ASSESSING THE RELATIONSHIP BETWEEN ENVIRONMENTAL CONDITIONS AND THE BLUE CRAB FISHERY IN RELATION TO RESTORATION GOALS FOR THE CALOOSAHATCHEE RIVER

Agreement No: OT050973

ANNUAL REPORT

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9 April 2007

EXECUTIVE SUMMARY

This report investigated and evaluated the landings, effort and catch-per-unit effort of the blue crab landings relative to environmental conditions within and around the Caloosahatchee River/Estuary. Original efforts of this project were directed toward obtaining daily crab landings and effort data from local crabbers who set their traps in the Caloosahatchee River/Estuary. Dependent variables collected included number and size of blue crabs landed as well as location and number of pots and amount of time pots are set (i.e., soak time) as a measure of effort. Independent variables were the location of landings and environmental water conditions. Those specific water conditions included water clarity (Secchi disk depth), surface temperature, salinity, and dissolved oxygen (DO). These were recorded each day that crab landings data were obtained by a research assistant and represent a time-specific indicator of relative water conditions in the general sampling region. Temperature, DO, and salinity were measured using an YSI (Yellow Springs Instruments) Model 85 electronic probe. Secchi depth was measured vertically using a standard Secchi disk. Daily environmental measures and catch reports were complied and entered into a Microsoft Access database which was included with this report. Additional environmental data from South Florida Water Management District (SFWMD) monitoring sites in the Caloosahatchee River including salinity, temperature, DO and Secchi disk, as well as water discharge information were also entered and included into the database. Major findings of this study are a correlation between the Secchi disk measurement and the catch per unit effort (CPUE) of crabs caught in the Caloosahatchee River. When Secchi disk readings were high (water was clearer), the CPUE was higher. Results of analysis of variance (ANOVA) of CPUE with water

quality parameters including flow rate indicated no significant differences. Quarterly reports have been written and submitted to the District in accordance with the original proposal. That proposal sets forth ten tasks to be accomplished during the two year period of this study. This report will constitute tasks number nine (final analysis) and task number ten (annual report). To date, the independent fishery sampling (task five) was not completed.

INTRODUCTION

Recent, unverified evidence indicates that landings of blue crabs gathered from the Caloosahatchee River have varied significantly over the past few years. Crab fishermen associate their irregular catches with the variations in salinity in the River because salinity variations coincide with artificial alterations as the result of pulsed discharges from Lake Okeechobee and natural alterations due to excessive rains and drought conditions in the Caloosahatchee River (Chamberlain and Doering 2005). The daily sampling effort put forth by licensed commercial crabbers in the area is substantial and has the potential to serve as a valuable data source that permits an assessment of the environmental impacts of freshwater releases through the Caloosahatchee on blue crab (*Callinectes sapidus*) fishery. However, the Florida Fish and Wildlife Conservation Commission (through its data collection and management division at the Florida Marine Research Institute - FMRI, now known as the Florida Fish and Wildlife Research Institute - FWRI) does not record blue crab catch data specific to the Caloosahatchee River but only for Lee County. Additionally, virtually no environmental data are collected in concert with the landings data, thereby precluding any attempt at cause and effect analysis. This study proposed to obtain, investigate and evaluate the landings, effort and catch-per-unit effort of the blue crab landings data relative to environmental conditions within and around the Caloosahatchee River/Estuary. Once these site-specific landings data were obtained, the data was associated with a variety of environmental-condition variables to learn more about the local relationship between blue crab landings and the environmental conditions in the River.

Preliminary analysis, included in this report, consists of summary statistics of all dependent and independent data. The relationships between blue crab landings and catch per unit effort relative to environmental water conditions within the Caloosahatchee River were investigated.

Original efforts of this project were directed toward obtaining daily crab landings and effort data from local crabbers who set their traps in the Caloosahatchee River/Estuary. Dependent variables collected included number and size of blue crabs landed as well as location and number of pots and amount of time pots are set (i.e., soak time) as a measure of effort. The location of landings and field measures of water conditions were also collected. Those specific water conditions include water clarity (Secchi disk depth), surface temperature, salinity, and dissolved oxygen (DO). These were recorded each day that crab landings data were obtained by the SCCF technician and represent a time-specific indicator of relative water conditions in the general sampling region. Temperature, DO, and salinity were measured using an YSI (Yellow Springs Instruments) Model 85 electronic probe. Secchi depth has been measured vertically using a standard Secchi disk. Daily environmental measures and catch reports have been complied and entered into the data base. Additionally environmental data from South Florida Water Management District (SFWMD) monitoring sites in the Caloosahatchee River including salinity, temperature, DO and Secchi disk, as well as water discharge information were entered into the database.

MATERIALS AND METHODS

Crab Harvest Data **-** Generally speaking the crab fishermen that were contacted tend to go out on the water every other day during the week. Therefore the researcher collected data on a consistent basis. Preliminary data collection and assessment of the type of data to be collected was begun in May, 2005. Due to various logistic and equipment problems consistent data collection commenced approximately in the beginning of June 2005 and ended in December 2006. The researcher was able to go out on a boat with a commercial crabber averaging about once a week and sometimes more. The timing generally depended on the crabbers and the weather. Occasionally, the crabbers decided to go out less frequently because the catch was so low that it was not cost effective for them harvest every other day. This schedule allowed for consistent and regular data collection.

The collection of crab harvest data has been divided into two distinct groups. The first grouping of data is the data that was directly collected by being onboard a boat as the harvest took place. This data is referred to in this report as the ‘boat data’. The other is the type of information obtained from trip tickets (see below) and South Florida Water Management water quality database (DB Hydro). This is referred to as ‘trip ticket data’. The data collected from the individual boat trips and the trip ticket data have been entered into multi-relational database (Microsoft Access). The database is named ‘Blue Crab 4’ in the table ‘traps’.

Through trial and error it was established which basic data was to be collected and still have the observer be unobtrusive on the boat. Due to the nature of the traps and the number of crabs captured per trap it was possible to determine the number of crabs in a particular trap and the sex of each of those crabs. It was also fairly simple to determine if there was a mating pair in a trap and if there were any "peelers" in that trap (see below). The researcher was able to mark each trap with a GPS unit and retain the coordinates in relation to the trap. After a trap was pulled, the crabs were all loaded into the same container until the culling process. At the time of the culling it was possible to determine the sex and the number of crabs that were being returned to the River. The reason for the rejection of the crabs was usually because they were not yet fully grown into their most recent molt. In this case the crab was considered 'light' and if it were opened would not yield much meat.

At this point the crabber was also able to determine if a crab was a 'peeler'. A peeler is a crab whose molt (ecdysis) is imminent. Usually, the crab will molt within the next few days of showing signs of molting. This condition is exhibited by physical characteristics of the shell. The most significant indication is seen in the propodus section (the second section from the distal end) of the swimming fin (the number five pereopod). These crabs can be held separately and allowed to molt while in captivity. Thus the seller obtains a soft-shell crab, which is worth more money than a hard crab of the same size. Often times a peeler female will be in a trap with a male holding onto it. The male senses the molt of the female due to a release of hormones. When he locates the female he will hold her underneath him until she molts. At that point he will be able to inseminate her. He will then continue to hold onto her until she has hardened enough such that she can not be inseminated by another male. The female will only be inseminated once in her life. After she is inseminated she will be able to spawn numerous times but will not be inseminated again (Steele 1979). This has no bearing to the crabbers unless the female has spawned and is carrying eggs on her abdomen. If she is, it is illegal to keep her and she must be returned to the water immediately.

Difficulties encountered in data collection during commercial fishing operations - At one point it was thought that the data collection might be expanded to include the weight of a random sample of crabs. It was thought that it may have been possible to use a fish scale and a bucket to do some weight measurements. Weight was to use random traps and weigh the entire contents of that trap. If enough samples were taken then it was thought it may be possible to get an idea of size classification. It was difficult to obtain specific measurements of the crabs (i.e., weight and length) on the boat due to the logistics of extracting a sample from the catch. The largest problem was that the crabbers did not like the catch to be over handled as it usually lead to greater mortality of the crabs. However alternative handling techniques designed to reduce physical damage to the crabs were developed and some data relative to size was collected.

Catch from trip tickets - The second set of data that was collected was the data contained on 'trip tickets'. These are records that are mandatory for the FWS but are subject to privacy laws after the fishermen have turned them over to the FWS. Therefore getting the specifics of the information is slightly more difficult than just pulling it up on the web site. The researcher was able to obtain a limited number of trip tickets directly from the fishermen. This information is also included in the 'Blue Crab 4' database in the table titled 'trip ticket'. The type of information that is obtained from the tickets is; the total amount of crabs captured by weight and divided into three classes; 1) pounds of number 1s (males wider than 6"), 2) pounds of number 2s (males under 6" and females) and the number of individual peelers. Other information includes the soak time (the amount of time the trap has been in the water), the date, the area fished (specific sections of the state set up by FWS), the amount of time spent fishing, the type of gear used, the approximate depth of the traps, the number of traps used and the amount for which the product was sold. The records for the fishermen do not specifically indicate that they have been crabbing in the Caloosahatchee River but various codes on the ticket indicate that they have been in Lee in county inland waters. It may be possible to deduce from this that they have been working the River as I have not yet encountered any other commercial fishermen working any other bodies of water in Lee County.

Water Quality - Water quality data was collected from the surface waters concurrent to the crab harvest at multiple locations. As the crabber approached a trap to empty it, he slowed the boat. He would then capture the float and the line that connects to the trap. After securing the line he put the boat in idle a turned the wheel hard over so that the boat would go into a slow spin. At this point it was possible measure salinity, dissolved oxygen and temperature. Since the boat was still moving and the capture processes took approximately 30 seconds it was difficult to get a reading from the bottom. The crabber did, however, periodically slow to a complete stop to perform a cull of the catch to that point. It was possible to then get a Secchi disk measurement. These data are in the database called “Blue Crab 4” in the table ‘traps’.

In addition to the crab harvest data and water quality data collected onboard the boat water quality and flow data for the River were collected. The SFWMD water database know as DBHydro provides records of water flow released from Lake Okeechobee down into the Caloosahatchee River. The S79 lock (that is the Franklin Lock) has been chosen as the water flow measuring point. This is the final control point for water released from Lake Okeechobee that enters into the Caloosahatchee River Estuary System. Several downriver stations were monitored for water quality. These stations are designated by SFWMD as CES03, CES04, CES05, CES06 and CES07. They are located in the River from approximately the I75 overpass to approximately Shell Point at various intervals. Among other parameters they are used to monitor DO, salinity, temperature and Secchi disk depth.

Additional Effort Not Included in Original Proposal **-** the exact position of all the traps we could find on the River (at least on a seasonal basis) with a GPS unit was determined. Originally, it was thought that an attempt could be made to photograph the buoys from the air and then use a GIS system to digitize the image and make a record of the placement of the buoys in the River. The researcher attempted to ride along with SFWMD in their helicopter to low level aerial photographs first hand. In addition, two attempts at examining low-level satellite photographs from various internet sites proved unsuccessful. The resolution of these images proved inadequate in being able to accurately identify the presence of buoys. In the mean time a boat was used to mark as many buoys as could be found. Locating the buoys in the water was difficult and required more time but it gave an overall view of the location of the traps on the River.

Although scheduled to fly over the Caloosahatchee River and attempt to photograph the location of the trap buoys, space was not available due to scheduling conflicts on the SFWMD helicopter. Four separate surveys of the entire river, however, were conducted by boat. The boat surveys were done by beginning at the mouth of the River and visually identifying crab trap buoys. Once a line of buoys was found, the boat was maneuvered alongside the buoy to obtain precise latitude and longitude information with a GPS unit. The crabbers tend to deploy the taps in rows so once a row was found we would follow it either to the end or to a significant landmark. While traversing the line, inspections were conducted for other rows of traps. The survey was conducted along the southern River bank and as far north as the I-75 overpass. The trap survey was then conducted down River, along the northern bank until reaching the mouth of the River again. Since the center of the River is a channel there are no traps there and it was relatively easy to stop at the channel when traveling across the River. These data have been put into a GIS map. This process was repeated approximately every quarter to assess any general change in trap distribution throughout the lower portions of the River.

Data analysis - Analysis of the data with regard to flow was divided into low flow (≤ 3,000 cubic feet per second) and high flow (> 3,000 CFS) based on earlier studies done on water quality and submerged aquatic vegetation (Chamberlain and Doering 2005). All the data were analyzed using SPSS statistical software. The raw data from the boat consisted of 104 separate trips. Each boat trip pulled anywhere from 80 to 175 traps depending on the day and/or the number of traps available to the fisherman. The trip ticket data were taken from a total of 1998 separate tickets. Each ticket represents the total of traps pulled by that one fisherman for that day. The number of traps each day ranged from 75 up to as many as 600. The data from the FWS were obtained as totals and actual number of points that are represented are unknown but are dependent upon the number of crab fishermen that worked the areas in and around the Caloosahatchee River for the years given. An analysis of the data includes summations and graphical data to illustrate relationships.

The data collected on the boat, the data from the trip tickets and some additional data on harvest obtained from FWS were examined separately. However, all data were treated in the same manner. That is, they were examined in terms of harvest and effort compared to the flow volume of the River and the water quality of the River, separately. Analysis included analysis of variance (ANOVA) with 0.05 significance and Pearson's correlation matrix analysis.

Data collected directly by the researcher onboard the boat was examined. A summation of the data is given in Table 1. The data was classified by pounds of crab collected, and numbers of crabs collected. Catch per unit effort figures were calculated from pounds of crabs harvested rather than individuals. Mainly this was done to so that the data could be compared later to the trip ticket data which is only reported in pounds. Natural log transformations were done on the data due to the non-normal nature of the distribution of the flow patterns from the lock at S79 (the Franklin Lock). Analysis of variance (ANOVA) ($p < 0.05$) was used to determine any significant relationship between flow and/or the various water quality parameters and the crab harvest in terms of total catch, catch per trap and catch per trap per day (Table 2). Further investigation was done with a correlation matrix to determine if any of the relationships were related to each other in any way.

RESULTS

Ride along catch data - In an analysis of variance there was no statistically significant difference found between the total number of pounds harvested, the number crabs/trap or the number of crabs/trap/day and flow velocity. Figures 1-3 illustrate the volume of the Caloosahatchee River flow at S79 (in cubic feet per second) as compared to various crab harvest data. Figure 1 shows the flow of the river and the number of pounds of crab harvested on that day. The p value for this association was 0.18. Although the probability of these two means come from the same population is very close, the statistics show that the relationship is not significant. Figure 2 show the flow versus the number of crabs caught in each trap on each day. The p value for this association was 0.46. Figure 3 shows the flow versus the catch per unit of effort (CPUE) that is, crabs per trap per day of soak time. This is probably the most reliable measure since it is standardized over time and the number of traps. The corresponding p value for this association was 0.24. These p values indicate that the null hypothesis is rejected. This indicates that the catch per unit effort was not significantly different in low flow vs. high flow regimes.

The water quality measured on the boats was compared to the crab harvest data and the harvest effort. Figures 4-7 serve to illustrate these relationships. Figure 4 illustrates the pounds of harvest as well as individuals harvested versus the mean dissolved oxygen and mean daily temperature. The means in these cases is the mean of all the measurements taken onboard that boat during that harvest (N = 104). Figure 5 is also pounds and individuals versus the mean salinity and the mean Secchi disk depth. Figures 6 and 7 are the same water quality parameters versus the number of crabs caught per trap and the number of crabs caught per trap per day, respectively. Looking at the graphs collectively it appears that there may be some relative correlation between the Secchi disk readings and the crab harvest (Figure 7). They tend to rise and fall on almost all the same occasions. Visual inspection does not reveal any other distinctive patterns in the data ANOVAs performed on all of these relationships reveals that there are no statistically significant p values indicating that none of the independent variables could have come from the same distributions (Table 2). A further look at a correlation matrix for this data reveals that there are no other significant correlations except for the pounds/trap and Secchi disk reading (Table 3).

An analysis was done on these same data by using the monthly means of the harvest data and the water data. Statistics used on these data were using a correlation matrix to look for significant trends in the various data and the flow rates. Figures 8-11 illustrate this. Figure 8 indicates the harvest and the crabs per trap per day versus the flow at S79. Visually, when the flows are very high, above about 6,000 cubic feet per second, there seems to be a detrimental effect on the crabs harvested while below that that level there seems to be that inverse relationship. In figures 9 and 10 the various water quality parameters do not appear to be related to the harvest. Figure 11 indicates that, once again, the Secchi depth seems to coincide with both the pounds harvested and the mean crabs per trap. Although these trends appear to the naked eye when the statistics are applied there is no significant correlation between the flow rate at S79 or the associated water quality parameters and the rate of crabs caught per trap per day (Table 4).

Trip Ticket Data - Data that was gathered from the trip tickets were examined separately. The descriptive statistics of the data are listed in Table 5 and are summed up by month. The River flow and water quality depicted in figures 12 and 13 were taken from the SFWMD DB Hydro database. The numbers in each of these cases is the mean for the month in which they appear. The trend in any of these data is once again the inverse relationship between the flow of the River and the crab harvest.

Once again the distribution of the flow data is not normally distributed so the log value of the flow is used in the statistical calculations. When the log of the flow of the river is correlated with the standardized crab catch (CPUE) the results indicate that there is no significant correlation. The Pearson coefficient is -0.003 and the p value of the correlations is 0.99 for a two tailed test (Table 6). Furthermore, when flow is compared to total pounds caught (per month) and pounds of crab per trap (for each month) there are no significant correlations (Pearson coefficient 0.20 and 0.08 and p value 0.17 and 0.57, respectively; Table 6).

Water quality parameters were input from DBHydro and included temperature, dissolved oxygen Secchi disk and salinity. A look at table 5 will reveal that there are no significant correlations with regard to dissolved oxygen, temperature or salinity with the number of pounds caught the number of pounds per trap caught or the number of pounds per trap per day. There are also no correlations with the Secchi disk reading with respect to pounds caught or pounds per trap. There is however a significant correlation between the CPUE and the Secchi disk. The measurement for Secchi disk is an average over the whole river and at all depths. Therefore, this may indicate that the clarity of the water and the regularity of catching crabs are significantly related i.e., the more clear the water the larger the blue crab harvest. It is clear from this table that there is a significant correlation between the river flow rate and all the water quality parameters looked at (Table 6).

Finally there are data obtained directly from the FWRI. These data were submitted to the State of Florida by the wholesale fish houses with regard to blue crab harvest. The data were for all of Lee County. The data here are somewhat limited however they do show some interesting trends. Descriptive statistics are listed in table 7.

The capture data in terms of pounds of crabs captured for the year in Lee County were compared to the mean yearly flow at S79 (Fig. 14). Trend lines on the graph tend to indicate that over the years the mean flow rates have been increasing. The data also indicate that the total pounds of crabs on a yearly basis have been decreasing. However, the correlation statistics do not show any significant relationship between these two variables (Table 8).

When looking at the harvest in terms of the highest flow per year the trends are very similar to mean flow (Fig. 15). While the maximum flow shows an overall tendency to increase over the years the harvest rate in terms of pounds of crab shows and overall decrease. Once again the correlation analysis shows that there is no statistically significant relationship between these two variables (Table 8).

The final graph (Fig. 16) shows the annual mean flow at S79 versus the number of pounds harvested per trip or CPUE. The overall trends on this graph show that both the mean yearly flow and the pounds per trip both show an increasing trend. The correlation matrix does not show any significant relationship between these two variables (Table 8).

DISCUSSION

The overall goal of this project was to determine if the anecdotal evidence provided by fishermen that the freshwater releases from Lake Okeechobee down the Caloosahatchee River had an effect on the harvest of the blue crab (*Callinectes sapidus*). The use of fishermen as a source of data was a major component of this research. While initially difficult to obtain cooperation from them, after obtaining the trust of some individuals their cooperation provided a rich source of data.

The overall goals of this project were determine if there was any relationship between blue crab landings and catch per unit of effort relative to environmental conditions in the Caloosahatchee River. Other researchers have found that environmental conditions affect the various life stages of blue crabs in many different ways. Not only do these conditions affect the crabs but they also affect an assortment of other flora and fauna that ultimately have consequences for the blue crab population (Perkins-Visser, Wolcott et al. 1996; Hovel 1999; Hovel and Lipcius 2002; Eggleston 2003; Epifanio, Dittel et al. 2003; Reyns and Eggleston 2004; Heck and Valentine 2006).

The most significant finding in the data is the correlation between the Secchi disk reading and the CPUE of the crab harvest for the boat data. Although there is no direct cause and effect relationship between these two variables there is a significant correlation. The trends that were obtained from the data generally indicate that for the data collected on the boat there did not seem to be any direct link between the harvest effort and the various water quality parameters of the river. That includes the flow rate and the water quality including salinity, dissolved oxygen, temperature or Secchi disk measurements. While this indicates some relationship with the overall clarity of the water (the more clear the water the higher the CPUE) the other water quality parameters do not coincide with this comparison.

There is a direct relationship between the flow rate in the river and the clarity of the water in terms of Secchi disk readings so there may be some relationship there but the direct measurement of the water flow and the crab harvest do not bear out a direct relationship.

This relationship holds true for the boat data as well as the trip ticket data. Although there were differences in the sizes of these two data sets the consistency of the analysis leads one to look more closely at the Secchi disk reading and the associated water quality. Although there is no direct correlation between these particular catch data and all the other water quality parameters measured there is an association between the water flow and most of these water quality parameters (e.g., the flow may have some effect on the water quality and hence on the crab harvest).

To date the data collection for the fisheries independent sampling (or random sampling) was not adequately accomplished. The time and resources allotted to this effort was insufficient. The need for simultaneous independent sampling is important as it can reveal information about the natural distribution and abundance of *Callinectes sapidus* in the Caloosahatchee River and Estuary. Funding would be needed to provide for a series of full-time traps to be monitored regularly in order to obtain this information. The collection of the additional crab trap buoy data was completed however insufficient time was allotted for proper analysis of these data.

ACKNOWLEDGEMENTS

I would like to thank all those individuals involved in the crab fishing industry that were instrumental in helping me collect data as well as allowing me access to their working vessels. My thanks to Captain Ron Davis, Captain John Smith, Captain Lowel Hillman and Captain Ron Krimminger. I would also like to thank John Smith owner of John W. Smith Seafood and Wanda and Zoe owners of City Fish Market in Fort Myers Florida for allowing me access to the trip ticket data. I would like to thank all of my co-workers at the Sanibel-Captiva Conservation Foundation for their funding and help with data collection and analysis. Thanks to Dr. Steve Bortone, Jon Guinn, Mike Hannan, Brad Klement, A.J. Martignette, Maggie May, Molly Murphy, Jeff Siwicke and Justin Spinelli. Also my thanks to South Florida Water Management District for providing support and the Florida Fish and Wildlife Research Institute for data. This report was reviewed by Dr. Eric Milbrandt, Sanibel-Captiva Conservation Foundation.

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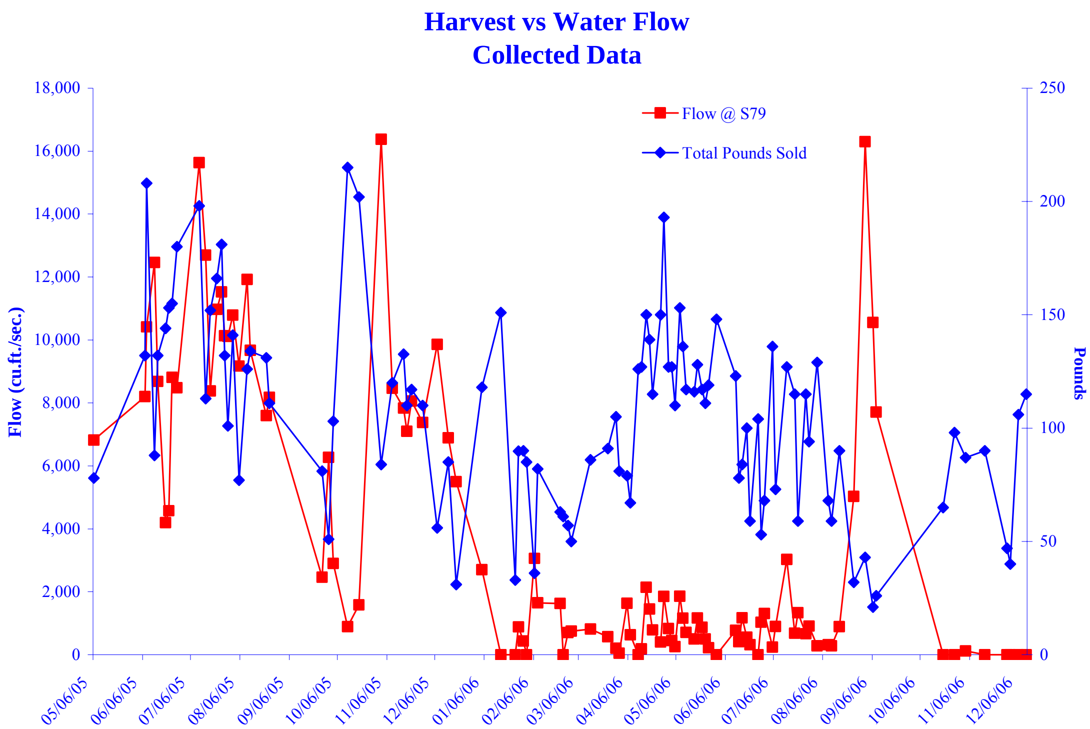

Figure 1. Number of pounds of crab harvested onboard commercial crab boats vs. flow (CFS) at lock S79.

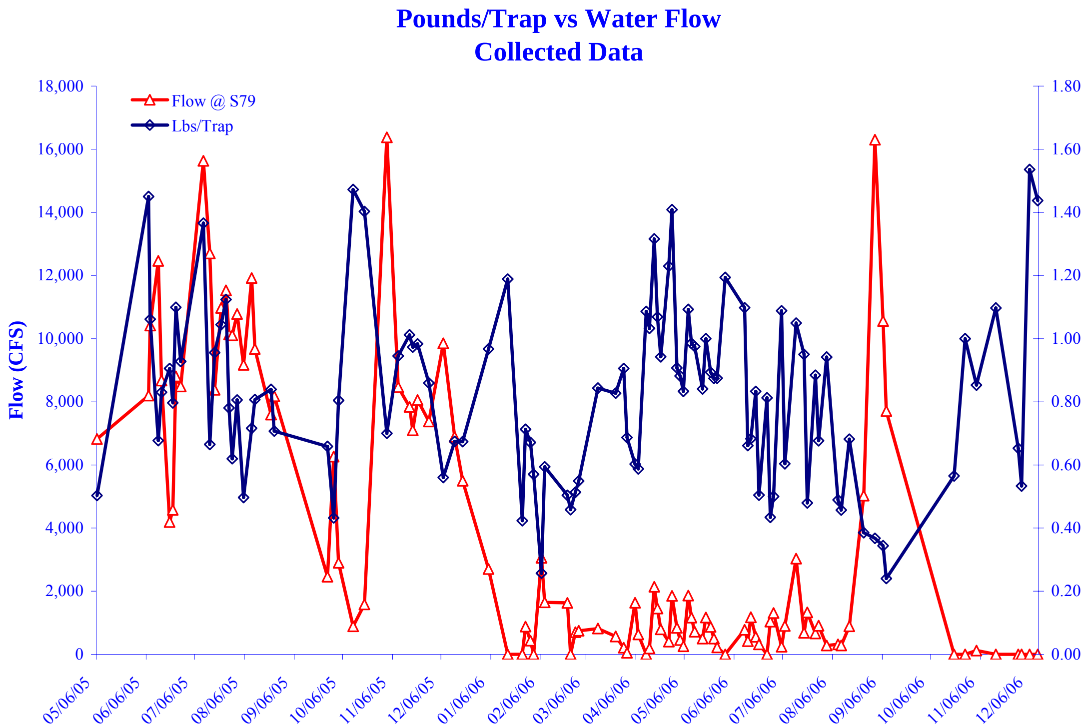

Figure 2. Number of crabs/trap monitored onboard commercial crab boats vs. flow at lock S79

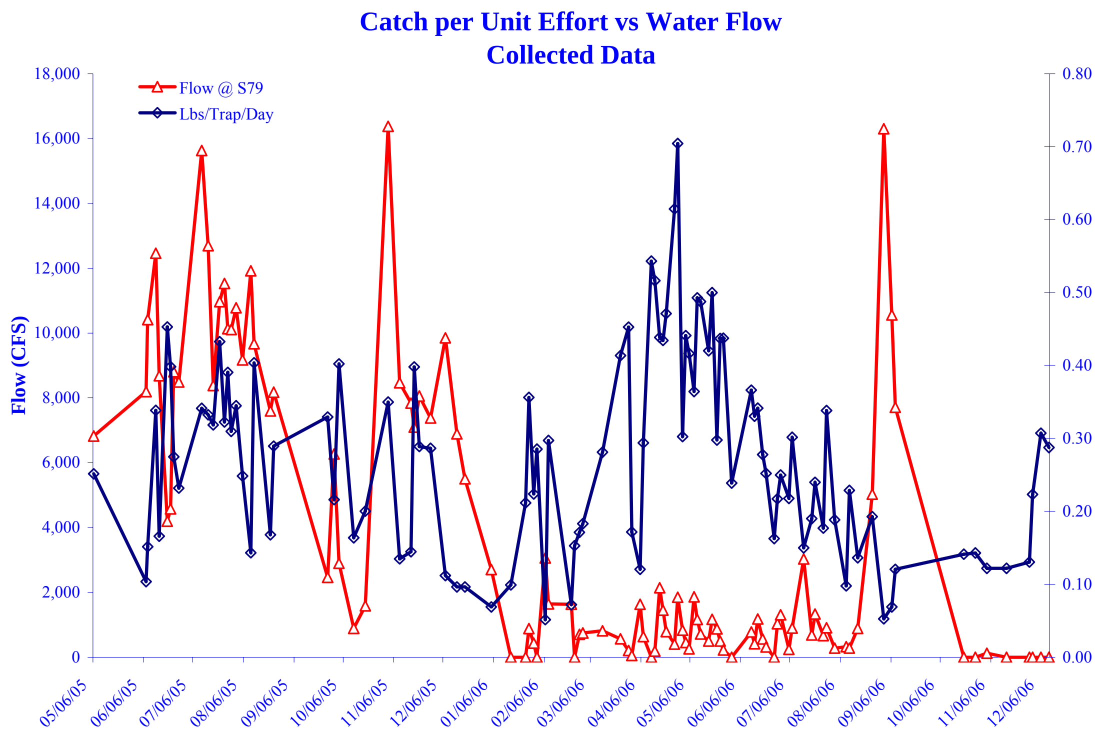

Figure 3. Catch per unit effort of crabs monitored onboard commercial crab boats versus the flow from lock S79.

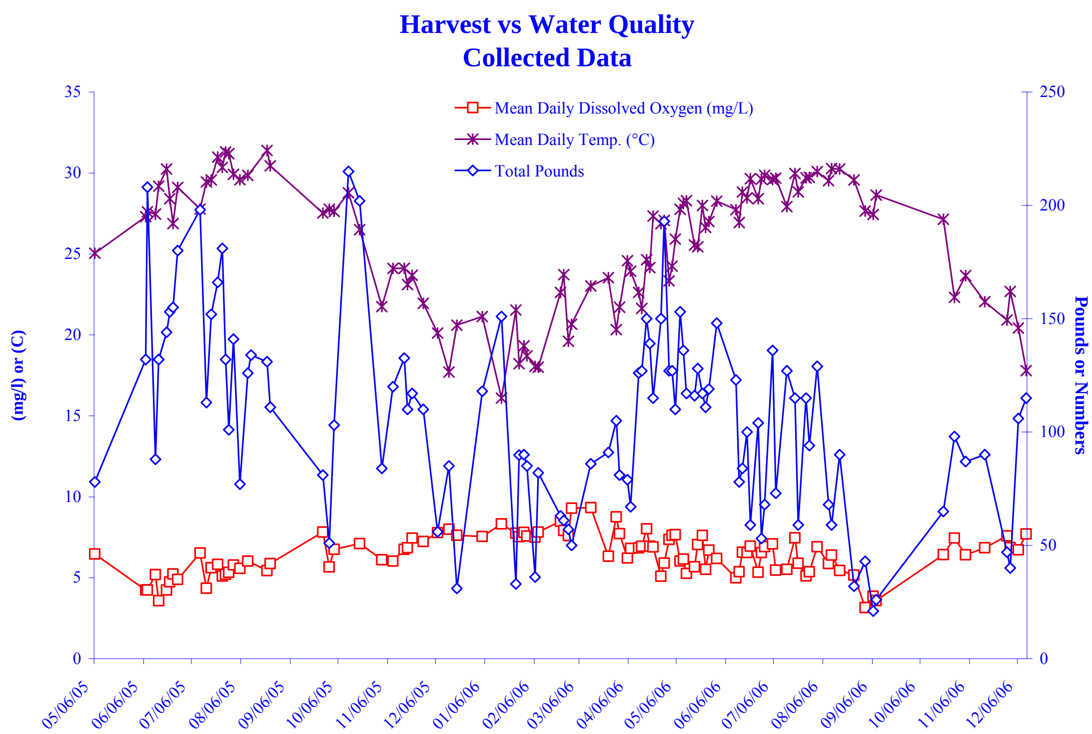

Figure 4. Harvest of crabs counted onboard versus mean daily temperature and mean daily dissolved oxygen.

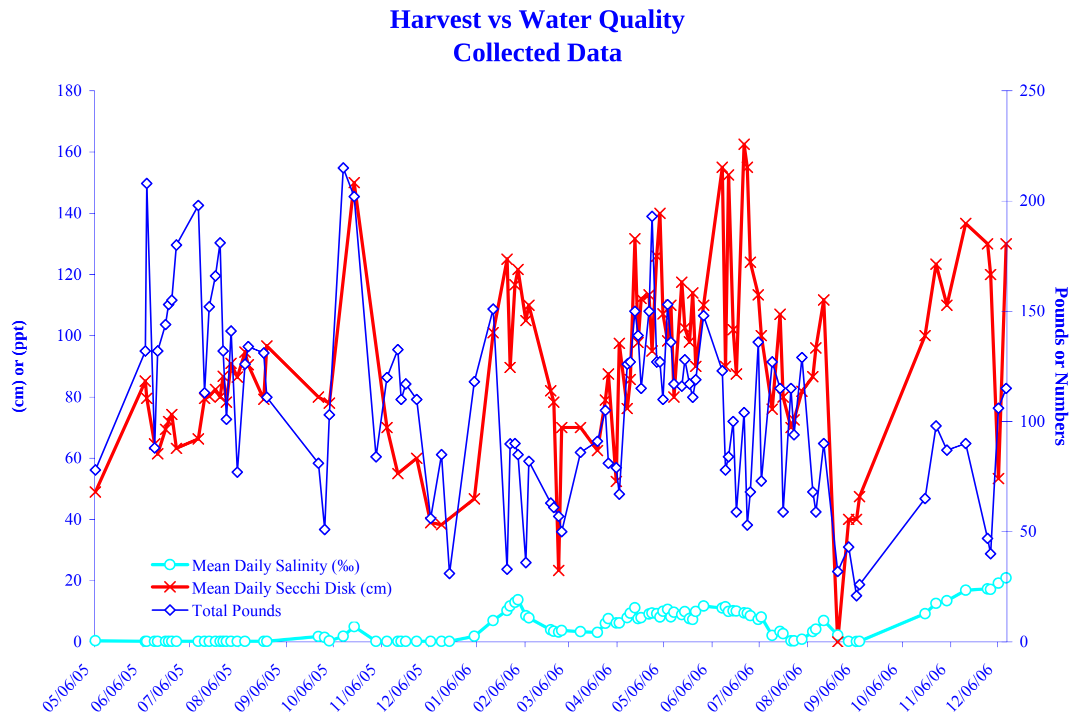

Figure 5. Harvest of crabs counted onboard versus mean daily salinity and mean daily Secchi disk depth.

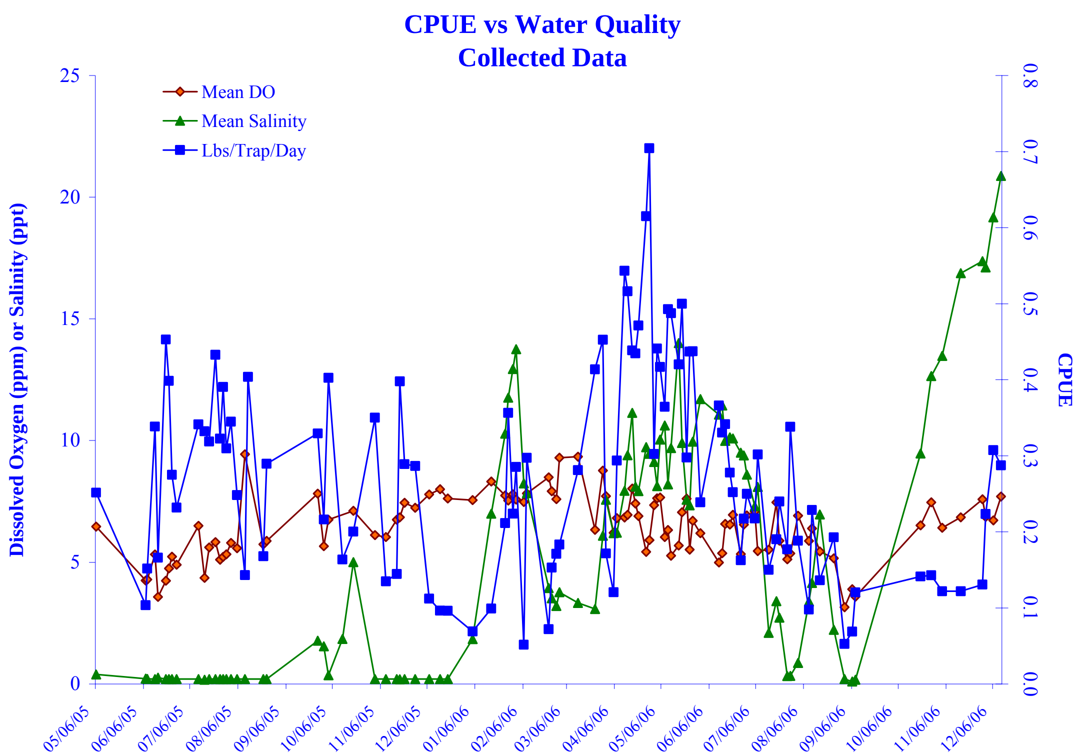

Figure 6. Number of crabs per trap observed onboard versus dissolved oxygen and salinity.

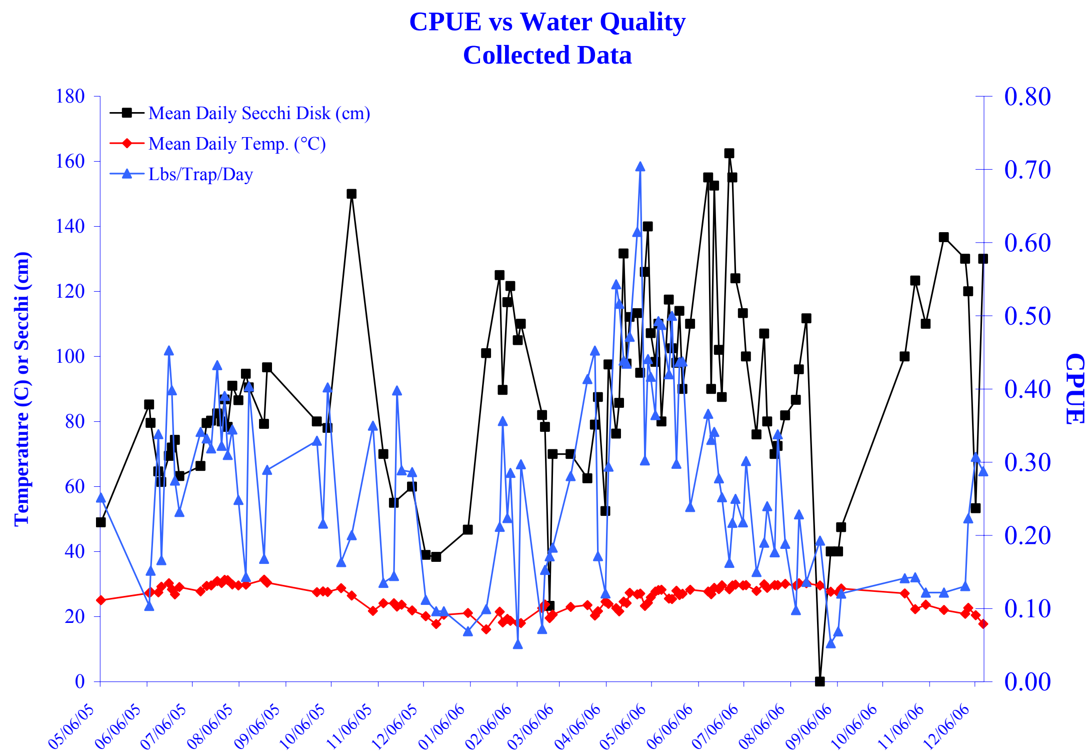

Figure 7. Catch per unit effort observed onboard versus mean temperature and mean Secchi disk depth.

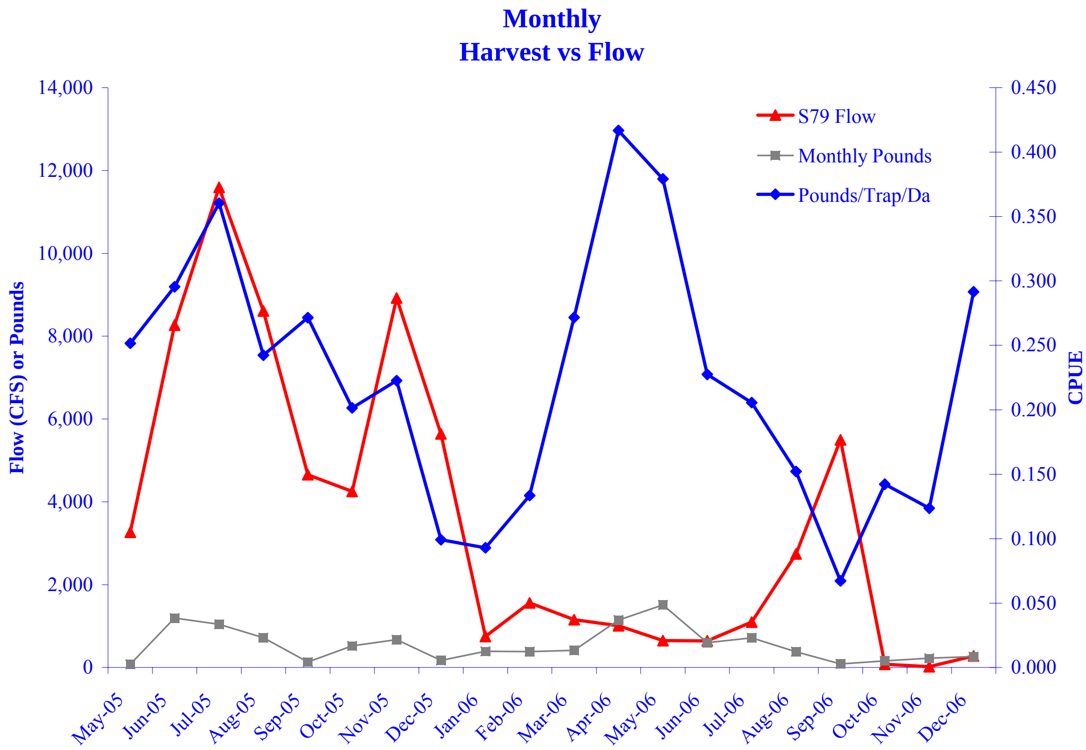

Figure 8. Monthly means of onboard harvest data versus flow at S79.

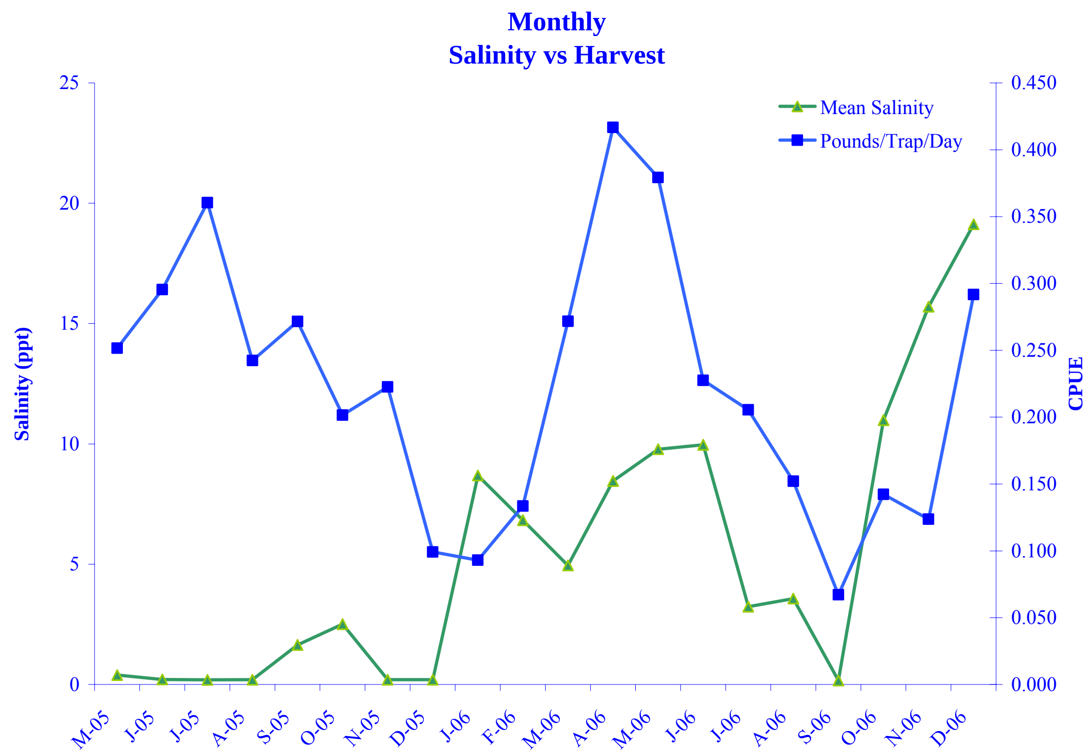

Figure 9. Monthly means of onboard harvest data versus mean monthly salinity.

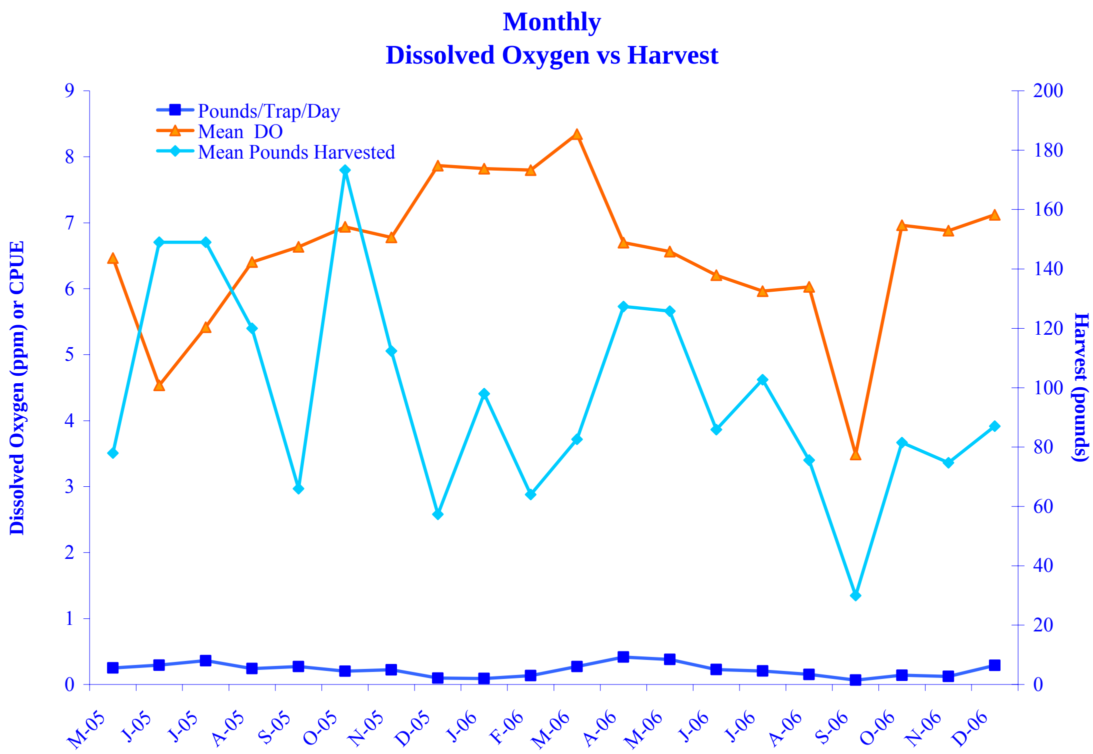

Figure 10. Monthly means of onboard harvest data versus mean monthly dissolved oxygen.

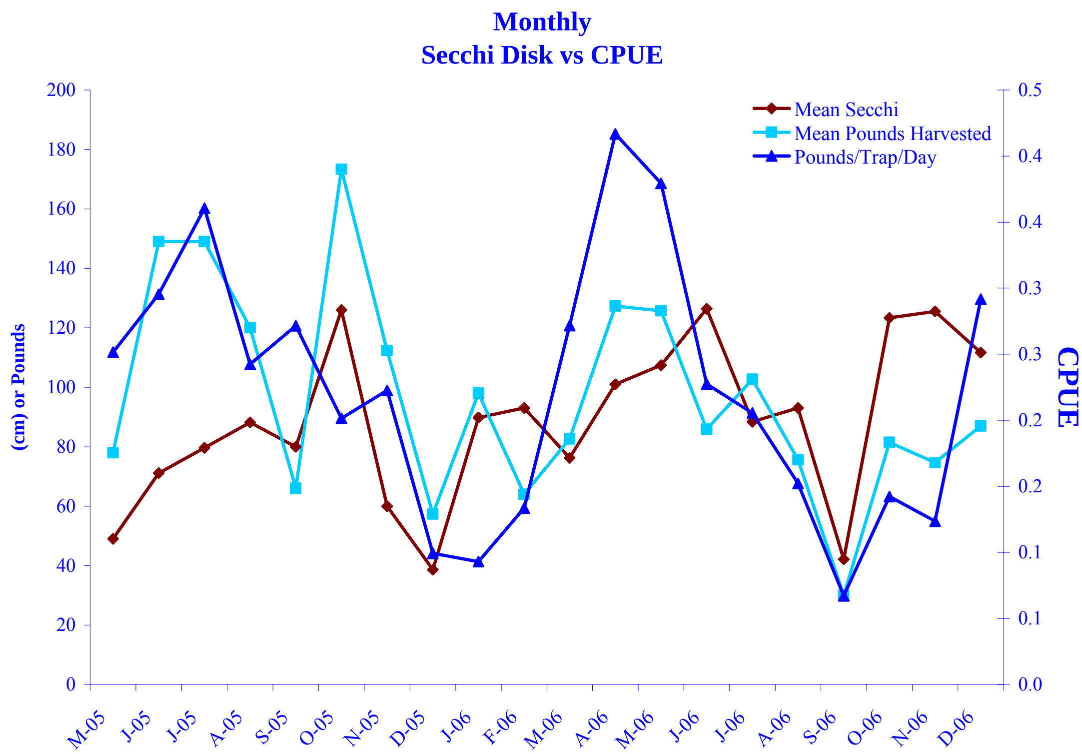

Figure 11. Monthly means of onboard harvest data versus mean monthly Secchi disk depth.

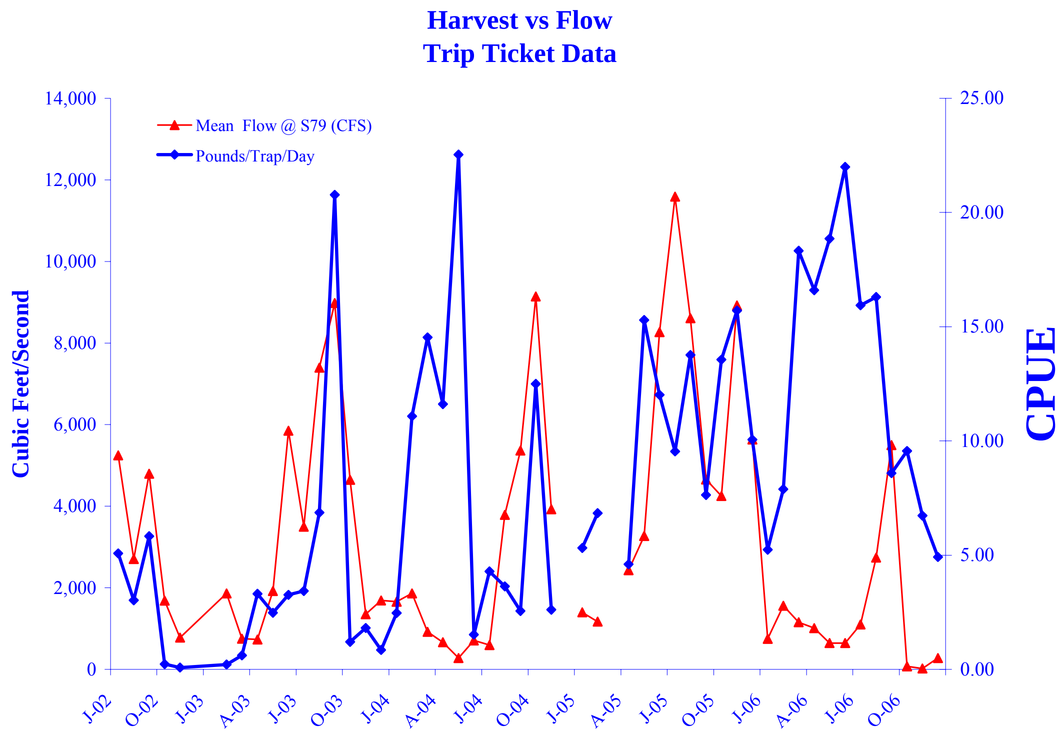

Figure 12. Trip ticket harvest data versus flow and mean flow at lock S79.

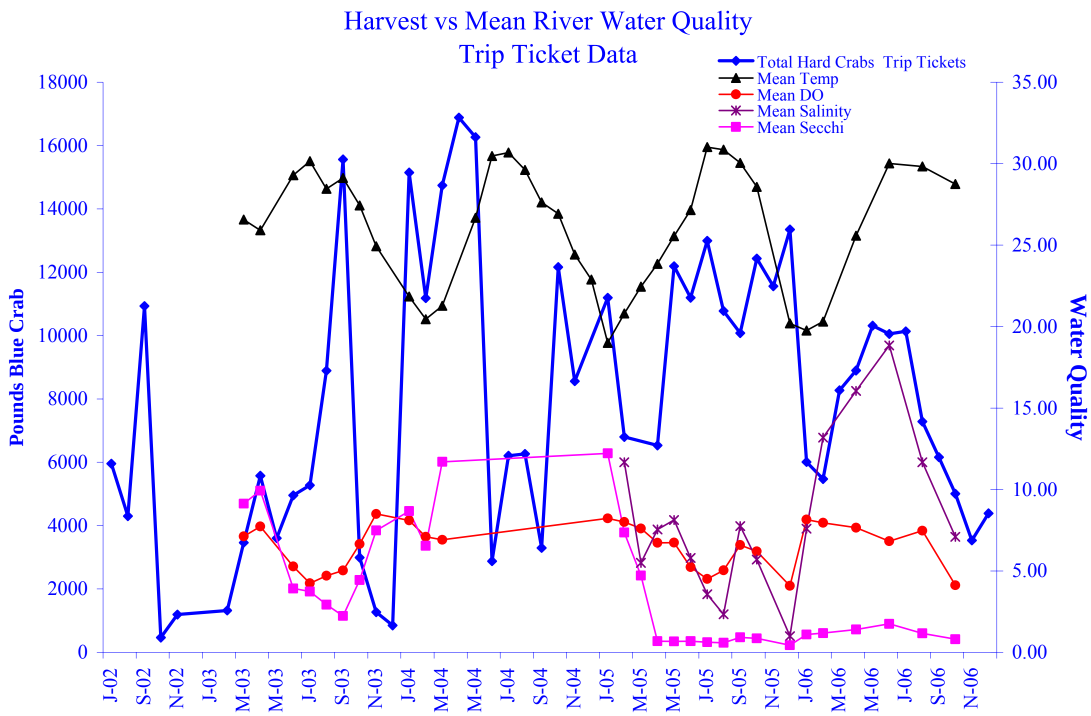

Figure 13. Harvest data from trip tickets versus water quality parameters.

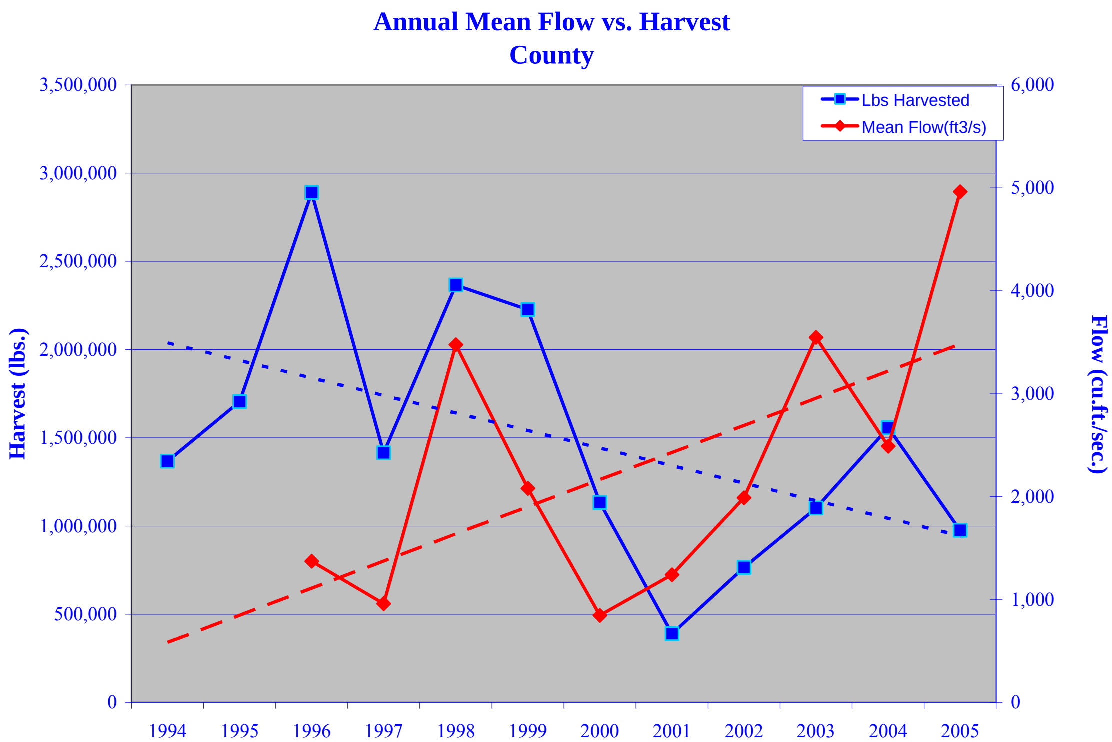

Figure 14. Annual mean flow at S79 versus harvest data for Lee County (dotted lines are trend lines).

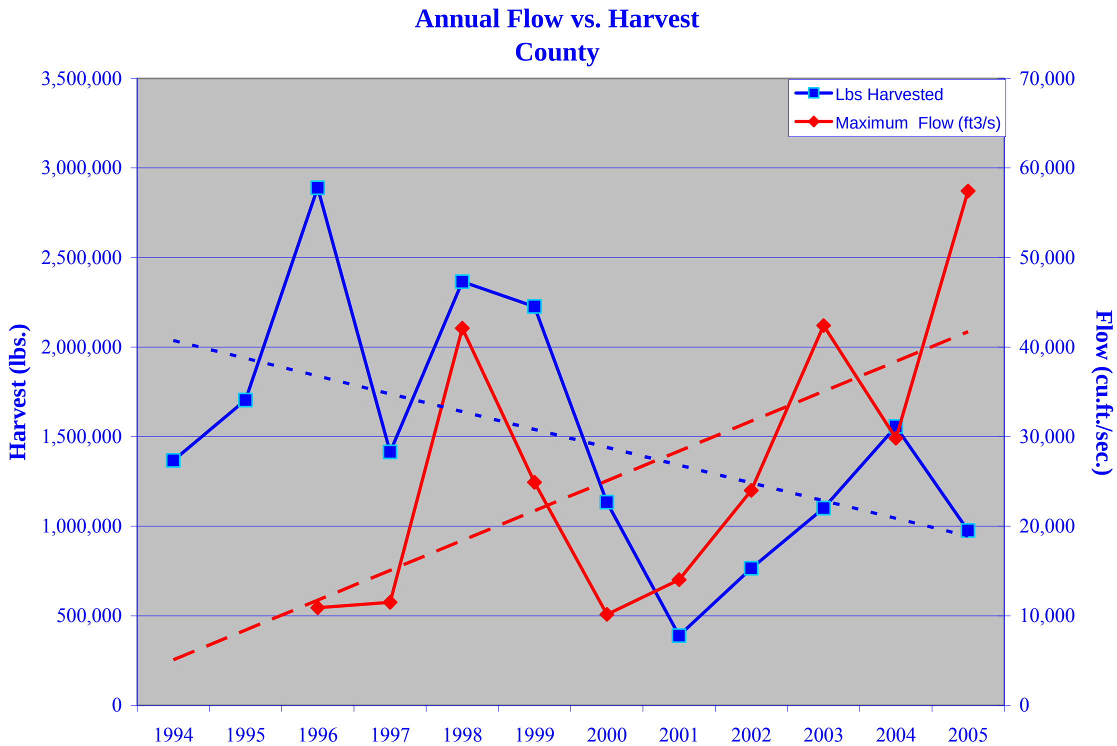

Figure 15. Total annual flow at S79 versus harvest data for Lee County (dotted lines are trend lines).

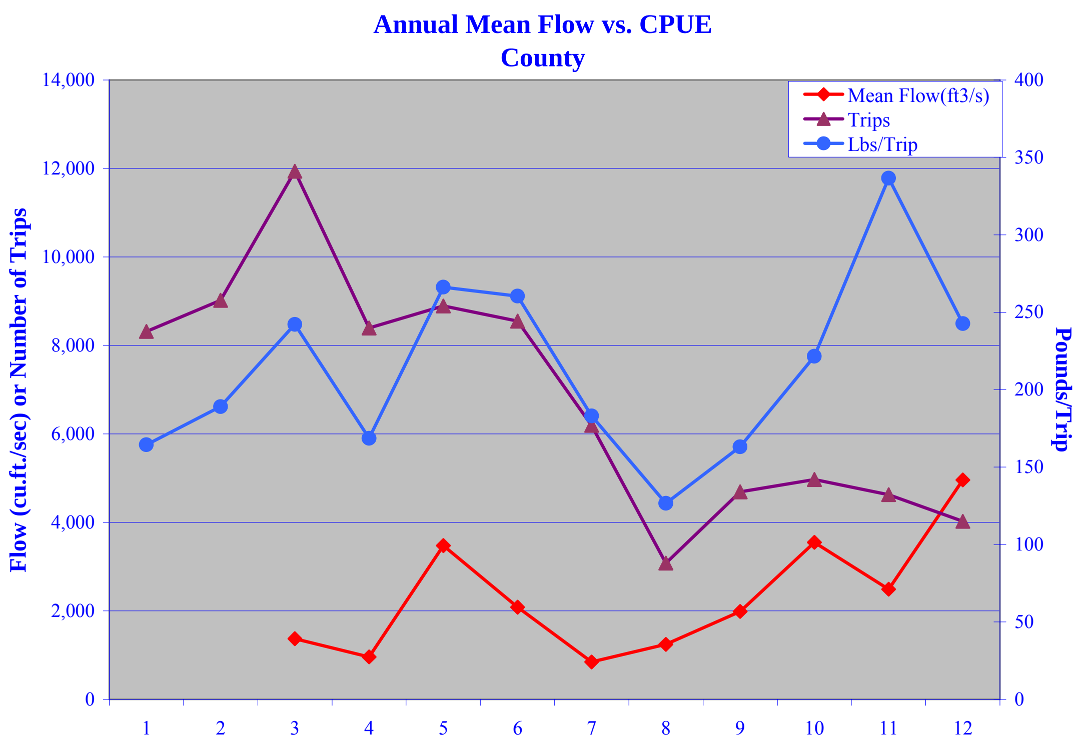

Figure 16. Annual mean flow at S79 versus catch per unit effort for data from Lee County.

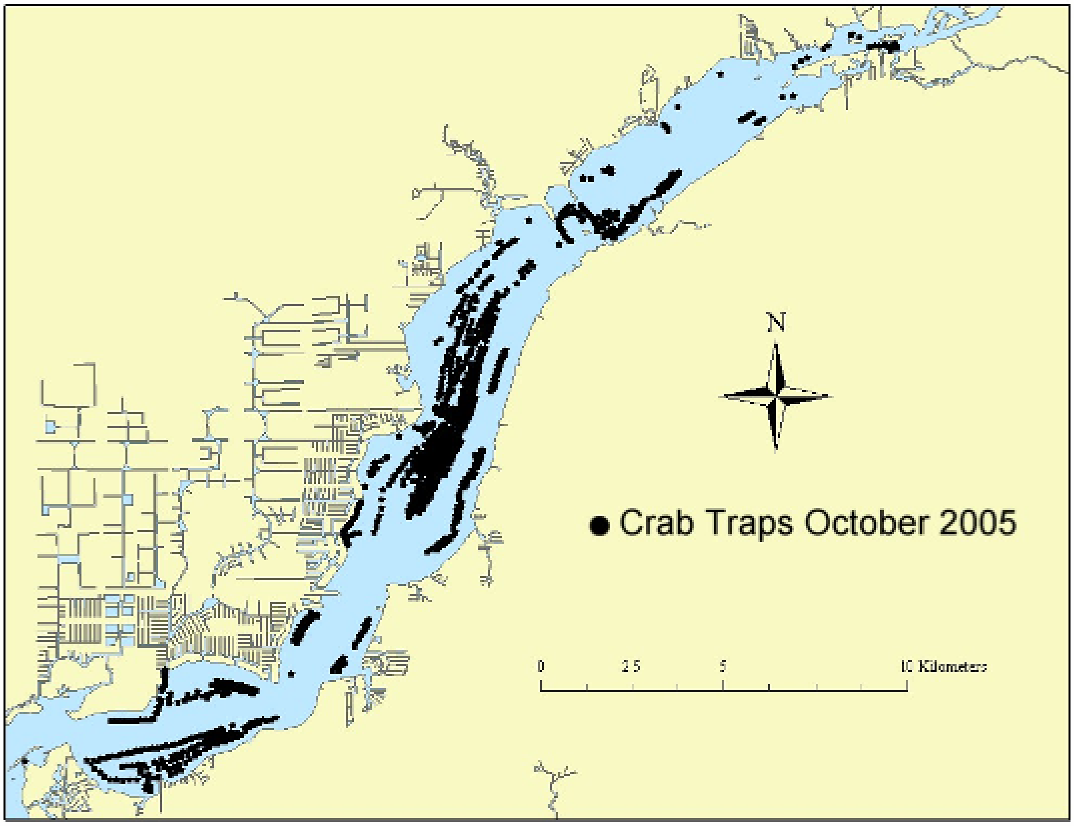

Figure 17. Distribution of crab traps set by commercial crabbers in the lower Caloosahatchee River in October 2005.

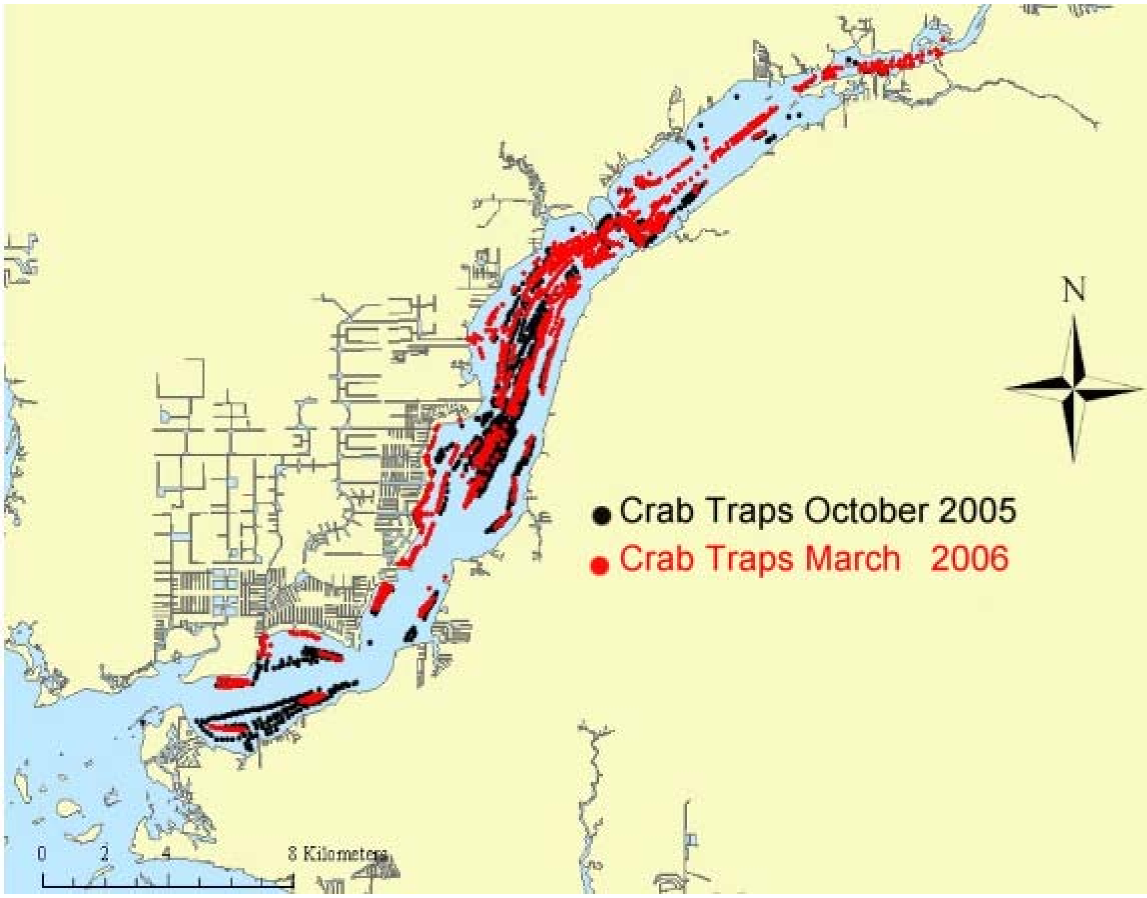

Figure 18. Distribution of crab traps set by commercial crabbers in October 2005 (black dots) and March 2006 (red dots).

		Pounds/Trap/Day	Pounds/Trap	Log transform of Flow in S79	Mean Dissolved Oxygen for that Day	Mean Temp (deg C) for that Day	Mean Salinity (ppt) for that Day	Mean Secchi Disk Reading (cm) for that Day
N	Valid	104	104	90	102	103	103	98
	Missing	0	0	14	2	1	1	6
Mean		.2789	.8219	7.5944	6.4127	25.8363	5.4438	90.4027
Std. Error of Mean		.01363	.02782	.14788	.12395	.38274	.51415	3.01611
Std. Deviation		.13902	.28367	1.40295	1.25186	3.88436	5.21805	29.85792
Variance		.019	.080	1.968	1.567	15.088	27.228	891.495

Table 1: Table of various frequencies of the boat data.

ANOVA						
		Sum of Squares	df	Mean Square	F	Sig.
Pounds/Trap/Day	Between Groups	2.726E-02	1	2.726E-02	1.416	.237
	Within Groups	1.963	102	1.925E-02		
	Total	1.991	103			
Pounds/Trap	Between Groups	4.425E-02	1	4.425E-02	.547	.461
	Within Groups	8.244	102	8.082E-02		
	Total	8.288	103			
Total Pounds	Between Groups	3208.917	1	3208.917	1.835	.179
	Within Groups	178368.996	102	1748.716		
	Total	181577.913	103			
Mean Dissolved Oxygen for that Day	Between Groups	40.056	1	40.056	33.881	.000
	Within Groups	118.226	100	1.182		
	Total	158.282	101			
Mean Temp (deg C) for that Day	Between Groups	102.214	1	102.214	7.185	.009
	Within Groups	1436.791	101	14.226		
	Total	1539.005	102			
Mean Salinity (ppt) for that Day	Between Groups	1437.365	1	1437.365	108.347	.000
	Within Groups	1339.892	101	13.266		
	Total	2777.257	102			
Mean Secchi Disk Reading (cm) for that Day	Between Groups	23788.413	1	23788.413	36.430	.000
	Within Groups	62686.631	96	652.986		
	Total	86475.044	97			

Table 2: ANOVA results for the boat data relative to the water flow in the S79 canal.

		Pounds/ Trap/Day	Pounds /Trap	Mean Dissolved Oxygen for that Day	Mean Temp (deg C) for that Day	Mean Salinity (ppt) for that Day	Mean Secchi Disk Reading (cm) for that Day	Log transform of Flow in S79
Pounds/Trap/Day	Pearson Correlation	1	.365(**)	-.027	.141	.151	.192	-.156
	Sig. (2-tailed)		.000	.790	.154	.128	.058	.143
	N	104	104	102	103	103	98	90
Pounds/Trap	Pearson Correlation	.365(**)	1	.028	-.011	.176	.214(*)	-.034
	Sig. (2-tailed)	.000		.782	.908	.075	.034	.747
	N	104	104	102	103	103	98	90
Mean Dissolved Oxygen for that Day	Pearson Correlation	-.027	.028	1	-.662(**)	.358(**)	.224(*)	-.424(**)
	Sig. (2-tailed)	.790	.782		.000	.000	.027	.000
	N	102	102	102	102	102	97	88
Mean Temp (deg C) for that Day	Pearson Correlation	.141	-.011	-.662(**)	1	-.380(**)	-.007	.162
	Sig. (2-tailed)	.154	.908	.000		.000	.949	.128
	N	103	103	102	103	103	97	89
Mean Salinity (ppt) for that Day	Pearson Correlation	.151	.176	.358(**)	-.380(**)	1	.625(**)	-.739(**)
	Sig. (2-tailed)	.128	.075	.000	.000		.000	.000
	N	103	103	102	103	103	97	89
Mean Secchi Disk Reading (cm) for that Day	Pearson Correlation	.192	.214(*)	.224(*)	-.007	.625(**)	1	-.430(**)
	Sig. (2-tailed)	.058	.034	.027	.949	.000		.000
	N	98	98	97	97	97	98	84
Log transform of Flow in S79	Pearson Correlation	-.156	-.034	-.424(**)	.162	-.739(**)	-.430(**)	1
	Sig. (2-tailed)	.143	.747	.000	.128	.000	.000	
	N	90	90	88	89	89	84	90

Table 3: Correlation matrix for the boat data for CPUE and water quality and flow parameters.

		Monthly Lbs/Trap/Day	Monthly Pounds	Monthly DO	Monthly Salinity	Monthly Secchi Disk	Log of Monthly Flow S79
Monthly Lbs/Trap/Day	Pearson Correlation	1	.718(**)	-.065	.035	.152	.164
	Sig. (2-tailed)		.000	.786	.884	.522	.489
	N	20	20	20	20	20	20
Monthly Pounds	Pearson Correlation	.718(**)	1	-.222	-.069	.176	.202
	Sig. (2-tailed)	.000		.347	.774	.459	.394
	N	20	20	20	20	20	20
Monthly DO	Pearson Correlation	-.065	-.222	1	.361	.245	-.339
	Sig. (2-tailed)	.786	.347		.118	.298	.144
	N	20	20	20	20	20	20
Monthly Salinity	Pearson Correlation	.035	-.069	.361	1	.719(**)	-.884(**)
	Sig. (2-tailed)	.884	.774	.118		.000	.000
	N	20	20	20	20	20	20
Monthly Secchi Disk	Pearson Correlation	.152	.176	.245	.719(**)	1	-.668(**)
	Sig. (2-tailed)	.522	.459	.298	.000		.001
	N	20	20	20	20	20	20
Log of Monthly Flow S79	Pearson Correlation	.164	.202	-.339	-.884(**)	-.668(**)	1
	Sig. (2-tailed)	.489	.394	.144	.000	.001	
	N	20	20	20	20	20	20

Table 4. Correlation matrix for the boat data summed up by month including CPUE and water quality as well as flow data.

		Total Pounds for Month	Pounds /Trap	Pound s/Trap /Day	Log of Mean flow of S79	Mean Temper ature	Mean DO	Mean of Secch i Disk	Mean of Salinity
N	Valid	50	50	50	50	30	26	26	15
	Missing	0	0	0	0	20	24	24	35
Mean		7896.08	27.678	8.271	7.5854	25.8909	6.554	3.8965	8.7014
Std. Error of Mean		623.51	2.4295	.9026	.17478	.71492	.2827	.77133	1.21822
Std. Deviation		4408.93	17.1790	6.3825	1.23588	3.91576	1.4415	3.9330	4.71816
Variance		19438711	295.128	40.736	1.527	15.333	2.078	15.469	22.261

Table 5. Descriptive statistics for the trip ticket data for monthly summations.

		Total Pounds for Month	Pounds/Trap	Pounds/ Trap/Day	Mean Temperature	Mean DO	Mean of Secchi Disk	Mean of Salinity	Log of Mean flow of S79
Total Pounds for Month	Pearson Correlation	1	.849(**)	.708(**)	-.097	-.290	-.067	-.399	.196
	Sig. (2-tailed)		.000	.000	.612	.151	.745	.141	.173
	N	50	50	50	30	26	26	15	50
Pounds/ Trap	Pearson Correlation	.849(**)	1	.790(**)	-.054	-.307	-.373	-.370	.082
	Sig. (2-tailed)	.000		.000	.776	.127	.061	.175	.570
	N	50	50	50	30	26	26	15	50
Pounds/ Trap/Day	Pearson Correlation	.708(**)	.790(**)	1	.228	-.258	-.415(*)	.436	-.003
	Sig. (2-tailed)	.000	.000		.226	.203	.035	.104	.985
	N	50	50	50	30	26	26	15	50
Mean Temp.	Pearson Correlation	-.097	-.054	.228	1	-.524(**)	-.473(*)	.032	.374(*)
	Sig. (2-tailed)	.612	.776	.226		.006	.015	.910	.042
	N	30	30	30	30	26	26	15	30
Mean DO	Pearson Correlation	-.290	-.307	-.258	-.524(**)	1	.555(**)	.674(**)	-.584(**)
	Sig. (2-tailed)	.151	.127	.203	.006		.003	.006	.002
	N	26	26	26	26	26	26	15	26
Mean of Secchi Disk	Pearson Correlation	-.067	-.373	-.415(*)	-.473(*)	.555(**)	1	.300	-.432(*)
	Sig. (2-tailed)	.745	.061	.035	.015	.003		.278	.027
	N	26	26	26	26	26	26	15	26
Mean of Salinity	Pearson Correlation	-.399	-.370	.436	.032	.674(**)	.300	1	-.556(*)
	Sig. (2-tailed)	.141	.175	.104	.910	.006	.278		.031
	N	15	15	15	15	15	15	15	15
Log of Mean flow of S79	Pearson Correlation	.196	.082	-.003	.374(*)	-.584(**)	-.432(*)	-.556(*)	1
	Sig. (2-tailed)	.173	.570	.985	.042	.002	.027	.031	
	N	50	50	50	30	26	26	15	50

Table 6. Correlation coefficients for the trip ticket data between the flow at S79, water quality parameters and catch data.

	Mean	Std. Deviation	N
Mean_Flowft3s	2295.8000	1337.22846	10
Total_Flowft3s	26726.2120	16206.34999	10
Lbs/Trip	213.6768	58.70407	12
Mean_Temp	25.8822	3.56141	5
Mean_DO	6.8792	1.07455	5
Mean_pH	7.9243	.39943	5
Mean_Secchi	48.5743	41.80572	3
Mean_Salinity	6.9508	2.88682	5

Table 7. Descriptive statistics for the data obtained from the Fish and Wildlife Research Institute.

		Mean_Flowft3s	Lbs/Trip	Mean_Temp	Mean_DO	Mean_pH	Mean_Secchi	Mean_Salinity
Mean_Flowft3s	Pearson Correlation	1	.469	-.827	.464	-.799	-1.000(**)	-.930
	Sig. (2-tailed)		.171	.173	.536	.201	.	.070
	N	10	10	4	4	4	2	4
Lbs/Trip	Pearson Correlation	.469	1	-.630	.961(*)	-.641	-1.000(**)	.048
	Sig. (2-tailed)	.171		.370	.039	.359	.	.952
	N	10	12	4	4	4	2	4
Mean_Temp	Pearson Correlation	-.827	-.630	1	-.938(*)	.433	.972	-.028
	Sig. (2-tailed)	.173	.370		.018	.466	.151	.964
	N	4	4	5	5	5	3	5
Mean_DO	Pearson Correlation	.464	.961(*)	-.938(*)	1	-.570	-.980	.092
	Sig. (2-tailed)	.536	.039	.018		.316	.127	.883
	N	4	4	5	5	5	3	5
Mean_pH	Pearson Correlation	-.799	-.641	.433	-.570	1	.569	.650
	Sig. (2-tailed)	.201	.359	.466	.316		.615	.235
	N	4	4	5	5	5	3	5
Mean_Secchi	Pearson Correlation	-1.000(**)	-1.000(**)	.972	-.980	.569	1	-.081
	Sig. (2-tailed)	.	.	.151	.127	.615		.948
	N	2	2	3	3	3	3	3
Mean_Salinity	Pearson Correlation	-.930	.048	-.028	.092	.650	-.081	1
	Sig. (2-tailed)	.070	.952	.964	.883	.235	.948	
	N	4	4	5	5	5	3	5

Table 8. Correlation matrix for the Fish and Wildlife Research Institute data showing catch data and water quality data.