# Chapter 1

## Creek Trawls

### Creek Trawl Abundances ~ All Abundances

Creek trawl abundances ~ all other abundance shows a very strong predictive relationship between subadult, immature females, and total T38 CPUE, suggesting that most of the catch in this survey may be juvenile, subadult, and most importantly (and significantly) immature females. There is a decently strong prediction (0.40 Adj R2) of mature females and immature females lagged by 2 years. Surprisingly, mature females may make up a fair amount of the total CPUE of the summer creek trawl catch (0.61 Adj R2). Subadult populations do have a weak prediction signal for the total CPUE with a 1 and 2 year lag.

### Creek Trawl Abundances ~ Landings

Wando Landings CPUE predict total creek trawl CPUE with a 2-year lag (0.31 Adj R2).

Small bit of Wando ladings CPUE on Juveniles (0.20 Adj R2)

Charleston Harbor system wide total landings very weakly predict subadults caught in the creek trawls almost equally with 0 and 2 years of lag. Wando landings CPUE also predict adults captured in the creek trawl with a 2-year lag with a weak prediction (0.20 Adj R2). These same Wando Landings CPUE predict mature females caught in the creeks (2-year lag) with a bit of a stronger relationship (0.40 Adj R2). Cooper landings predict immature with a weak relationship (0.21 Adj R2).

### Landings ~ Creek Trawl Abundances

Weak predictions of system wide landings with CPUEs only by creek trawl subadults

## Harbor Trawls

### Harbor Trawl Abundances ~ All Abundances

These regressions show only suggestions of the makeup of the catch on the harbor trawl. There are several very strong relationships between adult and mature female CPUEs (and vice versa), subadult and total CPUEs (and vice versa), and juvenile and subadult CPUEs (and vice versa) – all with no lag. Stronger predictive relationships are also found between the trammel net surveys and the potting surveys with no lag of harbor trawl abundances suggesting an overlap in sampling.

This survey does not show very strong relationships among itself with any range of lag, i.e., juveniles fo not have a strong relationship with adults of subadults (and vice versa).

### Harbor Trawls ~ Landings

None

## Landings

The Wando River’s CPUEs have a strong predictive relationship with juvenile and subadult crab, especially immature female crab in the harbor trawl with a 0 and 1-year lag. The Cooper River has a weaker but still decent predictive relationship with juveniles caught in the harbor trawl survey with a 1 and 2-year lag.

1. Is this more evidence of Wando River influence on immature females?
2. Strongest relationship is with Wando Landings CPUE and immature females in the harbor trawl with a 1-year lag, and then Charleston Harbor system wide landings CPUE and immature females in the harbor trawl with 0-year lag. Does this suggest…(?)

Strongest relationship with mature females is very weak (0.23 Adj R2), but still Wando Landings CPUE

1. Hmmm…

### Landings ~ Harbor Trawls

#### Ashley River Landings and CPUEs

Strong relationships with trammel net survey 0-year lag as predictor (0.54 Adj R2) for Ashley Landings CPUE, and immature females from the harbor trawl with a 2-year lag as predictor (Adj R2 0.46).

Weak predictive relationships between harbor trawl juveniles with a 2-year lag and Ashley Landings (Adj R2 0.30), and harbor trawl mature females with 1-year lag (Adj R2 0.22) and adults with 1-year lag (Adj R2 0.21) with Ashley CPUEs.

1. It seems as though the CPUEs, having a fishing effort factor, are more related to adult crab.

#### Cooper River Landings and CPUEs

Strongest relationship, but weak, is between Cooper River Landings CPUEs and the trammel net survey with a 2-year lag (Adj R2 0.38).

Weak but consistent relationships between Cooper Landings and harbor trawl immature females with a 2-year lag (Adj R2 0.34) harbor trawl total CPUEs with a 2-year lag (Adj R2 0.28), harbor trawl juveniles with a 2-year lag (Adj R2 0.23), and harbor trawl mature females with a 1-year lag (Adj R2 0.18).

#### Wando River Landings and CPUEs

The Wando River has a by far the most predictive relationships with abundances than the Cooper and Ashley Rivers.

Strongest relationships are with no lag and abundances of harbor trawl subadults (Adj R2 0.50), total CPUE (Adj R2 0.42), juveniles (Adj R2 0.37) and immature females (Adj R2 0.34) and the Wando Landings CPUEs.

Creek trawl CPUEs for juveniles (0.29) and subadults (Adj R2 0.23) with 1-year lag, and harbor trawl subadults (Adj R2 0.29) and total CPUEs (Adj R2 0.22) with a 1-year lag on Wando Landings CPUEs are weak but consistent.

#### Charleston Harbor Landings and CPUEs

Many weak relationships were found between Charleston Harbor Landings and CPUEs and various abundances with various lags.

Strongest relationships are between the Chas Harbor Landings CPUEs and harbor trawl immature females (Adj R2 0.44) and juveniles (Adj R2 0.33) with no lag.

Subadults from the creek trawl (adj R2 0.31) and harbor trawl (Adj R2 0.30) with one year lag are the next set of weaker relationships with Chas Harbor Landings CPUEs.

#### TOTALS - Charleston Harbor Landings and CPUEs

Trammel net survey abundances with 0-year lag (Adj R2 0.32) and harbor trawl immature abundances with 0-year lag (Adj R2 0.40) are the strongest predictors of the Charleston Harbor systemwide CPUEs.

Harbor trawl subadults and creek trawl subadults (both Adj R2 0.30) with 1-year lag are the next strongest relationships.

# Chapter 2

## Creek Trawl Abundances ~ Environmental Variables

### Juveniles (<60mm)

Long-term salinity indices from Wando and Ashley with a 1 & 2 year lag. Only one non salinity var > 0.3 Adj R2 - P88 spot temperature suggesting Ashley River temperatures explain more variance.

1. Maybe showing two cohorts of Juveniles (?) – either males and females growing at separate rates (unlikely during these instar), or spring and late summer cohorts.
2. Separating catches by river system, and re-testing?

### Subadult (>60mm - <127mm)

Strongest relationships are with long-term salinity indices in the Wando River with some influence of the Cooper River, for 0, 1 and 2 year lags.

1. The Wando has a longer series of data over time than the Ashley. The Cooper long-term indices of salinity are pretty strong too, indicating:
   1. The strong influence of the freshwater dam events from the Cooper on the subadults found in tidal creeks of Chas Harbor, or
   2. Intermingling of Cooper and Wando subadult or earlier with poor sampling coverage of the Cooper?
2. The lag and lead suggest
   1. Longer “span” of crab during these instars?
   2. Influence on both subadults and juveniles?
   3. High influence on this stage of crab, specifically by salinity regimes

### Adult (>127mm)

Weaker relationships with a range of long-term indices and measures of salinity from all three systems in the Ashley with 0 and 1 year of lag

1. May reflect sampling error due to short-term effects of blue crab range (i.e., adult crab have higher range and mobility, and may move based on salinity and
2. Temperature.) Weak but present relationship with P88 Ashley river spot salinity measurements.
3. Adult blue crab of both sexes should abandon the creeks during the period of sampling (early spring through early fall) when sexually mature. These “adult” blue crab could reflect larger immature blue crab caught as part of this survey

### Immature Females

Particularly strong relationships with immature females and long-term and long-term mean annual salinities in the **Wando River** for 0, 1 and 2 years of lag. Cooper river are also what I would call strong for this survey, but the Wando salinity metrics stand out. Customs House Temperature with a 1 year lag also have a weaker, but present in both 0 and 1 years of lag, relationship.

1. The Wando River may be important to immature females (subadult probably due to “subadult” analyses above).
   1. Separate these CPUEs by river?
2. Salinity may have the most influence on the abundance of immature, subadult females.
3. Temperature may have an affect on the short-term (daily, seasonal) movement of immature females.
   1. Maybe the interaction of temp and sal here?
4. We begin to see a Aug-Oct and Mar-May ENSO influence for 0 and 1 years of lag (~0.15 R2).

### Mature Females

Weaker relationships with Wando, Cooper and Ashley for all lags of abundance, but mainly with 0. A small fall precipitation influence with no lag. These “fall” months (Sep-Nov) *fall* just outside of sampling time (May-Sep).

1. Salinity’s influence on mature crab in the tidal creeks in summer may have more to do with short-term movement of blue crab than survival.

### Whole Catch

Strongest relationships with Wando, Cooper and Ashley River salinity metrics (all), with some influence of temperature with a two-year lag.

1. Ashley River’s influence is probably weaker due to smaller degrees of freedom in the model (smaller range for the coverage of the Ashley River data)
2. This survey may catch more immature females than any other life stages

## Harbor Trawl Abundances ~ Environmental Variables

### Juveniles (<60mm)

Strongest (really only) relationship Harbor trawl juveniles with a 2-year lag are predicted by a 24-month Ashley River CSI beginning in April (Adj R2 0.43).

1. Lag might suggest an effect of a long-term index of salinity on subadult or adult crab in previous years.

Very, very weak predictive relationship between winter precipitation with a 0 and 1 year lag both

### Subadults ((>60mm - <127mm)

Strongest relationship with the Ashley River “Winter” CSI (Dec – Feb) and 1-year lag for harbor trawl subadults. This relationship has only 19 degrees of freedom due to the limited range of USGS salinity data for the Ashely River.

Weaker, but still decent predictive relationships can be found with the Trammel Net Survey (TNS) and the harbor trawl subadults and no lag (Adj R2 0.32).

An extremely weak relationship between winter, spring and summer precipitation can be seen (Adj R2 ~.10); mostly notable due to the precision of all three relationships.

1. Ashley long-term salinity indices could have a strong relationship with subadults with a 1-year lag, but the incompleteness of the salinity dataset could mean this is a type (?) error?

### Adult (>127mm)

Across the board strong relationships with all long-term Ashley River salinity indices and measures and 1-year lag of adult harbor trawl abundances – backed up by the 24 month CSI and harbor trawl abundances with a 2-year lag.

Decent relationship with the bi-monthly P88 crab potting survey temperature and a 2-year lag (0.32 Adj R2).

1. Could this be a small effect of mesohaline area temperatures on adults and their returning…Nah, what does this mean – anything?

### Immature Females

Only a weak relationship between Wando long-term salinity indices and Immature Female CPUEs in the harbor trawl with a 2-year lag.

1. Does this weak relationship show a heavy influence on immature females and the Wando River?
   1. Wando preferred to immature females?
   2. Salinity from Wando affecting system-wide salinity?

### Mature Females

Strongest relationships with the full range of long-term Ashley River salinity indices, including winter and water year salinity indices and the harbor trawl mature female CPUEs with a 1-year lag.

1. Suggests an affect of Ashley River salinity on life stages occurring 1 year prior to maturity – immature and subadult?

### Whole Catch

Strong relationships with a 1-year lag and Ashley winter CSI (Adj R2 0.61) and 24-month Ashley CSI.

## Landings

### Ashley River

Landings CPUE have the strongest relationship with Ashley CSI 12-month.

Landings have strong and consistent relationship with spot salinity measurements from trammel, harbor and creek trawl surveys and a 1 and 2 year lag.

1. The lag is expected with adults making up landings, but what’s with the 1 and 2 year lag?
   1. Effect on juvs an subadults
   2. Cohorts?

Decent relationship with Customs House Water Year and Ashley Landings (Adj R2 0.32)

Winter precip and Ashley Landings CPUE

March-May climate indices have a pretty regular but weak relationship

### Cooper River

Strongest (weak but consistent) relationships with winter precipitation and a 2-year lag (Adj R2 0.30), and ONI Aug-Nov (Adj R2 0.25). ENSOs for Sep-Nov also showing similar weak signal (0.24 Adj R2) with a 0 and 1 year lag.

Wando and Cooper raw USGS salinities show a weak relationship with no lag (0.25 Adj R2)

### Wando River

Wando landings with no lag have a strong relationship with trammel net spot salinities (Adj R2 0.51), and CPUEs have the next strongest relationship with trammel and pot surveys spot salinities.

Winter precipitation continues with a steady but weak relationship (Adj R2 0.28) with CPUEs with 0 lag

### Charleston Harbor

Strongest relationship with trammel net spot temperatures and a 2-year lag (0.51 Adj R2)

Consistent strong relationships with landings and CPUEs and Wando and Ashley long-term salinity indices and 1-year lag with 12-month index, or 2-year lag and 24 -month index

1. Does this show movement, or because there’s a lag, effect on survivability?

Winter precip has its consistent relationship with no lag, but a little stronger with Harbor catch then rivers (Adj R2 0.33)

1. This has to be movement of crab as a response to rain?

### Charleston Harbor Watershed Wide

Strongest relationships with winter precip and CPUEs with 0 lag (Adj R2 0.48).

Strong and consistent relationships with long-term indices of salinity for the Wando and Cooper Rivers and 1 and 2-year lags with 12 and 24-month indices. Also 2-year lag with Wando raw USGS (landings and CPUEs)

## Pot Survey (Ashley River 4-hr)

This survey’s is strongly predicted by subadults in the harbor trawl survey (Adj R2 0.64), and with a weaker predictive relationship (Adj R2 0.42) with the harbor trawl overall CPUE. Wando River CPUEs also strongly predict the P88 abundance with a 1-year lag.

1. Is this also evidence of the Wando River being a nursery for immature female and subadult crab.

A bit of a weak prediction of winter precipitation on the P88 survey with a 1-year lag (Adj R2 0.29).

## Trammel Net Survey

Very strong predictive relationship of April Ashley River CSI (12-month) and a 2-year lag on trammel net survey abundnaces – backed up by a smaller, but still strong relationship with the April 24-month CSI for the Ashley River.

This survey might show an Ashley River bias in its catch, with Ashley River Landings CPUEs also predicting the trammel net catch with 0 lag.

Water temperature from the Customs House based on the water year (Oct-Sep) show a strong predictive relationship with a 0-year lag. Also, plenty of landings with weaker relationships and a 2-year lag.

1. Do both of these suggest a catch dominated by adult or mature crab?

Strong prediction of ONI from March to May on Trammel Net abundances with a 2-year lag.

1. Does this show a trickle down affect of the ONI on adult abundances years later?
   1. Maybe male due to the absence of the affect on the other surveys with similar range (harbor trawl), which are known to be female dominated adult catches?