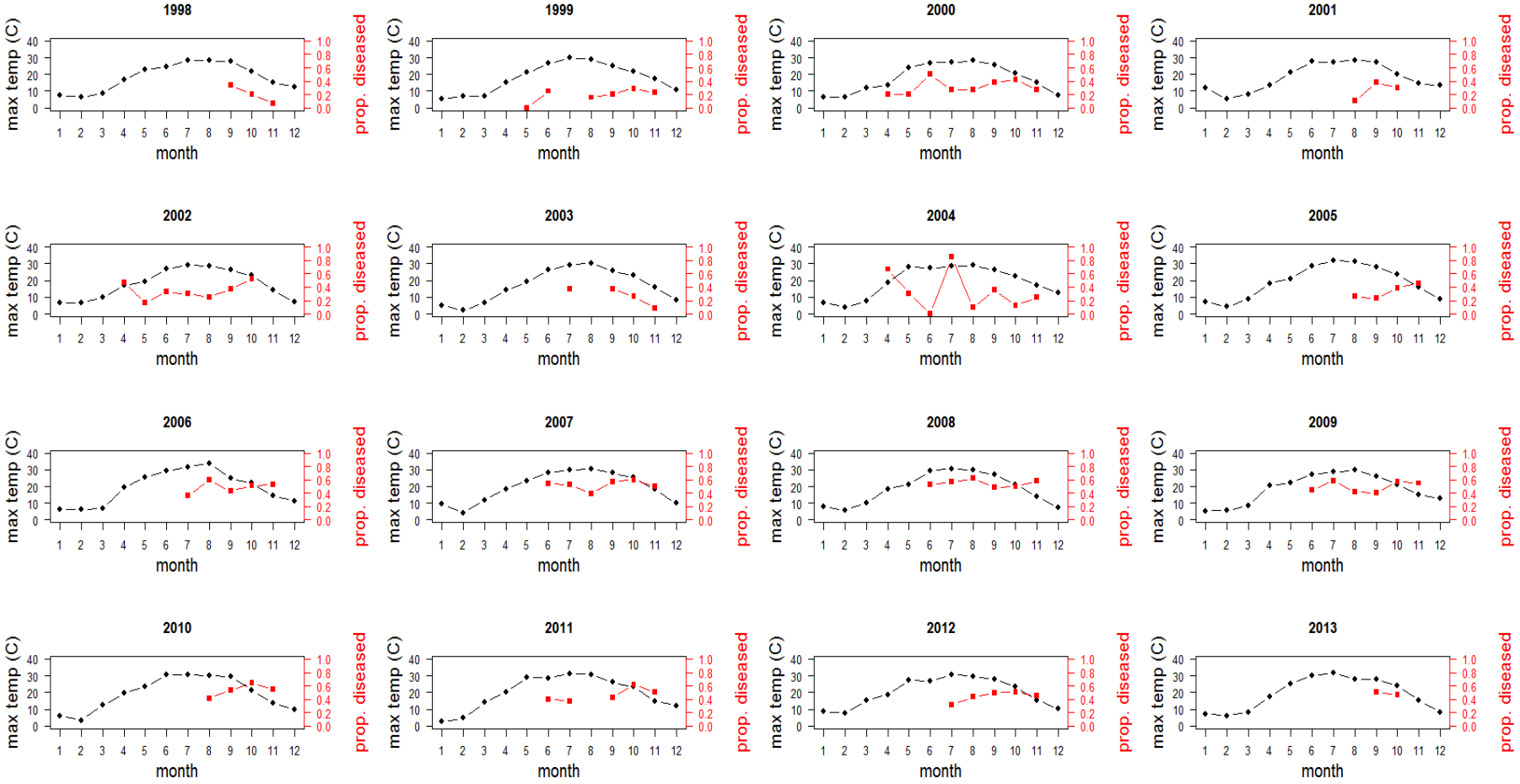
EXTRA SLIDES

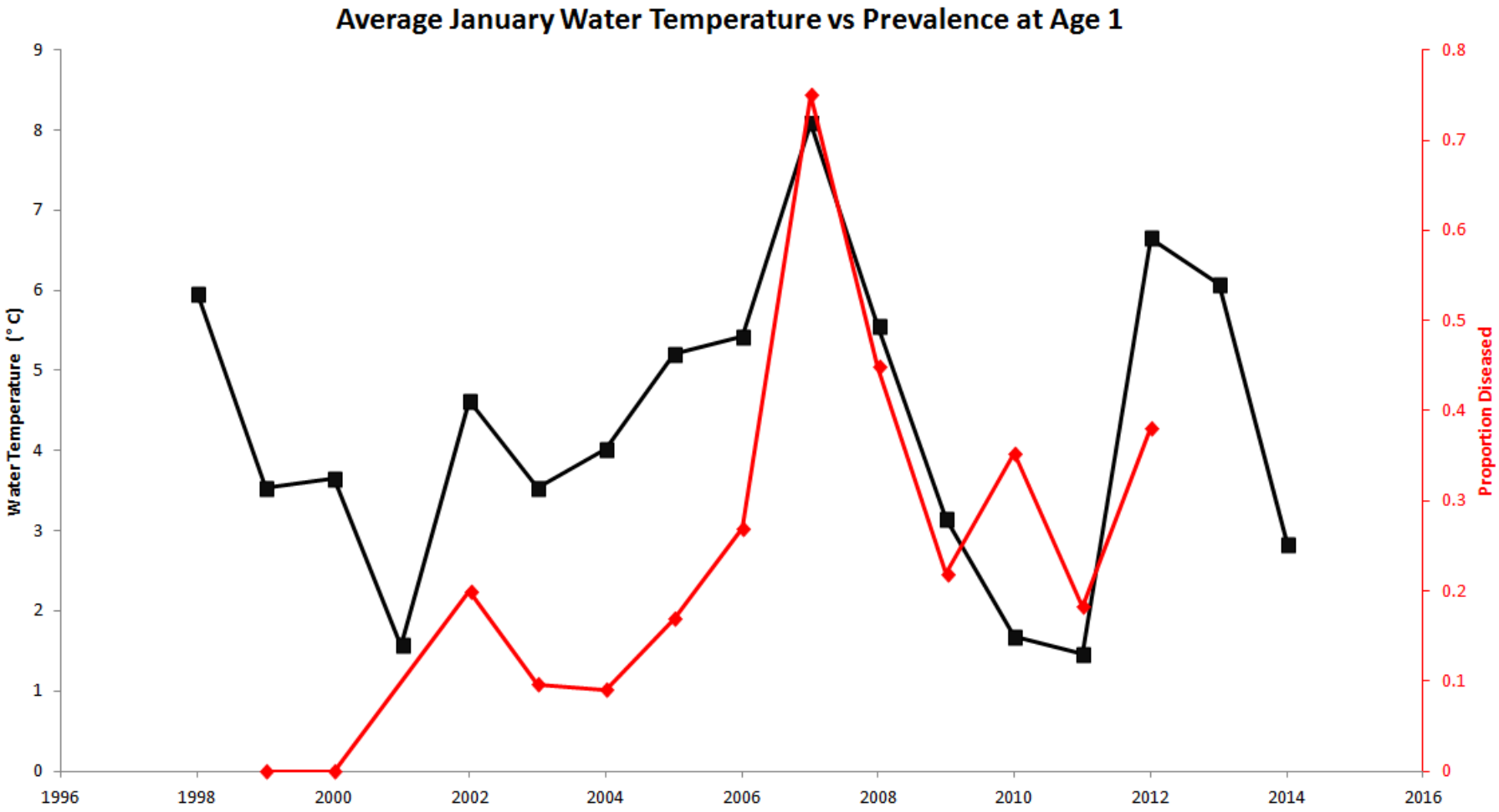

Proportion Diseased at Age
0.0
0.2
0.4
0.6
0.8
1.0
n=1357
n=816
n=1706
n=1647
n=2236
n=855
n=159
n=22
n=2
n=1
n=7
n=6
n=2
0
1
2
3
4
5
6
7
8
9
10
11
12
Age

Analyses to Date: Connecting Indicators to Environmental Variables

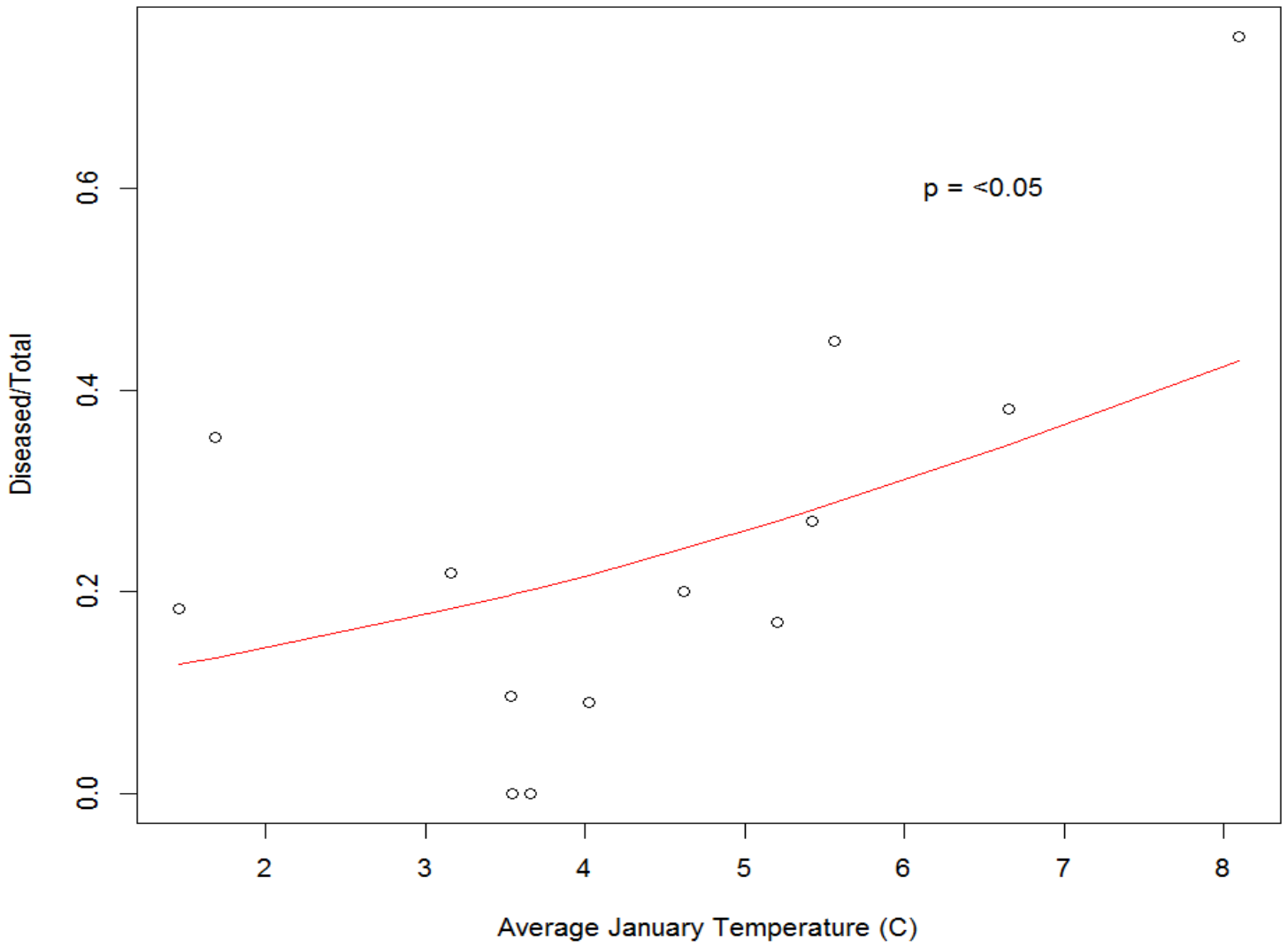

Body Condition Ranking vs Overall Proportion Diseased
Diseased/Total
1.0
0.9
0.8
0.7
0.6
0.5
0.4
p = <0.05
0
1
2
3
4
5
Body Condition Rank

Monthly Maximum Temperatures vs Overall Proportion Diseased

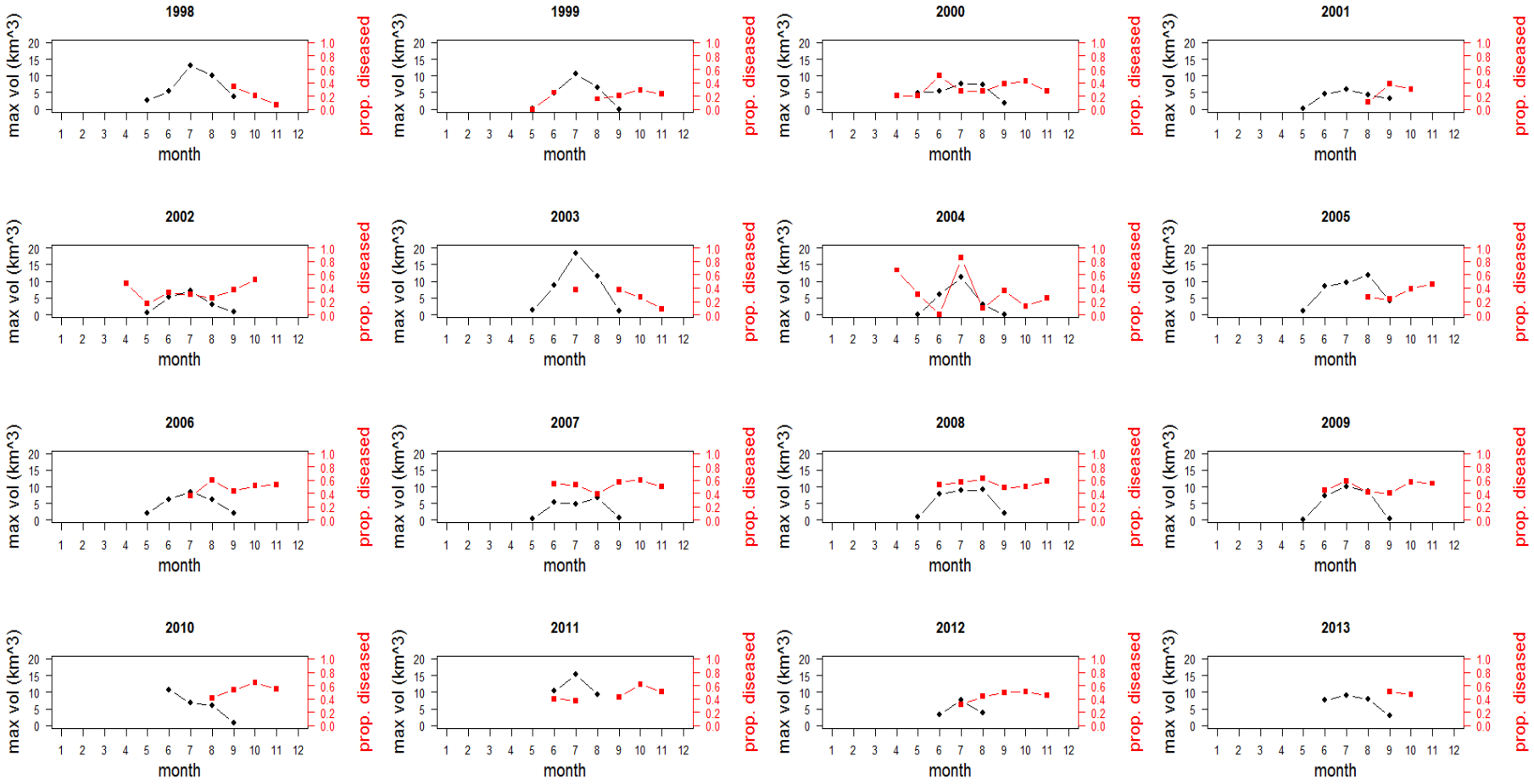



Average January Water Temperature vs Prevalence at Age 1
Water Temperature (° C)
Proportion Diseased
0
1
2
3
4
5
6
7
8
9
0
0.1
0.2
0.3
0.4
0.5
0.6
0.7
0.8
1996
1998
2000
2002
2004
2006
2008
2010
2012
2014
2016

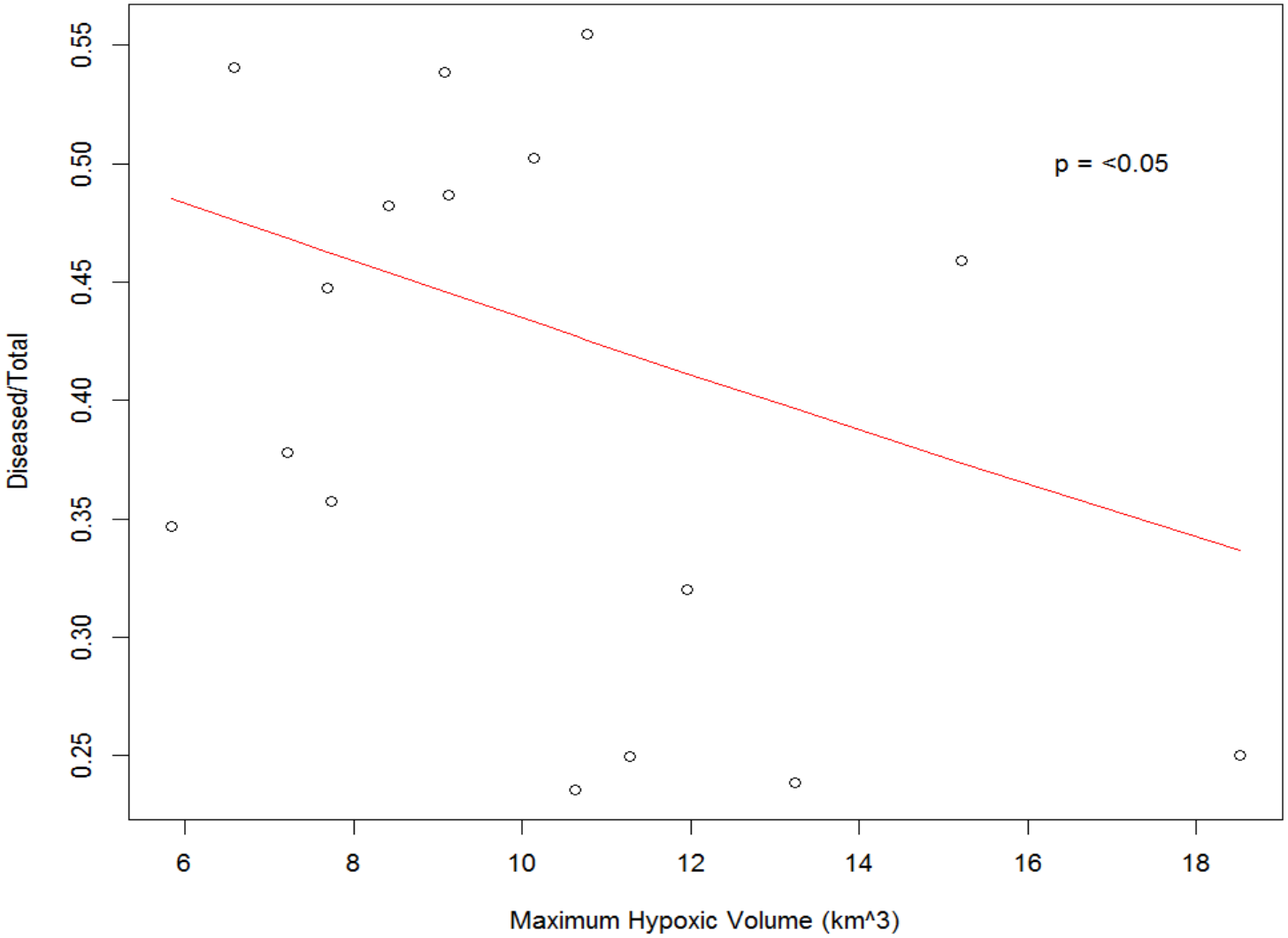
Average January Temperature vs Proportion Diseased at Age 1



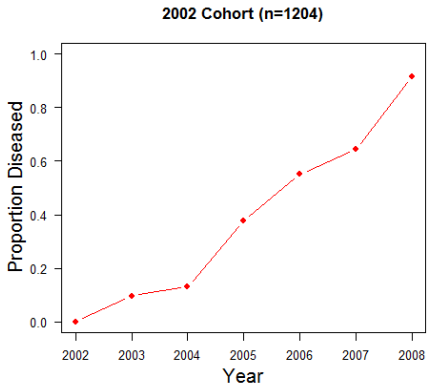
Monthly Maximum Hypoxic Volume vs Overall Proportion Diseased

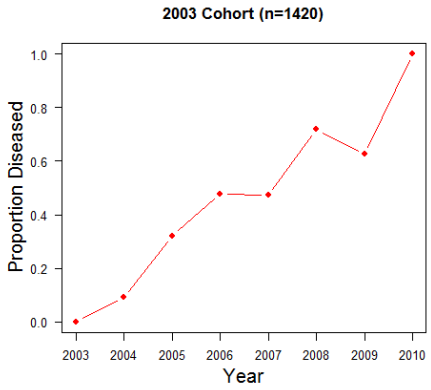


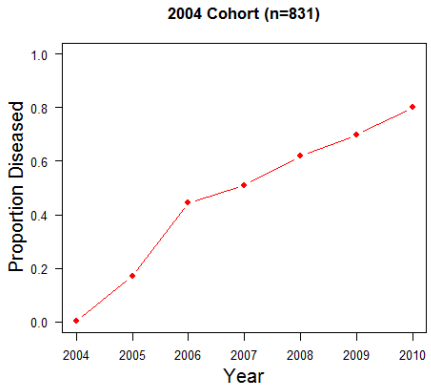
Maximum Annual Hypoxic Volume vs Overall Proportion Diseased

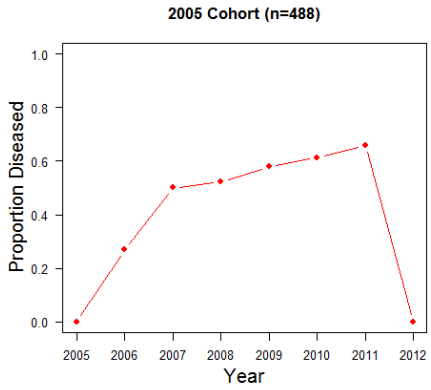


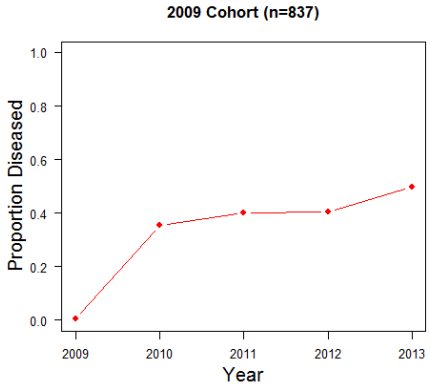
Prevalence Over Time (Cohorts)

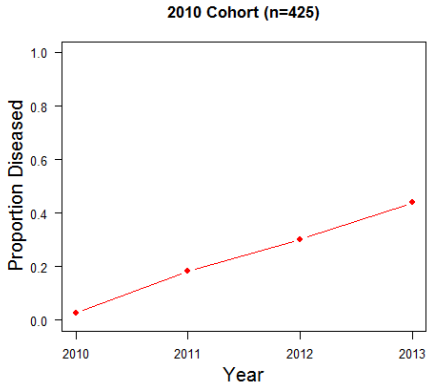


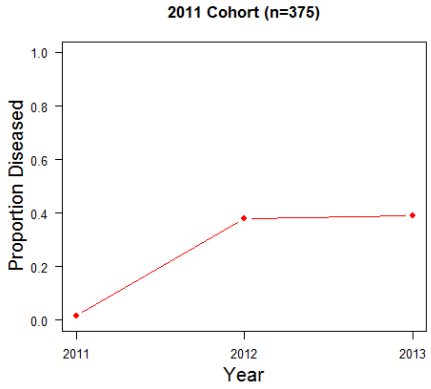




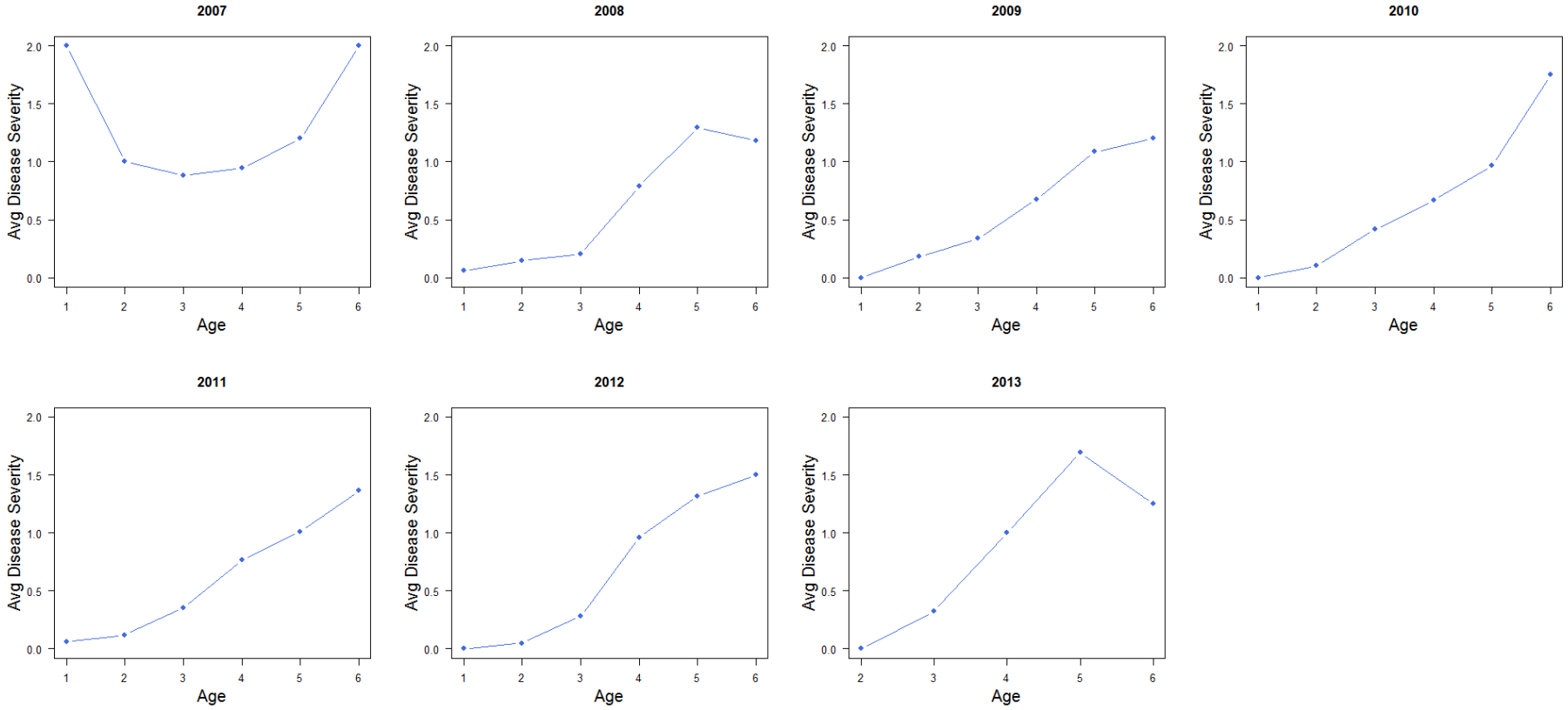


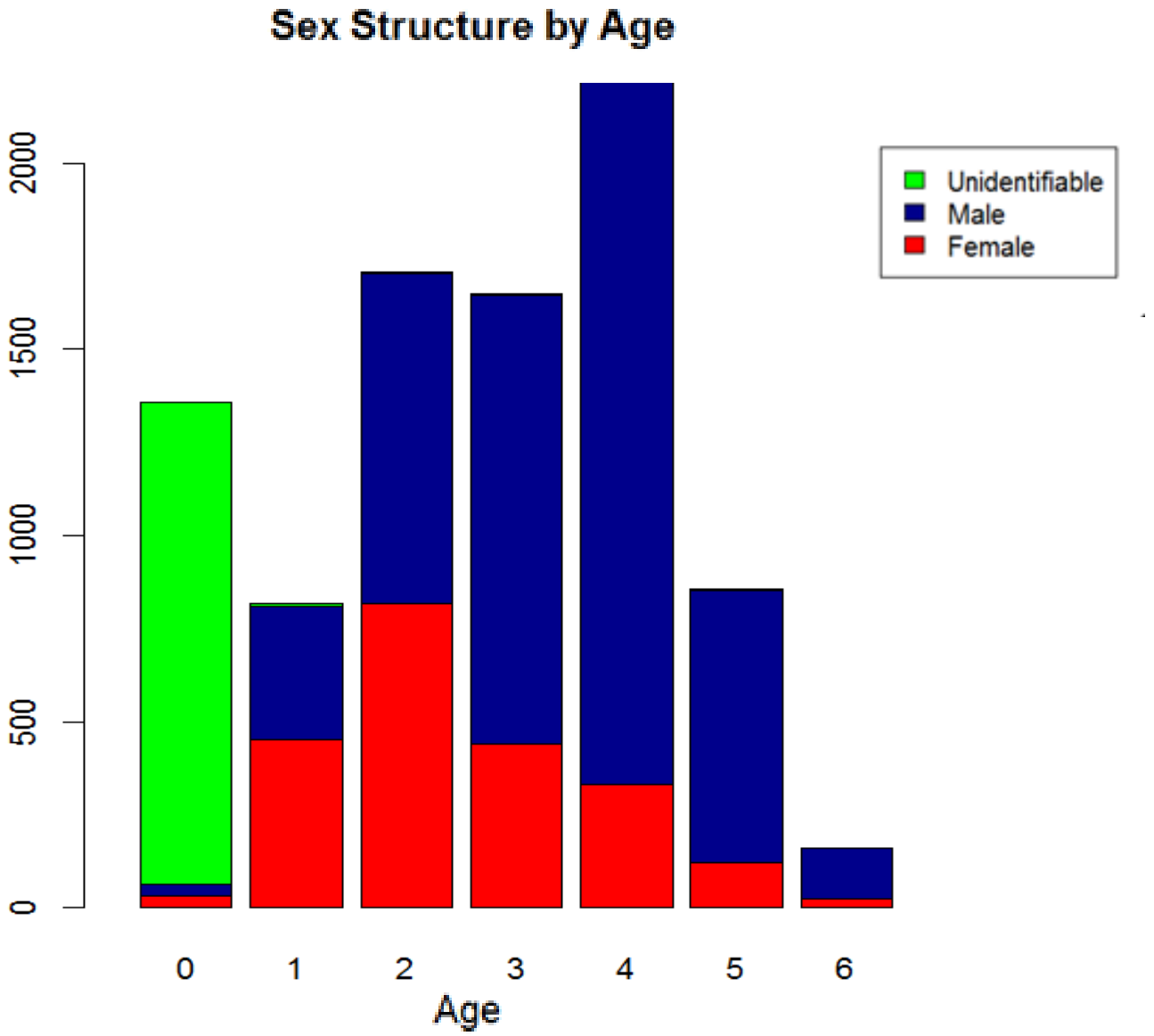




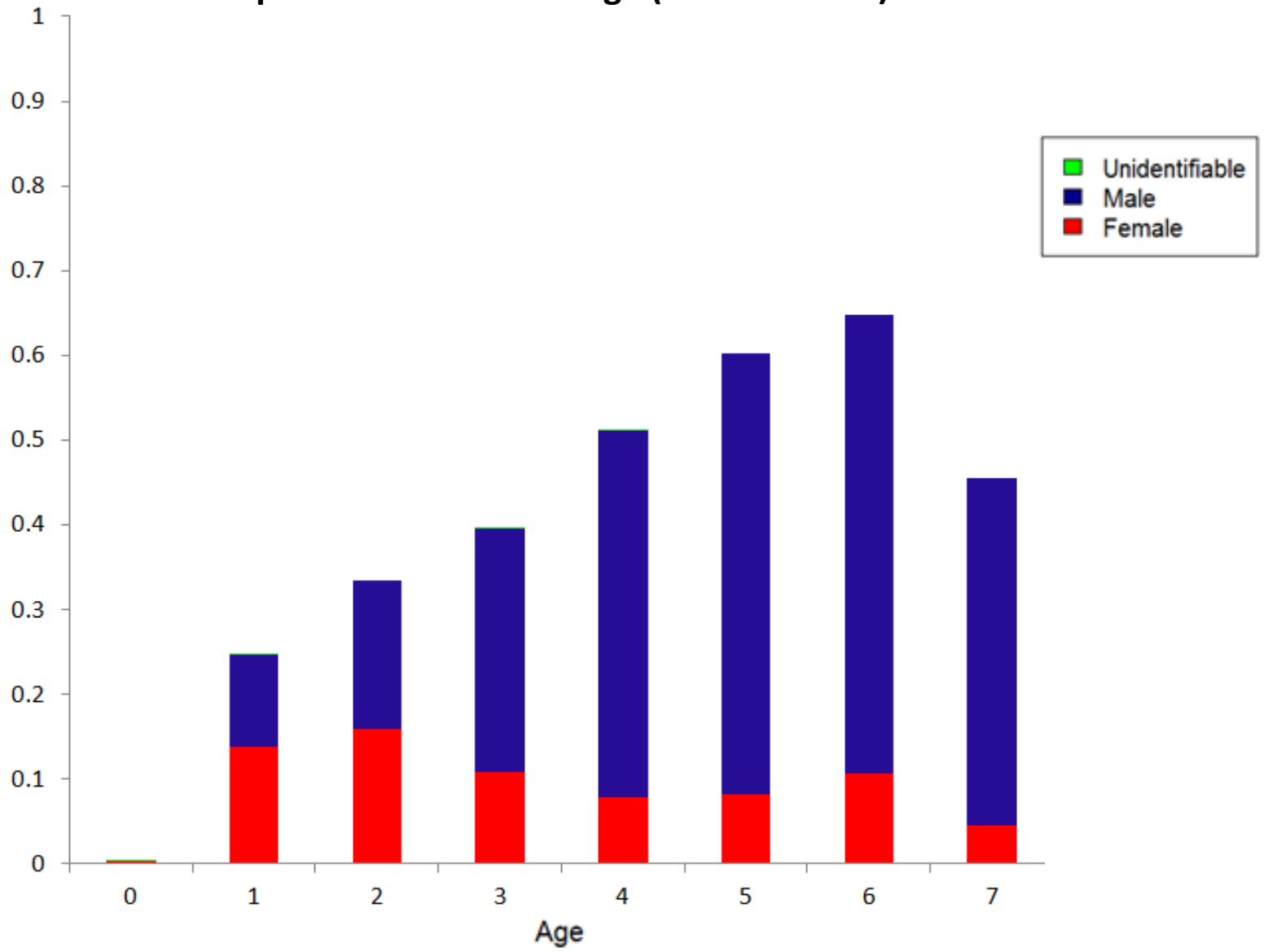


Overall Disease Severity at Age

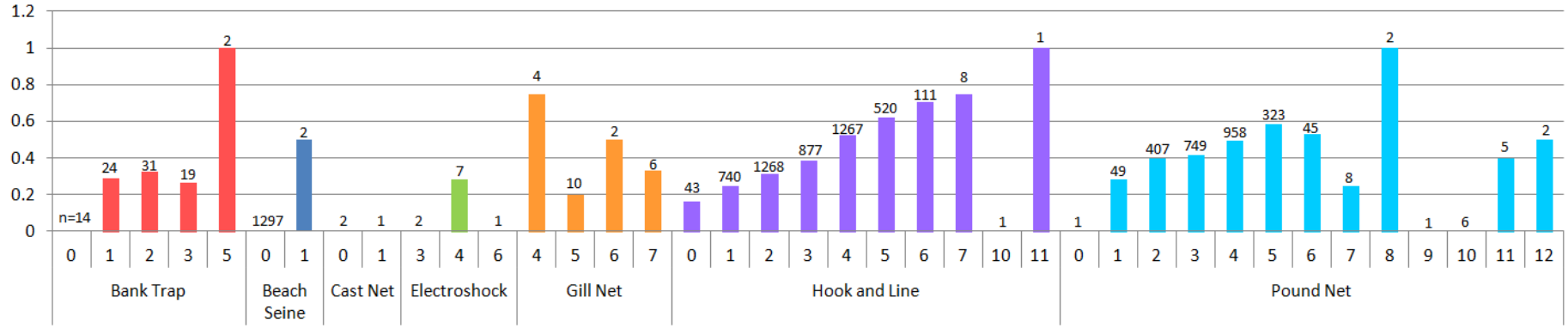



Sex Structure by Age
Unidentifiable
Male
Female
0
500
1000
1500
2000
0
1
2
3
4
5
6
Age

Proportion Diseased at Age (Sex Structure)



Proportion Diseased (Sample Gear Type)



Annual Compostition of Severity Rankings