DETERMINATION OF JUVENILE BLUE CRAB (*Callinectes sapidus*) SEASONAL GROWTH PARAMETERS FOR INPUT INTO POPULATION AND COMMUNITY ASSESSMENT MODELS

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Contents

ABSTRACT

Blue crab are an important species in Texas estuaries supporting important commercial and recreational fisheries while providing critical ecosystem services including serving as a critical food item for several federally and/or state listed species including Whooping cranes, Kemps Ridley turtles and Texas Diamondback terrapin (Hunt.and Slack 1989; Pugesek et al. 2008 and Slack et al. 2009; Davenport et al. 1992; Tucker et al. 1995; Davenport et al. 1992; Barichivich et al. 1999). Changes in the population levels of crabs can lead to potential negative impacts on these and many other species which prey on the juveniles. Therefore understanding the growth of early juvenile species is needed to evaluate critical life history parameters Determination of blue crab growth parameters is complicated by an inability to age individuals directly, a high dependence on environmental conditions and discontinuous growth. Furthermore, tracking growth through time using externally applied tags cannot be accomplished because of molting. This study uses internally implanted coded wire tags to monitor growth of crabs released into the wild in an attempt to describe and parameterize growth patterns across different size classes and environmental conditions.

INTRODUCTION

Blue crab growth

Blue crab growth is a discontinuous or stepwise process because it can only be achieved through molting. The molting process of blue crabs, as well as many other crustaceans and arthropods, is characterized by four phases: metecdysis, anecdysis, proecdysis, and ecdysis (Chan et al. 1988; Drach 1939). Metecdysis is the soft shell period (stage A and B), occurring right after molting. During metecdysis, the crab absorbs large amounts of water from the environment, helping it expand its size (Van Engel 1958). The anecdysis or inter-molt stage (stage C) is the larger molt stage, being characterized by extreme food consumption, which will influence on tissue growth. Proecdysis phase (stage D) is the last phase before molting, leading to many physiological and morphological changes. Finally, ecdysis, is characterized by the complete shedding of old carapace allowing crab's expansion (Chan et al. 1988; Drach 1939). In preparation to and during ecdysis, the blue crab ceases all its activities, including feeding, for about three to four days (Van Engel 1958).

Juveniles tend to molt more frequently than adults. Churchill (1919) and Robertson (1938) observed that, under lab conditions, crabs bellow 5 mm molt every 3 to 5 days, while crabs between 12 mm to 25 mm and larger than 101 mm carapace width will molt every 10 to 15 days and 20 to 50 days respectively. Van Engel (1958) suggested that crabs stop molting after achieving a fixed number of molts (18 to 20 molts). Many lab experiments have been performed to estimate growth rates of blue crabs, but very little is known about their growth in the wild (Leffler 1972; Miller and Smith 2003; Sulkin 1975).

Blue crab growth is known to be temperature dependent. Leffler (1972) found that, under lab conditions, the molt rate of blue crabs increased when temperature increased from 13^{o}C to 34^{o}C. Growth still occurred when increasing temperature from 27^{o}C to 34^{o}C, but in lower rates if compared to lower temperature (13^{o}C to 34^{o}C). Leffler (1972) also found that growth almost ceased when crabs were exposed to temperatures below 13^{o}C. Winget et al. (1976), using a recirculating culture system, found that growth per molt increased at 20^{o}C. The idea of a fixed number of molts is also defended by Leffler (1972), who believed that because of this fixed number of molts, blue crabs from different regions and different seasonal temperatures reach maturity at different sizes. A blue crab of 22 mm carapace width will molt 5 times at 15^{o}C to achieve 60 mm, while at 34^{o}C it would take 7 molts to achieve same size (Leffler 1972). Tagartz (1968), on the other hand, found that growth per molt did not change significantly between summer and winter months, suggesting that temperature does not influence growth per molt in the wild.

Salinity is another parameter that might influence on blue crab growth. As already mentioned, during ecdysis, large amounts of water are consumed by the blue crab, contributing to its extension. Therefore, it would make sense that waters with lower salinity concentrations would be more easily absorbed by crabs, increasing their size if compared with crabs from higher salinities (Van Engel 1958). Conversely, Tagartz (1968) and Guering and Stickle (1997) found that growth per molt and molt rates were not directly influenced by salinity.

Limb losses and food availability are also important on growth and molt rates. Under lab conditions, Smith (1990) determined that the loss of one limb did not significantly affect growth increment, but two or more losses decreased growth increment after molt. As any other organism, blue crabs tend to grow more when more food is available. Therefore, food availability and their position on the food chain could impact growth rates.

Difficulties in aging

Age determination of blue crabs is hard to be studied due to the lack of hard parts such as otoliths, scales, teeth, or growth rings. The only hard part a blue crab has is its carapace, which is completely shed and left behind after molting. Lipofuscin, also known as age pigments, have been used for ageing many crustaceans, such as lobster, crayfish, and prawn (Belchier et al. 1998; Belchier et al. 1994; Sheehy et al. 1995). Ju et al (1999; 2001) used Lipofuscin accumulation levels from nervous tissues of blue crabs for age determination and suggested that their methods is a reliable tool to age blue crabs in the wild. However, the reliability of this model has been questioned due to the large size variations of blue crabs at age X, as well as other problems associated with the use of lipofuscin that were flawed during the performance of these experiments (Sheehy 2008).

Growth Models

In fisheries, one of the most commonly used growth model is the Von Bertalanffy Growth Function (VBGF) developed by von Bertalanffy (1938) (1) The VBGF is a continuous growth curve of length at age and the parameters obtained from the function (L_∞, k, and t_0) are then used on stock assessment models.

$$L_t = L_\infty\left(1 - e^{-k[t-t_0]} \right) \qquad (1)$$

Although the VBGF has been used in the past to model growth of blue crabs (Pellegrin et al. 2001; Rothschild et al. 1992; Rugolo et al. 1998), there are many issues associated with the use of this function. First, the function doesn’t take into consideration the sex specific growth characteristics of blue crabs, in which females stop growing after undergoing terminal molt, usually within their first year of life in the Gulf of Mexico, while males continue growing (Pellegrin et al. 2001). Second, length at age is unknown since there are not reliable ways to age blue crabs thus far. Last, the VBGF is of continuous nature, while blue crabs grow in a discontinuous manner.

Discontinuous growth models for crustaceans, also called molt-process models, use growth per molt (GPM) and intermolt period (IP) as Y and X-axis respectively to create a growth pattern (Hiatt 1948). Molt-process models have been used to model growth of many crustaceans (McCaughran and Powell 1977; Wainwright and Armstrong 1993). GPM is easy to obtain by getting a measurement before and after molting. However, modeling IP can become problematic, especially when out of laboratory settings, when time elapsed and temperature are harder to monitor.

Smith (1997) described a discontinuous growth model for crustacean that also uses GPM, but IP has been modified to accommodate the fact that temperature will interfere on time between molts. In this method, IP is no longer a chronological measurement of time, but a physiological measurement of time in the form of degree-days (2)

$$°\mathrm{C}.d = T_j^* - T_{min}$$

Where,

$$T_j^* = \begin{cases} \bar{T}_j \ , & T_{min} \le \bar{T}_j < T_{max} \\ T_{max} \ , & \bar{T}_j \ge T_{max} \end{cases} \tag{2}$$

$\bar{T}_j$ is the daily average temperature over j days, while T_{min} and T_{max} are the minimum and maximum temperature threshold that a species can withstand. Brylawski and Miller (2006) used Smith's method to parameterize the discontinuous growth of blue crabs under lab and field enclosed conditions and obtained a value of 10.8°C for T_{min} . Smith (1997), on the other hand, found T_{min} to be 9.8°C.

Eggleston et al. (2004) used a discontinuous growth model application on blue crabs, without converting IP to degree-days. Their study compared the GPM and IP of blue crabs reared in lab and field tagged crabs and found that GPM is not significant different between laboratory reared and field tagged crabs. However, IP was smaller for lab crabs, suggesting that lab reared crabs growth at a faster pace than crabs in the wild. Eggleston et al (2004) also compared their discontinuous blue crab growth model with the VBGF and suggested that the continuous model (VBGF) can be satisfactorily used to fit the discontinuous growth of blue crabs.

The VBGF has been modified by multiple authors to better accommodate mark-recapture data and seasonality. Fabens (1986) mathematically changed the VBGF so that mark-recapture data can be used without depending on ageing individuals. The Fabens Method produced **Error! Reference source not found.**

$$\Delta L = (L_\infty - L_t)(\,1 - e^{-k\Delta t}\,) \qquad (\,3\,)$$

Where L_∞ and k are the same VBGF parameters described in **Error! Reference source not found.**, ΔL is the change in length for an individual of initial length L_t over a Δt period.

Francis (Francis 1988) proposed a new approach for the analysis of growth thru tagging experiment using a maximum likelihood approach that takes in consideration the fact that variability occurs in individual's growth rate data from tagging studies (4)

$$\Delta L = \left\{\frac{\beta g_\alpha - \alpha g_\beta}{g_\alpha - g_\beta} - L_1\right\}\left\{1 - \left[1 + \frac{g_\propto - g_\beta}{\alpha - \beta}\right]^{\Delta t}\right\} \qquad (\,4\,)$$

This maximum likelihood approach proposes to substitute the VBGF parameters ($L\infty$ and k) with new parameters that will better fit tagging data. These new parameters are g_α and g_β, which are the mean annual growth of individuals of length α and β.

Objectives

The objectives of this study are to fit growth increment data from individually tagged and released blue crabs and caged individuals to a growth model in order to describe growth patterns and determine growth parameters (K and $L\infty$) for input into population dynamics and stock assessment models.

METHODS

Study Site

Galveston Bay (Figure 1) is the largest and most productive estuary of Texas, measuring approximately 600 m^2. Located in the northeast coast of Texas, Galveston Bay connects to the Gulf of Mexico and receives freshwater inflows from the San Jacinto and Trinity Rivers. Moses Lake, located in Galveston Bay, was the site selected for this study due to its somewhat enclosed geography.

In 1954, a seawall was constructed in Moses Lake as a protection measurement against hurricanes (Figure 2) and in 1966, a tidal control gate was built at Miller's Pointe to control the flow in and out of Moses Lake ("Moses Lake", Handbook of Texas Online). Therefore, the only way crabs could get out of this water body is either through the tidal control gate into Galveston Bay or upstream through Moses Bayou.

Figure 1: Moses Lake and Galveston Bay

Within Moses Lake, we selected two smaller areas to conduct the study and increase the chances of recapture tagged individuals. The first area (area 1) is part of the men made seawall and it is shown in Figure 2. The second area (area 2) is a more natural estuary that connects to area one through a narrow channel (Figure 2). Area 1 is deep in the middle, while area 2 is shallow all around. We were hoping to target all size groups by choosing nearby locations of deep and shallow depth.

Figure 2: Areas 1 and 2 within Moses Lake

Mark and Recapture Study

Collapsible crab pots were placed on sites 1, 2, 3, 4, and 5 to collect and recapture tagged crabs (Figure 3). Each site received 5 collapsible traps. Aside from collapsible crab pots, we also used seines, dip nets and regular crab pots to aid on crab collection. Crabs collected at site n were also released at site n. Mark-recapture events were performed once or twice a week between February 2012 and May 2013.

Figure 3: Sites of trap placement

Due to molting, externally tagging a crab for growth analysis is not an option. Internal tags, such as microwire or coded wire tags (CWTs) and visual implant fluorescent elastomer (VIFE) tags, are preferred for marking crustaceans. Although VIFE tags are cheaper and yield lower immediate mortality than CWTs, the second are preferred due to tag efficiency and longer retention rates (Davis et al. 2004). For those reasons, we opted to used CWT in this study. Tags used were sequential pre-cut CWTs, measuring 1.1 mm long and 0.25 mm diameter the from Northwest Marine Technology (NMT) (Northwest Marine Technology, Shaw Island, Washington 98286).

Tags were inserted into the basal muscle of blue crabs' fifth pereiopod using single shot injector, also from NMT. When correctly inserted, tag retention rates are of 88% through the first molt and 100% after second molt for juvenile blue crabs between 18 and 28 mm carapace width (Eggleston et al. 2004; van Montfrans et al. 1986). Tag retention rates are even higher through first molt when tagging individuals over 29 mm carapace width (98.2% retention rate). CWT have also been found to not interfere on GPM or IP of blue crabs (Eggleston et al. 2004). To assure tags were successfully inserted, we scanned each crab with Handheld Wand Detector by NMT before releasing. In addition to the internal CWT, crabs were also externally marked with blue colored nail polish or paint pain so that we know whether the tagged blue crab have actually molted or not if recaptured.

Figure 4: Tagging a blue crab using single-shot injector and CWT. Photo from Glen Sutton

Recaptured crabs were recognized after being scanned by the Handheld Wand Detector. If a tagged crab still had the external nail polish or paint pen mark, it means that the crab had not yet molted and was then returned to the water. If the external mark was absent, we then brought crabs back to the lab for tag extraction. We carefully dissected recaptured crabs to extract tags, which were read with MagniViewer from NMT. Each tag has 4 sets of numbers: a 2-digit agency code, a 2-digit Data 1 code, a 2-digit Data 2 code (batch number), and a 5 digit sequence number, which is unique to each tag. The sequence number can then be easily matched to its correspondent reference tag sheet, which was used to write down crab's individual information during tagging. All tagged and recaptured crab data from this study has been included in (Table xii) in the tables section of this report.

Crabs Held in Captivity

A total of 24 Fabrill vinyl-coated rectangular minnow traps (18"L x 8"W x 8"H with 1" mesh – Cabella's item #IK-014387) were modified by closing funnel entrance so crabs could not escape once encaged. We then placed modified traps in area 1, side by side, one meter apart. All traps were attached to a long piece of rope that was being held in place by cinderblocks and being marked by buoys.

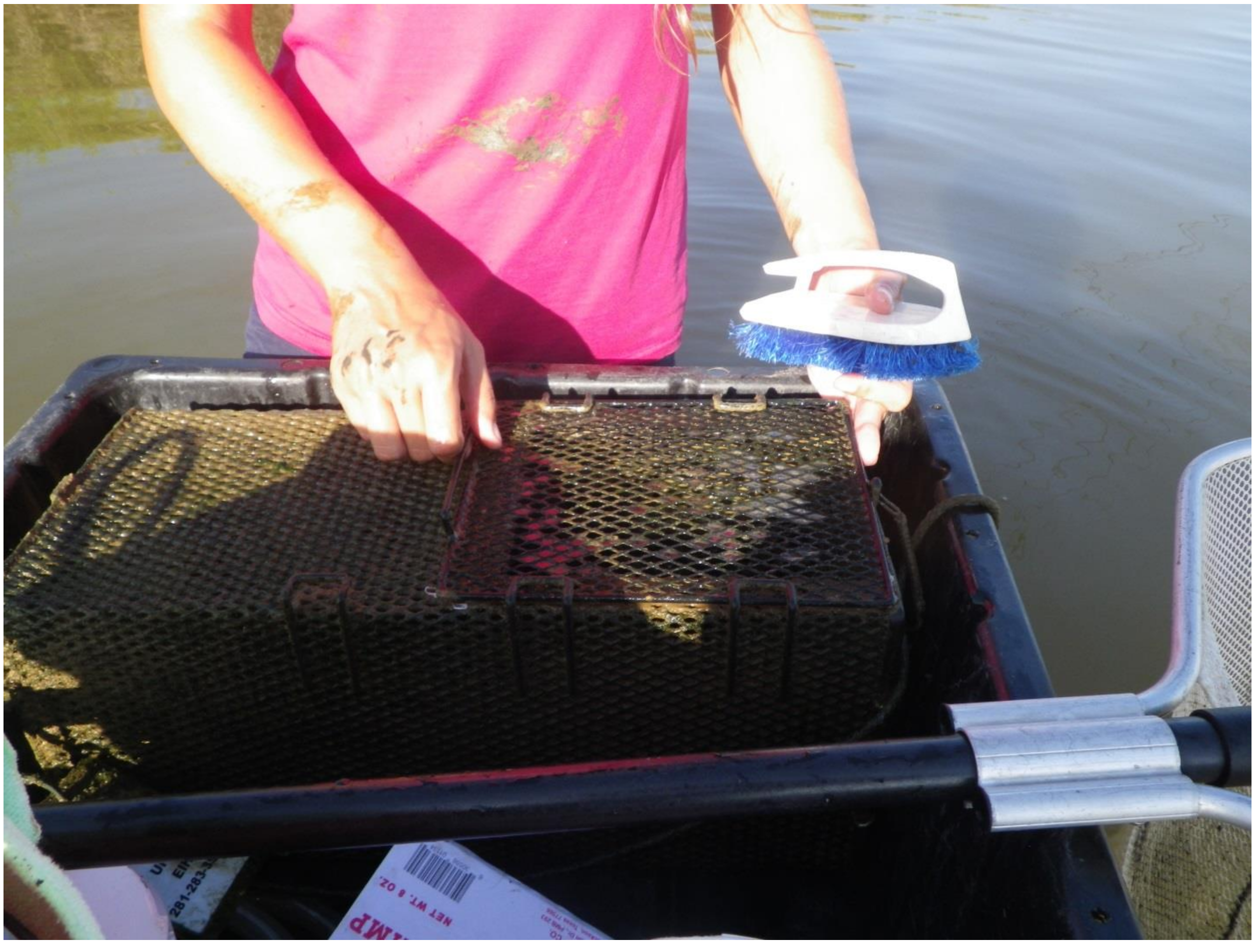

Figure 5: Blue crabs used in cage study were collected with the aid of seines, traps, or dip net. Each crab was measured (carapace width), sexed, tagged using procedure described above, and place into its own individual cage to avoid cannibalism. Molt stage and limb losses were also noted.

Every week, we went to the site and retook all measurements (carapace width, sex, limb losses and molt stage). We also fed a medium size bait shrimp to crabs kept in even numbered traps on a weekly basis. Many blue crab growth studies in the past used frequent or ad libitum feeding (Brylawski and Miller 2006; Leffler 1972; Tagatz 1968), which might influence their growth rates. Our goal was to feed only half of the encaged individuals and see if their growth rates were significantly higher than individuals not being fed weekly. Even though half of the blue crabs in cages were not being fed by us, plenty of food was available. Every week when we went to take measurements, we would find small fishes (golbies, pinfish, etc), small blue crabs, mud crabs, amphipods, muscles, and other individuals that were small enough to pass through the 1” mesh. All caged crab data recorded have been summarized in (Table xi) in the tables section of this report.

Environmental Data

To measure environmental data such as dissolved oxygen (D.O.), salinity, and temperature near cages (site 1), we used Greenspan PH 800 452 5272, model CS304, data logger with battery pack, model BPAA23, both from Stevens, in the years of 2011 and 2012. However, due to technical issues, we switched to using a HOBO conductivity data logger – U24-001 in 2013. We also deployed HOBO conductivity data logger in different occasions near sites 2 and 3.

Weekly field water quality measurements were collected using YSI and water quality kits, and checked side-by-side data loggers deployed in the field to assure accurate measurement. Data logger measurements that did not agree with field measurements were excluded from data analysis of degree days.

All environmental data collected during the study have been summarized in (Table xiii) in the tables section of this report.

RESULTS

Caged crabs study

Growth rate

The growth rate of blue crabs kept in cages had a mean and standard deviation of 0.43mm/day and 0.25mm/day respectively. Descriptive statistics are included in (Table 1). Growth rate distribution presented a right skewed pattern (**Error! Reference source not found.**). Log-transformed growth rates yield a more normal distribution (**Error! Reference source not found.**).

Mean	0.4280293
Std Dev	0.2455959
Std Err Mean	0.0311907
Upper 95% Mean	0.490399
Lower 95% Mean	0.3656597
N	62

Table 1: Growth rate descriptive statistics for caged crabs.

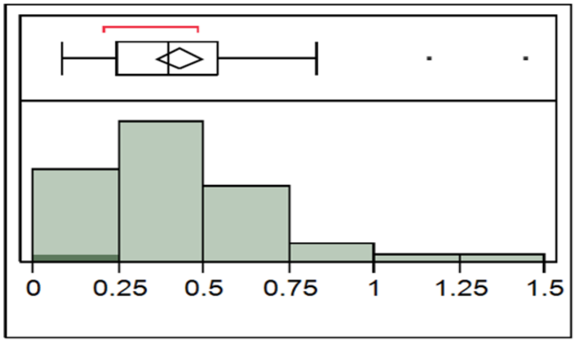

Fig 6: Untransformed growth rate distribution

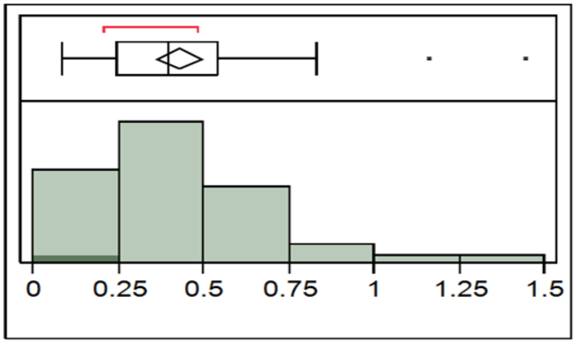

Fig 7: Log transformed growth rate distribution

Effects on growth

We used the log transformed growth rate data to run a generalized linear model to compare the effects of sex, limb losses, average temperature (between growth change measurements), initial size, and whether crabs were weekly fed or not . According to the model, feeding (p=0.0357), limb loses (p=0.0302), and average temperature (p<0.0001) had a significant influence on the growth rates of blue crabs held in cages (Table 2). The plot of residuals for the generalized linear model did not show any patterns, suggesting that no obvious additional factors are influencing results (FFigure 5).

Source	**DF**	**L-R ChiSquare**	**Prob>ChiSq**
Fed(Y/N)	1	4.4119019	0.0357*
Sex	1	3.7681412	0.0522
Limb lost categories	3	8.9331675	0.0302*
Temp	1	16.260449	<.0001*
Pre-molt size	1	2.4938769	0.1143

Table 2; Effects test on growth rates for caged crabs

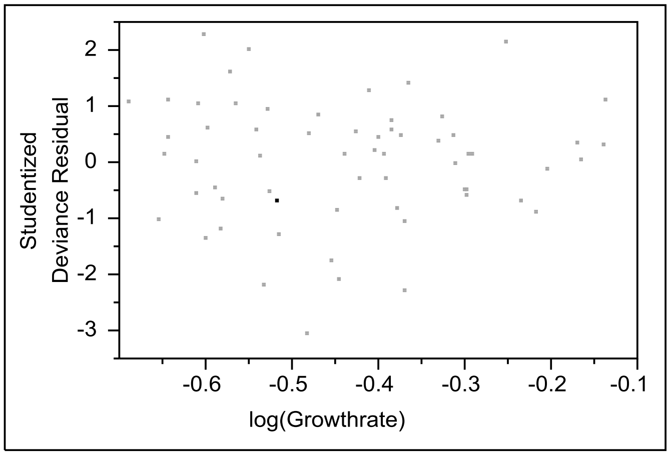

Figure 5: Standardized deviance residual plot of predicted log-transformed growth rate of crabs held in cages

Tag and recapture

Growth rate

The scatter plot of growth rates versus initial carapace width for the tagging data shows that most of the crabs recaptured were less than 50 mm and showed no apparent decreasing trend with increased size (Figure 9). The mean growth rate of the tagging data was slightly higher than growth rate of crabs held in cages (0.48mm/day and 0.43mm/day respectively). The growth rate distribution for the tagging data also showed a right skewed pattern (FFigure 7). Log-transformed rates provide a more normal distribution for analysis (Figure 8).

Mean	0.4759383
Std Dev	0.3905346
Std Err Mean	0.0249503
Upper 95% Mean	0.5250838
Lower 95% Mean	0.4267928
N	245

Table 4: Growth rate statistics for blue crabs tagged and recaptured in the wild

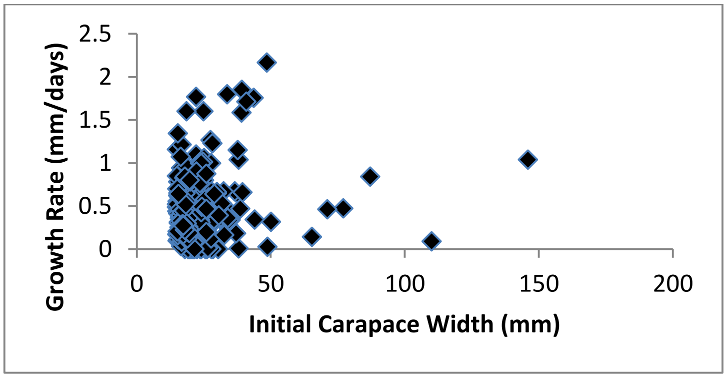

Figure 6: Growth rate of blue crabs tagged and recaptured in the wild as a function of initial carapace width

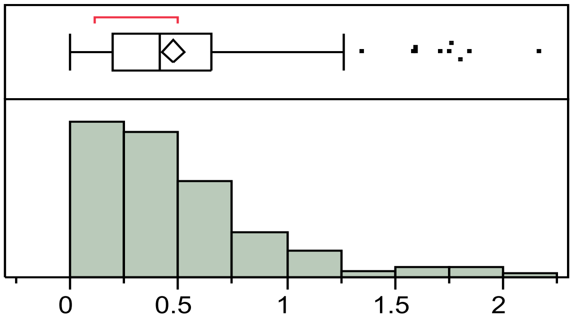

Figure 7: Untransformed growth rate distribution of blue crab tagged and recaptured in the wild

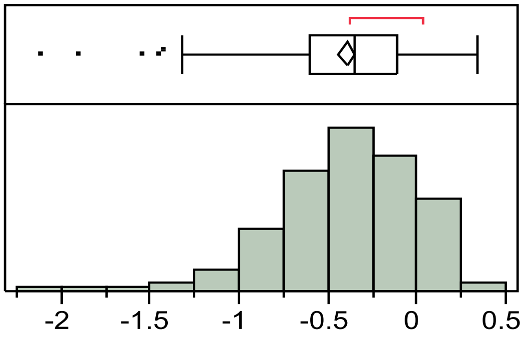

Figure 8: Log-transformed growth rate distribution of blue crab tagged and recaptured in the wild

Effects on growth

We also used the log-transformed tagging data to run a generalized linear model, this time comparing the effects of sex, initial carapace width (size), average temperature, and limb losses. The model suggests that only temperature has an effect on the growth rate of crabs tagged and recaptured in the wild ($p < 0.0001$) (Table 6). The residual plot for this model suggested no obvious additional processes affect the model fit (FFigure 9).

Source	**DF**	**L-R ChiSquare**	**Prob>ChiSq**	
Sex	1	0.337734	0.5611	
Size1	1	0.654521	0.4185	
LL#	5	8.774501	0.1184	
AvgTemp	1	63.82275	<.0001*	

Table 6: Effects tests on growth rates of crabs released into the wild

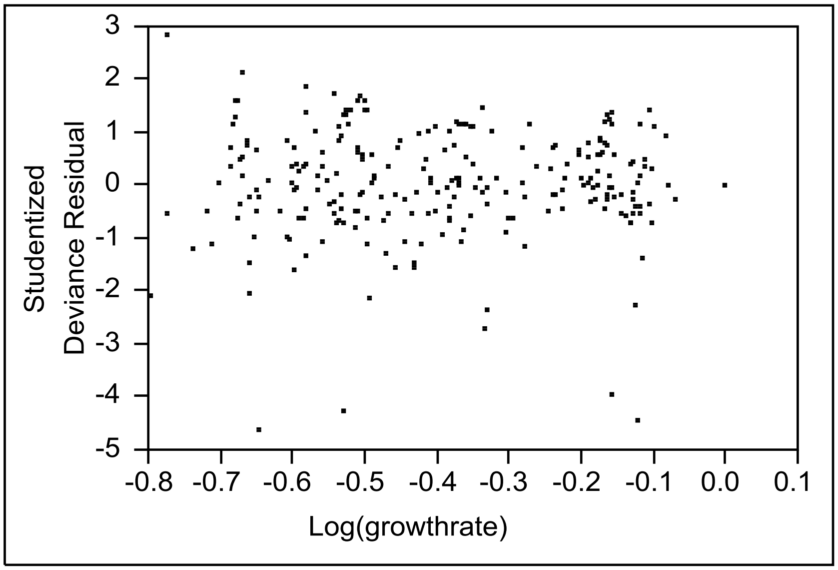

Figure 9: Standardized deviance residual plot of predicted log-transformed growth rate of blue crabs tagged and recaptured in the wild

Growth models

A series of potential growth models are being selected for use with these data to describe and parameterize growth. Initial plans were to analyze the data using specifically developed tagging study growth models, Fabens (1986), Appeldoorn (1987), and Fransis (1988), where growth increment data can be applied to determine parameters L∞ and K. However, preliminary analyses of these data suggest that growth does not follow a typical von Bertallanfy growth trajectory (i.e. deceasing growth rates with increasing size). Therefore, additional models are being considered including a Gompertz (1825) and a temperature dependent molt process growth model (Brylawski and Miller. 2006).

TABLES

Table xi: Raw data for cage study. When molt stage absent, crab was either missing both swimmer or molt stage was not noted during processing.

			Pre-molt				Post-Molt		
Crab #	**Cage #**	**Sex**	**Date**	**Size**	**Molt Stage**	**Limb Losses**	**Date**	**Size**	**Molt Stage**
1	1	F	2/8/2012	19.0	C	0	2/15/2012	22.4	A
1	1	F	2/15/2012	22.4	A	0	3/16/2012	26.8	C
1	1	F	3/16/2012	26.8	C	0	4/4/2012	32.3	C
2	2	F	2/15/2012	24.3	B	1	3/16/2012	31.6	C
3	3	F	2/22/2012	23.1	C	0	3/21/2012	27.9	C
4	4	M	2/8/2012	19.4	C	1	3/16/2012	24.5	D
4	4	M	3/16/2012	24.5	D	1	3/28/2012	30.4	B
5	5	F	2/8/2012	18.9	C	0	3/7/2012	22.9	C
5	5	F	3/7/2012	22.9	C	1	4/4/2012	27.4	C
6	6	M	2/8/2012	18.5	C	0	3/1/2012	23.1	D
6	6	M	3/1/2012	23.1	D	0	3/16/2012	30.0	C
6	6	M	3/16/2012	30.0	C	0	4/4/2012	36.9	C
7	7	M	2/15/2012	20.2	B	0	3/16/2012	23.5	C
7	7	M	3/16/2012	23.5	C	0	4/4/2012	28.0	C
8	8	F	2/22/2012	19.9	C	1	3/7/2012	25.3	C
8	8	F	3/7/2012	25.3	C	0	3/28/2012	32.7	C
9	9	M	2/8/2012	20.6	C	2	3/16/2012	24.4	C
9	9	M	3/16/2012	24.4	C	0	4/4/2012	29.1	C
10	10	F	2/15/2012	19.4	C	1	3/7/2012	24.6	C
10	10	F	3/7/2012	24.6	C	0	3/21/2012	30.7	B
11	12	M	2/15/2012	30.7	D	0	2/22/2012	40.1	C
11	12	M	2/22/2012	40.1	C	0	3/16/2012	50.6	B
12	13	M	2/8/2012	29.0	C	1	3/1/2012	33.7	C
12	13	M	3/1/2012	33.7	C	2	4/4/2012	37.9	-
13	14	M	2/22/2012	32.9	C	0	3/21/2012	39.8	C
14	15	M	2/8/2012	28.6	C	0	2/22/2012	35.2	C
15	16	F	2/22/2012	29.2	D	0	3/1/2012	35.2	C
15	16	F	3/1/2012	35.2	C	0	3/21/2012	48.1	C
24	7	F	5/16/2012	19.0	C	0	5/24/2012	23.6	C
24	7	F	5/24/2012	23.6	C	3	6/8/2012	29.0	C
24	7	F	6/8/2012	29.0	C	4	6/12/2012	35.7	D
24	7	F	6/12/2012	35.7	D	6	7/5/2012	40.0	B
24	7	F	7/5/2012	40.0	B	5	7/27/2012	46.3	C

24	7	F	7/27/2012	46.3	C	7	8/9/2012	55.2	C
24	7	F	8/9/2012	55.2	C	3	8/22/2012	66.9	C
24	7	F	8/22/2012	66.9	C	2	9/19/2012	83.5	-
24	7	F	9/19/2012	83.5	-	3	10/17/2012	99.2	B
25	8	F	3/16/2012	21.5	C	9	6/8/2012	24.7	-
26	9	M	5/24/2012	20.7	C	8	6/8/2012	23.3	D
26	9	M	6/8/2012	23.3	D	2	6/13/2012	29.9	C
26	9	M	6/13/2012	29.9	C	2	6/28/2012	36.4	C
26	9	M	6/28/2012	36.4	C	6	7/13/2012	41.1	C
26	9	M	7/13/2012	41.1	C	5	7/27/2012	47.2	B
26	9	M	7/27/2012	47.2	B	8	8/15/2012	53.6	C
26	9	M	8/15/2012	53.6	C	8	9/12/2012	62.3	-
26	9	M	9/12/2012	62.3	-	7	10/4/2012	74.8	C
30	1	M	5/24/2012	28.6	C	8	6/8/2012	30.7	C
30	1	M	6/8/2012	30.7		8	6/22/2012	34.4	D
30	1	M	6/22/2012	34.4		8	7/5/2012	39.7	C
31	2	M	5/24/2012	24.2	C	2	6/8/2012	29.7	-
31	2	M	6/8/2012	29.7	-	9	6/13/2012	33.6	-
31	2	M	6/13/2012	33.6	-	8	6/28/2012	38.2	D
31	2	M	6/28/2012	38.2	D	2	7/5/2012	45.6	-
31	2	M	7/5/2012	45.6	-	8	7/18/2012	50.7	-
31	2	M	7/18/2012	50.7	-	8	7/31/2012	60.0	-
31	2	M	7/31/2012	60.0	-	8	8/22/2012	69.7	-
31	2	M	8/22/2012	69.7	-	8	9/5/2012	80.2	-
31	2	M	9/5/2012	80.2	-	7	10/10/2012	96.8	-
31	2	M	10/10/2012	96.8	-	5	11/28/2012	117.1	B
31	2	M	11/28/2012	117.1	B	0	3/27/2013	147.0	B
32	3	M	5/24/2012	25.6	C	4	6/8/2012	29.9	C
32	3	M	6/8/2012	29.9	C	1	6/22/2012	38.4	D
32	3	M	6/22/2012	38.4	D	1	6/28/2012	48.1	B
32	3	M	6/28/2012	48.1	B	7	7/27/2012	54.5	C
32	3	M	7/27/2012	54.5	C	8	8/9/2012	61.1	B
32	3	M	8/9/2012	61.1	B	9	8/31/2012	68.2	-
33	4	F	5/24/2012	26.3	C	4	6/8/2012	31.1	-
33	4	F	6/8/2012	31.1	-	6	6/13/2012	38.1	C
33	4	F	6/13/2012	38.1	C	6	6/28/2012	46.2	D
33	4	F	6/28/2012	46.2	D	4	7/5/2012	57.3	C
33	4	F	7/5/2012	57.3	C	7	7/27/2012	67.1	D
33	4	F	7/27/2012	67.1	D	0	8/9/2012	83.5	C
33	4	F	8/9/2012	83.5	C	3	8/31/2012	102.7	B
33	4	F	8/31/2012	102.7	B	0	10/10/2012	122.4	B
33	4	F	10/10/2012	122.4	B	0	4/11/2013	152.5	C
36	10	F	5/24/2012	21.8	C	8	6/8/2012	26.1	C

36	10	F	6/8/2012	26.1	C	7	6/22/2012	29.0	D
36	10	F	6/22/2012	29.0	D	1	6/28/2012	35.9	B
36	10	F	6/28/2012	35.9	B	8	7/18/2012	40.9	-
36	10	F	7/18/2012	40.9	-	7	7/31/2012	44.4	-
36	10	F	7/31/2012	44.4	-	6	8/15/2012	50.0	A
37	11	F	5/24/2012	23.7	D	0	5/30/2012	27.3	-
38	12	F	5/24/2012	19.6	C	0	6/8/2012	21.7	-
39	6	F	6/8/2012	23.6	D	0	6/13/2012	30.6	C
39	6	F	6/13/2012	30.6	C	3	6/28/2012	37.6	D
39	6	F	6/28/2012	37.6	D	2	7/5/2012	46.2	C
39	6	F	7/5/2012	46.2	C	6	7/27/2012	54.9	-
39	6	F	7/27/2012	54.9	-	7	8/9/2012	66.1	C
39	6	F	8/9/2012	66.1	C	0	8/31/2012	85.9	D
39	6	F	8/31/2012	85.9	D	0	9/26/2012	109.1	C
39	6	F	9/26/2012	109.1	C	0	1/2/2013	133.6	B
40	11	F	6/8/2012	17.8	C	1	6/22/2012	22.6	-
40	11	F	6/22/2012	22.6	-	8	6/28/2012	27.8	D
40	11	F	6/28/2012	27.8	D	4	7/5/2012	32.3	C
42	5	M	6/28/2012	19.6	C	0	7/5/2012	23.1	C
42	5	M	7/5/2012	23.1	C	0	7/13/2012	26.8	B
42	5	M	7/13/2012	26.8	B	2	7/27/2012	32.1	C
42	5	M	7/27/2012	32.1	C	8	8/9/2012	37.7	D
42	5	M	8/9/2012	37.7	D	1	8/15/2012	48.5	-
42	5	M	8/15/2012	48.5	-	4	8/31/2012	55.5	D
42	5	M	8/31/2012	55.5	D	1	9/12/2012	69.0	C
42	5	M	9/12/2012	69.0	C	2	10/4/2012	87.3	C
45	8	M	7/5/2012	23.3	C	2	7/13/2012	28.1	D
45	8	M	7/13/2012	28.1	D	0	7/18/2012	35.6	B
45	8	M	7/18/2012	35.6	B	8	8/9/2012	40.3	D
45	8	M	8/9/2012	40.3	D	2	8/15/2012	51.8	D
45	8	M	8/15/2012	51.8	D	5	8/31/2012	61.7	-
45	8	M	8/31/2012	61.7	-	8	9/13/2012	71.2	D
45	8	M	9/13/2012	71.2	D	1	9/26/2012	90.5	A
45	8	M	9/26/2012	90.5	A	0	10/31/2012	110.9	C
45	8	M	10/31/2012	110.9	C	0	3/13/2013	139.0	B
46	12	M	7/5/2012	23.0	C	0	7/13/2012	26.6	C
46	12	M	7/13/2012	26.6	C	0	7/27/2012	34.3	D
46	12	M	7/27/2012	34.3	D	1	7/31/2012	41.2	-
46	12	M	7/31/2012	41.2	-	8	8/9/2012	43.9	B
46	12	M	8/9/2012	43.9	B	5	8/22/2012	52.4	B
46	12	M	8/22/2012	52.4	B	6	9/12/2012	62.5	B
46	12	M	9/12/2012	62.5	B	1	10/4/2012	81.3	-
46	12	M	10/4/2012	81.3	-	3	10/24/2012	101.4	C

46	12	M	10/24/2012	101.4		3	2/27/2013	125.0	C
46	12	M	2/27/2013	125.0	C	0	5/15/2013	144.3	C
49	15	M	7/5/2012	30.5	-	8	7/27/2012	34.2	D
49	15	M	7/27/2012	34.2	D	7	8/15/2012	40.3	D
49	15	M	8/15/2012	40.3	D	2	8/31/2012	48.2	-
49	15	M	8/31/2012	48.2	-	8	9/12/2012	57.9	D
49	15	M	9/12/2012	57.9	D	2	9/26/2012	75.2	-
52	18	F	7/5/2012	29.9	C	9	7/18/2012	33.3	C
52	18	F	7/18/2012	33.3	C	2	7/27/2012	38.2	B
52	18	F	7/27/2012	38.2	C	3	8/9/2012	48.8	C
52	18	F	8/9/2012	48.8	C	4	8/31/2012	59.4	D
52	18	F	8/31/2012	59.4	D	2	9/12/2012	73.9	C
52	18	F	9/12/2012	73.9	C	0	10/4/2012	95.6	D
52	18	F	10/4/2012	95.6	D	0	11/14/2012	117.7	C
52	18	F	11/14/2012	117.7	C	0	4/11/2013	155.9	B
53	19	F	7/5/2012	30.5	C	6	7/18/2012	33.9	-
53	19	F	7/18/2012	33.9	-	5	7/27/2012	38.6	B
53	19	F	7/27/2012	38.6	B	9	8/9/2012	43.6	C
53	19	F	8/9/2012	43.6	C	8	8/22/2012	49.6	B
53	19	F	8/22/2012	49.6	B	0	9/5/2012	64.5	C
53	19	F	9/5/2012	64.5	C	0	9/19/2012	84.1	B
53	19	F	9/19/2012	84.1	B	2	10/17/2012	101.4	A
54	20	F	7/5/2012	34.8	-	9	7/27/2012	36.7	-
57	23	M	7/5/2012	20.3	C	3	7/18/2012	23.5	C
57	23	M	7/18/2012	23.5	C	0	7/27/2012	28.6	C
57	23	M	7/27/2012	28.6	C	1	8/9/2012	35.8	-
57	23	M	8/9/2012	35.8	-	8	8/15/2012	40.6	C
57	23	M	8/15/2012	40.6		8	9/5/2012	46.1	C
57	23	M	9/5/2012	46.1	C	3	9/12/2012	59.1	B
57	23	M	9/12/2012	59.1	B	4	10/4/2012	74.3	C
57	23	M	10/4/2012	74.3	C	0	10/31/2012	87.1	B
59	1	M	7/13/2012	25.1	D	1	7/18/2012	30.9	-
60	24	F	7/13/2012	26.9	C	8	7/31/2012	29.2	-
60	24	F	7/31/2012	29.2	-	5	8/9/2012	34.4	-
60	24	F	8/9/2012	34.4	-	3	8/15/2012	42.4	C
60	24	F	8/15/2012	42.4	C	4	8/31/2012	53.8	D
61	17	M	7/13/2012	26.1	D	4	7/27/2012	30.6	D
61	17	M	7/27/2012	30.6	D	4	8/9/2012	38.3	D
61	17	M	8/9/2012	38.3	D	1	8/15/2012	48.3	C
61	17	M	8/15/2012	48.3	C	0	8/31/2012	62.8	D
61	17	M	8/31/2012	62.8	D	0	9/12/2012	81.3	B
61	17	M	9/12/2012	81.3	B	3	10/10/2012	97.6	C
62	22	M	7/13/2012	20.4	C	0	7/27/2012	25.9	D

62	22	M	7/27/2012	25.9	D	6	7/31/2012	30.8	-
62	22	M	7/31/2012	30.8	-	7	8/9/2012	35.8	C
62	22	M	8/9/2012	35.8	C	5	8/22/2012	44.5	-
62	22	M	8/22/2012	44.5	-	1	8/31/2012	56.4	D
62	22	M	8/31/2012	56.4	D	0	9/12/2012	72.0	-
62	22	M	9/12/2012	72.0	-	7	9/26/2012	88.2	B
62	22	M	9/26/2012	88.2	B	0	10/31/2012	111.6	C
62	22	M	10/31/2012	111.6	C	5	3/13/2013	137.1	B
63	13	F	7/13/2012	27.6	D	0	7/18/2012	34.8	-
64	14	M	7/18/2012	25.6	C	0	7/27/2012	31.0	C
64	14	M	7/27/2012	31.0	C	3	8/9/2012	37.2	C
64	14	M	8/9/2012	37.2	C	0	8/15/2012	50.4	B
64	14	M	8/15/2012	50.4	B	0	8/31/2012	63.3	D
64	14	M	8/31/2012	63.3	D	0	9/12/2012	81.3	B
64	14	M	9/12/2012	81.3	B	0	10/10/2012	102.9	B
64	14	M	10/10/2012	102.9	B	1	2/27/2013	121.4	B
65	1	M	7/31/2012	20.5	-	0	8/9/2012	24.6	C
65	1	M	8/9/2012	24.6	C	0	8/15/2012	31.5	C
65	1	M	8/15/2012	31.5	C	0	8/31/2012	40.6	D
65	1	M	8/31/2012	40.6	D	3	9/5/2012	50.6	C
65	1	M	9/5/2012	50.6	C	1	9/19/2012	62.2	C
65	1	M	9/19/2012	62.2	C	0	10/10/2012	79.6	C
65	1	M	10/10/2012	79.6	C	1	10/31/2012	97.1	B
66	11	F	7/31/2012	54.1	-	8	8/15/2012	60.7	D
66	11	F	8/15/2012	60.7	D	7	8/31/2012	70.9	C
66	11	F	8/31/2012	70.9	C	6	9/26/2012	81.5	B
66	11	F	9/26/2012	81.5	B	2	10/31/2012	95.2	C
68	16	M	7/31/2012	41.3	-	8	8/15/2012	47.5	-
68	16	M	8/15/2012	47.5	-	8	8/31/2012	54.0	D
68	16	M	8/31/2012	54.0	D	4	9/12/2012	65.8	C
68	16	M	9/12/2012	65.8	C	0	10/4/2012	84.3	
69	20	F	7/31/2012	28.4	-	10	8/15/2012	30.0	-
70	21	F	7/31/2012	25.5	-	0	8/9/2012	32.1	B
70	21	F	8/9/2012	32.1	B	3	8/22/2012	39.4	C
70	21	F	8/22/2012	39.4	C	8	9/5/2012	45.8	D
70	21	F	9/5/2012	45.8	D	0	9/12/2012	57.9	B
70	21	F	9/12/2012	57.9	B	1	9/26/2012	74.1	B
70	21	F	9/26/2012	74.1	B	0	11/7/2012	84.0	C
71	13	M	8/9/2012	19.4	C	0	8/15/2012	24.3	C
71	13	M	8/15/2012	24.3	C	3	8/31/2012	38.3	B
71	13	M	8/31/2012	38.3	B	1	9/12/2012	47.2	-
71	13	M	9/12/2012	47.2	-	8	9/26/2012	57.9	C
71	13	M	9/26/2012	57.9	C	0	10/10/2012	73.6	B

71	13	M	10/10/2012	73.6	B	5	11/7/2012	90.4	C
72	10	M	8/22/2012	21.8	D	0	8/31/2012	26.2	-
72	10	M	8/31/2012	26.2	-	8	9/5/2012	29.4	B
72	10	M	9/5/2012	29.4	B	6	9/19/2012	36.0	C
72	10	M	9/19/2012	36.0	C	2	10/4/2012	46.6	C
72	10	M	10/4/2012	46.6	C	1	10/17/2012	63.7	C
72	10	M	10/17/2012	63.7	C	2	11/7/2012	81.9	B
72	10	M	11/7/2012	81.9	B	7	1/16/2013	88.8	A
72	10	M	1/16/2013	88.8	A	5	3/27/2013	103.5	B
72	10	M	3/27/2013	103.5	B	1	5/15/2013	129.0	B
74	20	M	8/31/2012	23.0	B	4	9/12/2012	26.9	B
74	20	M	9/12/2012	26.9	B	9	9/26/2012	30.6	-
74	20	M	9/26/2012	30.6	-	8	10/17/2012	37.0	C
74	20	M	10/17/2012	37.0	-	8	11/14/2012	43.8	B
74	20	M	11/14/2012	43.8	-	7	1/31/2013	51.2	C
74	20	M	1/31/2013	51.2	C	1	3/20/2013	62.6	C
74	20	M	3/20/2013	62.6	C	0	4/24/2013	78.8	C
75	24	M	9/5/2012	24.0	B	0	9/12/2012	31.1	B
75	24	M	9/12/2012	31.1	B	0	9/26/2012	41.5	-
75	24	M	9/26/2012	41.5	-	6	10/4/2012	49.3	B
75	24	M	10/4/2012	49.3	B	0	10/24/2012	61.0	-
75	24	M	10/24/2012	61.0	-	8	11/28/2012	71.4	B
75	24	M	11/28/2012	71.4	B	3	2/21/2013	88.8	B
75	24	M	2/21/2013	88.8	B	1	4/17/2013	114.6	C
76	3	F	9/26/2012	18.6	C	0	10/4/2012	23.3	C
76	3	F	10/4/2012	23.3	C	0	10/17/2012	30.3	D
76	3	F	10/17/2012	30.3	D	0	10/24/2012	37.1	B
76	3	F	10/24/2012	37.1	B	6	11/28/2012	43.0	B
76	3	F	11/28/2012	43.0	B	0	2/4/2013	53.7	B
76	3	F	2/4/2013	53.7	B	4	3/27/2013	67.5	B
76	3	F	3/27/2013	67.5	B	0	5/8/2013	83.4	C
77	15	F	10/24/2012	21.8	C	0	11/7/2012	30.2	C
77	15	F	11/7/2012	30.2	C	1	12/7/2012	37.9	C
77	15	F	12/7/2012	37.9	C	2	2/13/2013	46.7	C
77	15	F	2/13/2013	46.7	C	2	3/27/2013	62.5	D
77	15	F	3/27/2013	62.5	D	1	4/24/2013	82.3	B
78	16	F	10/31/2012	21.0	D	0	11/7/2012	27.5	B
78	16	F	11/7/2012	27.5	B	3	12/12/2012	34.0	C
78	16	F	12/12/2012	34.0	C	3	2/13/2013	41.0	A
80	19	F	1/21/2013	21.7	C	1	2/4/2013	24.9	C
80	19	F	2/4/2013	24.9	C	3	3/27/2013	28.9	D
80	19	F	3/27/2013	28.9	D	3	4/24/2013	34.9	B
80	19	F	4/24/2013	34.9	B	1	5/15/2013	45.8	B

81	17	M	1/21/2013	18.7	C	0	2/13/2013	23.2	C
81	17	M	2/13/2013	23.2	C	0	3/6/2013	29.9	C
81	17	M	3/6/2013	29.9	C	0	3/27/2013	37.9	C
81	17	M	3/27/2013	37.9	C	4	4/27/2013	47.1	C
82	11	M	1/21/2013	18.1	C	0	2/4/2013	23.6	C
82	11	M	2/4/2013	23.6	C	1	3/13/2013	30.1	C
82	11	M	3/13/2013	30.1	C	0	3/27/2013	39.7	B
82	11	M	3/27/2013	39.7	B	0	4/24/2013	52.4	C
83	23	F	1/31/2013	19.8	C	0	2/27/2013	25.2	C
83	23	F	2/27/2013	25.2	C	4	3/27/2013	30.5	A
84	7	F	1/31/2013	21.9	C	0	2/4/2013	27.0	A
84	7	F	2/4/2013	27.0	A	0	3/6/2013	34.8	C
84	7	F	3/6/2013	34.8	C	0	3/27/2013	45.0	A
84	7	F	3/27/2013	45.0	A	1	4/24/2013	57.7	A
88	13	M	3/13/2013	22.0	C	0	3/20/2013	30.1	C
88	13	M	3/20/2013	30.1	C	4	4/24/2013	40.1	C
89	23	M	4/11/2013	18.9	C	1	4/17/2013	22.2	C
86	1	M	3/6/2013	22.9	C	0	3/20/2013	29.1	C
86	1	M	3/20/2013	29.1	C	0	4/3/2013	38.7	B
86	1	M	4/3/2013	38.7	B	1	5/1/2013	50.2	D
87	5	M	3/6/2013	20.2	C	1	3/20/2013	27.2	A
87	5	M	3/20/2013	27.2	A	1	4/11/2013	35.4	C
87	5	M	4/11/2013	35.4	C	3	5/15/2013	45.2	C

Table xii: Data for tagging study. When molt stage absent, crab was either missing both swimmer or molt stage was not noted during processing

		Tag Info				Recapture Info		
Crab #	**Sex**	**Date**	**Size (mm)**	**LL#**	**Molt Stage**	**Date**	**Size (mm)**	**Molt Stage**
1	M	2/3/2012	28.4	5	-	3/2/2012	28.3	-
2	M	2/3/2012	24.5	0	D	3/2/2012	32.1	C
3	F	2/3/2012	22.9	0	C	3/2/2012	30.0	C
4	F	2/3/2012	34.9	1	C	3/2/2012	44.7	B
5	F	2/3/2012	25.4	1	C	3/2/2012	32.2	C
6	F	2/3/2012	27.5	1	C	3/2/2012	32.0	B
7	M	2/3/2012	27.7	0	D	3/2/2012	35.5	D
8	F	2/3/2012	19.4	0	D	3/2/2012	24.1	C
9	M	2/3/2012	17.1	1	C	3/2/2012	22.3	C
10	M	2/3/2012	24.2	0	D	4/2/2012	38.7	-
11	F	2/3/2012	25.5	0	D	4/2/2012	32.0	-
12	F	2/3/2012	28.0	3	C	4/2/2012	32.2	-
13	M	2/3/2012	25.2	1	C	3/5/2012	28.9	-
14	M	2/3/2012	25.5	0	C	4/2/2012	32.4	-
15	M	2/3/2012	19.4	0	D	3/2/2012	24.1	C
16	M	3/5/2012	23.7	1	B	4/2/2012	23.7	-
17	M	6/22/2012	38.2	0	D	7/5/2012	46.3	D
18	M	6/28/2012	43.6	0	C	7/5/2012	55.9	C
19	M	7/5/2012	38.0	0	D	7/13/2012	46.3	D
20	M	6/22/2012	21.5	1	C	7/13/2012	32.7	-
21	M	7/19/2012	19.7	0	C	7/23/2012	19.7	D
22	F	7/20/2012	22.1	0	D	7/23/2012	27.4	B
23	M	7/20/2012	34.9	4	D	7/30/2012	39.2	-
24	M	7/25/2012	22.1	0	E	7/30/2012	27.6	-
25	F	7/23/2012	17.2	0	D	7/30/2012	21.6	-
26	M	7/25/2012	20.7	1	C	7/30/2012	20.7	-
27	M	7/23/2012	39.1	0	D	8/7/2012	62.9	C
28	F	7/25/2012	15.1	2	C	8/7/2012	20.8	C
29	M	7/20/2012	22.8	0	D	8/7/2012	37.4	D
30	M	7/23/2012	23.3	0	D	8/7/2012	38.0	D
31	F	7/30/2012	17.2	0	-	8/7/2012	20.7	C
32	F	7/25/2012	22.9	4	C	8/7/2012	27.6	D
33	M	7/20/2012	27.1	0	D	8/8/2012	40.3	D
34	M	7/26/2012	18.0	0	C	8/9/2012	21.8	D
35	M	7/26/2012	26.9	0	D	8/9/2012	35.3	D
36	M	7/31/2012	18.4	0	-	8/9/2012	22.6	D

37	F	7/31/2012	20.2	0	-	8/9/2012	25.1	D
38	M	8/7/2012	18.7	0	C	8/13/2012	22.1	B
39	F	7/30/2012	36.6	0	-	8/13/2012	46.0	D
40	F	8/7/2012	30.4	0	C	8/13/2012	30.2	D
41	M	8/7/2012	33.7	1	D	8/13/2012	44.5	C
42	F	8/7/2012	20.3	2	C	8/13/2012	25.4	C
43	F	8/7/2012	48.5	0	D	8/13/2012	61.5	C
44	M	7/30/2012	23.7	0	-	8/13/2012	34.5	B
45	M	7/25/2012	19.7	0	D	8/13/2012	29.2	D
46	F	8/7/2012	21.7	1	C	8/13/2012	27.4	C
47	F	8/7/2012	22.5	1	C	8/13/2012	22.4	D
48	M	8/8/2012	39.2	1	D	8/14/2012	50.3	D
49	M	7/31/2012	16.4	0	-	8/14/2012	22.4	B
50	M	8/8/2012	18.4	1	0	8/14/2012	22.1	C
51	M	8/8/2012	20.8	0	C	8/14/2012	25.9	C
52	F	8/8/2012	27.8	3	C	8/14/2012	27.7	D
53	F	7/25/2012	15.9	0	D	8/14/2012	27.9	D
54	M	8/8/2012	27.5	1	D	8/14/2012	35.1	D
55	F	8/9/2012	15.4	0	C	8/15/2012	20.1	D
56	F	7/30/2012	32.4	0	-	8/20/2012	46.5	C
57	F	8/13/2012	16.5	0	D	8/20/2012	23.1	B
58	M	8/13/2012	25.1	0	C	8/20/2012	32.5	C
59	F	8/13/2012	18.0	0	C	8/20/2012	21.6	C
60	M	8/13/2012	20.3	3	D	8/20/2012	25.1	D
61	F	8/13/2012	25.1	0	C	8/20/2012	30.7	C
62	M	8/7/2012	24.1	0	D	8/20/2012	36.6	C
63	M	8/13/2012	19.1	1	D	8/20/2012	22.9	D
64	F	8/14/2012	15.5	0	C	8/21/2012	20.1	C
65	F	8/14/2012	65.3	0	B	8/21/2012	66.3	C
66	M	8/14/2012	48.8	0	B	8/21/2012	49.0	D
67	F	8/14/2012	16.0	2	C	8/21/2012	18.5	C
68	M	8/14/2012	15.2	0	C	8/21/2012	19.1	C
69	F	8/14/2012	17.3	3	C	8/21/2012	20.3	D
70	F	8/14/2012	28.2	0	C	8/21/2012	36.8	C
71	F	8/14/2012	18.0	0	C	8/21/2012	22.9	D
72	M	8/14/2012	18.3	0	C	8/21/2012	22.9	D
73	M	8/14/2012	15.0	0	C	8/21/2012	23.1	C
74	M	8/20/2012	19.1	1	D	8/29/2012	23.6	D
75	F	8/21/2012	40.9	0	C	8/29/2012	54.6	C
76	M	8/21/2012	15.0	0	C	8/29/2012	18.9	D
77	M	8/8/2012	22.5	0	C	8/29/2012	33.0	C
78	M	8/21/2012	16.8	0	D	8/29/2012	26.5	C
79	M	8/21/2012	19.0	2	C	8/29/2012	22.5	C

80	F	8/21/2012	17.5	2	C	8/31/2012	22.5	D
81	M	8/21/2012	110.0	4	-	8/31/2012	110.9	-
82	M	8/31/2012	18.6	1	D	9/5/2012	23.4	C
83	M	8/31/2012	24.9	0	D	9/5/2012	32.9	C
84	M	8/29/2012	18.5	0	D	9/6/2012	31.3	B
85	F	8/31/2012	15.0	2	C	9/12/2012	25.2	C
86	M	8/20/2012	38.6	0	D	9/6/2012	46.6	D
87	M	8/7/2012	17.7	0	C	9/6/2012	36.0	D
88	F	8/29/2012	19.8	0	D	9/6/2012	24.1	C
89	M	8/31/2012	37.7	0	B	9/12/2012	51.5	C
90	M	8/29/2012	20.5	0	B	9/6/2012	25.1	C
91	F	8/13/2012	15.0	2	C	9/6/2012	27.5	C
92	F	8/29/2012	27.7	1	D	9/6/2012	35.7	D
93	M	8/29/2012	18.8	0	C	9/6/2012	19.1	D
94	F	8/29/2012	20.8	1	C	9/6/2012	26.5	C
95	F	9/6/2012	18.4	0	D	9/20/2012	29.6	D
96	M	10/10/2012	23.8	0	D	10/24/2012	29.9	D
97	F	10/17/2012	23.5	0	D	10/24/2012	30.5	B
98	F	9/20/2012	16.6	0	C	10/11/2012	26.0	D
99	M	10/3/2012	25.6	0	C	10/10/2012	25.0	C
100	F	9/20/2012	17.2	2	D	10/11/2012	20.0	D
101	F	10/3/2012	21.2	0	C	10/11/2012	21.2	D
102	M	9/9/2012	17.8	0	C	10/31/2012	29.5	C
103	F	9/20/2012	16.4	0	C	10/11/2012	18.1	C
104	F	10/11/2012	25.8	0	C	10/25/2012	31.6	C
105	M	10/11/2012	20.8	1	E	10/25/2012	28.4	B
106	M	10/11/2012	18.5	0	C	10/25/2012	22.5	C
107	F	10/11/2012	19.8	0	C	10/18/2012	24.9	B
108	M	10/10/2012	24.8	0	D	10/17/2012	31.9	C
109	M	9/19/2012	17.3	0	C	10/4/2012	20.6	C
110	F	10/18/2012	24.0	0	D	10/25/2012	31.0	B
111	F	10/18/2012	20.2	0	B	10/25/2012	20.1	D
112	M	10/18/2012	15.4	0	C	10/25/2012	18.3	C
113	M	10/18/2012	26.2	0	C	10/25/2012	26.0	D
114	F	10/11/2012	16.0	0	C	10/25/2012	19.5	C
115	M	10/11/2012	18.2	1	C	10/18/2012	21.5	B
116	M	8/29/2012	15.5	1	D	9/20/2012	30.8	D
117	M	10/18/2012	15.3	0	D	10/25/2012	24.7	B
118	M	10/11/2012	22.9	0	D	10/18/2012	27.1	C
119	M	9/5/2012	29.9	0	B	9/19/2012	39.0	D
120	F	10/11/2012	19.9	0	C	10/25/2012	24.8	C
121	M	9/6/2012	15.4	0	C	9/20/2012	24.1	C
122	M	9/11/2012	16.0	0	C	9/19/2012	19.1	B

123	F	9/6/2012	15.6	0	C	9/20/2012	24.6	B
124	M	9/6/2012	17.6	0	C	10/3/2012	30.8	C
125	M	10/10/2012	29.1	0	C	10/24/2012	38.1	C
126	F	9/20/2012	17.8	0	B	10/3/2012	21.9	C
127	F	9/20/2012	15.9	0	C	10/3/2012	19.2	C
128	F	11/7/2012	21.6	0	D	11/18/2012	27.9	D
129	F	11/8/2012	18.2	2	C	11/16/2012	23.4	B
130	F	11/8/2012	18.2	2	C	11/16/2012	22.4	B
131	M	11/7/2012	20.1	0	C	11/21/2012	25.0	C
132	F	11/7/2012	25.8	0	D	11/21/2012	32.0	C
133	F	11/7/2012	23.1	0	D	11/21/2012	29.9	D
134	F	10/10/2012	19.9	0	C	11/21/2012	28.7	C
135	M	10/31/2012	24.0	0	C	11/21/2012	24.0	D
136	M	9/19/2012	15.7	1	C	11/21/2012	34.8	C
137	M	10/25/2012	23.3	0	C	11/8/2012	29.7	D
138	M	10/11/2012	34.1	1	D	11/8/2012	42.1	D
139	F	10/25/2012	29.9	0	C	11/8/2012	39.2	D
140	F	10/25/2012	16.4	0	C	11/8/2012	21.9	D
141	F	10/11/2012	17.8	0	B	11/8/2012	27.1	B
142	M	10/25/2012	16.6	0	C	11/8/2012	20.8	C
143	M	10/25/2012	16.6	0	B	11/8/2012	20.2	B
144	M	10/31/2012	16.9	0	C	11/21/2012	23.2	C
145	F	10/31/2012	22.2	0	D	11/7/2012	28.5	C
146	F	11/8/2012	16.1	3	D	11/16/2012	21.6	C
147	M	11/8/2012	21.5	0	B	11/16/2012	21.5	D
148	F	10/25/2012	28.4	1	C	11/16/2012	35.8	C
149	F	11/8/2012	16.0	2	C	11/16/2012	19.7	C
150	F	11/8/2012	26.5	0	C	11/16/2012	26.6	D
151	M	11/8/2012	18.0	4	C	11/29/2012	17.9	D
152	M	11/8/2012	18.8	0	C	11/29/2012	22.9	C
153	F	11/16/2012	21.0	0	C	11/29/2012	22.5	C
154	M	11/8/2012	19.1	0	C	11/29/2012	22.0	B
155	F	11/16/2012	19.3	1	D	11/29/2012	23.3	B
156	M	11/16/2012	19.1	0	A	11/29/2012	18.2	C
157	F	11/16/2012	38.0	1	B	11/29/2012	38.1	D
158	F	10/31/2012	21.7	0	D	1/2/2013	36.9	C
159	F	11/21/2012	24.7	1	C	12/19/2012	31.6	D
160	F	10/31/2012	18.9	2	C	12/19/2012	28.8	C
161	M	10/31/2012	23.5	1	C	12/19/2012	40.1	C
162	M	11/21/2012	44	3	D	12/19/2012	53.6	C
163	F	11/16/2012	24.7	0	C	12/14/2012	30.0	D
164	F	11/21/2012	15.2	0	C	12/19/2012	17.9	C
165	M	11/29/2012	23.2	0	C	12/14/2012	29.9	D

166	F	11/29/2012	39.4	1	D	12/14/2012	49.3	B
167	F	11/16/2012	21.9	0	D	12/14/2012	27.6	C
168	M	11/16/2012	22.6	3	D	12/14/2012	33.3	B
169	F	1/15/2013	20.6	0	--	2/14/2013	24.6	D
170	F	12/14/2012	17.1	0	B	2/14/2013	20.1	C
171	M	1/10/2013	16	0	C	2/14/2013	26.6	C
172	M	1/10/2013	17	1	C	2/14/2013	19.6	C
173	M	12/7/2012	19.2	1	C	1/21/2013	22.5	C
174	M	11/29/2012	34.3	0	D	2/14/2013	53.3	B
175	M	1/10/2013	23.7	0	C	2/14/2013	36.8	C
176	M	11/16/2012	15.6	2	C	12/14/2012	18.8	C
177	M	11/29/2012	22.4	3	D	12/14/2012	27.7	C
178	M	11/8/2012	17.6	2	D	12/14/2012	27.0	C
179	M	12/19/2012	27.7	0	C	2/13/2013	34.6	C
180	F	12/14/2012	37.1	3	D	1/23/2013	44.5	D
181	F	10/31/2012	24.3	1	C	12/7/2012	30.2	D
182	M	11/7/2012	19.3	0	C	12/7/2012	24.1	C
183	F	11/2/2012	25.2	0	D	12/7/2012	32.2	C
184	M	11/29/2012	16.5	2	C	1/10/2013	18.0	C
185	F	11/8/2012	15.5	3	C	1/10/2013	22.5	C
186	M	12/19/2012	16.7	2	D	2/4/2013	20.7	C
187	M	12/7/2012	21.3	1	C	2/4/2013	25.8	C
188	F	10/10/2012	15.1	0	C	2/4/2013	35.4	D
189	F	1/2/2013	35	0	D	2/4/2013	46.2	D
190	F	11/21/2012	34.4	0	C	2/4/2013	59.7	B
191	M	10/10/2012	34	0	C	2/4/2013	76.4	C
192	M	10/31/2012	20.9	1	C	12/17/2012	40.6	C
193	F	2/4/2013	15.3	0	D	3/13/2013	21.4	C
194	F	3/14/2013	17.7	0	C	3/21/2013	23.5	B
195	F	3/14/2013	18.3	0	C	3/21/2013	23.8	C
196	F	2/4/2013	18.1	1	C	3/13/2013	22.9	C
197	F	12/7/2012	32.6	2	C	3/13/2013	48.3	C
198	M	2/14/2013	77.1	0	C	3/28/2013	97.0	C
199	M	3/20/2013	16.4	0	C	3/27/2013	23.9	B
200	M	3/21/2013	16.7	1	C	3/28/2013	19.7	C
201	M	2/4/2013	87.1	0	D	3/13/2013	118.2	C
202	M	10/31/2012	31.8	0	C	3/27/2013	109.7	A
203	M	3/20/2013	18.5	1	D	3/27/2013	22.4	C
204	M	12/19/2012	26.1	0	D	3/13/2013	44.3	C
205	F	3/13/2013	17.1	0	C	3/27/2013	20.7	C
206	M	2/27/2013	17.8	1	C	3/27/2013	22.1	C
207	M	2/4/2013	23.8	0	C	2/27/2013	30.9	C
208	F	3/21/2013	15.1	0	C	3/28/2013	20.0	C

209	F	3/13/2013	15.7	0	C	3/27/2013	20.1	D
210	F	2/14/2013	21.5	1	A	3/14/2013	20.8	D
211	F	3/21/2013	18	0	D	3/28/2013	23.9	C
212	M	4/3/2013	16.4	1	C	4/17/2013	20.3	C
213	M	4/10/2013	17.2	1	C	5/1/2013	20.7	C
214	M	4/3/2013	21.5	0	D	4/17/2013	27.5	C
215	M	3/27/2013	18.1	1	C	4/17/2013	22.8	D
216	M	4/3/2013	19.3	0	C	4/17/2013	22.9	C
217	M	2/21/2013	16.4	0	C	4/17/2013	34.5	C
218	M	4/2/2013	18.9	1	C	5/1/2013	22.5	C
219	M	4/2/2013	145.9	1	D	5/1/2013	176.0	C
220	M	3/14/2013	71.1	0	D	5/1/2013	93.3	D
221	M	4/3/2013	17.6	0	C	5/1/2013	30.0	C
222	M	3/13/2013	18.3	0	C	4/3/2013	29.2	A
223	F	3/27/2013	15.5	0	D	4/3/2013	20.0	B
224	F	3/20/2013	25.5	0	C	4/3/2013	33.6	C
225	F	3/13/2013	19.6	1	C	4/3/2013	24.5	C
226	F	3/21/2013	30.6	0	C	5/1/2013	46.7	B
227	M	4/2/2013	19.2	0	C	5/1/2013	24.8	D
228	F	3/20/2013	28.9	0	D	4/3/2013	37.9	D
229	M	3/13/2013	16.1	0	C	4/3/2013	20.5	N/A
230	M	3/27/2013	18.7	1	D	4/11/2013	23.2	C
231	F	3/27/2013	17.4	0	D	4/11/2013	20.0	C
232	F	3/27/2013	15.2	0	D	4/11/2013	18.3	C
233	F	3/27/2013	20	0	D	4/3/2013	25.5	A
234	F	4/3/2013	25.9	0	B	5/1/2013	31.5	C
235	M	3/21/2013	23.5	0	C	4/2/2013	32.7	B
236	F	12/7/2012	19.6	1	C	4/11/2013	43.2	C
237	M	4/2/2013	19.7	0	C	4/10/2013	26.1	C
238	F	3/21/2013	17.1	0	B	4/10/2013	22.9	D
239	M	4/2/2013	25.9	0	C	4/10/2013	32.9	C
240	M	3/28/2013	24	0	C	4/10/2013	29.6	B
241	F	3/28/2013	24.3	0	C	4/10/2013	30.7	C
242	F	4/3/2013	18	0	C	5/15/2013	27.5	D
243	F	4/10/2013	17.3	1	B	5/22/2013	28.8	B
244	F	4/10/2013	50.1	0	B	5/22/2013	63.5	C
245	M	8/7/2012	25.9	0	D	5/27/2013	162.0	C

Table xiii. Environmental data collected at study site. Temperature data points marked with * indicate that these values were unavailable and calculated using the average temperate values for the days preceding and following the unavailable period. Data points marked with an – indicate data was unavailable (instrument failure).

Date	Daily Average Temperature	Daily Average Salinity	DataSource
1/1/2012	13.94	-	TWDB
1/2/2012	13.26	-	TWDB
1/3/2012	12.57	-	TWDB
1/4/2012	12.52	-	TWDB
1/5/2012	12.83	-	TWDB
1/6/2012	13.38	-	TWDB
1/7/2012	13.89	-	TWDB
1/8/2012	14.55	-	TWDB
1/9/2012	14.96	-	TWDB
1/10/2012	14.76	-	TWDB
1/11/2012	14.21	-	TWDB
1/12/2012	13.36	-	TWDB
1/13/2012	12.49	-	TWDB
1/14/2012	11.91	-	TWDB
1/15/2012	12.32	-	TWDB
1/16/2012	13.14	-	TWDB
1/17/2012	13.79	-	TWDB
1/18/2012	13.73	-	TWDB
1/19/2012	14.08	-	TWDB
1/20/2012	15.12	-	TWDB
1/21/2012	15.93	-	TWDB
1/22/2012	16.72	-	TWDB
1/23/2012	16.87	-	TWDB
1/24/2012	16.73	-	TWDB
1/25/2012	16.99	-	TWDB
1/26/2012	16.64	-	TWDB
1/27/2012	16.24	-	TWDB
1/28/2012	16.11	-	TWDB
1/29/2012	15.38	-	TWDB
1/30/2012	15.14	-	Greenspan
1/31/2012	15.30	-	Greenspan
2/1/2012	16.30	-	Greenspan
2/2/2012	16.82	-	Greenspan
2/3/2012	17.14	-	Greenspan
2/4/2012	18.14	-	Greenspan
2/5/2012	17.20	-	Greenspan

2/6/2012	15.12	-	Greenspan
2/7/2012	14.60	-	Greenspan
2/8/2012	14.64	-	Greenspan
2/9/2012	14.29	-	Greenspan
2/10/2012	13.73	-	Greenspan
2/11/2012	13.23	-	Greenspan
2/12/2012	11.74	-	Greenspan
2/13/2012	11.20	-	Greenspan
2/14/2012	11.88	-	Greenspan
2/15/2012	12.31	-	Greenspan
2/16/2012	14.07	-	Greenspan
2/17/2012	14.14	-	Greenspan
2/18/2012	14.33	-	Greenspan
2/19/2012	14.49	-	Greenspan
2/20/2012	14.51	-	Greenspan
2/21/2012	15.16	-	Greenspan
2/22/2012	16.03	-	Greenspan
2/23/2012	17.92	-	Greenspan
2/24/2012	17.71	-	Greenspan
2/25/2012	14.23	-	Greenspan
2/26/2012	14.18	-	Greenspan
2/27/2012	14.62	-	Greenspan
2/28/2012	15.20	-	Greenspan
2/29/2012	16.51	-	Greenspan
3/1/2012	17.99	-	Greenspan
3/2/2012	19.36	-	Greenspan
3/3/2012	19.01	-	Greenspan
3/4/2012	16.84	-	Greenspan
3/5/2012	17.04	-	Greenspan
3/6/2012	17.84	-	HOBO
3/7/2012	18.22	-	HOBO
3/8/2012	19.23	-	HOBO
3/9/2012	18.62	-	HOBO
3/10/2012	16.25	-	HOBO
3/11/2012	16.48	-	HOBO
3/12/2012	16.87	-	HOBO
3/13/2012	17.57	-	HOBO
3/14/2012	19.23	-	HOBO
3/15/2012	20.60	-	HOBO
3/16/2012	21.64	-	HOBO
3/17/2012	22.03	-	HOBO
3/18/2012	21.92	-	HOBO
3/19/2012	21.46	-	HOBO

3/20/2012	20.83	-	HOBO
3/21/2012	19.66	-	HOBO
3/22/2012	19.18	-	HOBO
3/23/2012	19.80	-	HOBO
3/24/2012	20.65	-	HOBO
3/25/2012	21.53	-	HOBO
3/26/2012	22.37	-	HOBO
3/27/2012	22.39	-	HOBO
3/28/2012	22.36	-	HOBO
3/29/2012	22.57	-	HOBO
3/30/2012	22.62	-	HOBO
3/31/2012	23.32	-	HOBO
4/1/2012	23.96	-	HOBO
4/2/2012	23.72	-	HOBO
4/3/2012	23.76	-	HOBO
4/4/2012	23.93	-	HOBO
4/5/2012	23.66	-	HOBO
4/6/2012	23.12	-	HOBO
4/7/2012	23.75	-	TWDB
4/8/2012	24.07	-	TWDB
4/9/2012	24.55	-	TWDB
4/10/2012	24.56	-	TWDB
4/11/2012	24.82	-	TWDB
4/12/2012	24.38	-	TWDB
4/13/2012	24.08	-	TWDB
4/14/2012	23.95	-	TWDB
4/15/2012	23.87	-	TWDB
4/16/2012	23.44	-	TWDB
4/17/2012	22.55	-	TWDB
4/18/2012	22.45	-	TWDB
4/19/2012	22.58	-	TWDB
4/20/2012	22.59	-	TWDB
4/21/2012	21.44	-	TWDB
4/22/2012	21.24	-	TWDB
4/23/2012	21.54	-	TWDB
4/24/2012	21.64	-	TWDB
4/25/2012	21.97	-	TWDB
4/26/2012	22.47	-	TWDB
4/27/2012	22.81	-	TWDB
4/28/2012	23.18	-	TWDB
4/29/2012	23.61	-	TWDB
4/30/2012	23.95	-	TWDB
5/1/2012	24.32	-	TWDB

5/2/2012	24.68	-	TWDB
5/3/2012	25.99	-	TWDB
5/4/2012	25.84	-	TWDB
5/5/2012	26.09	-	TWDB
5/6/2012	26.20	-	TWDB
5/7/2012	26.13	-	TWDB
5/8/2012	26.16	-	TWDB
5/9/2012	25.99	-	TWDB
5/10/2012	25.85	-	TWDB
5/11/2012	25.04	-	TWDB
5/12/2012	24.58	-	TWDB
5/13/2012	24.82	-	TWDB
5/14/2012	25.12	-	TWDB
5/15/2012	25.10	-	TWDB
5/16/2012	25.09	-	HOBO
5/17/2012	25.08	-	HOBO
5/18/2012	25.33	-	HOBO
5/19/2012	25.40	-	HOBO
5/20/2012	25.74	-	HOBO
5/21/2012	26.48	-	HOBO
5/22/2012	26.48	-	HOBO
5/23/2012	26.31	-	HOBO
5/24/2012	25.74	-	HOBO
5/25/2012	25.75	-	HOBO
5/26/2012	25.89	-	HOBO
5/27/2012	26.60	-	HOBO
5/28/2012	26.95	-	HOBO
5/29/2012	27.30	-	HOBO
5/30/2012	27.35	-	HOBO
5/31/2012	27.19	-	HOBO
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6/2/2012	26.76	-	HOBO
6/3/2012	26.98	-	HOBO
6/4/2012	26.97	-	HOBO
6/5/2012	27.71	-	HOBO
6/6/2012	28.08	-	HOBO
6/7/2012	28.38	-	HOBO
6/8/2012	28.45	-	HOBO
6/9/2012	28.09	-	HOBO
6/10/2012	28.42	-	HOBO
6/11/2012	28.25	-	HOBO
6/12/2012	28.47	-	HOBO
6/13/2012	28.35	-	HOBO

6/14/2012	27.91	-	HOBO
6/15/2012	27.87	-	HOBO
6/16/2012	27.81	-	HOBO
6/17/2012	27.51	-	HOBO
6/18/2012	27.72	-	HOBO
6/19/2012	27.17	-	HOBO
6/20/2012	26.73	-	HOBO
6/21/2012	26.85	-	HOBO
6/22/2012	27.84	-	HOBO
6/23/2012	28.28	-	HOBO
6/24/2012	29.77	-	HOBO
6/25/2012	30.27	-	HOBO
6/26/2012	29.99	-	HOBO
6/27/2012	30.34	-	HOBO
6/28/2012	30.31	-	HOBO
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7/3/2012	28.73	14.930591105	HOBO
7/4/2012	28.97	15.548955864	HOBO
7/5/2012	29.31	16.04260486	HOBO
7/6/2012	29.66	16.177088123	HOBO
7/7/2012	29.87	16.254050097	HOBO
7/8/2012	29.16	16.661475622	HOBO
7/9/2012	28.65	16.935117835	HOBO
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7/11/2012	27.53	17.339691977	Greenspan
7/12/2012	26.97	17.471223395	Greenspan
7/13/2012	26.33	17.596416633	Greenspan
7/14/2012	26.44	17.398166263	Greenspan
7/15/2012	26.80	17.126211389	Greenspan
7/16/2012	27.05	16.916715914	Greenspan
7/17/2012	27.90	16.510399585	Greenspan
7/18/2012	29.33	15.714477952	Greenspan
7/19/2012	30.62	15.018033425	Greenspan
7/20/2012	31.44	14.833643652	Greenspan
7/21/2012	31.10	14.988533556	Greenspan
7/22/2012	30.47	15.185408034	Greenspan
7/23/2012	30.02	15.343151732	Greenspan
7/24/2012	30.25	15.268181947	Greenspan
7/25/2012	30.13	15.278959735	Greenspan
7/26/2012	29.90	15.301774942	Greenspan

7/27/2012	30.02	15.213412416	Greenspan
7/28/2012	30.34	15.06338715	Greenspan
7/29/2012	30.68	14.919879279	Greenspan
7/30/2012	30.24	15.028355203	Greenspan
7/31/2012	30.58	14.929601016	Greenspan
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8/2/2012	30.37	15.002473165	Greenspan
8/3/2012	30.18	15.076247699	Greenspan
8/4/2012	30.26	15.062476061	Greenspan
8/5/2012	31.22	14.798326912	Greenspan
8/6/2012	30.85	14.901889062	Greenspan
8/7/2012	30.81	14.920339906	Greenspan
8/8/2012	31.03	14.874301222	Greenspan
8/9/2012	30.59	15.243068757	Greenspan
8/10/2012	29.81	15.761227105	Greenspan
8/11/2012	29.66	16.001606312	Greenspan
8/12/2012	29.41	16.388356652	Greenspan
8/13/2012	29.44	16.464373528	Greenspan
8/14/2012	29.11	16.786336995	Greenspan
8/15/2012	28.79	17.186651057	Greenspan
8/16/2012	28.83	17.412863371	Greenspan
8/17/2012	29.25	17.119043987	Greenspan
8/18/2012	28.97	17.106034358	Greenspan
8/19/2012	28.35	17.507413365	Greenspan
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8/22/2012	27.98	16.960724138	Greenspan
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8/24/2012	27.74	16.902205058	Greenspan
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8/26/2012	26.96	16.111465256	Greenspan
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8/28/2012	29.71	14.436354952	Greenspan
8/29/2012	28.89	14.261282085	Greenspan
8/30/2012	28.53	14.426471703	Greenspan
8/31/2012	28.27	14.685688798	Greenspan
9/1/2012	28.38	14.809997264	Greenspan
9/2/2012	28.58	14.902579866	Greenspan
9/3/2012	28.73	15.065933917	Greenspan
9/4/2012	28.78	15.018112806	Greenspan
9/5/2012	28.67	15.098314726	Greenspan
9/6/2012	28.99	14.864293322	Greenspan
9/7/2012	29.16	14.739147645	Greenspan

9/8/2012	29.10	14.642753376	Greenspan
9/9/2012	27.98	15.082861283	Greenspan
9/10/2012	26.28	16.003925445	Greenspan
9/11/2012	25.59	16.842151765	Greenspan
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9/13/2012	26.85	16.385911416	Greenspan
9/14/2012	26.87	16.541372843	Greenspan
9/15/2012	27.30	16.412757262	Greenspan
9/16/2012	27.54	16.542562363	Greenspan
9/17/2012	27.80	16.606125694	Greenspan
9/18/2012	27.92	16.683116512	Greenspan
9/19/2012	27.25	17.062039338	Greenspan
9/20/2012	26.75	17.50374585	Greenspan
9/21/2012	26.33	18.051296944	Greenspan
9/22/2012	26.48	18.41358332	Greenspan
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9/24/2012	27.38	18.489549687	Greenspan
9/25/2012	27.21	19.114674281	Greenspan
9/26/2012	27.10	19.641916548	Greenspan
9/27/2012	27.18	19.710554822	Greenspan
9/28/2012	27.43	19.591818569	Greenspan
9/29/2012	27.31	19.52738525	Greenspan
9/30/2012	26.45	19.800261374	Greenspan
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10/2/2012	24.51	20.535576109	Greenspan
10/3/2012	24.03	20.702551533	Greenspan
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10/5/2012	23.82	7.4955863609	Greenspan
10/6/2012	24.47	7.3885449741	Greenspan
10/7/2012	23.30	7.6193358063	Greenspan
10/8/2012	21.80	7.9644997507	Greenspan
10/9/2012	20.96	8.2169423191	Greenspan
10/10/2012	21.28	8.2016567228	Greenspan
10/11/2012	22.42	8.0266955111	Greenspan
10/12/2012	23.05	7.9151289369	Greenspan
10/13/2012	23.49	7.8413945129	Greenspan
10/14/2012	23.96	7.7771700266	Greenspan
10/15/2012	24.55	7.6683161318	Greenspan
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10/17/2012	23.16	7.9851095348	Greenspan
10/18/2012	23.69	7.8776559628	Greenspan
10/19/2012	22.61	8.1266470097	Greenspan
10/20/2012	22.02	8.3168990795	Greenspan

10/21/2012	22.36	8.373853024	Greenspan
10/22/2012	22.97	8.3352617565	Greenspan
10/23/2012	23.17	8.3241801404	Greenspan
10/24/2012	23.60	8.2542451107	Greenspan
10/25/2012	23.75	8.2651304859	Greenspan
10/26/2012	23.90	8.1878767468	Greenspan
10/27/2012	20.53	8.9702086585	Greenspan
10/28/2012	18.31	9.577756344	Greenspan
10/29/2012	17.52	9.9513096654	Greenspan
10/30/2012	17.21	10.184426637	Greenspan
10/31/2012	17.63	9.547497455	Greenspan
11/1/2012	19.46	8.3625586519	Greenspan
11/2/2012	20.41	8.201390162	Greenspan
11/3/2012	21.32	8.0871253976	Greenspan
11/4/2012	21.98	8.4298670143	Greenspan
11/5/2012	21.94	8.6690258234	Greenspan
11/6/2012	21.49	8.5453610433	Greenspan
11/7/2012	21.18	8.7281329399	Greenspan
11/8/2012	20.82	8.8309257771	Greenspan
11/9/2012	20.92	8.8249539732	Greenspan
11/10/2012	21.11	8.787448847	Greenspan
11/11/2012	21.57	8.7065227403	Greenspan
11/12/2012	21.21	8.7711689937	Greenspan
11/13/2012	18.57	9.3421380937	Greenspan
11/14/2012	16.76	9.8152821986	Greenspan
11/15/2012	16.13	10.052397764	Greenspan
11/16/2012	15.74	10.201625624	Greenspan
11/17/2012	15.84	10.223376149	Greenspan
11/18/2012	15.45	10.356182504	Greenspan
11/19/2012	15.41	10.40678304	Greenspan
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11/21/2012	16.82	10.064920926	Greenspan
11/22/2012	17.19	9.9895582926	Greenspan
11/23/2012	18.19	9.7952715852	Greenspan
11/24/2012	17.80	9.8058319934	Greenspan
11/25/2012	16.99	10.043622593	Greenspan
11/26/2012	17.83	9.8616755015	Greenspan
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11/28/2012	17.50	9.8974345328	Greenspan
11/29/2012	16.64	10.111677399	Greenspan
11/30/2012	16.85	10.071806319	Greenspan
12/1/2012	17.54	9.9194250895	Greenspan
12/2/2012	18.38	9.722061554	Greenspan

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12/4/2012	20.14	9.3448952937	Greenspan
12/5/2012	20.12	9.3272932453	Greenspan
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12/7/2012	19.44	9.4706341215	Greenspan
12/8/2012	19.78	9.4060084567	Greenspan
12/9/2012	20.20	9.3161633756	Greenspan
12/10/2012	19.56	9.4174073027	Greenspan
12/11/2012	16.52	10.120462176	Greenspan
12/12/2012	14.87	10.57430636	Greenspan
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12/16/2012	16.76	10.170099229	Greenspan
12/17/2012	17.58	9.59421509	Greenspan
12/18/2012	17.34	9.8939736717	Greenspan
12/19/2012	17.46	32.174889806	Greenspan
12/20/2012	17.31	30.287873041	Greenspan
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12/22/2012	13.80	33.472197878	Greenspan
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12/26/2012	13.73	33.768822562	Greenspan
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12/28/2012	12.46	35.277994868	Greenspan
12/29/2012	11.40	36.47227716	Greenspan
12/30/2012	10.27	37.941696595	Greenspan
12/31/2012	10.11	38.357348101	Greenspan
1/1/2013	11.48	35.679307466	Greenspan
1/2/2013	10.76	35.543407513	Greenspan
1/3/2013	9.78	37.257538676	Greenspan
1/4/2013	9.43	37.997649287	Greenspan
1/5/2013	9.02	38.774483913	Greenspan
1/6/2013	9.02	38.43806746	Greenspan
1/7/2013	9.41	37.919043871	Greenspan
1/8/2013	9.72	37.648590434	Greenspan
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1/11/2013	12.34	32.512464779	Greenspan
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1/13/2013	14.78	26.199515356	Greenspan
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1/17/2013	8.91	33.097345948	Greenspan
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1/30/2013	18.22	23.643571183	Greenspan
1/31/2013	16.50	24.721576668	Greenspan
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2/2/2013	*15.72	-	*Calculated
2/3/2013	*15.72	-	*Calculated
2/4/2013	*15.72	-	*Calculated
2/5/2013	*15.72	-	*Calculated
2/6/2013	*15.72	-	*Calculated
2/7/2013	*15.72	-	*Calculated
2/8/2013	*15.72	-	*Calculated
2/9/2013	*15.72	-	*Calculated
2/10/2013	*15.72	-	*Calculated
2/11/2013	*15.72	-	*Calculated
2/12/2013	*15.72	-	*Calculated
2/13/2013	*15.72	-	*Calculated
2/14/2013	15.56	24.951358741	Greenspan
2/15/2013	15.77	24.932291555	Greenspan
2/16/2013	15.44	25.171921254	Greenspan
2/17/2013	15.01	25.462962524	Greenspan
2/18/2013	15.40	25.285653351	Greenspan
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2/21/2013	15.84	24.959600238	Greenspan
2/22/2013	16.74	24.381310494	Greenspan
2/23/2013	16.49	24.579588521	Greenspan
2/24/2013	16.37	24.656986752	Greenspan
2/25/2013	16.71	24.518039467	Greenspan
2/26/2013	15.64	25.172267668	Greenspan

2/27/2013	15.81	25.165500712	Greenspan
2/28/2013	15.09	25.567168433	Greenspan
3/1/2013	14.76	25.942736269	HOBO
3/2/2013	14.37	27.297351731	HOBO
3/3/2013	13.50	28.015732353	HOBO
3/4/2013	13.81	27.938069818	HOBO
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3/6/2013	16.30	18.696421429	HOBO
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3/8/2013	15.71	18.226385417	HOBO
3/9/2013	16.53	18.05015625	HOBO
3/10/2013	17.18	17.9396625	HOBO
3/11/2013	16.40	18.213904167	HOBO
3/12/2013	15.98	18.433704167	HOBO
3/13/2013	16.40	18.182239583	HOBO
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3/16/2013	17.93	17.89053125	HOBO
3/17/2013	18.94	17.719675	HOBO
3/18/2013	20.43	17.612689583	HOBO
3/19/2013	20.95	17.56073125	HOBO
3/20/2013	20.57	17.540483333	HOBO
3/21/2013	20.53	17.556404167	HOBO
3/22/2013	20.84	17.446839583	HOBO
3/23/2013	21.65	17.144764583	HOBO
3/24/2013	21.08	17.207114583	HOBO
3/25/2013	18.62	17.809954167	HOBO
3/26/2013	17.41	18.15625	HOBO
3/27/2013	16.49	18.476675	HOBO
3/28/2013	17.20	18.412233333	HOBO
3/29/2013	18.12	18.229941667	HOBO
3/30/2013	19.29	17.993397917	HOBO
3/31/2013	20.03	17.807652083	HOBO
4/1/2013	20.98	17.50950625	HOBO
4/2/2013	20.92	17.536410417	HOBO
4/3/2013	20.41	17.319185417	HOBO
4/4/2013	19.24	16.8897875	HOBO
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4/7/2013	19.22	-	HOBO
4/8/2013	20.28	-	HOBO
4/9/2013	20.94	-	HOBO
4/10/2013	21.73	-	HOBO

4/11/2013	20.69	-	HOBO
4/12/2013	20.17	-	HOBO
4/13/2013	19.80	-	HOBO
4/14/2013	21.05	-	HOBO
4/15/2013	21.78	-	HOBO
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4/17/2013	22.26	-	HOBO
4/18/2013	22.42	-	HOBO
4/19/2013	19.70	-	HOBO
4/20/2013	18.30	-	HOBO
4/21/2013	18.37	-	HOBO
4/22/2013	19.12	-	HOBO
4/23/2013	20.48	-	HOBO
4/24/2013	20.74	-	HOBO
4/25/2013	19.50	-	HOBO
4/26/2013	19.78	-	HOBO
4/27/2013	20.80	-	HOBO
4/28/2013	21.71	-	HOBO
4/29/2013	22.52	-	HOBO
4/30/2013	23.29	-	HOBO
5/1/2013	24.34	-	HOBO
5/2/2013	*23.20	-	*Calculated
5/3/2013	*23.20	-	*Calculated
5/4/2013	*23.20	-	*Calculated
5/5/2013	*23.20	-	*Calculated
5/6/2013	*23.20	-	*Calculated
5/7/2013	*23.20	-	*Calculated
5/8/2013	22.05	19.24	HOBO
5/9/2013	22.17	19.29	HOBO
5/10/2013	22.83	18.56	HOBO
5/11/2013	23.23	18.09	HOBO
5/12/2013	24.44	17.72	HOBO
5/13/2013	23.16	18.03	HOBO
5/14/2013	23.72	17.86	HOBO
5/15/2013	23.70	17.87	HOBO
5/16/2013	23.99	17.79	HOBO
5/17/2013	24.53	17.60	HOBO
5/18/2013	25.28	17.31	HOBO
5/19/2013	25.76	17.12	HOBO
5/20/2013	26.24	16.80	HOBO
5/21/2013	26.56	17.22	HOBO
5/22/2013	27.00	17.17	HOBO
5/23/2013	27.40	17.05	HOBO

5/24/2013	27.57	16.96	HOBO
5/25/2013	27.57	16.90	HOBO
5/26/2013	27.60	16.97	HOBO
5/27/2013	27.67	16.97	HOBO
5/28/2013	27.58	17.03	HOBO
5/29/2013	27.34	17.13	HOBO
5/30/2013	27.37	17.00	HOBO
5/31/2013	27.77	16.69	HOBO

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