Relationships between blue crab life history and salinity, and landings and freshwater inflow

Blue Crab Advisory Board

October 2008

Effects of environmental factors on blue crabs

- Intrinsic (i.e. physiological and/or biological)
- Extrinsic (i.e., affecting composition of the surrounding biotic environment)
- Synergistic – (i.e. salinity and temperature, salinity and freshwater discharge)

Intrinsic effects of low salinity

Physiological

- Decapod molting
  - Small decrease in molting increments
  - Usually at salinity extremes
- Osmoregulation
  - At higher salinities blue crabs expend more energy maintaining blood chemistry than they do at low salinities.

Intrinsic effects of low salinity

Biological

- Females migrate from low to high salinity waters to spawn and hatch their eggs.
- Megalopae flood tide transport
  - Stimulated to swim into the water column by increasing salinity associated with flood tide, moving them into the estuary.
  - Megalopae are inhibited from swimming on ebb tides by the associated salinity decrease, keeping them in the estuary.
- Reproduction
  - Spatial and temporal distribution of crabs
  - Timing of molting

Extrinsic effects of low salinity

- Reduction of marine predators of juvenile blue crabs
- Increased areas of suitable habitat in the middle and lower estuaries where juvenile blue crabs can forage and develop
- Broaden an estuary's signal to offshore megalopae, thus increasing the potential recruitment population base

Extrinsic effects of salinity

- Higher flows carry more detrital and nutrient matter which may either directly or indirectly enhance food availability.
- Prey limitation at low flow (high salinities) may increase cannibalism.

Extrinsic effects of salinity

- Effects of salinity on parasites
  - *Hematodinium* spp. infections can cause significant mortalities in high salinity embayments and estuaries, preferentially infect mature females that move to higher salinities to breed.
  - *Octolasmis mulleri* (gill barnacle) infestation rates were 39% in crabs from waters with salinities >22‰, and 1-2% in crabs from waters with salinities <22‰
    - The barnacle does not survive in low salinity waters, with 100% mortality in <5‰.

Studies relating salinity to catch rates

- Texas – (Hammerschmidt, 1982; Funicelli, 1984)
- Louisiana - (Guilory, 2000)
- Georgia – (Rogers et al., 1990)
- Florida – (Wilbur, 1993)
- Maryland – (Lipcius and Van Engel, 1990)

Texas

- Distribution of blue crabs from trawl samples showed the greatest catch rates occurring in areas where salinities were 0-5‰.
- Catches from Corpus Christi and upper Laguna Madre had greatest catch rates at salinities of 20 - 30‰. However, mean annual salinity for these systems were above 25‰.
- It is possible that salinity changes in general rather than just low salinities affect juvenile crab abundance.
- An increase in abundance in 1979 was most likely due to lower coastwide salinities than in previous years.

Louisiana

- Highest catches were found at salinities below 5‰.

- High Mississippi River discharges and low salinity were associated with increased blue crab recruitment and commercial harvest.

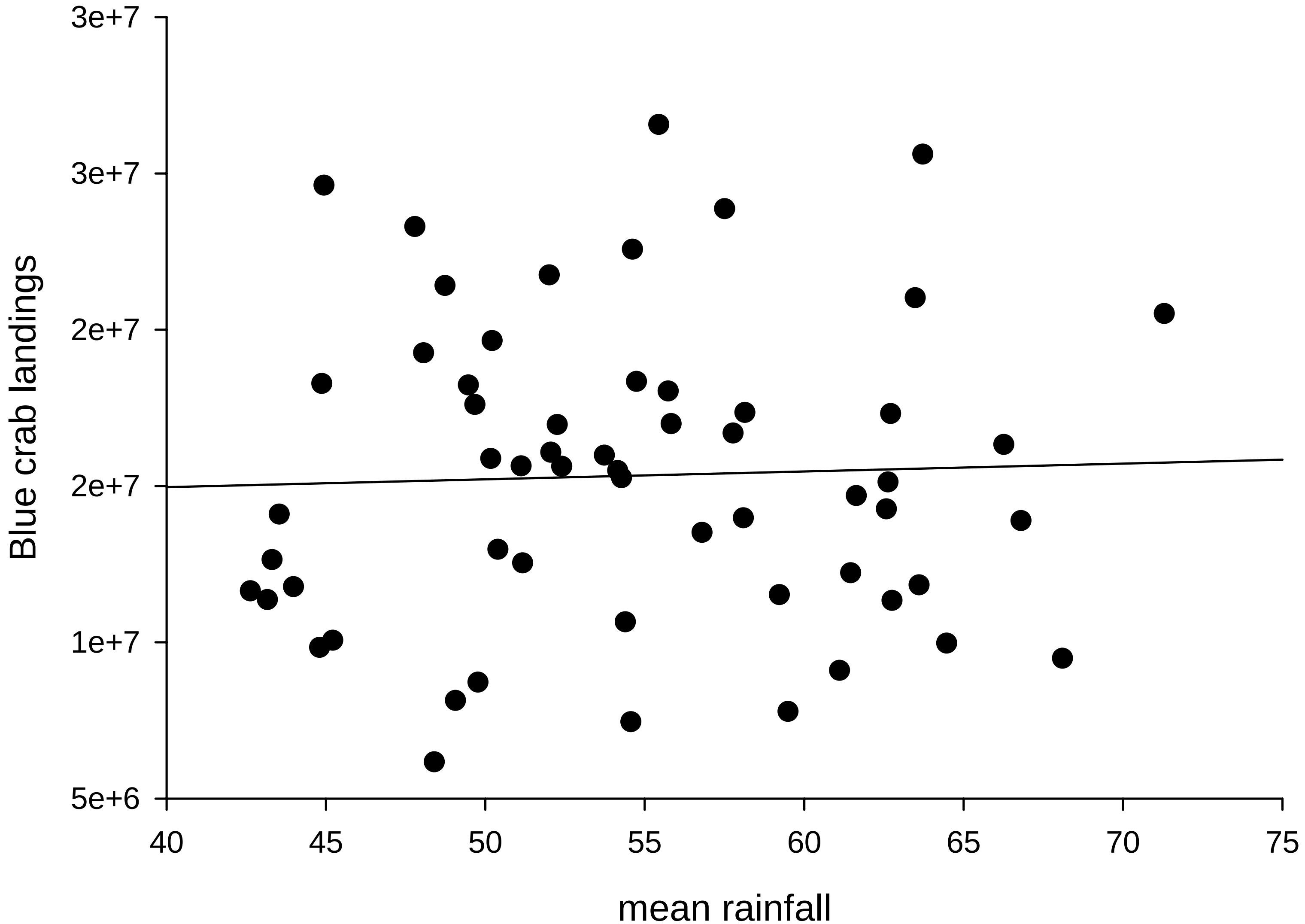
Copeland and Bechtel (1974) reviewed blue crab resource survey data and associated environmental parameters from the Gulf of Mexico and proposed that catches were distributed as follows:

- Water temperature-range, 0° – 40° C; optimum catch between 10° and 35° C.
- Salinity-range, 0.0‰-40.0‰; optimum catch between 0.0‰-27.0‰.
- Season-range, all months; maximum catch during spring and fall
- Location-range, all estuarine locations; optimum catch in primary rivers, secondary streams, marsh and tertiary bays.

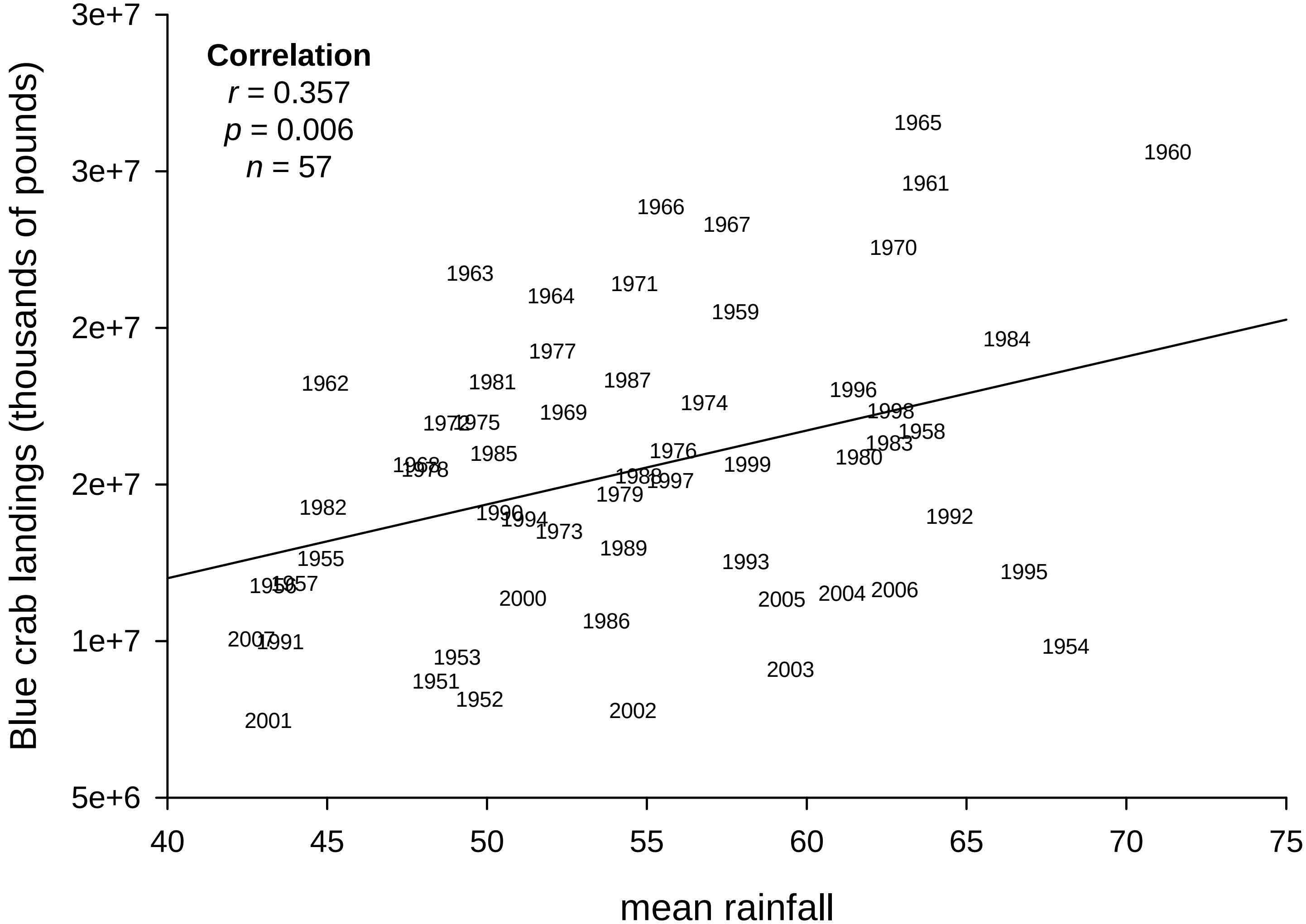
Florida

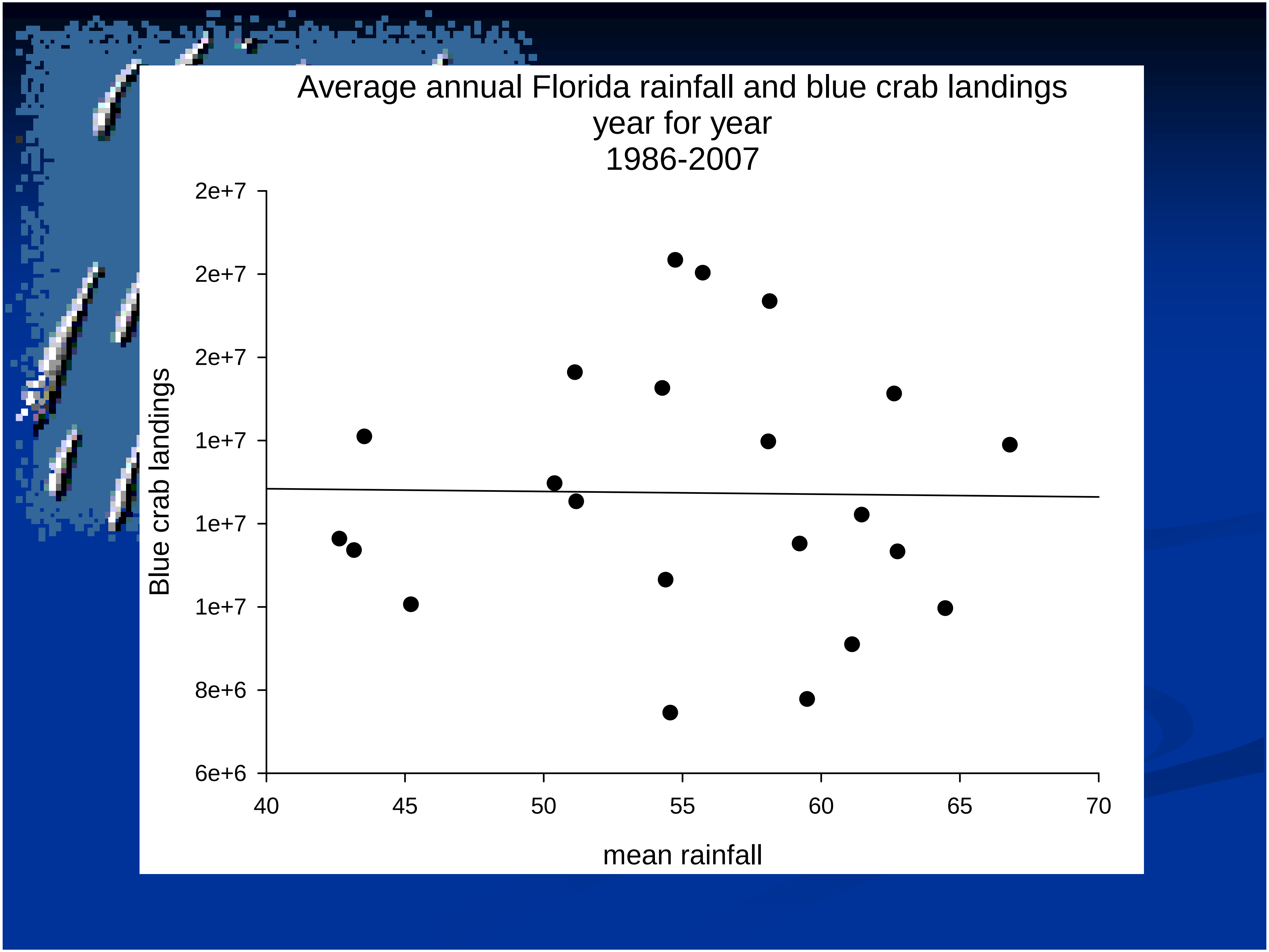
- Statistically significant correlations between freshwater discharge from the Apalachicola River and commercial blue crab catch were positive and primarily restricted to a time lag of one year.
- Higher flows were associated with higher blue crab landings the following year and lower flows with poorer landings the next year.

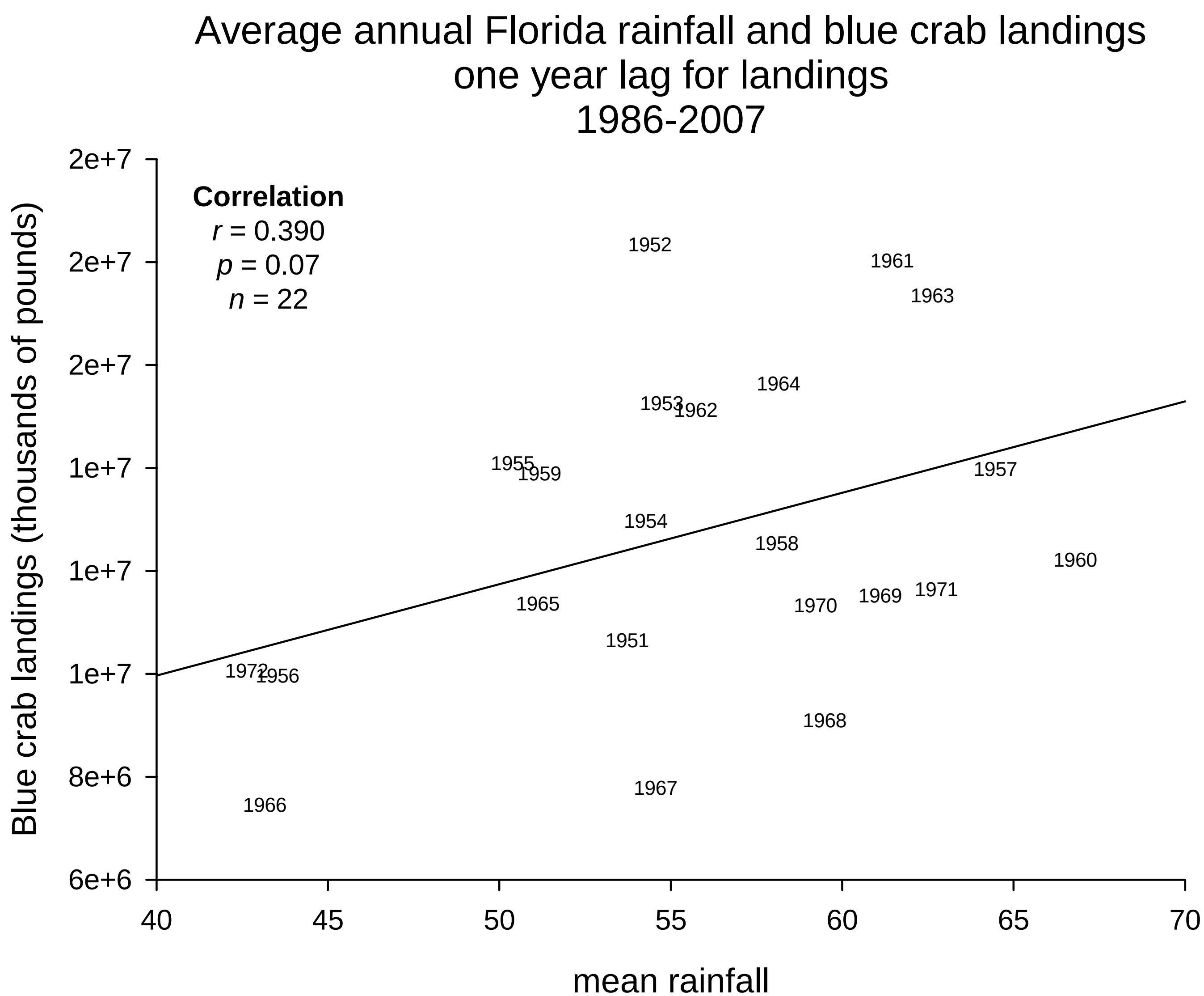
Average annual Florida rainfall and blue crab landings
year for year
1950-2007

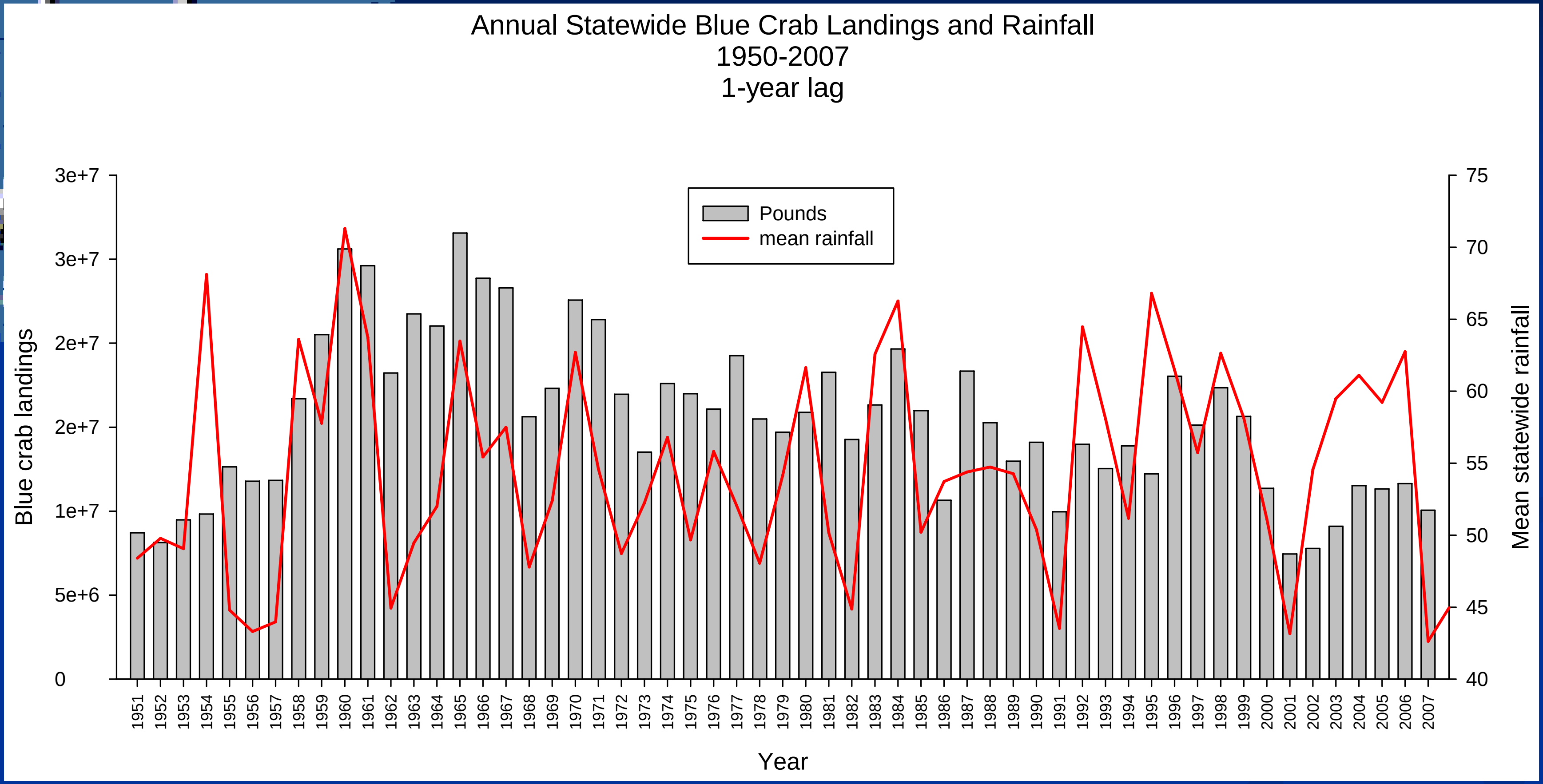


Average annual Florida rainfall and blue crab landings one year lag for landings 1950-2007

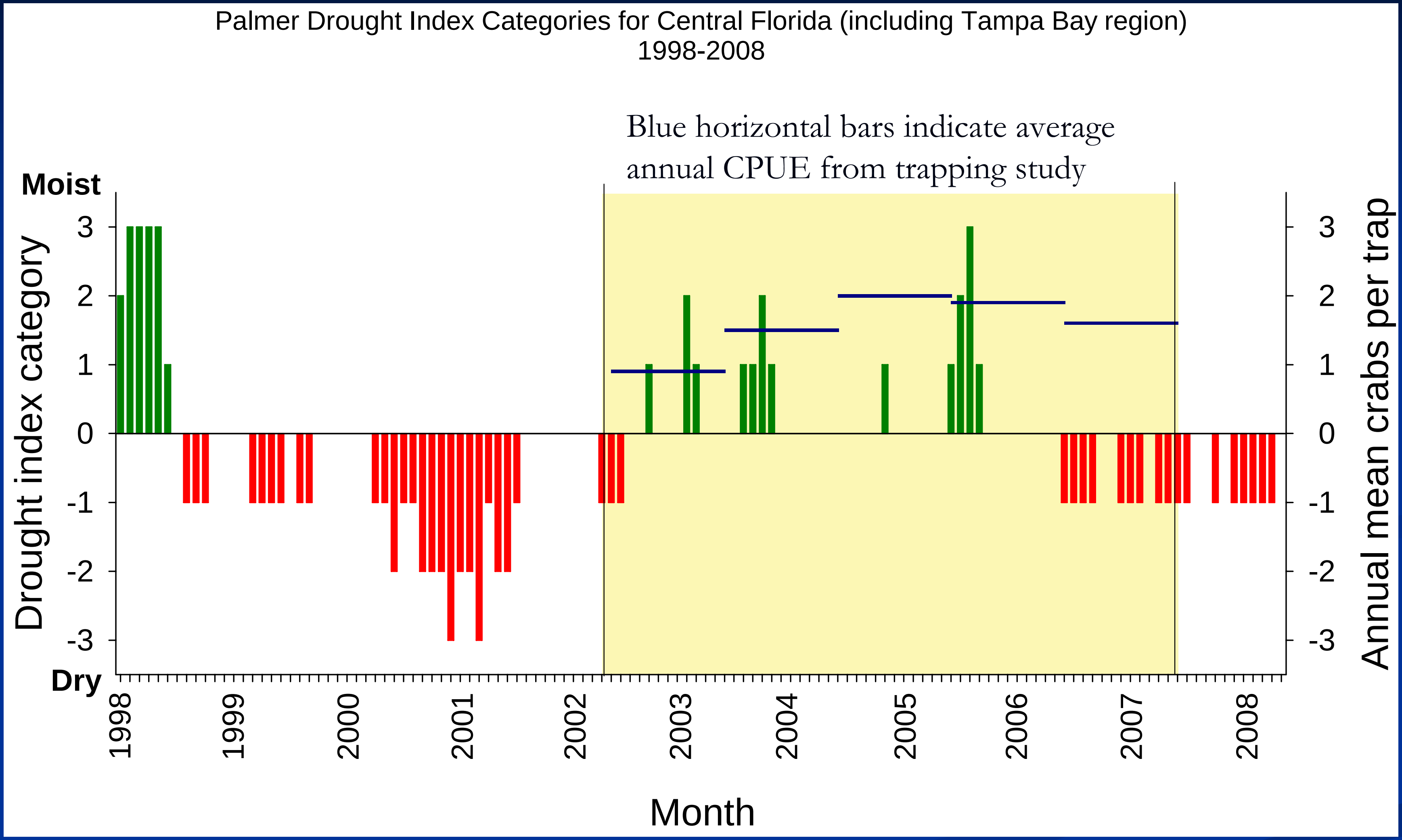


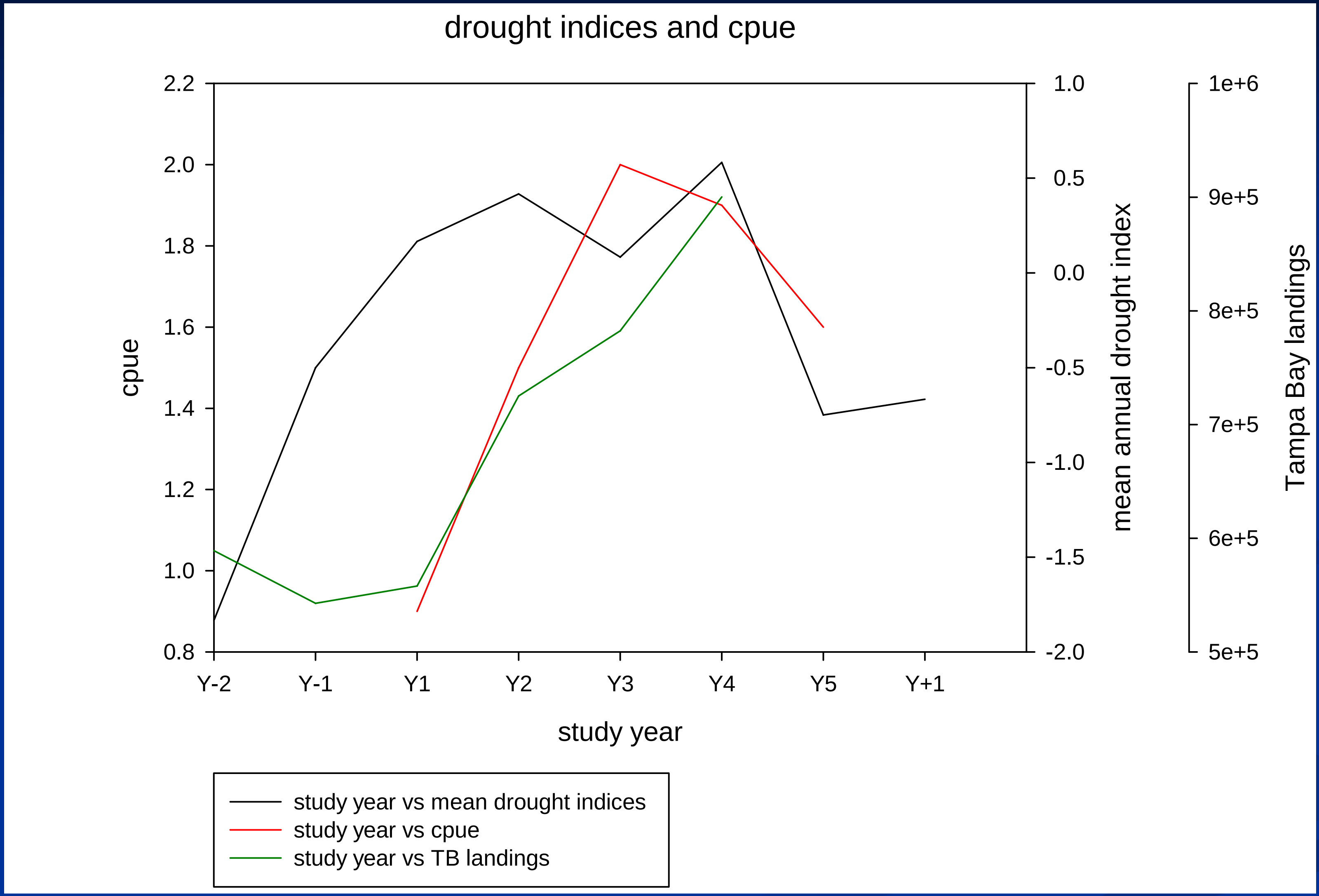

Average annual Florida rainfall and blue crab landings
year for year
1986-2007
2e+7
2e+7
2e+7
1e+7
1e+7
1e+7
8e+6
6e+6
Blue crab landings
40
45
50
55
60
65
70
mean rainfall


Average annual Florida rainfall and blue crab landings
one year lag for landings
1986-2007
Correlation
r = 0.390
p = 0.07
n = 22
Blue crab landings (thousands of pounds)
mean rainfall
2e+7
2e+7
2e+7
1e+7
1e+7
1e+7
8e+6
6e+6
40
45
50
55
60
65
70
1952
1961
1963
1964
1953
1962
1955
1959
1957
1954
1958
1960
1965
1970
1969
1971
1951
1972
1956
1968
1967
1966



Annual Statewide Blue Crab Landings and Rainfall
1950-2007
1-year lag
Pounds
mean rainfall
Blue crab landings
Mean statewide rainfall
Year
0
5e+6
1e+7
2e+7
2e+7
3e+7
3e+7
40
45
50
55
60
65
70
75
1951 1952 1953 1954 1955 1956 1957 1958 1959 1960 1961 1962 1963 1964 1965 1966 1967 1968 1969 1970 1971 1972 1973 1974 1975 1976 1977 1978 1979 1980 1981 1982 1983 1984 1985 1986 1987 1988 1989 1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007


Palmer Drought Index Categories for Central Florida (including Tampa Bay region)
1998-2008
Blue horizontal bars indicate average annual CPUE from trapping study
Moist
Dry
Drought index category
Annual mean crabs per trap
3
2
1
0
-1
-2
-3
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
Month


drought indices and cpue
cpue
2.2
2.0
1.8
1.6
1.4
1.2
1.0
0.8
Y-2
Y-1
Y1
Y2
Y3
Y4
Y5
Y+1
study year
1.0
0.5
0.0
-0.5
-1.0
-1.5
-2.0
mean annual drought index
1e+6
9e+5
8e+5
7e+5
6e+5
5e+5
Tampa Bay landings
study year vs mean drought indices
study year vs cpue
study year vs TB landings