

**Baseline Analysis of a  
Sonoran Mud Turtle (*Kinosternon sonoriense*)  
Population at Montezuma Well National  
Monument, Camp Verde, Arizona**

*Prepared by*  
Matthew Malone

*Submitted to*

Dr. Steven Garber  
Dr. Tony Krzysik  
&  
Dr. Richard Bloom

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Embry-Riddle Aeronautical University  
3200 Willow Creek Road  
Prescott, Arizona 86301  
(520) 708-6949

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*"A thing is right when it tends to preserve the integrity, stability, and beauty of a biotic community. It is wrong when it tends otherwise."*

Aldo Leopold

1949

**Abstract:**

Population size and morphometrics were established for a Sonoran mud turtle (*Kinosternon sonoriense*) population at Montezuma Well, Camp Verde, Arizona.

Population size was established using mark-recapture models and morphometrics were quantified by analysis of body size measurements. This provides critical baseline data that is required for future population monitoring projects, such as comprehensive long-term observation and ecological assessment of the park and surrounding regions. This will aid in the determination of adverse effects caused by pressures related to human population growth, recreation, and the introduction of exotic species. It will also help park managers to preserve the biodiversity of Montezuma Well by protecting and managing the long-term viability of its endemic species.

**Introduction:**

Ecosystems on local and global scales are persistently subjected to human environmental impacts including habitat destruction, deterioration, and fragmentation; pollution and acidification; and the intentional and accidental introduction of exotic species (Soulé and Wilcox 1980, Burgess and Sharpe 1981, Peters and Darling 1985, Soulé 1986, Schreiber and Newman 1988, Carleton 1989, Fajer et al. 1989, Klein 1989, Kremen 1992). Habitat destruction and fragmentation accounted for 85% of the risk to federally listed

threatened/ endangered species: 49% was attributed to the introduction of exotics, 24% to pollution, 17% to overkill (hunting, fishing, and commercial exploitation), and 3% to disease (Wilcove 1999). The numbers add up to more than 100% because multiple effects were identified for many species.

Conservation biologists concur that habitat destruction and fragmentation is the major factor worldwide for biodiversity loss and species extinctions (Ehrlich and Ehrlich 1981, Wilson 1992, Heywood 1995). When humans disturb landscapes, it usually leads to opportunities for invasion by "weedy" generalist species of plants and animals who are well adapted to human cohabitation. Many of these species out-compete, parasitize, feed on, or disease more specialized endemic species which evolved not having these pressures (Garber 1998). This is currently happening on a global scale, with mediterranean/chaparral and desert communities being significantly effected (Williams et al. 1985). Human pressures have had a proportionately higher impact on aquatic ecosystems than on terrestrial habitats, particularly in arid and semiarid regions (Krzysik 1990). Aquatic habitat degradation and the establishment of alien species have played major roles in the decimation of native fish populations and other aquatic fauna, especially in the western United States (Miller et al. 1989, Williams et al. 1989, Williams and Miller 1990, Minckley and Deacon 1991, Allan and Flecker 1993). Nonindigenous fish species have led to the decline and extinction of western fish faunas through hybridization, competition, and predation.

One of the most recent changes to the ecosystem at Montezuma Well in Camp Verde, Arizona was the human introduction of the red-eared slider (*Trachemys scripta*), a turtle that most people purchase as pets. This species is common and most widely distributed in the midwestern and southeastern United States. This introduction, if allowed to persist, could shock the homeostasis of the Well's ecosystem processes. Exotic species have dramatically impacted native flora and fauna from local to global scales (Elton 1958, Mooney and Drake 1986, Drake et al. 1989, La roe et al. 1995, Simberloff et al. 1997). Foreign invaders can and have affected native species in a variety of ways:

- Competition- Zebra mussels (*Dreissena polymorpha*) have spatially crowded out native bivalves and filtered out key nutrients from their habitat, with dramatic effects on other biological organisms in the Great Lakes region and beyond (LaRoe et. al 1995). Freshwater mussels may be one of the most endangered taxa in North America (Williams et al.1993).

- Infection- Dutch elm disease, caused by the fungus *Ophiostoma ulmi*, has devastated elms in 42 American states and 6 Canadian Provinces in previous 50 years (Sinclair et al 1987) killing over 40 million elms in the United States alone (Schumann 1991).

- Incompatibility- Melaleuca (*Melaleuca quinquenervia*), Brazilian pepper (*Schinus terebinthifolius*), and Australian pine (*Casuarina* spp.) have taken over nearly 630,000 ha (1,556,100 acres) of southern Florida, including Everglades

National Park. Impacts include dramatically changed habitats due to higher burn temperatures that kill native plants and their seeds, the smothering of native vegetation with thick litter accumulations, and dense roots which prevent egg laying by threatened and endangered species such as the American crocodile and sea turtles (Simberoff et. al 1997).

- Hybridization- Introduced trout have genetically swamped (also feed on and out-compete) western indigenous trout, devastating 38 taxa and replacing them with three common nonindigenous trout (coastal rainbow, Eastern brook trout and European brown trout) (Krzysik unpublished data).

There is a need to establish baseline statistics against which future changes can be documented with confidence. With good baseline data, many things can be interpreted about the health of a population based on its age distribution and sex ratio, and its growth rate and morphometrics. The need to establish these fundamental criteria has grown more acute with the increasing complexity, spatial and temporal scales, cumulative impacts, and environmental synergisms of ozone depletion, deforestation, widespread pollution, water resources depletion, dramatic decline in global biodiversity and the socio-political implications of regional and global climate change.

Montezuma Well is geographically located in the Temperate Zone (N 34° 39' W 111° 45') yet maintains a nearly constant annual water temperature (ca 18-24°C) and nutrient supply because it is fed by underground springs (Boucher et al. 1984). This continual

water inflow is accompanied by the constant outflow of water through an underground "swallow" at the southeastern side the Well, maintaining a consistent water level (Likens and Bormann 1974). In addition, the Well is surrounded by a 17-24m raised limestone rim, which reduces the amount of foreign elements and exposures entering the aquatic environment (Cole and Barry 1973). Given that the Well can maintain this uniquely stable environment, it is a prime location for the monitoring of ecological impact.

Chelonian (turtles and tortoises) populations are rapidly becoming threatened and endangered from local to regional and global scales due to anthropogenic impacts identical to those that have been summarized above from Wilcove (1999). However, chelonians are particularly exposed to overkill risks for food, the pet trade, and a variety of cultural practices (Van Abbema 1997). Aquatic vertebrates are exposed to and sensitive of a wide variety of environmental disturbances: habitat change, including disturbance regimes such as regulated, highly variable and non-seasonal instream flows and water drawdowns for irrigation and municipalities; interference by exotic species within spatially confined habitats; and even watershed habitat disturbance. Consequently, they represent potentially reliable ecological indicators of human disturbance. The need to establish baseline data and implement statistically valid ecological monitoring programs has been emphasized worldwide, and is most critical in natural resources management, achieving ecological sustainability, and remedying current trends in populations extinction (Noss and Cooperrider 1994, Sutherland 1996, Lannoo 1998, Wilcove 1999)

This study can aid the National Park Service in understanding the impacts of their alien species, helping park and community managers evaluate administrative choices.

In this study, Sonoran mud turtles (*Kinosternon sonoriense*) were trapped at Montezuma Well, Camp Verde, Arizona from July to November 1999. Little has been published on the age distributions, growth rates and morphometrics of Sonoran mud turtles. The purpose of the study was to obtain basic morphometric data, estimate the current population at the Well and compare the current estimate with data collected in 1983.

### **Study Area:**

Montezuma Well Nation Monument is located in west central Arizona in the Verde Valley, Yavapai County. This is the fastest growing rural county in the United States when compared with other counties of equal present day population sizes (see Table 1). The Well is a collapsed travertine spring located in the Miocene-Pliocene Verde formation (Nations et al. 1981) in the Great Basin Dessert Grasslands ecoregion (Brown and Lowe 1980). The Well's 17-24m (55.76-78.72ft.) high surrounding walls enclose a 7.6 ha (18.24 acres) pond with unknown depths exceeding 15m (49.2ft.) (Konieczki and Leake 1997) (see Figure 1). The water surface elevation is 1122m (3681ft) and the pond is fed a constant isothermal (ca 18-24°C) flow of water at a rate of 3.8m<sup>3</sup> per minute from three fissures at its bottom (Cole and Barry 1973, Boucher, et al. 1984). The inflow of water is counteracted by the draining of water through an underground cave into an irrigation canal built by early Native American Indian tribes. The Well is void of any fish due to the high concentrations of dissolved CO<sub>2</sub> (>550 mg l<sup>-1</sup>) in the water (Cole 1983), or its isolation from bodies of water that contain fish.

| <u>96 Pop</u> | <u>90 Pop</u> | <u>% Chg</u> | <u>Avg Inc</u> | <u>Countv</u>            | <u>Cty Seat</u>    | <u>St</u> |
|---------------|---------------|--------------|----------------|--------------------------|--------------------|-----------|
| 138,943       | 122,354       | 13.5         | 20.087         | <u>Medina County</u>     | <u>Medina</u>      | <u>OH</u> |
| 139,133       | 129,180       | 7.7          | 20.238         | <u>McLean County</u>     | <u>Bloomington</u> | <u>IL</u> |
| 139,368       | 107,714       | <b>29.3</b>  | 15.733         | <u>Yavapai County</u>    | <u>Prescott</u>    | <u>AZ</u> |
| 139,936       | 136,731       | 2.3          | 19.796         | <u>Greene County</u>     | <u>Xenia</u>       | <u>OH</u> |
| 140,112       | 135,982       | 3.0          | 18.510         | <u>Calhoun County</u>    | <u>Marshall</u>    | <u>MI</u> |
| 140,488       | 133,600       | 5.1          | 19.022         | <u>Monroe County</u>     | <u>Monroe</u>      | <u>MI</u> |
| 140,800       | 141,895       | -0.7         | 16.724         | <u>Chautauqua County</u> | <u>Mayville</u>    | <u>NY</u> |
| 141,115       | 131,761       | 7.1          | 22.35          | <u>Chittenden County</u> | <u>Burlington</u>  | <u>VT</u> |
| 141,308       | 130,943       | 7.9          | 23.343         | <u>Sussex County</u>     | <u>Newton</u>      | <u>NJ</u> |
| 141,646       | 128,181       | 10.5         | 18.695         | <u>Kenosha County</u>    | <u>Kenosha</u>     | <u>WI</u> |

Table 1. Population percentage change between 1990 and 1996 for United States counties of present populations between 138,943-141.646 provided by Harden Political InfoSystems

### **History:**

During the 12th century, Montezuma Well was home to the prehistoric Sinagua Indian tribe. An archeological study done on the cliff dwellings and numerous swallows around the Well have revealed the use of Sonoran mud turtles for food or perhaps ritual purposes (Hodges 1986). The evidence of fragments of mud turtle shells in these digs affords the turtles status of being an endemic species for at least 600 years.

### **Methods:**

PERMISSION- Permission for access to the study site was provided by the United States Department of the Interior, National Park Service after submission and approval of a proposal (Appendix I). This study is in accordance with the United States Department of

the Interior guidelines put forth by the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 [16 USC §§4701, 4702, 4711, 4712, 4721-28, 4741, 4751; 18 USC §42] (see Appendix II). This defines "nonindigenous species" as any biological organism or material outside of its native range and defines such species to be a "nuisance" when it impacts the copiousness and diversity of indigenous species and the aquatic ecosystem stability (McKnight 1993).

To avoid potential incompatibility with tourism, I conducted most research during hours when the park was closed: 7:00pm to 8:00am in the summer months and 5:00pm to 8:00am in the fall. Traps were set on eleven occasions (see Table 2).

| DATE              | TIME      |
|-------------------|-----------|
| 7/24/99-7/25/99   | 2100-0600 |
| 7/25/99           | 0900-2100 |
| 8/6/99-8/7/99     | 2100-0600 |
| 8/7/99            | 0700-1900 |
| 10/23/99-10/24/99 | 1700-0500 |
| 10/24/99          | 1000-1700 |
| 10/24/99-10/25/99 | 1800-0600 |
| 10/30/99-10/31/99 | 1800-1400 |
| 10/31/99-11/1/99  | 1700-1500 |
| 11/5/99-11/6/99   | 1700-1600 |
| 11/6/99-11/7/99   | 1700-1600 |

Table 2. List of trap dates and times

TRAPPING--Mud turtles were trapped using tarred, three ring hoop traps manufactured by the Nylon Net Company in Memphis, Tennessee. The nets were made up of a 2.54cm (1in) nylon mesh with a single 30.5cm (12in) funnel entrance. Traps were kept from

collapsing in on themselves using two 106.68cm (42in) long, 2.54cm (1in) by 5.08cm (2in) notched wooden braces (see Figure 2). Cans of sardines packed in soybean oil were used to bait the traps. The cans were opened only halfway, to preserve bait throughout the trapping period, and placed as far inside the trap as possible.

NOTE: Punching holes in the can would also be effective.

During the months of July and August five traps were set along the southern shoreline spaced approximately 50ft apart from each other. Twelve traps were used from October 23rd to November 7th. For the fall trap periods, a 10ft canoe was used to strategically space traps at approximately 100ft intervals to cover the entire circumference of the Well. The traps were submerged leaving enough exposed above the water's surface to allow trapped turtles to obtain air. When traps were set during Montezuma Well's open hours they were covered with aquatic vegetation to make them less visible to the public.

MARKING- Each captured turtles was marked by notching the marginal scutes with a 0.635cm (¼ in) triangular file. Notches were set only in the right and left I-IV and VIII-XI marginals because marking of the V-VII causes bleeding. Numbers correspond with notches proceeding in a clockwise direction around the carapace (see Table 3). The largest number of notches used was three. For example, if their were two notches in marginal scute R1 and one in R2, that would be turtle number 18; if their were two notches in marginal scute R1 and one in R3, that would be turtle number 19

(see Figure 3). This would continue in a clockwise direction around the turtle's carapace until reaching number 33 (two notches in marginal scute R2). The process is then repeated until reaching number 49, and so on.

| Scute # |   | 1 Notch | 2 Notches |
|---------|---|---------|-----------|
| R1      | = | 1       | 17        |
| R2      | = | 2       | 33        |
| R3      | = | 3       | 49        |
| R4      | = | 4       | 65        |
| R8      | = | 5       | 81        |
| R9      | = | 6       | 97        |
| R10     | = | 7       | 113       |
| R11     | = | 8       | 129       |
| L11     | = | 9       | 145       |
| L10     | = | 10      | 161       |
| L9      | = | 11      | 177       |
| L8      | = | 12      | 193       |
| L4      | = | 13      | 209       |
| L3      | = | 14      | 225       |
| L2      | = | 15      | 241       |
| L1      | = | 16      | 257       |

Table 3. Values of notches in marginal scutes, left (L) and right (R) based on dorsal view looking forward.

Because Sonoran mud turtles are susceptible to dehydration (Wygoda and Chmura 1990) and conduct most activity in the water (Ernst et al. 1994), captured turtles were returned to the area of acquisition within 5 minutes after marking and measurements were recorded.

**MEASUREMENT-** Carapace and plastron length and width were obtained using calipers. Carapace length was taken from the nuchal to the supracaudal, and width from the outer edge of the joining IV and V marginals from anatomical left to right. Plastron length was taken from the gular to the furthest edge of the anal scute and width measured

across the pectoral scutes (see Figure 4). Weight was acquired using a metric scale. Other unique features, such as scars, were also noted.

**AGE, GROWTH RATES, AND MORPHOMETRICS-** Only turtles with all previous growth rings discernable were used in the growth analysis (Hulse 1976). Age was determined using recognizable growth rings on abdominal lamina (Sexton 1959). Turtles that were one year of age or younger were termed juveniles. Accurate identification of previous growth rings up to the age of 8 could be determined in most cases. Growth rings of turtles over 8 could not be accurately measured because growth ring tended to cluster or fuse together. Such turtles were given an age designation of  $\geq 9$ . Turtles with excessive plastron wear were also given this designation.

**SEX RATIO-** Sexual differences in *kinosternid* turtles has been studied by Hallowell (1856), Agassiz (1857), Hay (1892), and Risley (1933) who noted males, when compared to females, had longer/thicker tails possessing a horny tip; larger heads; more skin between the scutes and the plastron; and two small scaly patches on the inner thighs (Mahmoud 1967). Females tended to be larger having a more convex plastron than males. Using these characteristics, I was able to distinguish male and female turtles among adults. I was unable to determine the sex of juvenile turtles, 1 year or younger in age.

STATISTICAL ANALYSIS- Linear regression was based on the least squares fit to the following model:

$$y = a + bx + \varepsilon$$

y = dependent (outcome) variable

x = independent (predictor) variable

a = intercept on the dependent variable axis, value of dependent variables when independent variable = 0

b= slope of regression line ( $\Delta y/\Delta x$ ), change in dependent variable relative to change in independent variable

$\varepsilon$  = error term (residuals), expresses the variability of the data around the regression line

This linear regression mode was used with carapace length as the independent variable and carapace width, plastron length, plastron width, weight and age as dependent variables.

For additional information on linear regression and its applications see Sokal and Rohlf (1995) and Zar (1999)

Multiple linear regression (MLR) is similar to the above model with the addition of more than one independent variable trying to predict the single dependent variable. In this study, four independent variables were used.

$$Y = a + b_1x_1 + b_2x_2 + b_3x_3 + b_4x_4 + \varepsilon$$

Multiple linear regression was used in this study to develop equations to predict body weight and again to predict age using the four measures of body size: carapace length and width, and plastron length and width.

Because body dimensions are highly correlated, the above model using all four metrics simultaneously, would result in spurious and uninterpretable partial correlation coefficients (the relative contribution from each independent variable to predict the dependent variable) (Green 1979). To avoid this problem *stepwise* multiple linear regressions were used in the analysis (Draper and Smith 1981, Cohen and Cohen 1983, Neter et al. 1985). As a first step, this method enters the independent variable that has the highest correlation (+ or -) with the dependent variable. In the second step, it enters the independent variable that has the next highest correlation, with the condition that the two combined independent variables improve significance. Additionally, at each step all variables currently in the model are tested for removal. In this stepwise analysis criteria for a variable to enter the model was  $P \leq 0.050$  and  $P \geq 0.100$  for variable removal from the model..

When estimating regression coefficients the assumption of normality is not required (Cohen and Cohen 1983). However, three assumptions must be met:

- 1) Errors are normally distributed with a mean of zero
- 2) Error variance is constant with respect to the range of the dependent variable
- 3) Errors are independent- there is no bias in estimating the dependent variable

The first two assumptions were examined graphically by plotting Studentized residuals on the ordinate versus standardized (z) predicted values on the abscissa. Additionally, model fit was examined by plotting standardized (z) predicted values on the ordinate versus raw data values of the dependent variable on the abscissa (see Appendix III). The third assumption is most critical in statistical analysis, but typically difficult to estimate (Green 1979, Underwood 1997).

SPSS software was used for calculating descriptive statistics and deriving regression models (SPSS 1998).

Sonoran mud turtle population sizes at Montezuma Well were estimated for 1983 and 1999. Mark-recapture raw data for 1983 was provided by Phillip C. Rosen (pers. comm). The 1999 data was obtained in this study. Population estimates were made using three mark and recaptures methods: Peterson, Schnabel Binomial, and Schumacher-Eschmeyer (Seber 1982, Krebs 1999). The following model was used for the Peterson method, because several recapture periods were available in each of the studies:

$$N_t = \frac{\left( \sum_{i=1}^{t-1} M_i + 1 \right) (C_t + 1)}{(M_t + 1)} - 1$$

$N_t$  = Peterson population estimate at time period ( $t$ )

$C_t$  = Total number of turtles captured at time period ( $t$ )

$M_t$  = Number of turtles marked and captured time period ( $t$ )

Population estimations were calculated using Ecological Methodology software (Krebs 1998).

### Results:

**POPULATION ESTIMATING AND COMPARISON-** The population size of Sonoran mud turtles at Montezuma Well in 1983 was between approximately 300-350 individuals (Range: 186-412; 95% Confidence Interval of all estimates: 124-1008)(see Table 4a).

#### 1983

| <b>Schnabel Binomial Estimate</b>              | <b>95% Confidence Interval</b> |
|------------------------------------------------|--------------------------------|
| 327                                            | 242 - 464                      |
|                                                |                                |
| <b>Schumacher Estimate</b>                     |                                |
| 346                                            | 259 - 522                      |
|                                                |                                |
| <b>Peterson Estimate (4 Recapture Periods)</b> |                                |
| 186                                            | 124 - 423                      |
|                                                |                                |
| 325                                            | 202 - 789                      |
|                                                |                                |
| 310                                            | 199 - 739                      |
|                                                |                                |
| 412                                            | 258 - 1008                     |

Table 4a. Population estimates of Sonoran mud turtles in 1983 using Rosen's raw data, based on the Peterson, Schnabel Binomial, and Schumacher-Eschmeyer methods (Kreb 1999).

#### 1999

| <b>Schnabel Binomial Estimate</b>              | <b>95% Confidence Interval</b> |
|------------------------------------------------|--------------------------------|
| 178                                            | 132 - 252                      |
|                                                |                                |
| <b>Schumacher Estimate</b>                     |                                |
| 162                                            | 130 - 217                      |
|                                                |                                |
| <b>Peterson Estimate (2 Recapture Periods)</b> |                                |
| 137                                            | 101 - 238                      |
|                                                |                                |
| 146                                            | 109 - 261                      |

Table 4b. Population estimates of Sonoran mud turtles in 1999 based on Peterson, Schnabel Binomial, and Schumacher-Eschmeyer methods (Kreb 1999).

The current, 1999, population size of Sonoran mud turtles at Montezuma Well is estimated at 137-178 individuals (95% Confidence Interval of all estimates: 101-261) (see Table 4b).

Although there is a lot of variability in the estimated population size, especially the 1983 estimates, a comparison of the 95% Confidence Intervals strongly suggests that the Sonoran mud turtle population at Montezuma Well has significantly decline by approximately 50% since 1983. Although animal populations have been known to fluctuate (sometimes dramatically), chelonian populations have not been known to vary at this magnitude (Ernst et al. 1994).

DESCRIPTIVE STATISTICS- Mean, standard error, and standard deviation were calculated for males, females, and juveniles for both the summer and fall sample periods. Sample sizes represented only the unmarked individuals. Standard error is a measure of how close to the estimated population mean is to the true population. Standard deviation was used to assess variability among individuals in the population. Standard deviation represents the "average" deviation of individuals from the population mean. Summer and fall months were summarized separately to examine seasonal variations (see Table 5a & 5b). Descriptive statistics for the entire sample (summer and fall combined) are provided in Table 5c.

### Summer Sample

| MALE            | Sample Size | Mean  | Standard Error | Standard Deviation |
|-----------------|-------------|-------|----------------|--------------------|
| Carapace length | 17          | 12.4  | 0.23           | 0.95               |
| Carapace width  | 17          | 8.18  | 0.11           | 0.47               |
| Plastron length | 17          | 10.64 | 0.15           | 0.6                |
| Plastron width  | 17          | 6.12  | 0.2            | 0.82               |
| Weight          | 8           | 508   | 20.69          | 58.5               |
| FEMALE          | Sample Size | Mean  | Standard Error | Standard Deviation |
| Carapace length | 4           | 12.3  | 0.33           | 0.67               |
| Carapace width  | 4           | 8.4   | 0.27           | 0.54               |
| Plastron length | 4           | 12    | 0.68           | 1.35               |
| Plastron width  | 4           | 6.5   | 0.23           | 0.45               |
| Weight          | 2           | 520   | 75             | 106.1              |
| JUVENILE        | Sample Size | Mean  | Standard Error | Standard Deviation |
| Carapace length | 6           | 8     | 0.5            | 1.22               |
| Carapace width  | 6           | 6     | 0.31           | 0.76               |
| Plastron length | 6           | 6.9   | 0.4            | 0.99               |
| Plastron width  | 6           | 4.1   | 0.18           | 0.44               |
| Weight          | 3           | 162   | 54             | 94                 |

Table 5a. Descriptive statistics for summer trapping period (July and August). Lengths and widths in centimeters, and weights in grams.

### Fall Sample

| MALE            | Sample Size | Mean  | Standard Error | Standard Deviation |
|-----------------|-------------|-------|----------------|--------------------|
| Carapace length | 35          | 12.3  | 0.12           | 0.69               |
| Carapace width  | 35          | 7.9   | 0.009          | 0.54               |
| Plastron length | 35          | 10.9  | 0.11           | 0.65               |
| Plastron width  | 35          | 6.2   | 0.006          | 0.32               |
| Weight          | 35          | 522.7 | 12.5           | 73.9               |

| FEMALE          | Sample Size | Mean   | Standard Error | Standard Deviation |
|-----------------|-------------|--------|----------------|--------------------|
| Carapace length | 28          | 12.88  | 0.14           | 0.72               |
| Carapace width  | 28          | 8.42   | 0.11           | 0.6                |
| Plastron length | 28          | 12.63  | 0.11           | 0.6                |
| Plastron width  | 28          | 6.9    | 0.0087         | 0.5                |
| Weight          | 28          | 609.1  | 10.5           | 55.34              |
| JUVENILE        | Sample Size | Mean   | Standard Error | Standard Deviation |
| Carapace length | 4           | 8.3    | 1.18           | 2.4                |
| Carapace width  | 4           | 5.8    | 0.8            | 1.6                |
| Plastron length | 4           | 7.43   | 1.23           | 2.5                |
| Plastron width  | 4           | 4.35   | 0.73           | 1.5                |
| Weight          | 4           | 272.25 | 76.4           | 152.8              |

Table 5b. Descriptive statistics for fall trapping period (October and November). Lengths and widths in centimeters, and weights in grams.

### Summer and Fall Sample Combined

| MALE            | Sample Size | Mean   | Standard Error | Standard Deviation |
|-----------------|-------------|--------|----------------|--------------------|
| Carapace length | 52          | 12.8   | 0.12           | 0.8                |
| Carapace width  | 52          | 8      | 0.0074         | 0.53               |
| Plastron length | 52          | 10.8   | 0.009          | 0.64               |
| Plastron width  | 52          | 6.2    | 0.0074         | 0.53               |
| Weight          | 43          | 519.93 | 10.8           | 70.9               |
| FEMALE          | Sample Size | Mean   | Standard Error | Standard Deviation |
| Carapace length | 2           | 12.8   | 0.13           | 0.73               |
| Carapace width  | 32          | 8.4    | 0.1            | 0.6                |
| Plastron length | 32          | 12.54  | 0.12           | 0.7                |
| Plastron width  | 32          | 6.8    | 0.008          | 0.47               |
| Weight          | 30          | 603.2  | 11.2           | 61.24              |
| JUVENILE        | Sample Size | Mean   | Standard Error | Standard Deviation |
| Carapace length | 10          | 8.1    | 0.52           | 1.64               |
| Carapace width  | 10          | 5.9    | 0.34           | 1.1                |
| Plastron length | 10          | 7.1    | 0.51           | 1.62               |
| Plastron width  | 10          | 4.2    | 0.3            | 0.9                |
| Weight          | 7           | 225    | 50.8           | 134.4              |

Table 5c. Descriptive statistics for entire period (July, August, October and November). Lengths and widths in centimeters, and weights in grams.

REGRESSION MODELS- Body length of animals are commonly and logically used to represent size variation in sample populations. Other morphological metrics, such as body width or weight, are, in turn, closely dependent on and show a significant relation to body length. In this study, carapace length (CL), a common metric used to assess body size of chelonians, was a reliable independent (predictor) variable for predicting the dependent (outcome) variables: carapace width, plastron length, plastron width, weight, and age; using the regression model (see Appendix III):

$$y = a + bCL$$

| Dependent Variable | MALE                          | FEMALE                         | JUVENILE                         |
|--------------------|-------------------------------|--------------------------------|----------------------------------|
| Carapace Width =   | 3.75 + 0.343CL<br>P<0.0005    | 0.793 + 0.595CL<br>P<0.0005    | 0.606 + 0.654CL<br>P<0.0005      |
| Plastron Length =  | 2.83 + 0.648CL<br>P<0.0005    | 3.68 + 0.692CL<br>P<0.0005     | (-)0.533 + 0.945CL<br>P<0.0005   |
| Plastron Width =   | 0.767 + 0.439CL<br>P<0.0005   | 3.60 + 0.254CL<br>P<0.024      | (-)0.130 + 0.533CL<br>P<0.0005   |
| Weight =           | 17.45 + 40.70CL<br>P<0.005    | (-)88.12 + 53.94CL<br>P<0.0005 | (-)148.23 + 44.66<br>P<0.14 (NS) |
| Age =              | (-)11.23 + 1.51CL<br>P<0.0005 | (-)12.73 + 1.57CL<br>P<0.004   | 0.385 + 0.07CL<br>P<0.020        |

Table 6. Regression models (equations) for predicting carapace width, plastron length, plastron width, weight, and age from the independent (predictor) variable carapace length for Sonoran mud turtles at Montezuma Well. P values of  $\leq 0.005$  are highly significant.  $P \leq 0.05$  are significant.  $P > 0.05$  is not significant.

Table 7 shows the value of  $R^2$  for the regression models of Table 6.  $R^2$  is the percent variance in the dependent variable that is explained by the fitted regression line.

| Dependent Variable | Sex      | R Squared (%) |
|--------------------|----------|---------------|
| Carapace Width     | Male     | 25            |
|                    | Female   | 57            |
|                    | Juvenile | 96            |
| Plastron Length    | Male     | 62            |
|                    | Female   | 52            |
|                    | Juvenile | 91            |
| Plastron Width     | Male     | 41            |
|                    | Female   | 16            |
|                    | Juvenile | 91            |
| Weight             | Male     | 18            |
|                    | Female   | 43            |
|                    | Juvenile | 38            |
| Age                | Male     | 33            |
|                    | Female   | 26            |
|                    | Juvenile | 52            |

Table 7. R<sup>2</sup> values for regression model of Table 6

Stepwise multiple regression was used to explore which independent variable or combination of independent variables could be used as a predictor of weight and age: (see Appendix IV)

$$\text{Weight or Age} = a + b_1\text{CL} + b_2\text{CW} + b_3\text{PL} + b_4\text{PW}$$

#### Model Prediction of Weight

##### **Males**

$$\text{Weight} = -159.43 + 62.70\text{PL} \quad P < 0.0005 \quad R^2 = 29\%$$

##### **Females**

$$\text{Weight} = -187.55 + 62.94\text{PL} \quad P < 0.0005 \quad R^2 = 55\%$$

Plastron length was statistically the best predictor of weight for both male and female Sonoran mud turtles at Montezuma Well.

### Model Prediction of Age

#### **Males**

$$\text{Age} = -14.41 + 2.77\text{CW} \quad P < 0.0005 \quad R^2 = 51\%$$

#### **Females**

$$\text{Age} = -12.73 + 1.57\text{CL} \quad P < 0.004 \quad R^2 = 26\%$$

#### **Juveniles**

$$\text{Age} = 0.295 + 0.111\text{CW} \quad P < 0.010 \quad R^2 = 59\%$$

Carapace length the best predictor of age for female Sonoran mud turtles. However, carapace width was the best predictor for male and juvenile Sonoran mud turtles.

### Model Prediction of Weight and Age for Entire Population (Males, Females, and Juveniles Combined)

#### **Total**

#### **Population**

$$\text{Weight} = -225.16 + 67.09\text{PL} \quad P < 0.0005 \quad R^2 = 77\%$$

$$\text{Age} = -9.02 + 1.31\text{CL} \quad P < 0.0005 \quad R^2 = 61\%$$

As in individual sexes, plastron length remained the best predictor of weight. However, carapace length was the best predictor of age.

TRAPPING PATTERNS- Female turtles were more readily caught in the fall sampling period compared to the summer trapping period (see Figure 5). Males did not exhibit any pattern. More juveniles were caught in the summer trapping period.

### **Discussion:**

POPULATION DECLINE- The Sonoran mud turtle population at Montezuma Well has decline approximately 50% between 1983 and 1999. This estimate is based on population estimates equated using three different models, Peterson. Schnabel Binomial, and Schumacher-Eschmeyer. A 95% confidence interval for these estimates strongly suggests that this decline is factual and significant.

Turtle species around the world are becoming increasingly threatened by biodiversity losses resulting from human activity. Currently, there are 100 chelonians, out of the pool of 260+ species, that are threatened by extinction (Van Abbema 1997). The 1996 IUCN *Red List of Threatened Animals* determined that among fresh water turtles, 5 were critically endangered, 17 endangered, 29 vulnerable, and 51 threatened. In recent years, chelonians have gained attention because of the magnitude of their global population declines and extinction rates. The responsibility of documenting these declines is left to the scientific community and conservation ecologists. Creditable information reflecting the reduction in turtle numbers are needed to persuade the general public and its political representatives of the need for concern and action (Gibbons 1997). In order to gain the awareness of the global community, local biologists must provide statistical evidence that populations in bioregions are surrendering to ecological pressures. Without baseline studies like these, declines in populations are unable to be determined accurately due to the lack of historical evidence of previously existing population sizes. This historical evidence is needed not only for the monitoring of human impact but also to determine the relationship of the species to its habitat.

THREATS- One reason for this decline could be the introduction of the slider to the Well's habitat. In interviews with Park Service volunteers, all felt that the number of sliders had been increasing and the two species had been "balancing each other out" over the last few years. Rosen (pers. comm.) saw few sliders, estimating that there were 5-10 inhabiting the Well when he performed his study in 1983. National Park Service workers and I have identified many more. This population increase of sliders could be a contributor to the major decline of the Sonoran mud turtle population at the Well.

Kinosternid and slider turtles do not fit the same biological niche (Bury 1989), however they do exhibit similar dietary habits. Both are opportunistic omnivores, spending most of their time foraging through submerged vegetation in shallow waters (less than 1 to 3m deep), however, mud turtles feed on the bottom while sliders tend to feed swimming just below the surface (Parmenter and Avery 1990, Hulse 1974).

Studies done in South Carolina populations of sliders have illustrated seasonal shifts towards winter diets composed entirely of aquatic vegetation (Parmenter 1980, Schubauer and Parmenter 1981). This seasonal shift from omnivorous feeding to cooler season herbivorous intake has also been observed in mud turtles (Mahmoud 1968). This seasonal preference can also be seen in the decline of trap success in the fall trap periods (see Table 8).

| Summer Night     | Summer Day      | Fall Night       | Fall Day        |
|------------------|-----------------|------------------|-----------------|
| 2.25 turtles/hr. | 1.3 turtles/hr. | 0.75 turtles/hr. | 0.58 turtles/hr |

Table 8. Seasonal trap frequency in turtles/hour.

In a twelve month field study Hulse (1974) determined that during the relatively cool spring and fall months Sonoran mud turtles are predominately a diurnal feeders, slowly becoming nocturnal with the warmer water temperatures of summer. I found that the mud turtles in Montezuma Well were both diurnally and nocturnally active with a higher trap frequency in the night trapping hours (see Table 8). This can be attributed the water's constant temperature (18-24°C) and turtles competing for feeding.

Sliders at the Well were very active during the day, frequently basking in numerous places around the shore. Sliders have been determined to be diurnal feeders, using visual detection of movement for prey detection and warm day time temperature levels to add in digestion. In a study done by Bjorndal (1986) he found that in one slider species (*Pseudemys nelsoni*) feeding and ingestion was stimulated and increased by the visual indication of other feeding turtles. During one of my fall, daytime trapping periods, two large sliders managed to get into one of my traps. This may indicate the two are competing for food with the larger sliders having an obvious size advantage.

Competition can also be occurring with juvenile turtles. Hatchling sliders begin exploring for food immediately after emerging from their eggs. In a study done on *T.s.*

*elegans* in Illinois. juvenile hatchling stomachs and intestines were examined and found to possessed unused yolk masses yet were filled to capacity with food.

Ambient water and air temperatures, and the quantity and availability of food can profoundly increase growth rate and success of red-eared slider (Parmenter and Avery 1990). Montezuma Well's habitat provides an oasis for slider turtles that have adapted in colder regions. In the relatively constant and mild thermal conditions in Montezuma Well, slider turtles may exhibit reduced mortality and have the opportunities for continual growth through out the year. Gibbons (1970 & 1981 et al.) has found that red-eared sliders in lakes fed by coolant water from nuclear reactors grew faster and attained larger sizes then comparable populations under more natural and seasonal thermal regimes. Evolutionarily, Sonoran mud turtle are native to this region and their survival demands the consistency of their ecosystem. Any alteration in the balance of their habitat can considerably decrease their populations.

SEASONAL ACTIVITY CYCLE- Sonoran mud turtles probably do not hibernate because of relatively constant annual water temperature. In the summer months of July and August there were 27 unmarked turtles captured and 0 recaptures. In the fall months of October and November there was a total of 67 turtles captured, 31 of them being unmarked and 36 recaptures. Only 9 of the 36 recaptured turtles had been marked in the summer months. This could indicate that there are different populations active at different times of the year.

Another finding was that the number of males caught in the summer (accumulated by number of traps used) was only slightly higher than those caught in the fall (6 more individuals). However the number of females caught in the fall months was considerably higher (18 more individuals) than those caught in summer. I hope that these questions can be addressed in future longer-term studies.

NESTING-Three nesting sites were discovered. Two were successful and one had been exhumed in an area where numerous holes had been dug. The increase of urban development can host numerous scavengers that prey on turtle nests.

Another explanation for this could be the increase of development surrounding the park area. This would welcome a host of human adapted scavengers to the area. Many common scavenger predators are afforded food, shelter and water in human-altered environments when resources are inadequate. This can decrease mortality levels of these predators and they can thrive (Boarman p103). Another human influence on the mortality of turtle eggs and juveniles is the over kill of larger predator which prey on small scavengers.

MONITORING- This study demonstrates that carapace length was a statistically reliable variable for predicting other morphometric parameters at a population level. Plastron length and carapace length was also determined to be reliable predictors of weight and age, respectively. This suggests that population surveys can be carried out expeditiously with little training of surveyors and simple equipment to estimate more complex metrics such as weight and age. This infers that inexperienced personnel such as volunteers, cub

scouts, or even school children could participate in collection of large amounts of quantitative data. This data can then be used by professional biologists to determine major ecological and demographic parameters. This allows for easier manageability of the endemic population by park supervisors and staff. Due to the relatively isolated nature of Montezuma Well, the decline of endemic mud turtle populations hold significant importance. Its laboratory like conditions make it a distinct location for the facilitation of future long term monitoring. This generally stable environment presents the ideal setting for studies of endemism and potential exposures.

In retrospect, different extents of plastron wear can be categorized to represent ages beyond recognition by growth rings (Garber & Burger 1995). Hulse (1976) noted that erosion of the plastral growth rings in *Kinosternon sonoriense* is usually rapid due to their bottom-feeding behavior. Mud turtles at Montezuma Well do not feed on a rough bottom, but rather appear to feed in water columns among submerged aquatic plants and on a soft substrate. This could infer that their plastral wear occurs at a slower rate. Turtles that are found to have excessive wear can be used to determine terrestrial movement as well. It should be determined if females have more wear than male due to their laying of eggs.

### **Conclusion:**

This study provides information on an endemic element of the park's native environment and the possible negative effects of exotic species. It supports conservation effort and aids in better understanding human regional impact.

The tourist experience is an important part of the National Parks Service's mission, however, it should not take precedence over the conservation of Montezuma Well's natural environment. The Sonoran mud turtle is an important part of its unique ecosystem and must be managed. Traditionally, less prominent species of turtles like the mud turtle have been overlooked due to their relative lack of importance to humans. Generally, only species that provide as a human resource or those that are considered to be visually or emotionally appealing have invoked human sympathy and action (Burger and Garber 1995). Conversely, less well known species like the Sonoran mud turtle are also suffering declines in populations, as shown by this study. The ecological risks and causes of these less well revealed declines must also be monitored to insure that species do not becoming endangered or extinct.

If the slider turtles are determined to be having negative effects on the Well's endemics, they should be remove. In fact, as enforced by the National Park Systems Organic Act (see Appendix V), a case can be made for there removal immediately. It is the job of the National Parks Service to ensure the preservation of their natural native ecosystems. Instead of waiting for empirically evidence proving that sliders are inflicting adverse effects on Montezuma Well's endemics, park managers should take a more proactive position. Methodology, such as that suggested by this study, should be initiated to monitor this population of endemic mud turtle.

There has not been much research done on this species and there is still much to be determined. While the mud turtles declines may not be directly attributable to the

introduction of the sliders, it is definitely an issue that needs to be addressed. The focus of this study cannot be a solitary indicator of the biotic responses of the region, however it could be used to facilitate other projects and support the monitoring of local and global environmental change.

**Advisors:**

Dr. Anthony J. Krzysik

Ph.D.-University of Pittsburgh, Biology/Ecology 1978

M.S.-University of Pittsburgh, Physical Chemistry 1972

B.S.-Carnegie-Mellon University, Chemistry 1963

Dr. Steven D. Garber

Ph.D.-Rutgers University, Ecology and Evolution, 1994

M.S.-University of Kansas, Ecology and Systematics, 1979

B.S.-Cornell University, Natural Resources, 1977

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Figure 1.

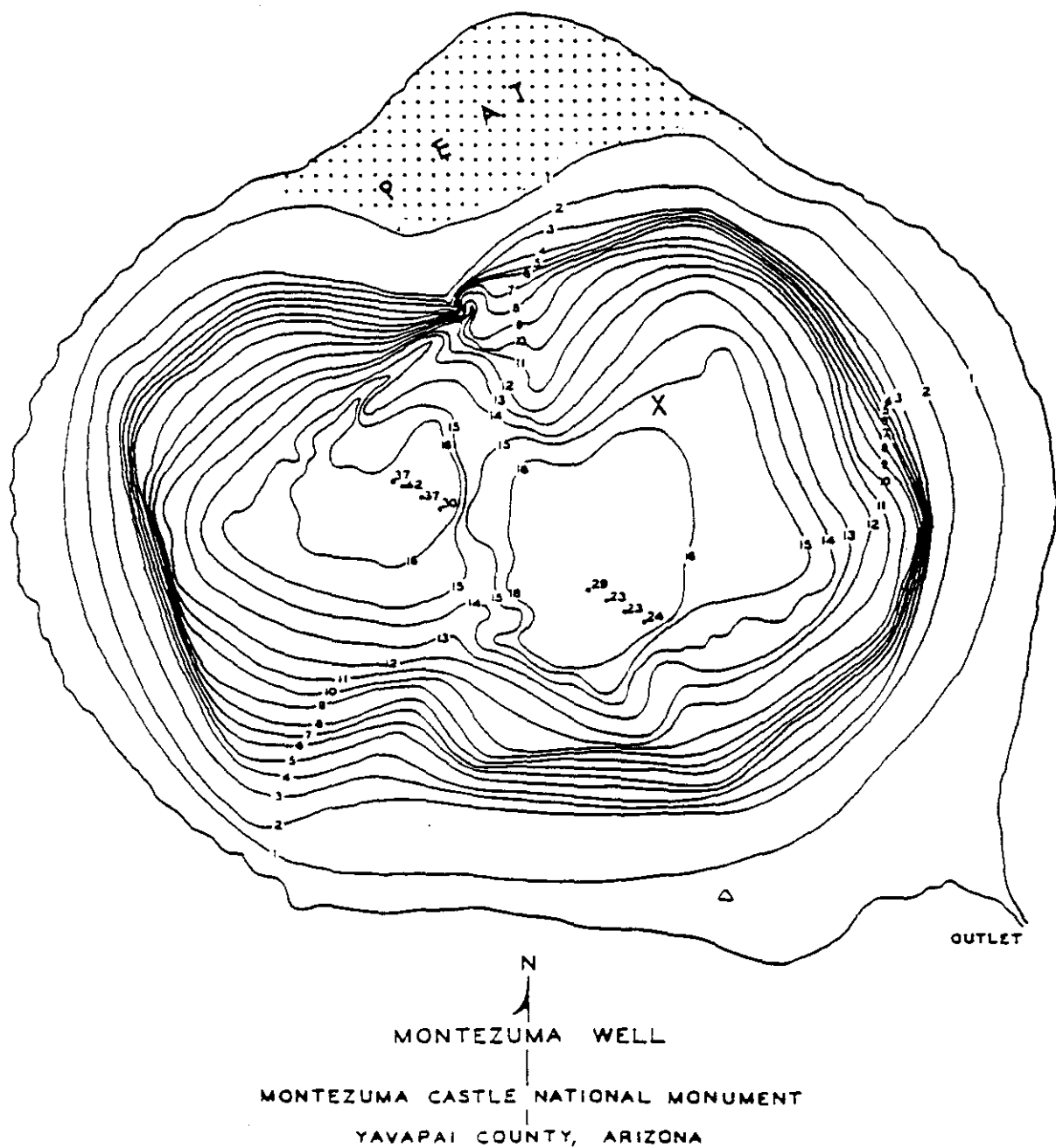


Figure 1.—Bathymetric map of Montezuma Well, Yavapai Co., Arizona. Contour interval, 1.0 m; 1.5 cm represents 50 m; X marks region of "northeast" inlet.

Figure 2.

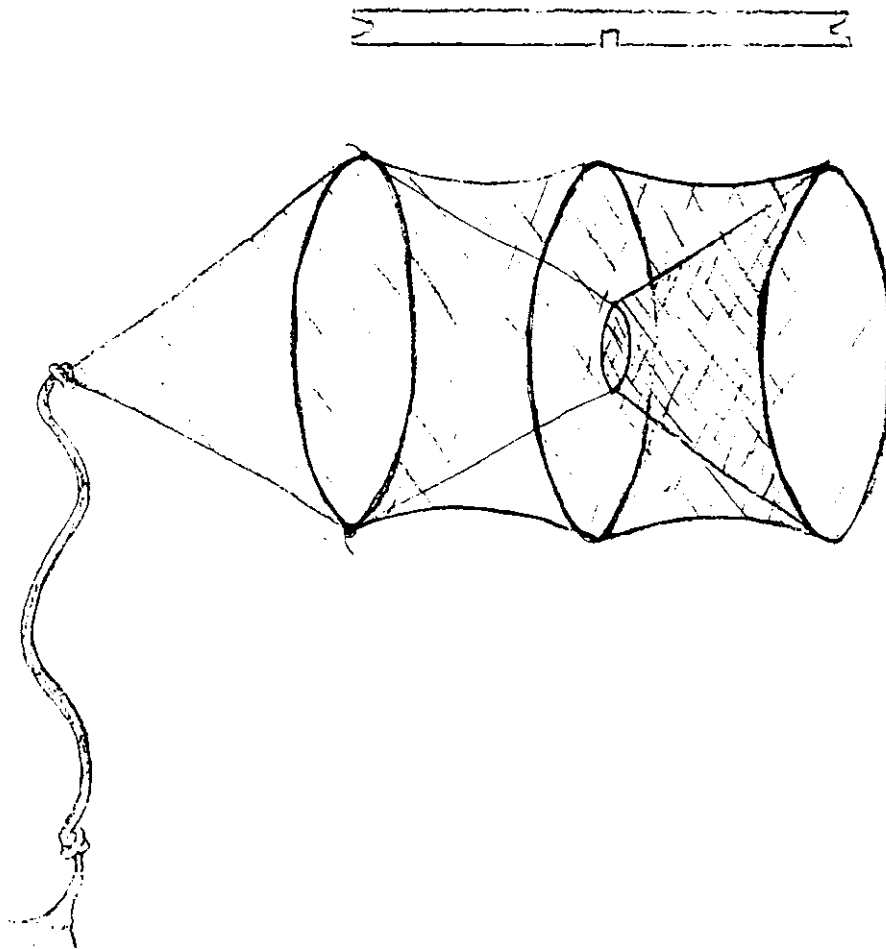


Figure2.- Three ring nylon hoop trap and wooden brace.

**Figure 3.**

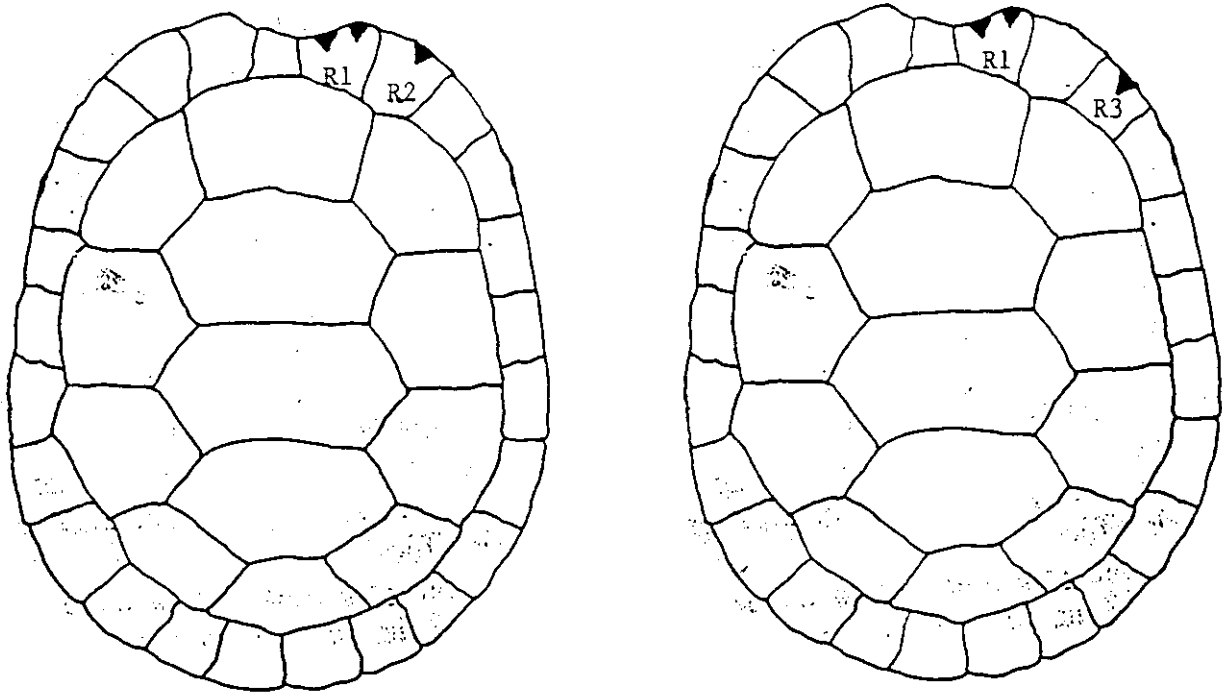


Figure 3.- Example of notching procedure used marking mud turtles at Montezuma Well, Camp Verde, Arizona.

Figure 4.

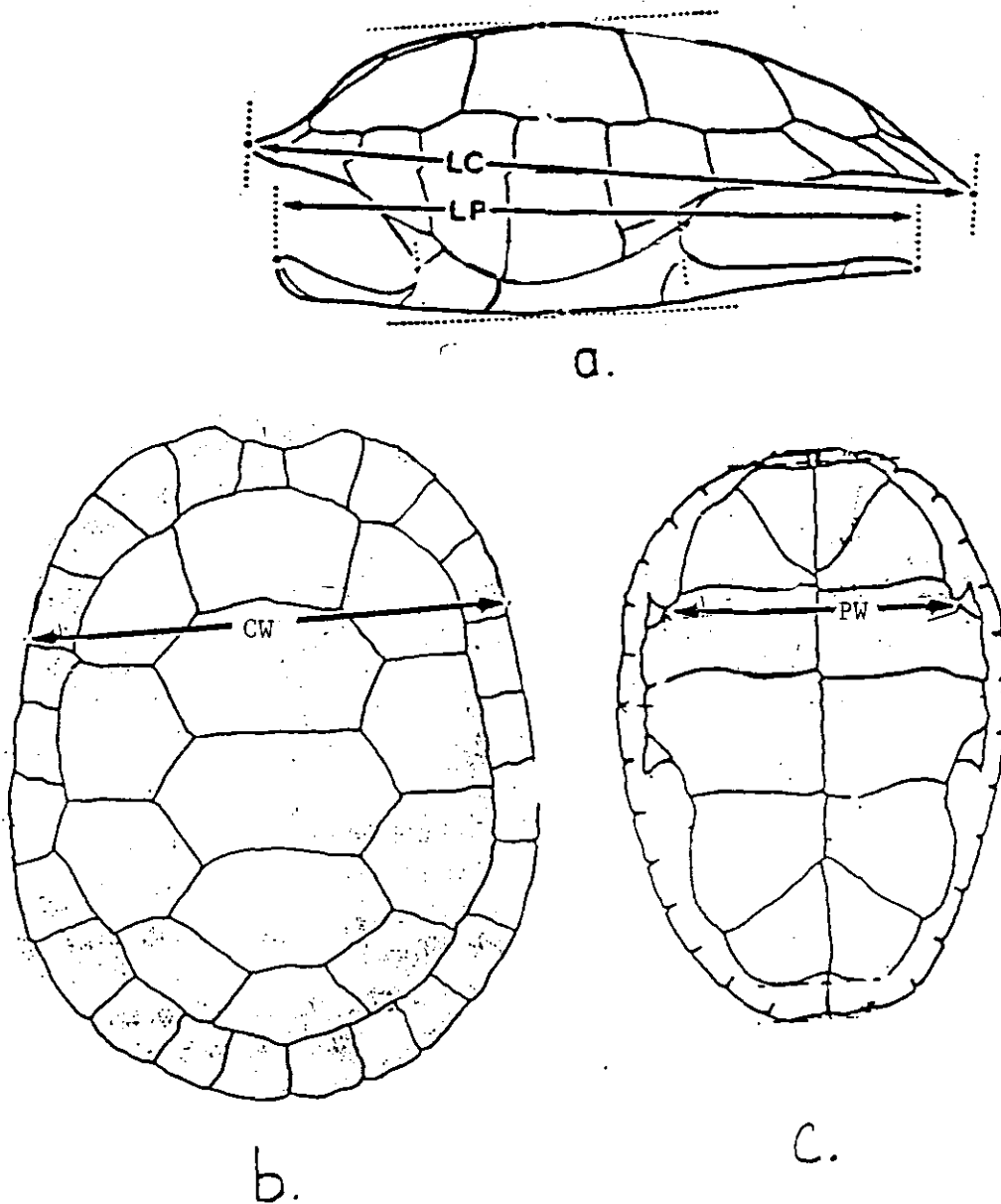


Figure 4.- (a.)Measurement vectors for determining length of carapace (LC) and plastron (LP); (b.)measurement vector for determining carapace width (CW); (c.)measurement vector for determining plastron width (PW).

**Figure 5.**

## **Trapping Success of Sonoran Mud Turtles**

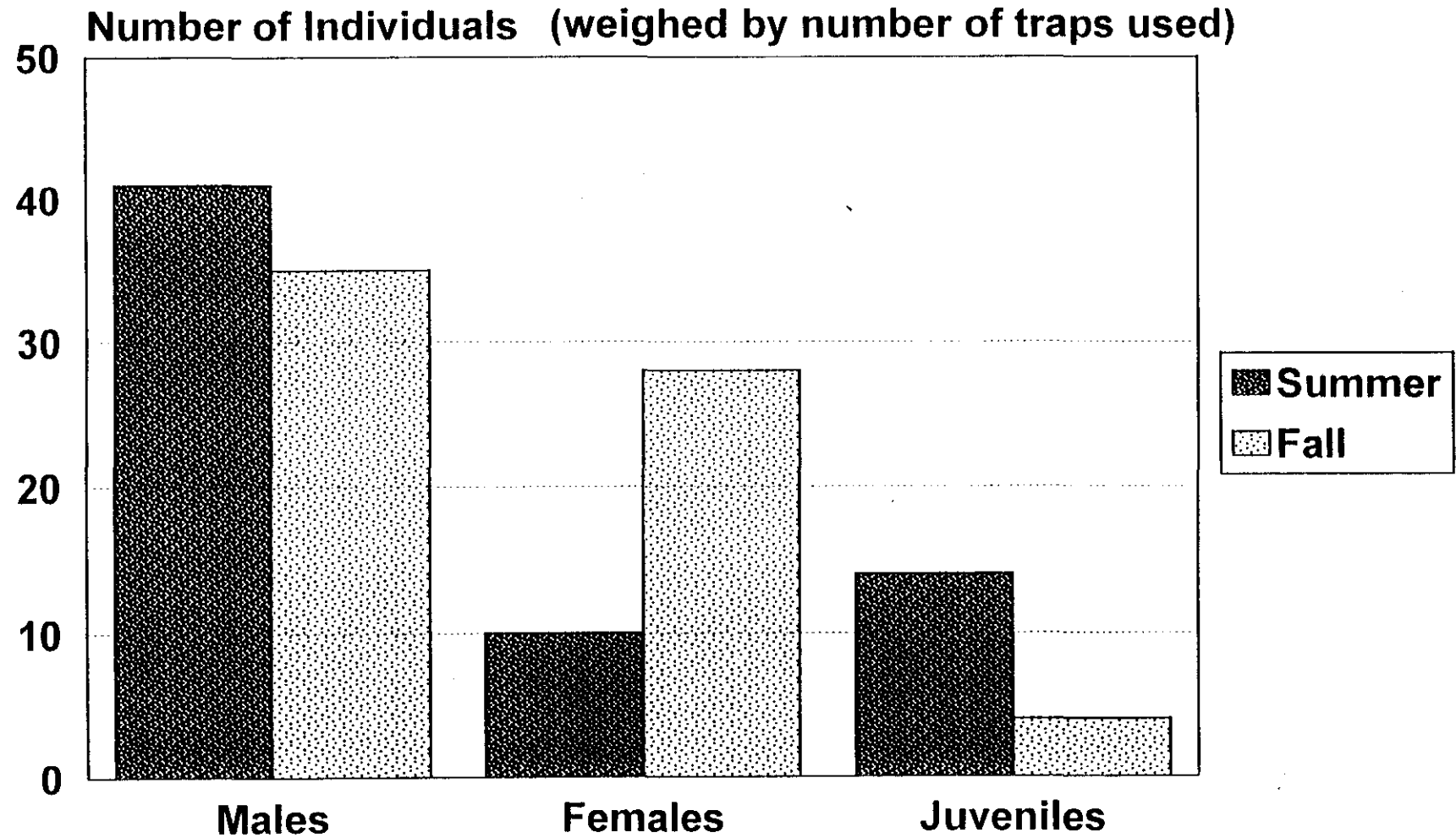


Figure 5.- Comparison of trap success between the summer and fall trapping periods.

# Appendix I

## **Have Introduced Sliders (*Trachemys scripta*) Affected Sonoran Mud Turtle (*Kinosternon sonoriense*) Populations at Montezuma Castle National Monument in Camp Verde, Arizona?**

*Prepared for*  
Glenn Henderson  
Superintendent of Montezuma Castle National Monument  
Camp Verde, AZ

*Proposal by*  
Matthew Malone and Steven D. Garber

Embry-Riddle Aeronautical University  
3200 Willow Creek Road  
Prescott, Arizona 86301

(520) 708-6949

**Abstract:**

We will investigate whether non-native sliders (*Trachemys scripta*) introduced at Montezuma Well in Camp Verde, Arizona have affected native Sonoran mud turtles (*Kinosternon sonoriense*). We will decipher when sliders were introduced at Montezuma Well, and whether their numbers have been increasing. With a mark and recapture study, we will estimate the number of Sliders and Sonoran mud turtles. We will then compare our results with those of Rosen (1987) to find if the mud turtle and pond slider populations have changed, in number, over time. From our analysis we will determine whether introduced sliders have had any effect on the native herpetofauna.

**Problem Statement:**

If the sliders have increased in number and are affecting the indigenous mud turtles, this will be significantly important and may affect how introduced slider populations are viewed. This could lead to elimination or proper management of sliders. Our investigation complies with the United States Department of the Interior guidelines put forth by the Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 [16 USC §§4701, 4702, 4711, 4712, 4721-28, 4741, 4751; 18 USC §42] (McKnight 1993). This study will help investigators understand the impact of introduced reptiles and could help wildlife managers at Montezuma Castle in the protection of their habitat.

**Objectives:**

The goals of our research are to learn whether sliders are affecting mud turtle populations and to help park managers sustain a viable minimum population of mud turtles. Our study will provide an update of the research done by Rosen (1987); supplying more baseline data that could facilitate future projects and support the monitoring of the species at Montezuma Well.

**Methods:**

Turtles are to be trapped at Montezuma Well in Camp Verde, Arizona. Montezuma Well is a 112m (368ft) across, 17m (55ft) deep limestone sinkhole in Northern Arizona. We

will note all data using Rosen's (1987) methods. Carapace length, turtle age, air, water and cloacal temperatures will be recorded. Threats such as competition, predation, and habitat alteration will also be taken into account and examined with regard to potential impact on turtle populations.

Turtles will be trapped using 12 baited hoop traps strategically placed inconspicuously along the shorelines from June 1999-September 1999. Rosen (1987) studied Sonoran mud turtles at Montezuma Well using hoop traps with a 2.54cm (1in) mesh and single 30.5cm (12in) funnel entrance. As in Rosen's (1987) study, traps will be set for four days in June, three nights in July, and three nights in August. Traps will be baited with canned sardines that will be ground together with Vienna sausages. The juvenile turtles will be captured in commercial minnow traps with 0.64cm (1/4in) mesh and funnel openings of 7.6cm (3in). Whenever possible, turtles will be caught by hand or with a dip net (Rosen 1987).

Captured turtles will be individually coded by notching marginal scutes with a file, and recorded before being released. Records will be compared with those collected by Rosen in 1983-84. Growth annuli and shell wear will be used as an age indicator (Sexton 1959; Garber & Burger 1995). For older turtles growth rings will be analyzed to quantify age. This will help determine age stability and dynamic.

We will calculate adult survivorship by assuming a stable age distribution. This will be checked by using the Lincoln Index to calculate surviving turtles marked by P.C. Rosen from 1983-84. Measurements of turtles will include carapacial length and width; total shell depth; plastral length; length and width of anterior, mid, posterior and plastral lobes; length of all carapacial and plastral scutes; bridge length; length of anterior and posterior plastral hinges; head length and width; rostral length; and interorbital width (Ernst, Barbour, Ernst, and Butler 1974). Also facial stripes and other unique features will be noted. Inventory of known nesting sites and eggs laid will be compiled. This data will then be compared with juvenile population to determine survival.

Sexual differences in *kinosternid* turtles have been studied by Hallowell (1856), Agassiz (1857), Hay (1892), and Risley (1933) who found characteristics commonly found in males, as compared to females. Longer, thicker tail bearing a horny tip, larger head, more skin between the scutes and the plastron, and two small scaly patches on the inner thighs (Mahmound 1967). Using these characteristics we will establish male to female ratio.

Blood samples will not be drawn from turtles unless we are given permission. Blood samples would allow us to investigate genetic variance and uniqueness of the Montezuma Well population. This is not a high priority, but if we were allowed to collect blood samples now we will not have to trap again to conduct this work. Our techniques, if given permission, will not harm or maim the turtles in anyway. We will use sterile syringes, no cutting, and no tissue sampling. We have extreme experience with these techniques.

#### **Park Participation:**

We request the use of any literature on hand pertaining to the ecology of the park or to our study in general. Mud turtles are diurnally active during the fall, winter, and spring months, becoming more nocturnal with the onset of summer (Hulse 1974; 1976). Consequently, we would also like access to the park during closed hours. We would conduct almost all of our trapping during off-hours so we will not interfere with visitors. Sonoran mud turtles are harshly affected by dehydration (Wygoda and Chmura 1990) and conduct most activity in the water (especially creeping methodically along the bottom looking for food) (Ernst, Lovich, Barbour 1994). If the Park allows, turtles may also be collected by hand, using snorkel gear, after normal business hours.

#### **Conclusion:**

We urge you to give this proposal serious consideration and we are available to discuss its particulars with you at any time.

**Personnel:**

Biologist: Steven D. Garber

Ph.D.: Rutgers University, Ecology and Evolution, 1994

M.S.: University of Kansas, Ecology and Systematics, 1979

B.S.: Cornell University, Natural Resources, 1977

(Resume Enclosed)

Biologist: Matthew M. Malone

Student: Embry Riddle Aeronautical University, Environmental Science

Technology and Globalization, graduation Dec. 1999

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Wygoda, M L., and C. M. Chmura 1990. Effects of shell closure on water loss in Sonoran mud turtles, *Kinosternon sonoriense*. Southwestern. Naturalist. 35:228-229.

# Appendix II

## Digest of Federal Resource Laws of Interest to the U.S. Fish and Wildlife Service

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### Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990

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This Act, Nonindigenous Aquatic Nuisance Prevention and Control Act of 1990 -- Title I of P.L.

101-646 (104 Stat. 4761, 16 U.S.C. 4701, enacted November 29, 1990) established a broad new Federal program to prevent introduction of and to control the spread of introduced aquatic nuisance species and the brown tree snake. The U.S. Fish and Wildlife Service, the U.S. Coast Guard, the Environmental Protection Agency, the Army Corps of Engineers, and the National Oceanic and Atmospheric Administration all were assigned major, new responsibilities, including membership on an Aquatic Nuisance Species Task Force established to develop a program of prevention, monitoring, control, and study.

Responsibilities involving the Service include:

- o As a Task Force member, the Service must be consulted by the Secretary of the Transportation (through the Coast Guard) on regulations requiring ballast-water exchange or treatment requirements for ships entering the Great Lakes.
  - o As a Task Force member and joint chair of the Task Force, the Service must: (1) jointly conduct a study on the environmental effects of ballast water exchange on receiving water and identify areas within waters of the U.S. and the Exclusive Economic Zone where exchange of ballast water poses no threat; (2) jointly conduct a study of whether aquatic nuisance species threaten the ecological characteristics and uses of the waters of the U.S. other than the Great Lakes; and (3) cooperate in a study to determine the need for controls on vessels entering waters of the U.S. other than the Great Lakes.
  - o The Service must act with the National Oceanic and Atmospheric Administration as co-chair of the Aquatic Nuisance Species Task Force, and by May 29, 1991, the Director and the Under Secretary of NOAA were directed to develop an MOU describing their roles in carrying out the subtitle.
  - o The Task Force, composed of Federal agencies and representatives of States and regional entities, is to develop and implement an aquatic nuisance species program to prevent their introduction and dispersal in waters of the U.S.
- By December 29, 1990, the Task Force was directed to request the Great Lakes Commission to convene a panel for Great Lakes regional coordination.
- o The Director may make grants to States for implementation of approved management plans submitted by State Governors.
  - o The Task Force shall advise the Secretary of State concerning aquatic nuisance species in waters shared with other countries.
  - o By November 29, 1991, the Task Force was directed to identify and evaluate approaches for reducing the risk of adverse consequences from intentional introductions and report to Congress.
  - o The Task Force shall undertake a program to control the brown tree snake.

The relevant documents comprising the legislative history include: H.R. 5390; pages H13277-87 from the October 27, 1990, Congressional Record, reporting final passage in the House; page S17147-60 from the October 26, 1990, Congressional Record, reporting passage by the Senate; Senate Report 101-523, filed on October 2, 1990; and pages H8492-96 from the October 1, 1990, Congressional Record, reporting passage in the House amended.

## Regression

## Appendix III

SEX = male

Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

a. All requested variables entered.

b. Dependent Variable: carapace width

c. SEX = male

Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .500 <sup>a</sup> | .250     | .235              | .4652                      | 1.269         |

a. Predictors: (Constant), carapace length

b. Dependent Variable: carapace width

c. SEX = male

ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 3.616          | 1  | 3.616       | 16.710 | .000 <sup>a</sup> |
|       | Residual   | 10.819         | 50 | .216        |        |                   |
|       | Total      | 14.434         | 51 |             |        |                   |

a. Predictors: (Constant), carapace length

b. Dependent Variable: carapace width

c. SEX = male

Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | 3.748                       | 1.034      |                           | 3.625 | .001 |
|       | carapace length | .343                        | .084       | .500                      | 4.088 | .000 |

a. Dependent Variable: carapace width

b. SEX = male

# Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|---------|-----------|----------------|----|
| Predicted Value                   | 7.2775    | 8.4424  | 7.9673    | .2663          | 52 |
| Std. Predicted Value              | -2.591    | 1.784   | .000      | 1.000          | 52 |
| Standard Error of Predicted Value | 6.452E-02 | .1807   | 8.719E-02 | 2.708E-02      | 52 |
| Adjusted Predicted Value          | 7.2483    | 8.4906  | 7.9695    | .2653          | 52 |
| Residual                          | -.7970    | 1.0198  | 1.657E-15 | .4606          | 52 |
| Std. Residual                     | -1.713    | 2.192   | .000      | .990           | 52 |
| Stud. Residual                    | -1.814    | 2.330   | -.002     | 1.017          | 52 |
| Deleted Residual                  | -.9156    | 1.1517  | -2.15E-03 | .4863          | 52 |
| Stud. Deleted Residual            | -1.858    | 2.443   | .000      | 1.032          | 52 |
| Mahal. Distance                   | .000      | 6.713   | .981      | 1.395          | 52 |
| Cook's Distance                   | .000      | .351    | .029      | .063           | 52 |
| Centered Leverage Value           | .000      | .132    | .019      | .027           | 52 |

a. Dependent Variable: carapace width

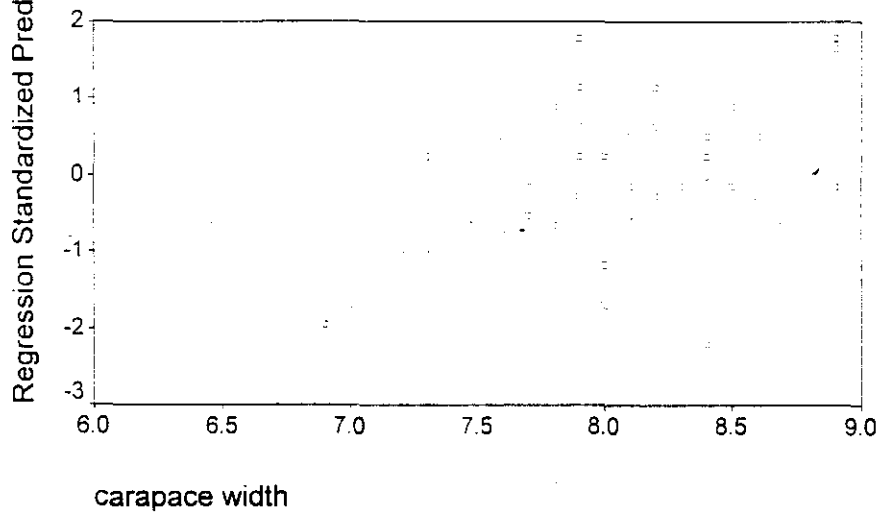
b. SEX = male

## Charts

### Scatterplot

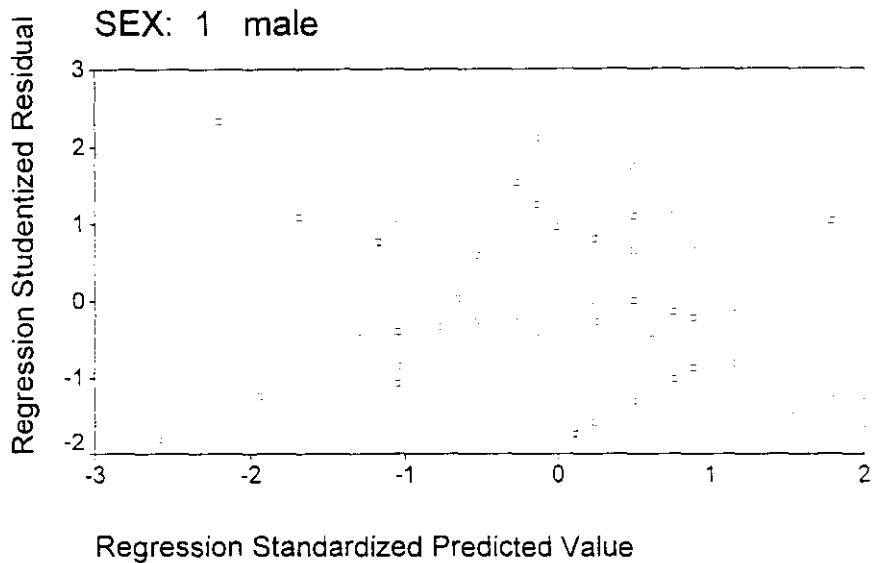
Dependent Variable: carapace width

SEX: 1 male



## Scatterplot

Dependent Variable: carapace width



**SEX = female**

### Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

- a. All requested variables entered.
- b. Dependent Variable: carapace width
- c. SEX = female

### Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .757 <sup>a</sup> | .573     | .558              | .3826                      | 1.589         |

- a. Predictors: (Constant), carapace length
- b. Dependent Variable: carapace width
- c. SEX = female

ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 5.883          | 1  | 5.883       | 40.179 | .000 <sup>a</sup> |
|       | Residual   | 4.392          | 30 | .146        |        |                   |
|       | Total      | 10.275         | 31 |             |        |                   |

a. Predictors: (Constant), carapace length

b. Dependent Variable: carapace width

c. SEX = female

Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | .793                        | 1.204      |                           | .659  | .515 |
|       | carapace length | .595                        | .094       | .757                      | 6.339 | .000 |

a. Dependent Variable: carapace width

b. SEX = female

Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|---------|-----------|----------------|----|
| Predicted Value                   | 7.6948    | 9.1822  | 8.4125    | .4356          | 32 |
| Std. Predicted Value              | -1.647    | 1.767   | .000      | 1.000          | 32 |
| Standard Error of Predicted Value | 6.764E-02 | .1390   | 9.298E-02 | 2.285E-02      | 32 |
| Adjusted Predicted Value          | 7.6941    | 9.2099  | 8.4116    | .4333          | 32 |
| Residual                          | -.8278    | .7077   | 1.443E-15 | .3764          | 32 |
| Std. Residual                     | -2.163    | 1.850   | .000      | .984           | 32 |
| Stud. Residual                    | -2.201    | 1.909   | .001      | 1.013          | 32 |
| Deleted Residual                  | -.8565    | .7539   | 8.964E-04 | .3990          | 32 |
| Stud. Deleted Residual            | -2.363    | 2.002   | -.008     | 1.048          | 32 |
| Mahal. Distance                   | .000      | 3.122   | .969      | .980           | 32 |
| Cook's Distance                   | .000      | .119    | .030      | .038           | 32 |
| Centered Leverage Value           | .000      | .101    | .031      | .032           | 32 |

a. Dependent Variable: carapace width

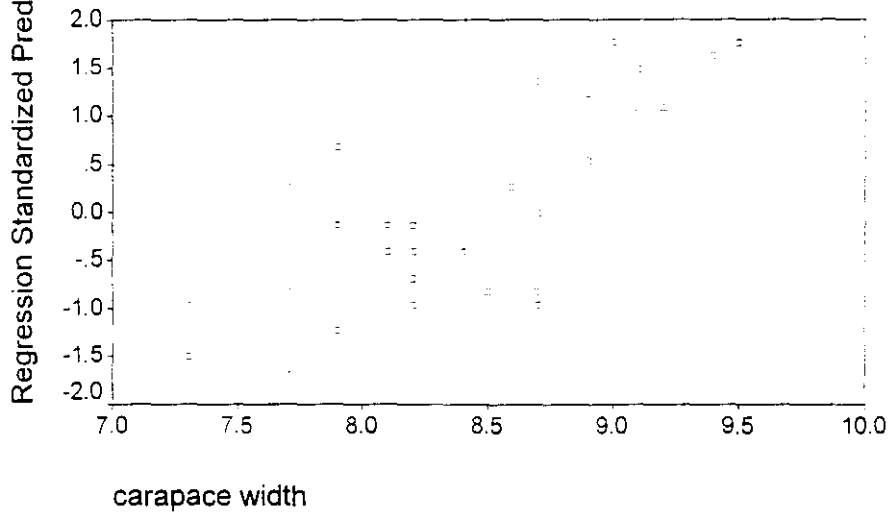
b. SEX = female

## Charts

### Scatterplot

Dependent Variable: carapace width

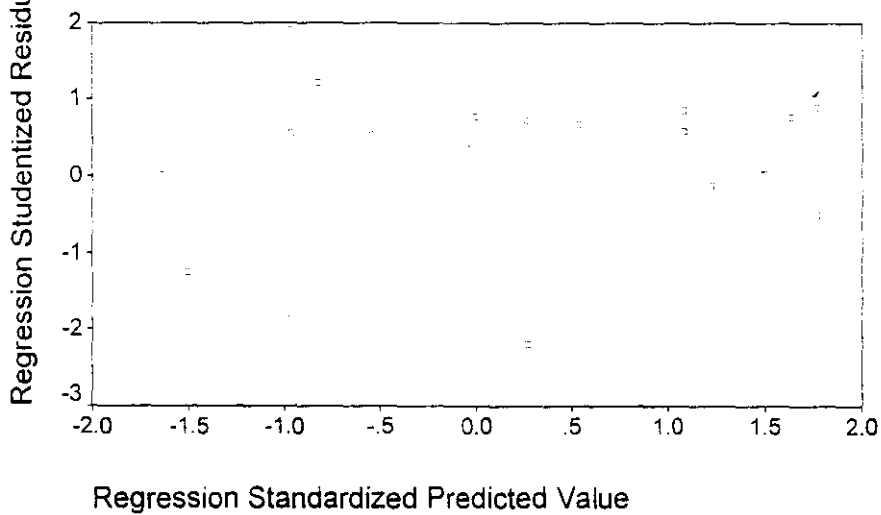
SEX: 2 female



### Scatterplot

Dependent Variable: carapace width

SEX: 2 female



**SEX = juvenile**

### Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

- a. All requested variables entered.
- b. Dependent Variable: carapace width
- c. SEX = juvenile

### Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .981 <sup>a</sup> | .963     | .958              | .2237                      | 1.930         |

- a. Predictors: (Constant), carapace length
- b. Dependent Variable: carapace width
- c. SEX = juvenile

### ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F       | Sig.              |
|-------|------------|----------------|----|-------------|---------|-------------------|
| 1     | Regression | 10.276         | 1  | 10.276      | 205.372 | .000 <sup>a</sup> |
|       | Residual   | .400           | 8  | 5.003E-02   |         |                   |
|       | Total      | 10.676         | 9  |             |         |                   |

- a. Predictors: (Constant), carapace length
- b. Dependent Variable: carapace width
- c. SEX = juvenile

### Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                 | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)      | .606                        | .375       |                           | 1.618  | .144 |
|       | carapace length | .654                        | .046       | .981                      | 14.331 | .000 |

- a. Dependent Variable: carapace width
- b. SEX = juvenile

# Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|---------|-----------|----------------|----|
| Predicted Value                   | 3.6777    | 7.1413  | 5.8800    | 1.0685         | 10 |
| Std. Predicted Value              | -2.061    | 1.180   | .000      | 1.000          | 10 |
| Standard Error of Predicted Value | 7.075E-02 | .1692   | 9.587E-02 | 3.011E-02      | 10 |
| Adjusted Predicted Value          | 3.9152    | 7.1554  | 5.9030    | 1.0276         | 10 |
| Residual                          | -.2610    | .4271   | 3.553E-16 | .2109          | 10 |
| Std. Residual                     | -1.167    | 1.910   | .000      | .943           | 10 |
| Stud. Residual                    | -1.235    | 2.023   | -.040     | 1.052          | 10 |
| Deleted Residual                  | -.4152    | .4795   | -2.30E-02 | .2706          | 10 |
| Stud. Deleted Residual            | -1.284    | 2.708   | .016      | 1.216          | 10 |
| Mahal. Distance                   | .000      | 4.248   | .900      | 1.284          | 10 |
| Cook's Distance                   | .000      | .985    | .165      | .297           | 10 |
| Centered Leverage Value           | .000      | .472    | .100      | .143           | 10 |

a. Dependent Variable: carapace width

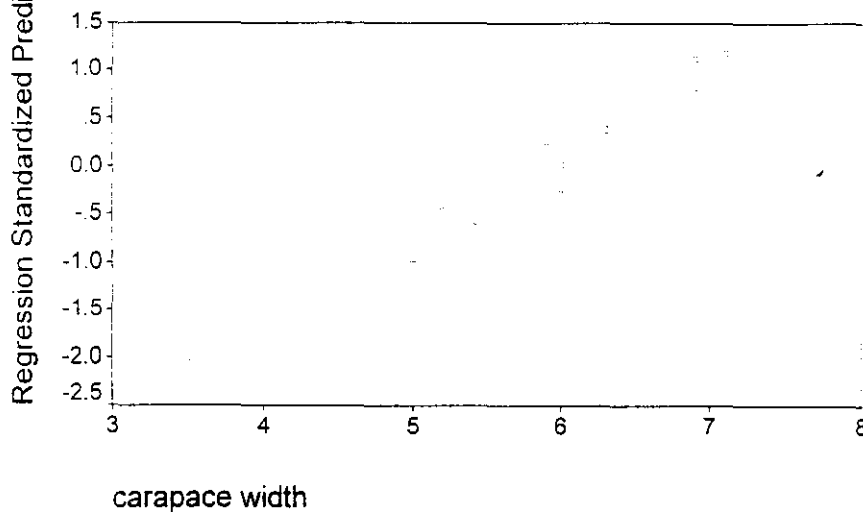
b. SEX = juvenile

## Charts

### Scatterplot

Dependent Variable: carapace width

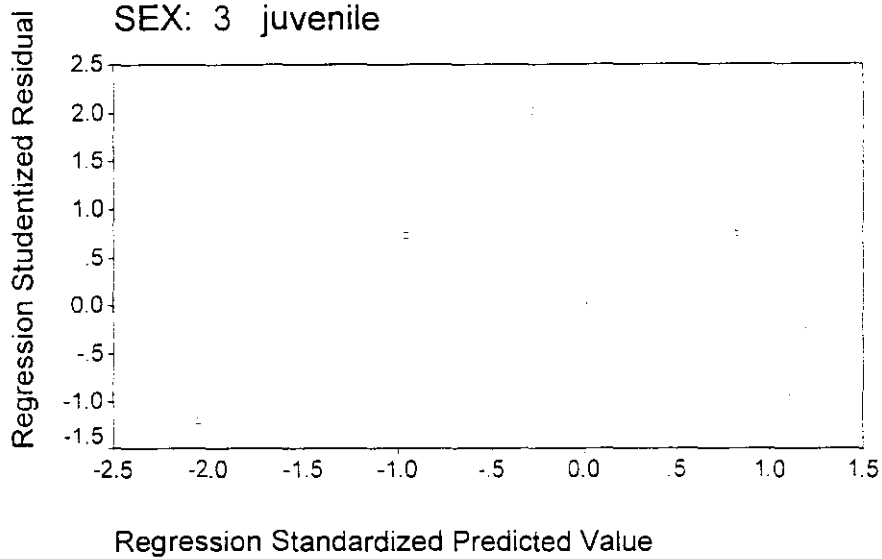
SEX: 3 juvenile



## Scatterplot

Dependent Variable: carapace width

SEX: 3 juvenile



## Regression

SEX = male

Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

- a. All requested variables entered.
- b. Dependent Variable: plastron length
- c. SEX = male

Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .787 <sup>a</sup> | .619     | .612              | .3987                      | 1.695         |

- a. Predictors: (Constant), carapace length
- b. Dependent Variable: plastron length
- c. SEX = male

# ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 12.931         | 1  | 12.931      | 81.352 | .000 <sup>a</sup> |
|       | Residual   | 7.948          | 50 | .159        |        |                   |
|       | Total      | 20.879         | 51 |             |        |                   |

a. Predictors: (Constant), carapace length

b. Dependent Variable: plastron length

c. SEX = male

## Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | 2.825                       | .886       |                           | 3.188 | .002 |
|       | carapace length | .648                        | .072       | .787                      | 9.020 | .000 |

a. Dependent Variable: plastron length

b. SEX = male

## Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|---------|-----------|----------------|----|
| Predicted Value                   | 9.4992    | 11.7023 | 10.8038   | .5035          | 52 |
| Std. Predicted Value              | -2.591    | 1.784   | .000      | 1.000          | 52 |
| Standard Error of Predicted Value | 5.530E-02 | .1549   | 7.474E-02 | 2.321E-02      | 52 |
| Adjusted Predicted Value          | 9.5701    | 11.7380 | 10.8076   | .5032          | 52 |
| Residual                          | -.9783    | .8753   | 1.025E-16 | .3948          | 52 |
| Std. Residual                     | -2.454    | 2.195   | .000      | .990           | 52 |
| Stud. Residual                    | -2.511    | 2.218   | -.005     | 1.014          | 52 |
| Deleted Residual                  | -1.0241   | .8935   | -3.76E-03 | .4140          | 52 |
| Stud. Deleted Residual            | -2.658    | 2.313   | -.007     | 1.036          | 52 |
| Mahal. Distance                   | .000      | 6.713   | .981      | 1.395          | 52 |
| Cook's Distance                   | .000      | .178    | .025      | .045           | 52 |
| Centered Leverage Value           | .000      | .132    | .019      | .027           | 52 |

a. Dependent Variable: plastron length

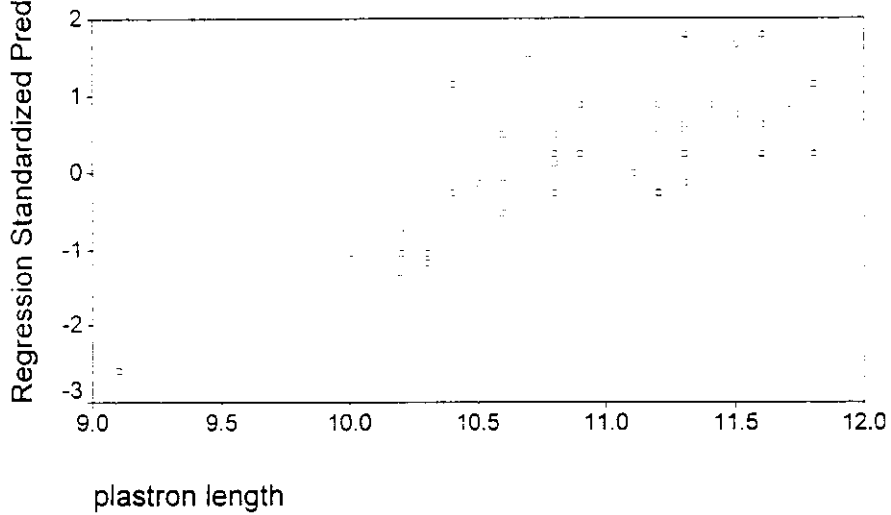
b. SEX = male

## Charts

### Scatterplot

Dependent Variable: plastron length

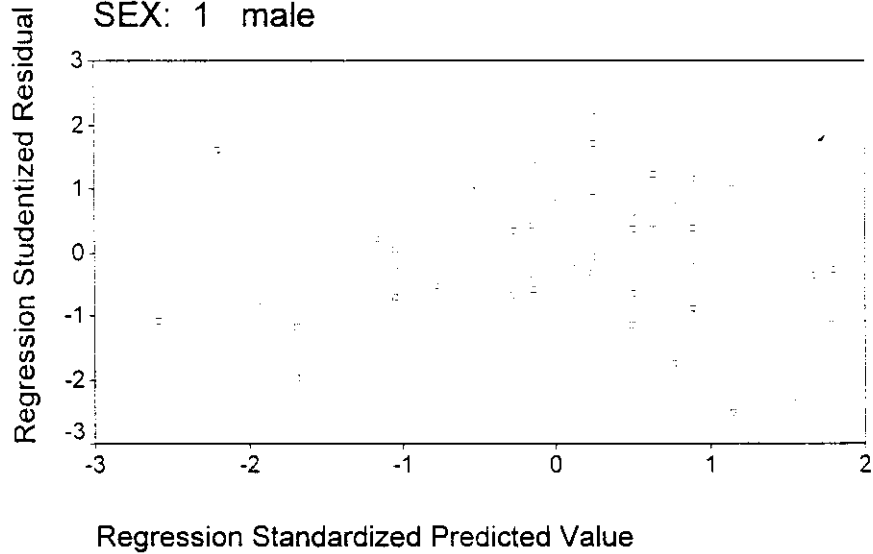
SEX: 1 male



### Scatterplot

Dependent Variable: plastron length

SEX: 1 male



**SEX = female**

### Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   | .                 | Enter  |

- a. All requested variables entered.  
b. Dependent Variable: plastron length  
c. SEX = female

### Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .720 <sup>a</sup> | .519     | .503              | .4960                      | 2.284         |

- a. Predictors: (Constant), carapace length  
b. Dependent Variable: plastron length  
c. SEX = female

### ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 7.960          | 1  | 7.960       | 32.360 | .000 <sup>a</sup> |
|       | Residual   | 7.379          | 30 | .246        |        |                   |
|       | Total      | 15.339         | 31 |             |        |                   |

- a. Predictors: (Constant), carapace length  
b. Dependent Variable: plastron length  
c. SEX = female

### Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | 3.681                       | 1.560      |                           | 2.359 | .025 |
|       | carapace length | .692                        | .122       | .720                      | 5.689 | .000 |

- a. Dependent Variable: plastron length  
b. SEX = female

### Casewise Diagnostics<sup>a,b</sup>

| Case Number | Std. Residual | plastron length |
|-------------|---------------|-----------------|
| 56          | -3.244        | 10.10           |

- a. Dependent Variable: plastron length  
b. SEX = female

# Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|---------|-----------|----------------|----|
| Predicted Value                   | 11.7089   | 13.4391 | 12.5437   | .5067          | 32 |
| Std. Predicted Value              | -1.647    | 1.767   | .000      | 1.000          | 32 |
| Standard Error of Predicted Value | 8.768E-02 | .1802   | .1205     | 2.962E-02      | 32 |
| Adjusted Predicted Value          | 11.8225   | 13.4755 | 12.5474   | .5019          | 32 |
| Residual                          | -1.6089   | 1.1066  | 4.219E-15 | .4879          | 32 |
| Std. Residual                     | -3.244    | 2.231   | .000      | .984           | 32 |
| Stud. Residual                    | -3.456    | 2.285   | -.003     | 1.026          | 32 |
| Deleted Residual                  | -1.8259   | 1.1608  | -3.63E-03 | .5315          | 32 |
| Stud. Deleted Residual            | -4.380    | 2.472   | -.022     | 1.153          | 32 |
| Mahal. Distance                   | .000      | 3.122   | .969      | .980           | 32 |
| Cook's Distance                   | .000      | .805    | .046      | .143           | 32 |
| Centered Leverage Value           | .000      | .101    | .031      | .032           | 32 |

a. Dependent Variable: plastron length

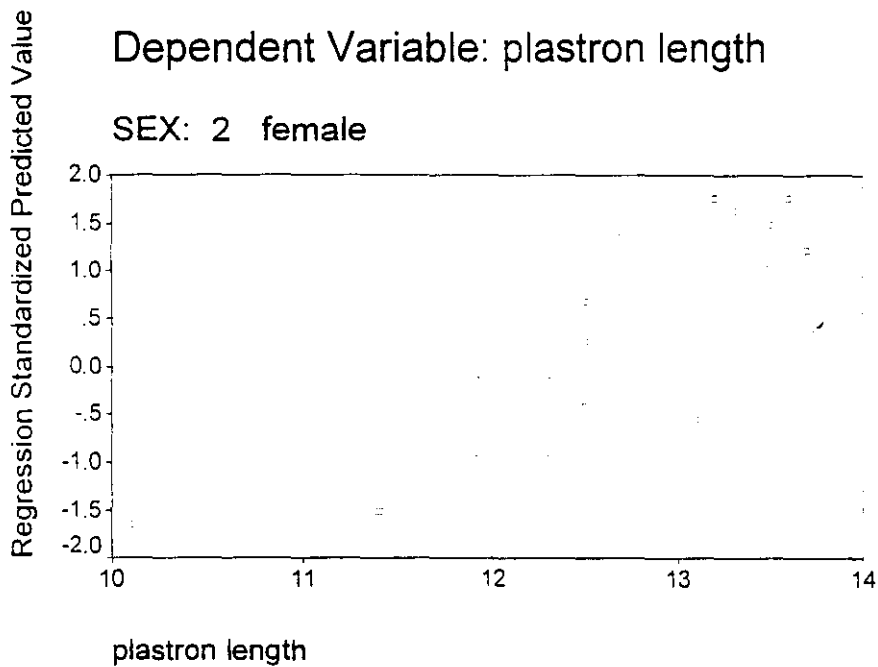
b. SEX = female

## Charts

### Scatterplot

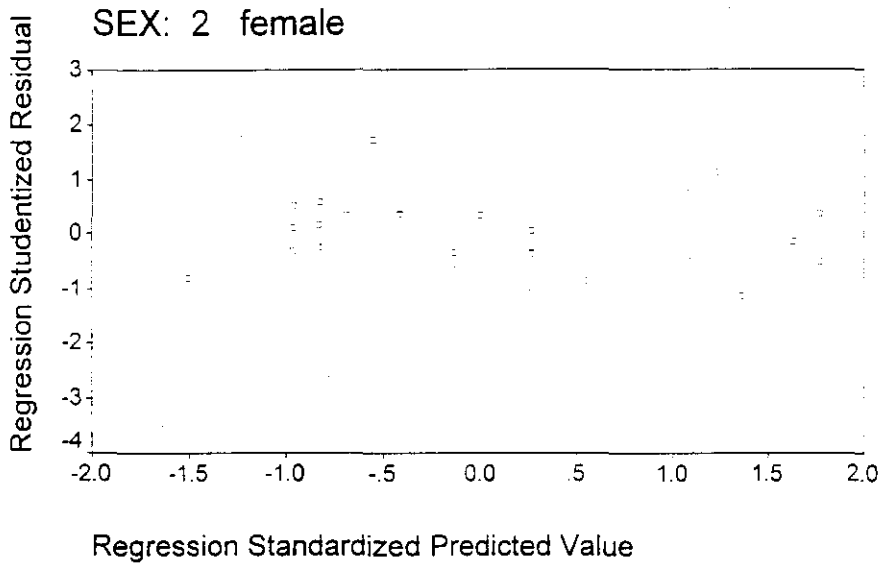
Dependent Variable: plastron length

SEX: 2 female



## Scatterplot

Dependent Variable: plastron length



**SEX = juvenile**

### Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

a. All requested variables entered.

b. Dependent Variable: plastron length

c. SEX = juvenile

### Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .953 <sup>a</sup> | .908     | .896              | .5223                      | 2.294         |

a. Predictors: (Constant), carapace length

b. Dependent Variable: plastron length

c. SEX = juvenile

ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 21.467         | 1  | 21.467      | 78.704 | .000 <sup>a</sup> |
|       | Residual   | 2.182          | 8  | .273        |        |                   |
|       | Total      | 23.649         | 9  |             |        |                   |

a. Predictors: (Constant), carapace length

b. Dependent Variable: plastron length

c. SEX = juvenile

Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | -.533                       | .875       |                           | -.609 | .560 |
|       | carapace length | .945                        | .106       | .953                      | 8.872 | .000 |

a. Dependent Variable: plastron length

b. SEX = juvenile

Residuals Statistics<sup>a,b</sup>

|                                   | Minimum | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|---------|---------|-----------|----------------|----|
| Predicted Value                   | 3.9068  | 8.9130  | 7.0900    | 1.5444         | 10 |
| Std. Predicted Value              | -2.061  | 1.180   | .000      | 1.000          | 10 |
| Standard Error of Predicted Value | .1652   | .3950   | .2238     | 7.031E-02      | 10 |
| Adjusted Predicted Value          | 3.9160  | 9.0884  | 7.0837    | 1.5489         | 10 |
| Residual                          | -.9461  | .5815   | -4.00E-16 | .4924          | 10 |
| Std. Residual                     | -1.811  | 1.113   | .000      | .943           | 10 |
| Stud. Residual                    | -1.919  | 1.276   | .006      | 1.029          | 10 |
| Deleted Residual                  | -1.0620 | .7643   | 6.290E-03 | .5883          | 10 |
| Stud. Deleted Residual            | -2.444  | 1.338   | -.052     | 1.150          | 10 |
| Mahal. Distance                   | .000    | 4.248   | .900      | 1.284          | 10 |
| Cook's Distance                   | .000    | .256    | .095      | .100           | 10 |
| Centered Leverage Value           | .000    | .472    | .100      | .143           | 10 |

a. Dependent Variable: plastron length

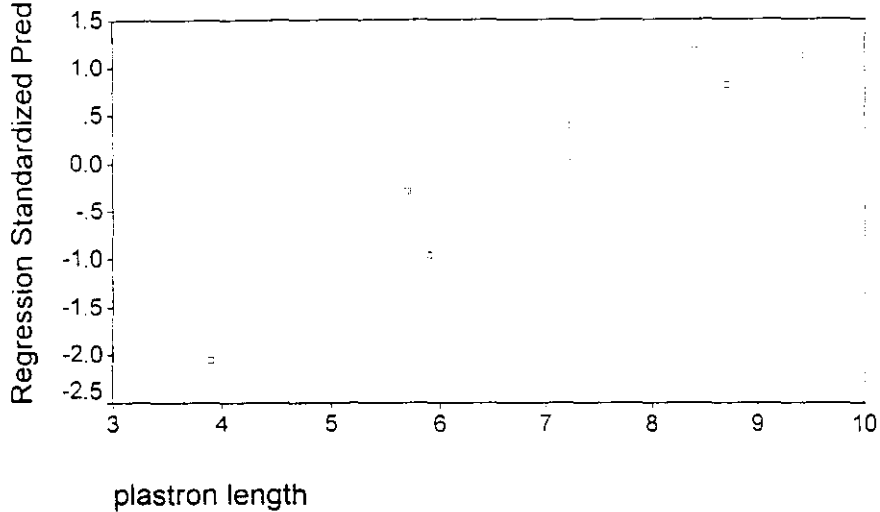
b. SEX = juvenile

## Charts

### Scatterplot

Dependent Variable: plastron length

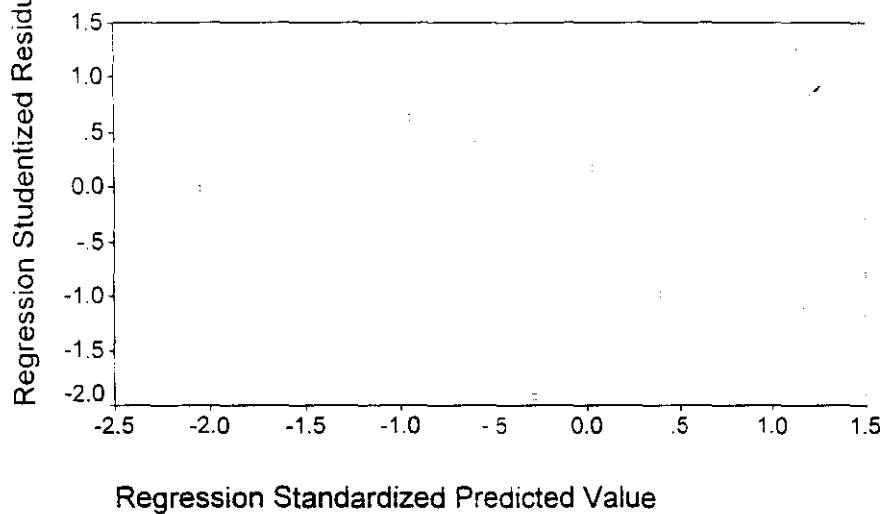
SEX: 3 juvenile



### Scatterplot

Dependent Variable: plastron length

SEX: 3 juvenile



**Regression**

**SEX = male**

**Variables Entered/Removed<sup>b,c</sup>**

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

- a. All requested variables entered.  
b. Dependent Variable: plastron width  
c. SEX = male

**Model Summary<sup>b,c</sup>**

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .642 <sup>a</sup> | .413     | .401              | .4112                      | 2.180         |

- a. Predictors: (Constant), carapace length  
b. Dependent Variable: plastron width  
c. SEX = male

**ANOVA<sup>b,c</sup>**

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 5.941          | 1  | 5.941       | 35.129 | .000 <sup>a</sup> |
|       | Residual   | 8.456          | 50 | .169        |        |                   |
|       | Total      | 14.398         | 51 |             |        |                   |

- a. Predictors: (Constant), carapace length  
b. Dependent Variable: plastron width  
c. SEX = male

**Coefficients<sup>a,b</sup>**

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | .767                        | .914       |                           | .839  | .405 |
|       | carapace length | .439                        | .074       | .642                      | 5.927 | .000 |

- a. Dependent Variable: plastron width  
b. SEX = male

**Casewise Diagnostics<sup>a,b</sup>**

| Case Number | Std. Residual | plastron width |
|-------------|---------------|----------------|
| 5           | 5.145         | 8.90           |

- a. Dependent Variable: plastron width  
b. SEX = male

# Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|---------|-----------|----------------|----|
| Predicted Value                   | 5.2907    | 6.7840  | 6.1750    | .3413          | 52 |
| Std. Predicted Value              | -2.591    | 1.784   | .000      | 1.000          | 52 |
| Standard Error of Predicted Value | 5.704E-02 | .1597   | 7.709E-02 | 2.394E-02      | 52 |
| Adjusted Predicted Value          | 5.2535    | 6.8092  | 6.1731    | .3413          | 52 |
| Residual                          | -.6738    | 2.1160  | 2.118E-15 | .4072          | 52 |
| Std. Residual                     | -1.638    | 5.145   | .000      | .990           | 52 |
| Stud. Residual                    | -1.678    | 5.369   | .002      | 1.022          | 52 |
| Deleted Residual                  | -.7065    | 2.3042  | 1.925E-03 | .4341          | 52 |
| Stud. Deleted Residual            | -1.710    | 8.168   | .054      | 1.338          | 52 |
| Mahal. Distance                   | .000      | 6.713   | .981      | 1.395          | 52 |
| Cook's Distance                   | .000      | 1.282   | .034      | .177           | 52 |
| Centered Leverage Value           | .000      | .132    | .019      | .027           | 52 |

a. Dependent Variable: plastron width

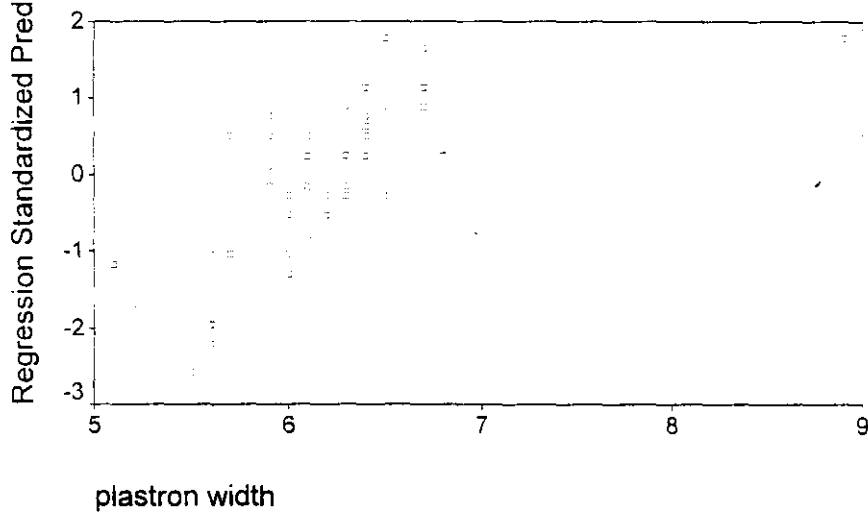
b. SEX = male

## Charts

### Scatterplot

Dependent Variable: plastron width

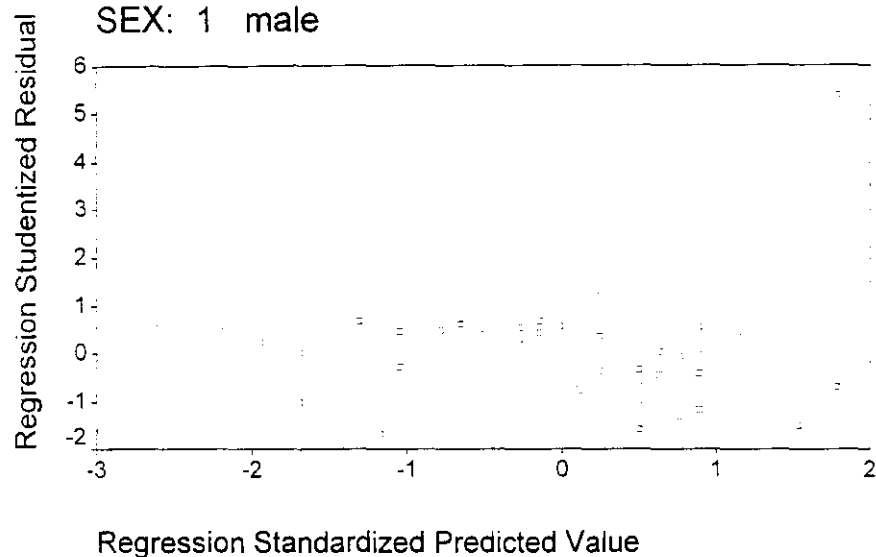
SEX: 1 male



# Scatterplot

Dependent Variable: plastron width

SEX: 1 male



**SEX = female**

## Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

a. All requested variables entered.

b. Dependent Variable: plastron width

c. SEX = female

## Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .397 <sup>a</sup> | .158     | .130              | .4370                      | 2.044         |

a. Predictors: (Constant), carapace length

b. Dependent Variable: plastron width

c. SEX = female

# ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F     | Sig.              |
|-------|------------|----------------|----|-------------|-------|-------------------|
| 1     | Regression | 1.072          | 1  | 1.072       | 5.614 | .024 <sup>a</sup> |
|       | Residual   | 5.728          | 30 | .191        |       |                   |
|       | Total      | 6.800          | 31 |             |       |                   |

a. Predictors: (Constant), carapace length

b. Dependent Variable: plastron width

c. SEX = female

## Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | 3.595                       | 1.375      |                           | 2.615 | .014 |
|       | carapace length | .254                        | .107       | .397                      | 2.369 | .024 |

a. Dependent Variable: plastron width

b. SEX = female

## Casewise Diagnostics<sup>a,b</sup>

| Case Number | Std. Residual | plastron width |
|-------------|---------------|----------------|
| 75          | -4.060        | 5.30           |

a. Dependent Variable: plastron width

b. SEX = female

## Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|---------|-----------|----------------|----|
| Predicted Value                   | 6.5405    | 7.1754  | 6.8469    | .1860          | 32 |
| Std. Predicted Value              | -1.647    | 1.767   | .000      | 1.000          | 32 |
| Standard Error of Predicted Value | 7.725E-02 | .1587   | .1062     | 2.609E-02      | 32 |
| Adjusted Predicted Value          | 6.5655    | 7.2267  | 6.8486    | .1856          | 32 |
| Residual                          | -1.7739   | .5833   | 2.720E-15 | .4298          | 32 |
| Std. Residual                     | -4.060    | 1.335   | .000      | .984           | 32 |
| Stud. Residual                    | -4.231    | 1.392   | -.002     | 1.022          | 32 |
| Deleted Residual                  | -1.9267   | .6345   | -1.69E-03 | .4643          | 32 |
| Stud. Deleted Residual            | -6.550    | 1.415   | -.076     | 1.360          | 32 |
| Mahal. Distance                   | .000      | 3.122   | .969      | .980           | 32 |
| Cook's Distance                   | .000      | .771    | .041      | .137           | 32 |
| Centered Leverage Value           | .000      | .101    | .031      | .032           | 32 |

a. Dependent Variable: plastron width

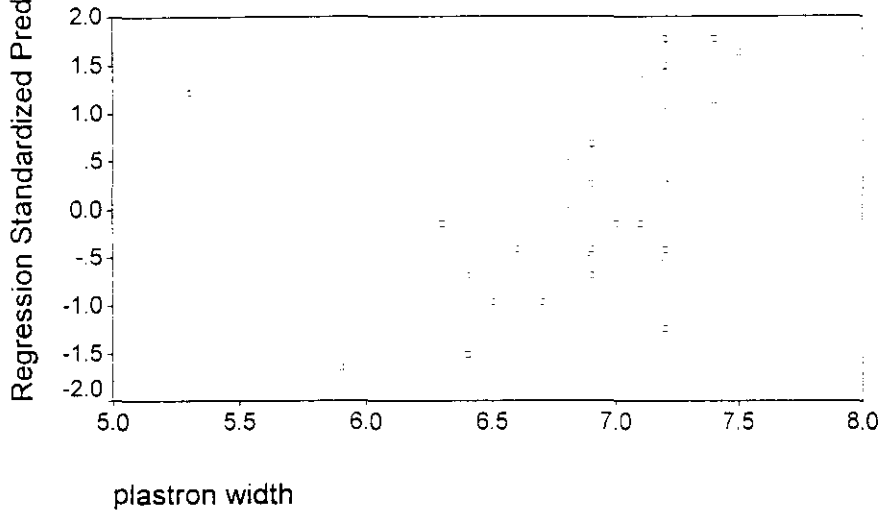
b. SEX = female

## Charts

## Scatterplot

Dependent Variable: plastron width

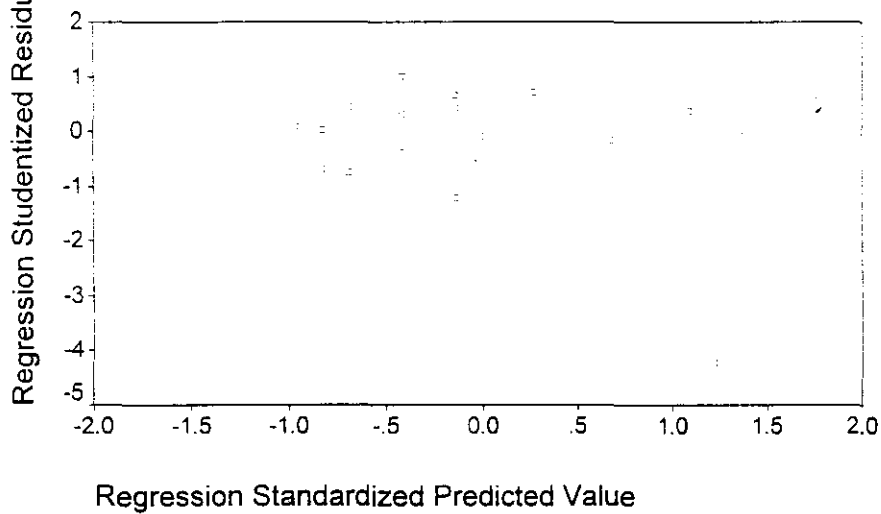
SEX: 2 female



## Scatterplot

Dependent Variable: plastron width

SEX: 2 female



**SEX = juvenile**

**Variables Entered/Removed<sup>b,c</sup>**

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

- a. All requested variables entered.  
b. Dependent Variable: plastron width  
c. SEX = juvenile

**Model Summary<sup>b,c</sup>**

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .954 <sup>a</sup> | .911     | .900              | .2892                      | .565          |

- a. Predictors: (Constant), carapace length  
b. Dependent Variable: plastron width  
c. SEX = juvenile

**ANOVA<sup>b,c</sup>**

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 6.832          | 1  | 6.832       | 81.661 | .000 <sup>a</sup> |
|       | Residual   | .669           | 8  | 8.366E-02   |        |                   |
|       | Total      | 7.501          | 9  |             |        |                   |

- a. Predictors: (Constant), carapace length  
b. Dependent Variable: plastron width  
c. SEX = juvenile

**Coefficients<sup>a,b</sup>**

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | -.130                       | .485       |                           | -.269 | .795 |
|       | carapace length | .533                        | .059       | .954                      | 9.037 | .000 |

- a. Dependent Variable: plastron width  
b. SEX = juvenile

# Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|---------|-----------|----------------|----|
| Predicted Value                   | 2.3743    | 5.1984  | 4.1700    | .8713          | 10 |
| Std. Predicted Value              | -2.061    | 1.180   | .000      | 1.000          | 10 |
| Standard Error of Predicted Value | 9.148E-02 | .2188   | .1240     | 3.894E-02      | 10 |
| Adjusted Predicted Value          | 2.6072    | 5.3346  | 4.1927    | .8350          | 10 |
| Residual                          | -.3984    | .5009   | 3.553E-16 | .2727          | 10 |
| Std. Residual                     | -1.377    | 1.732   | .000      | .943           | 10 |
| Stud. Residual                    | -1.596    | 1.833   | -.031     | 1.055          | 10 |
| Deleted Residual                  | -.5346    | .5613   | -2.27E-02 | .3481          | 10 |
| Stud. Deleted Residual            | -1.808    | 2.252   | -.014     | 1.175          | 10 |
| Mahal. Distance                   | .000      | 4.248   | .900      | 1.284          | 10 |
| Cook's Distance                   | .001      | .567    | .153      | .198           | 10 |
| Centered Leverage Value           | .000      | .472    | .100      | .143           | 10 |

a. Dependent Variable: plastron width

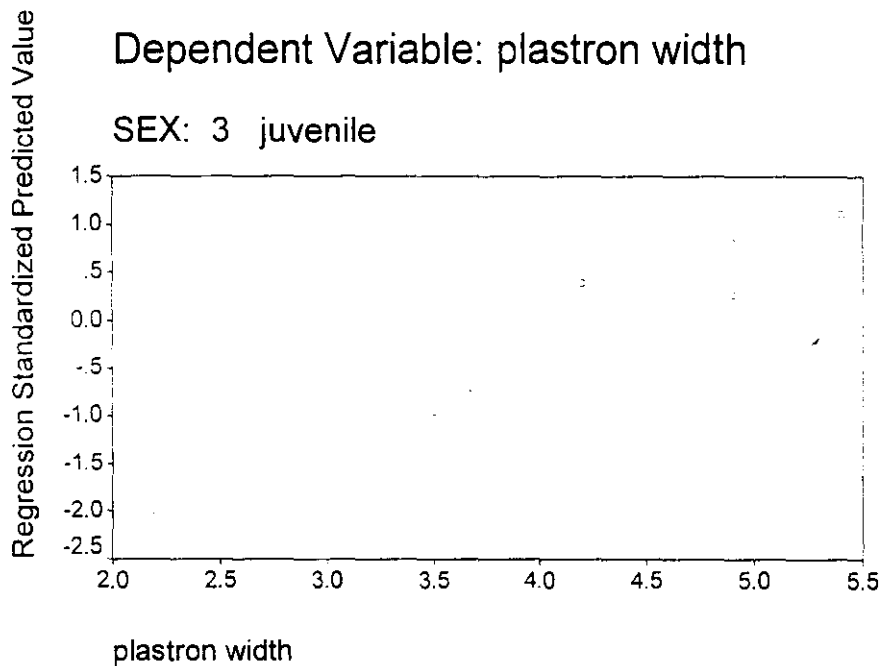
b. SEX = juvenile

## Charts

### Scatterplot

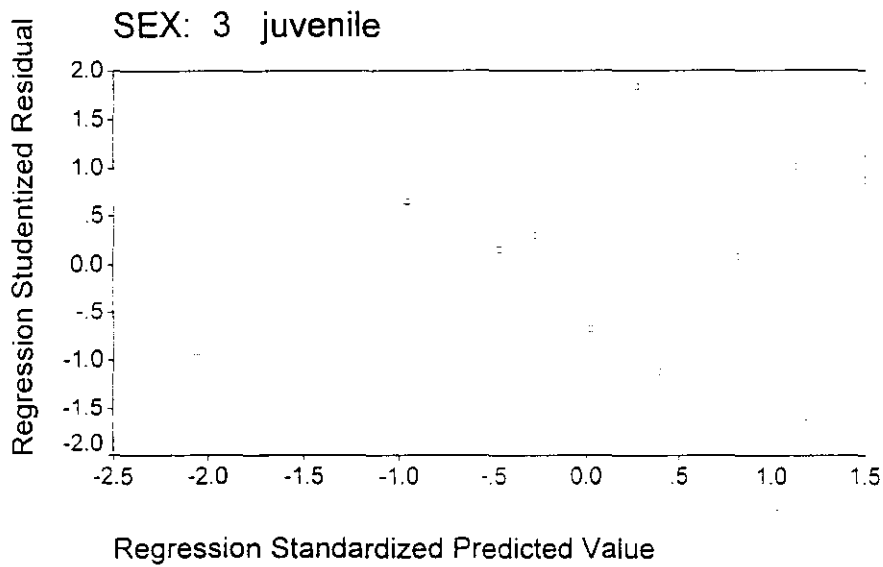
Dependent Variable: plastron width

SEX: 3 juvenile



# Scatterplot

Dependent Variable: plastron width



## Regression

SEX = male

### Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

a. All requested variables entered.

b. Dependent Variable: weight

c. SEX = male

### Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .421 <sup>a</sup> | .177     | .157              | 65.0692                    | 1.864         |

a. Predictors: (Constant), carapace length

b. Dependent Variable: weight

c. SEX = male

ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F     | Sig.              |
|-------|------------|----------------|----|-------------|-------|-------------------|
| 1     | Regression | 37379.007      | 1  | 37379.007   | 8.828 | .005 <sup>a</sup> |
|       | Residual   | 173593.78      | 41 | 4233.995    |       |                   |
|       | Total      | 210972.79      | 42 |             |       |                   |

a. Predictors: (Constant), carapace length

b. Dependent Variable: weight

c. SEX = male

Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | 17.447                      | 169.406    |                           | .103  | .918 |
|       | carapace length | 40.698                      | 13.697     | .421                      | 2.971 | .005 |

a. Dependent Variable: weight

b. SEX = male

Casewise Diagnostics<sup>a,b</sup>

| Case Number | Std. Residual | weight |
|-------------|---------------|--------|
| 50          | -3.310        | 323.00 |

a. Dependent Variable: weight

b. SEX = male

Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum  | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|----------|-----------|----------------|----|
| Predicted Value                   | 436.6405  | 575.0150 | 519.9302  | 29.8325        | 43 |
| Std. Predicted Value              | -2.792    | 1.846    | .000      | 1.000          | 43 |
| Standard Error of Predicted Value | 9.9434    | 29.7364  | 13.3700   | 4.3133         | 43 |
| Adjusted Predicted Value          | 438.3935  | 577.1854 | 520.0163  | 30.1566        | 43 |
| Residual                          | -215.3865 | 133.4738 | -7.27E-14 | 64.2899        | 43 |
| Std. Residual                     | -3.310    | 2.051    | .000      | .988           | 43 |
| Stud. Residual                    | -3.365    | 2.096    | -.001     | 1.009          | 43 |
| Deleted Residual                  | -222.5915 | 139.3516 | -8.61E-02 | 67.0839        | 43 |
| Stud. Deleted Residual            | -3.907    | 2.191    | -.013     | 1.064          | 43 |
| Mahal. Distance                   | .004      | 7.795    | .977      | 1.507          | 43 |
| Cook's Distance                   | .000      | .189     | .022      | .039           | 43 |
| Centered Leverage Value           | .000      | .186     | .023      | .036           | 43 |

a. Dependent Variable: weight

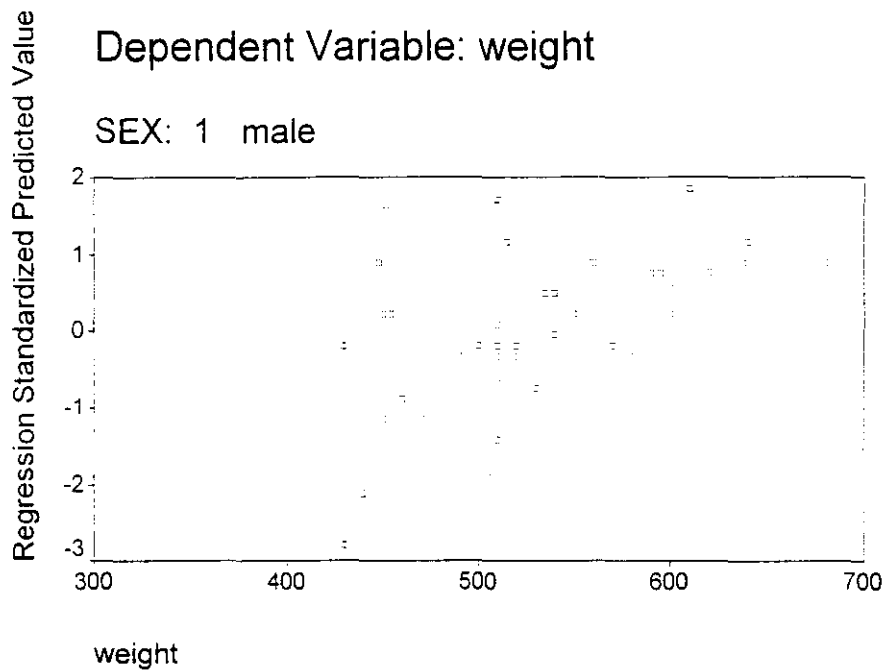
b. SEX = male

## Charts

### Scatterplot

Dependent Variable: weight

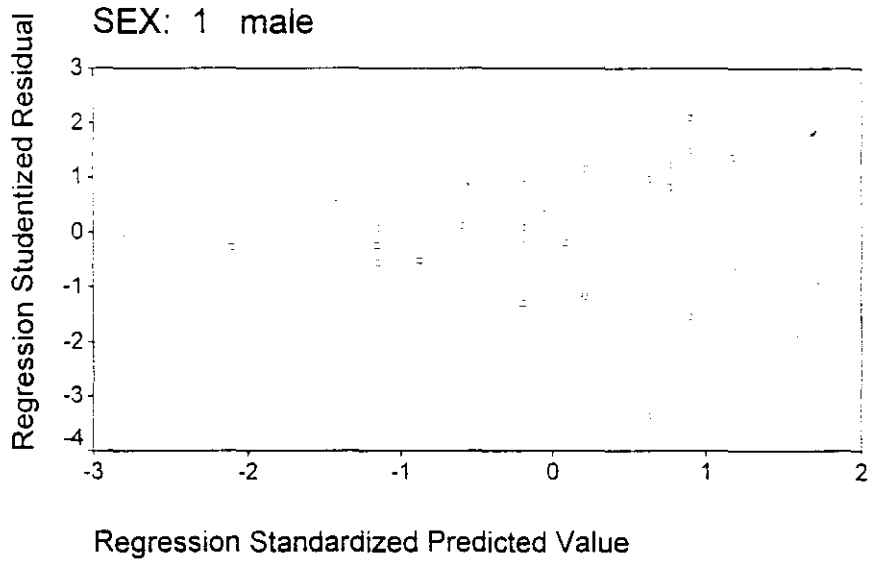
SEX: 1 male



### Scatterplot

Dependent Variable: weight

SEX: 1 male



**SEX = female**

# Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

- a. All requested variables entered.
- b. Dependent Variable: weight
- c. SEX = female

## Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .653 <sup>a</sup> | .427     | .406              | 47.1848                    | 1.726         |

- a. Predictors: (Constant), carapace length
- b. Dependent Variable: weight
- c. SEX = female

## ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 46434.844      | 1  | 46434.844   | 20.856 | .000 <sup>a</sup> |
|       | Residual   | 62339.322      | 28 | 2226.404    |        |                   |
|       | Total      | 108774.17      | 29 |             |        |                   |

- a. Predictors: (Constant), carapace length
- b. Dependent Variable: weight
- c. SEX = female

## Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | -88.120                     | 151.614    |                           | -.581 | .566 |
|       | carapace length | 53.937                      | 11.810     | .653                      | 4.567 | .000 |

- a. Dependent Variable: weight
- b. SEX = female

# Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum  | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|----------|-----------|----------------|----|
| Predicted Value                   | 537.5439  | 672.3852 | 603.1667  | 40.0150        | 30 |
| Std. Predicted Value              | -1.640    | 1.730    | .000      | 1.000          | 30 |
| Standard Error of Predicted Value | 8.6170    | 17.4338  | 11.8434   | 2.9057         | 30 |
| Adjusted Predicted Value          | 538.2886  | 672.5572 | 603.1693  | 39.7891        | 30 |
| Residual                          | -104.5122 | 76.2751  | 9.095E-14 | 46.3641        | 30 |
| Std. Residual                     | -2.215    | 1.617    | .000      | .983           | 30 |
| Stud. Residual                    | -2.291    | 1.691    | .000      | 1.025          | 30 |
| Deleted Residual                  | -111.8389 | 83.4499  | -2.62E-03 | 50.5119        | 30 |
| Stud. Deleted Residual            | -2.496    | 1.752    | -.015     | 1.067          | 30 |
| Mahal. Distance                   | .001      | 2.992    | .967      | .969           | 30 |
| Cook's Distance                   | .000      | .317     | .046      | .079           | 30 |
| Centered Leverage Value           | .000      | .103     | .033      | .033           | 30 |

a. Dependent Variable: weight

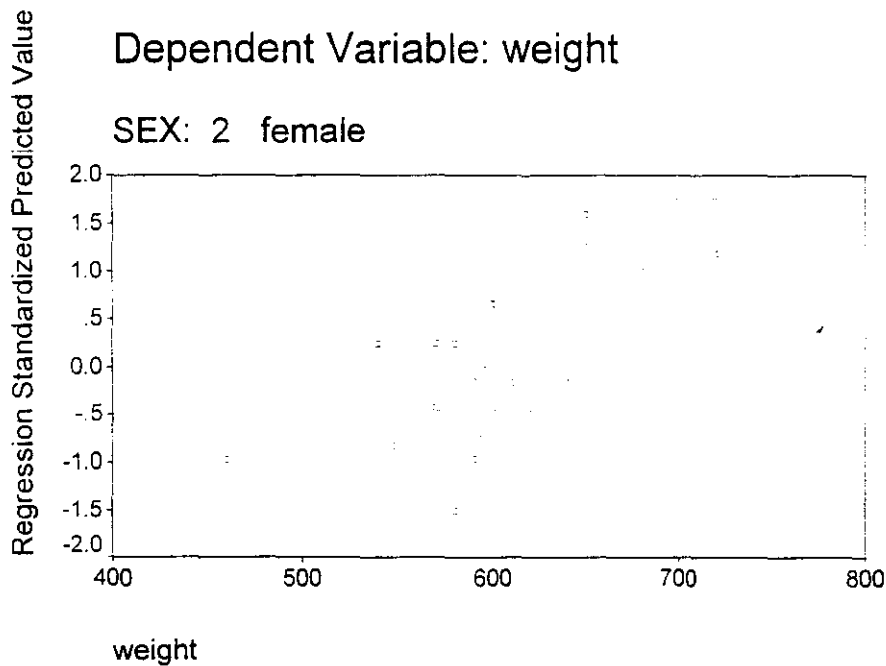
b. SEX = female

## Charts

### Scatterplot

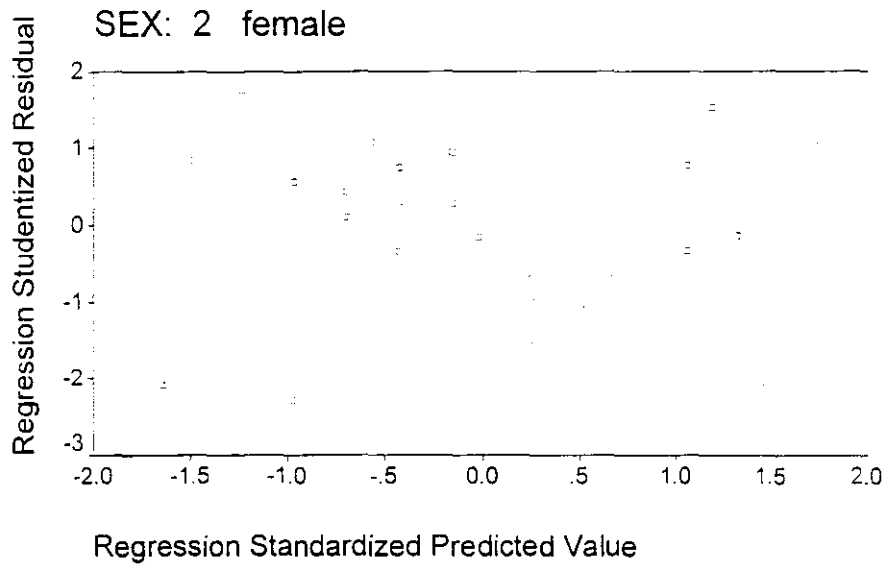
Dependent Variable: weight

SEX: 2 female



## Scatterplot

Dependent Variable: weight



**SEX = juvenile**

Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

- a. All requested variables entered.
- b. Dependent Variable: weight
- c. SEX = juvenile

Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .619 <sup>a</sup> | .383     | .259              | 115.6562                   | 1.304         |

- a. Predictors: (Constant), carapace length
- b. Dependent Variable: weight
- c. SEX = juvenile

ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F     | Sig.              |
|-------|------------|----------------|----|-------------|-------|-------------------|
| 1     | Regression | 41480.190      | 1  | 41480.190   | 3.101 | .139 <sup>a</sup> |
|       | Residual   | 66881.810      | 5  | 13376.362   |       |                   |
|       | Total      | 108362.00      | 6  |             |       |                   |

a. Predictors: (Constant), carapace length

b. Dependent Variable: weight

c. SEX = juvenile

Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | -148.230                    | 216.407    |                           | -.685 | .524 |
|       | carapace length | 44.660                      | 25.361     | .619                      | 1.761 | .139 |

a. Dependent Variable: weight

b. SEX = juvenile

Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum  | Mean      | Std. Deviation | N |
|-----------------------------------|-----------|----------|-----------|----------------|---|
| Predicted Value                   | 61.6721   | 298.3700 | 225.0000  | 83.1466        | 7 |
| Std. Predicted Value              | -1.964    | .882     | .000      | 1.000          | 7 |
| Standard Error of Predicted Value | 43.8638   | 102.5343 | 58.9141   | 20.2347        | 7 |
| Adjusted Predicted Value          | 16.4037   | 370.4746 | 221.3910  | 105.7789       | 7 |
| Residual                          | -192.3700 | 118.4260 | 1.624E-14 | 105.5792       | 7 |
| Std. Residual                     | -1.663    | 1.024    | .000      | .913           | 7 |
| Stud. Residual                    | -1.950    | 1.141    | .007      | 1.056          | 7 |
| Deleted Residual                  | -264.4746 | 147.1406 | 3.6090    | 142.4138       | 7 |
| Stud. Deleted Residual            | -3.566    | 1.187    | -.218     | 1.597          | 7 |
| Mahal. Distance                   | .006      | 3.859    | .857      | 1.356          | 7 |
| Cook's Distance                   | .000      | .713     | .172      | .248           | 7 |
| Centered Leverage Value           | .001      | .643     | .143      | .226           | 7 |

a. Dependent Variable: weight

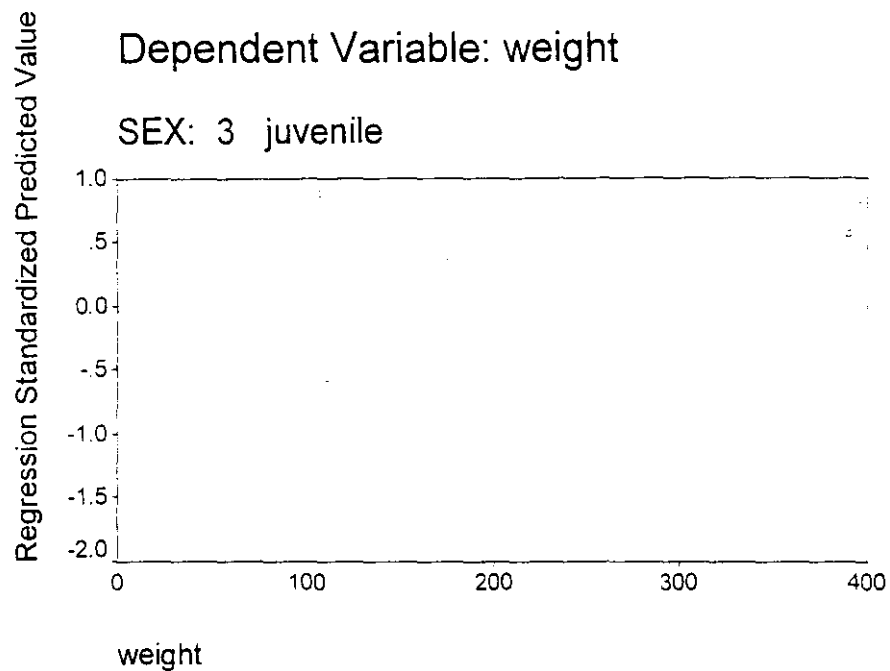
b. SEX = juvenile

## Charts

## Scatterplot

Dependent Variable: weight

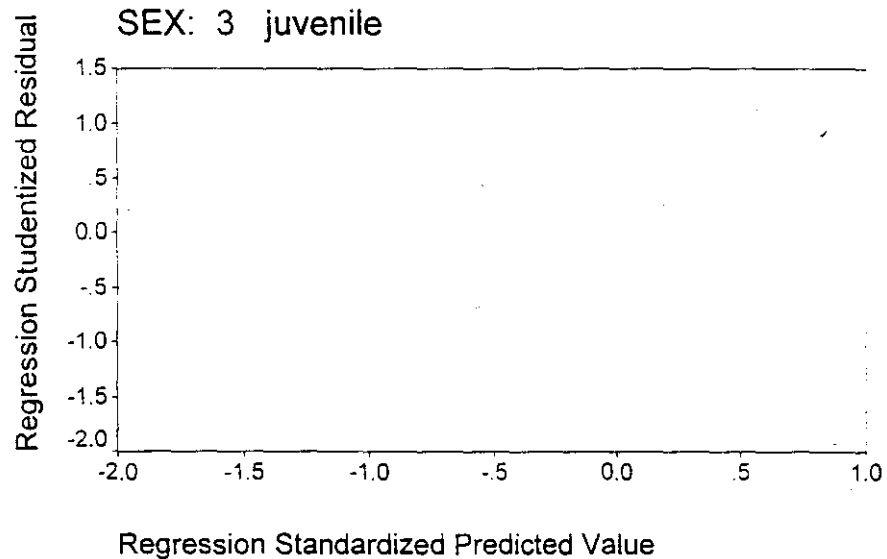
SEX: 3 juvenile



## Scatterplot

Dependent Variable: weight

SEX: 3 juvenile



Regression

SEX = male

### Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

- a. All requested variables entered.  
b. Dependent Variable: AGE  
c. SEX = male

### Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .571 <sup>a</sup> | .326     | .310              | 1.6136                     | 1.792         |

- a. Predictors: (Constant), carapace length  
b. Dependent Variable: AGE  
c. SEX = male

### ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 51.657         | 1  | 51.657      | 19.840 | .000 <sup>a</sup> |
|       | Residual   | 106.750        | 41 | 2.604       |        |                   |
|       | Total      | 158.407        | 42 |             |        |                   |

- a. Predictors: (Constant), carapace length  
b. Dependent Variable: AGE  
c. SEX = male

### Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                 | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)      | -11.226                     | 4.201      |                           | -2.672 | .011 |
|       | carapace length | 1.513                       | .340       | .571                      | 4.454  | .000 |

- a. Dependent Variable: AGE  
b. SEX = male

# Residuals Statistics<sup>a,b</sup>

|                                   | Minimum | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|---------|---------|-----------|----------------|----|
| Predicted Value                   | 4.3572  | 9.5013  | 7.4535    | 1.1090         | 43 |
| Std. Predicted Value              | -2.792  | 1.846   | .000      | 1.000          | 43 |
| Standard Error of Predicted Value | .2466   | .7374   | .3315     | .1070          | 43 |
| Adjusted Predicted Value          | 4.5835  | 9.5748  | 7.4676    | 1.1073         | 43 |
| Residual                          | -4.1987 | 3.5837  | -1.49E-15 | 1.5943         | 43 |
| Std. Residual                     | -2.602  | 2.221   | .000      | .988           | 43 |
| Stud. Residual                    | -2.716  | 2.346   | -.004     | 1.019          | 43 |
| Deleted Residual                  | -4.5748 | 3.9979  | -1.42E-02 | 1.6980         | 43 |
| Stud. Deleted Residual            | -2.963  | 2.490   | -.012     | 1.053          | 43 |
| Mahal. Distance                   | .004    | 7.795   | .977      | 1.507          | 43 |
| Cook's Distance                   | .000    | .330    | .034      | .082           | 43 |
| Centered Leverage Value           | .000    | .186    | .023      | .036           | 43 |

a. Dependent Variable: AGE

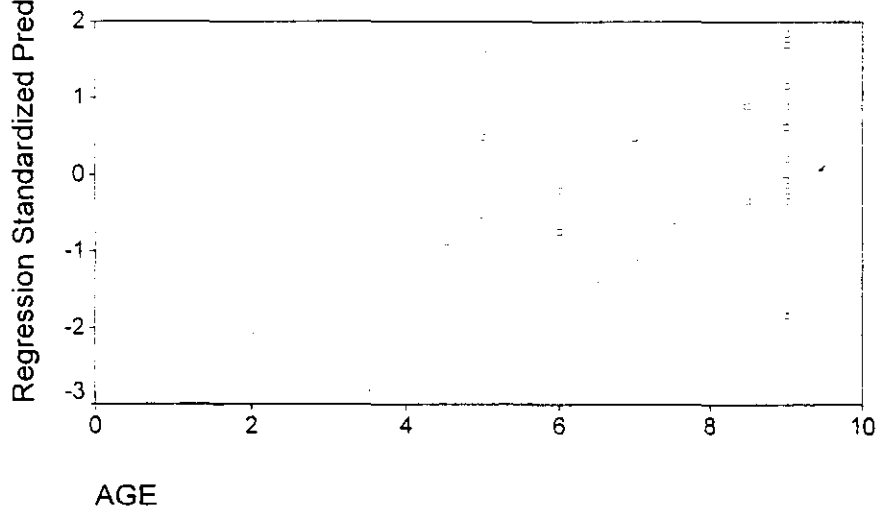
b. SEX = male

## Charts

### Scatterplot

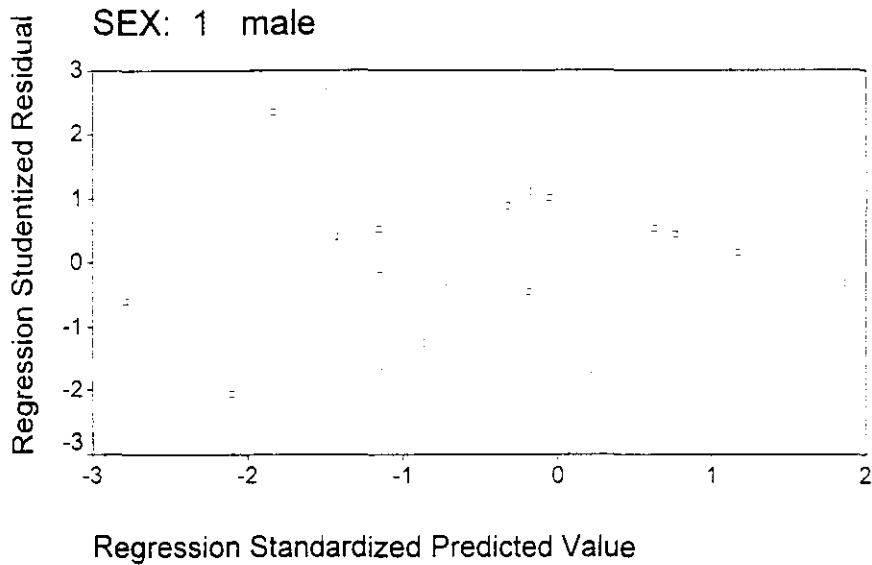
Dependent Variable: AGE

SEX: 1 male



## Scatterplot

Dependent Variable: AGE



**SEX = female**

### Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

a. All requested variables entered.

b. Dependent Variable: AGE

c. SEX = female

### Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .510 <sup>a</sup> | .260     | .233              | 2.0056                     | 1.878         |

a. Predictors: (Constant), carapace length

b. Dependent Variable: AGE

c. SEX = female

ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F     | Sig.              |
|-------|------------|----------------|----|-------------|-------|-------------------|
| 1     | Regression | 39.549         | 1  | 39.549      | 9.832 | .004 <sup>a</sup> |
|       | Residual   | 112.626        | 28 | 4.022       |       |                   |
|       | Total      | 152.175        | 29 |             |       |                   |

a. Predictors: (Constant), carapace length

b. Dependent Variable: AGE

c. SEX = female

Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                 | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)      | -12.725                     | 6.444      |                           | -1.975 | .058 |
|       | carapace length | 1.574                       | .502       | .510                      | 3.136  | .004 |

a. Dependent Variable: AGE

b. SEX = female

Residuals Statistics<sup>a,b</sup>

|                                   | Minimum | Maximum | Mean      | Std. Deviation | N  |
|-----------------------------------|---------|---------|-----------|----------------|----|
| Predicted Value                   | 5.5349  | 9.4701  | 7.4500    | 1.1678         | 30 |
| Std. Predicted Value              | -1.640  | 1.730   | .000      | 1.000          | 30 |
| Standard Error of Predicted Value | .3663   | .7410   | .5034     | .1235          | 30 |
| Adjusted Predicted Value          | 5.9137  | 9.5444  | 7.4623    | 1.1635         | 30 |
| Residual                          | -4.2664 | 2.6781  | 2.220E-15 | 1.9707         | 30 |
| Std. Residual                     | -2.127  | 1.335   | .000      | .983           | 30 |
| Stud. Residual                    | -2.165  | 1.381   | -.003     | 1.013          | 30 |
| Deleted Residual                  | -4.4174 | 2.8658  | -1.23E-02 | 2.0935         | 30 |
| Stud. Deleted Residual            | -2.329  | 1.405   | -.013     | 1.038          | 30 |
| Mahal. Distance                   | .001    | 2.992   | .967      | .969           | 30 |
| Cook's Distance                   | .000    | .189    | .031      | .043           | 30 |
| Centered Leverage Value           | .000    | .103    | .033      | .033           | 30 |

a. Dependent Variable: AGE

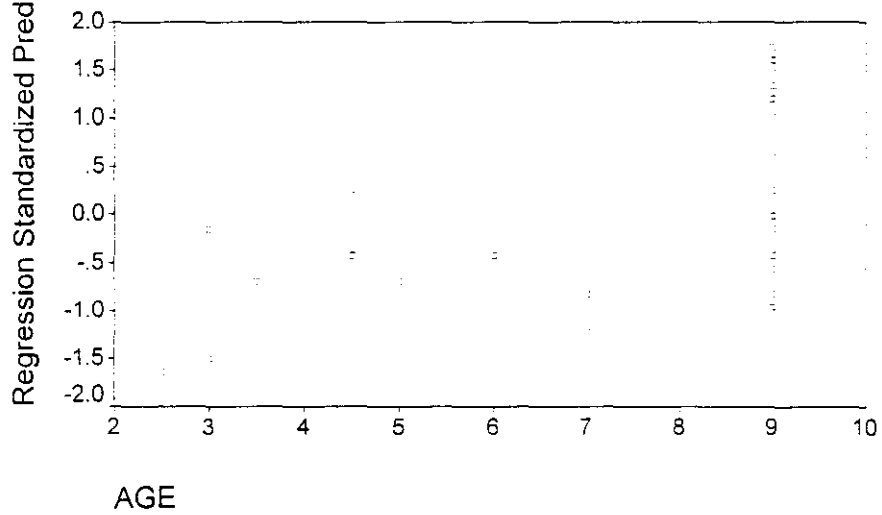
b. SEX = female

## Charts

## Scatterplot

Dependent Variable: AGE

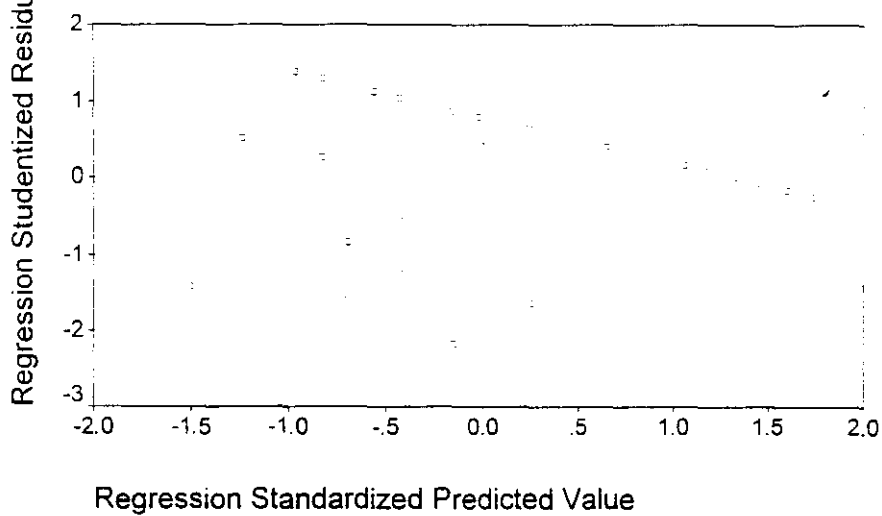
SEX: 2 female



## Scatterplot

Dependent Variable: AGE

SEX: 2 female



**SEX = juvenile**

### Variables Entered/Removed<sup>b,c</sup>

| Model | Variables Entered | Variables Removed | Method |
|-------|-------------------|-------------------|--------|
| 1     | carapace length   |                   | Enter  |

a. All requested variables entered.

b. Dependent Variable: AGE

c. SEX = juvenile

### Model Summary<sup>b,c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin-Watson |
|-------|-------------------|----------|-------------------|----------------------------|---------------|
| 1     | .724 <sup>a</sup> | .524     | .465              | .1156                      | 1.503         |

a. Predictors: (Constant), carapace length

b. Dependent Variable: AGE

c. SEX = juvenile

### ANOVA<sup>b,c</sup>

| Model |            | Sum of Squares | df | Mean Square | F     | Sig.              |
|-------|------------|----------------|----|-------------|-------|-------------------|
| 1     | Regression | .118           | 1  | .118        | 8.823 | .018 <sup>a</sup> |
|       | Residual   | .107           | 8  | 1.337E-02   |       |                   |
|       | Total      | .225           | 9  |             |       |                   |

a. Predictors: (Constant), carapace length

b. Dependent Variable: AGE

c. SEX = juvenile

### Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t     | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|-------|------|
|       |                 | B                           | Std. Error | Beta                      |       |      |
| 1     | (Constant)      | .385                        | .194       |                           | 1.986 | .082 |
|       | carapace length | 7.003E-02                   | .024       | .724                      | 2.970 | .018 |

a. Dependent Variable: AGE

b. SEX = juvenile

# Residuals Statistics<sup>a,b</sup>

|                                   | Minimum   | Maximum   | Mean      | Std. Deviation | N  |
|-----------------------------------|-----------|-----------|-----------|----------------|----|
| Predicted Value                   | .7140     | 1.0852    | .9500     | .1145          | 10 |
| Std. Predicted Value              | -2.061    | 1.180     | .000      | 1.000          | 10 |
| Standard Error of Predicted Value | 3.658E-02 | 8.747E-02 | 4.957E-02 | 1.557E-02      | 10 |
| Adjusted Predicted Value          | .7995     | 1.1143    | .9775     | 9.866E-02      | 10 |
| Residual                          | -.2140    | .1599     | 6.661E-17 | .1090          | 10 |
| Std. Residual                     | -1.850    | 1.383     | .000      | .943           | 10 |
| Stud. Residual                    | -2.828    | 1.549     | -.093     | 1.226          | 10 |
| Deleted Residual                  | -.5000    | .2005     | -2.75E-02 | .1930          | 10 |
| Stud. Deleted Residual            | -1.04E+08 | 1.731     | -10389795 | 32855416.967   | 10 |
| Mahal. Distance                   | .000      | 4.248     | .900      | 1.284          | 10 |
| Cook's Distance                   | .000      | 5.346     | .600      | 1.670          | 10 |
| Centered Leverage Value           | .000      | .472      | .100      | .143           | 10 |

a. Dependent Variable: AGE

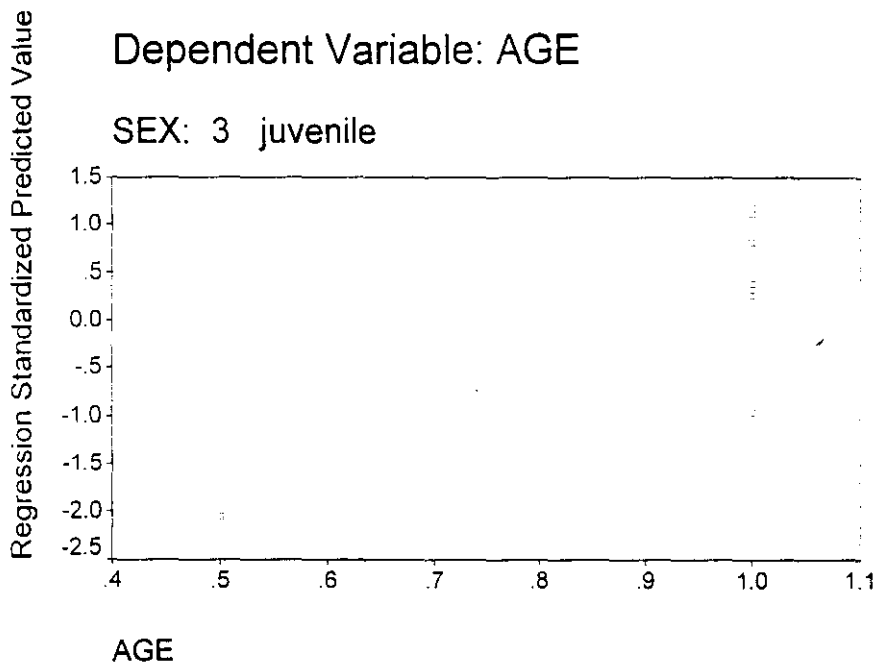
b. SEX = juvenile

## Charts

### Scatterplot

Dependent Variable: AGE

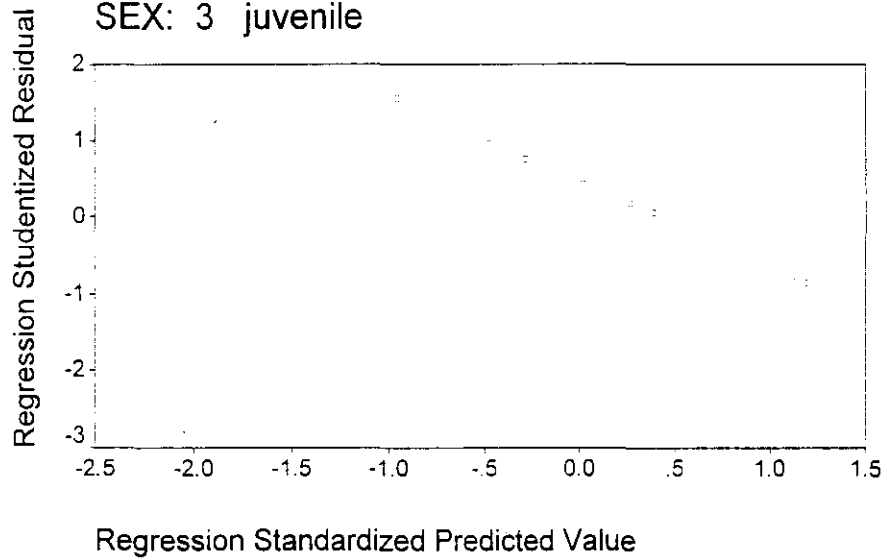
SEX: 3 juvenile



## Scatterplot

Dependent Variable: AGE

SEX: 3 juvenile



# Regression

## Appendix IV

SEX = male

Variables Entered/Removed<sup>c,d</sup>

| Model | Variables Entered | Variables Removed | Method                                                                                    |
|-------|-------------------|-------------------|-------------------------------------------------------------------------------------------|
| 1     | plastron length   |                   | Stepwise (Criteria: Probability-of-F-to-enter ≤ .050, Probability-of-F-to-remove ≥ .100). |
| 2     |                   | a plastron length | Remove                                                                                    |
| 3     | plastron length   |                   | Stepwise (Criteria: Probability-of-F-to-enter ≤ .050, Probability-of-F-to-remove ≥ .100). |

a. All requested variables entered.

b. All requested variables removed.

c. Dependent Variable: weight

d. SEX = male

Model Summary<sup>c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1     | .557 <sup>a</sup> | .310     | .293              | 59.5844                    |
| 2     | .000 <sup>b</sup> | .000     | .000              | 70.8743                    |
| 3     | .557 <sup>a</sup> | .310     | .293              | 59.5844                    |

a. Predictors: (Constant), plastron length

b. Predictor: (constant)

c. SEX = male

ANOVA<sup>c,d</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 65410.340      | 1  | 65410.340   | 18.424 | .000 <sup>a</sup> |
|       | Residual   | 145562.45      | 41 | 3550.304    |        |                   |
|       | Total      | 210972.79      | 42 |             |        |                   |
| 2     | Regression | .000           | 0  | .000        |        | . <sup>b</sup>    |
|       | Residual   | 210972.79      | 42 | 5023.162    |        |                   |
|       | Total      | 210972.79      | 42 |             |        |                   |
| 3     | Regression | 65410.340      | 1  | 65410.340   | 18.424 | .000 <sup>a</sup> |
|       | Residual   | 145562.45      | 41 | 3550.304    |        |                   |
|       | Total      | 210972.79      | 42 |             |        |                   |

a. Predictors: (Constant), plastron length

b. Predictor: (constant)

c. Dependent Variable: weight

d. SEX = male

Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                 | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)      | -159.432                    | 158.535    |                           | -1.006 | .320 |
|       | plastron length | 62.701                      | 14.608     | .557                      | 4.292  | .000 |
| 2     | (Constant)      | 519.930                     | 10.808     |                           | 48.105 | .000 |
| 3     | (Constant)      | -159.432                    | 158.535    |                           | -1.006 | .320 |
|       | plastron length | 62.701                      | 14.608     | .557                      | 4.292  | .000 |

a. Dependent Variable: weight

b. SEX = male

Excluded Variables<sup>c,d</sup>

| Model |                 | Beta In            | t     | Sig. | Partial Correlation | Collinearity Statistics |
|-------|-----------------|--------------------|-------|------|---------------------|-------------------------|
|       |                 |                    |       |      |                     | Tolerance               |
| 1     | carapace length | -.028 <sup>a</sup> | -.133 | .895 | -.021               | .398                    |
|       | carapace width  | -.002 <sup>a</sup> | -.014 | .989 | -.002               | .685                    |
|       | plastron width  | .010 <sup>a</sup>  | .042  | .967 | .007                | .332                    |
| 2     | carapace length | .421 <sup>b</sup>  | 2.971 | .005 | .421                | 1.000                   |
|       | carapace width  | .311 <sup>b</sup>  | 2.094 | .042 | .311                | 1.000                   |
|       | plastron width  | .458 <sup>b</sup>  | 3.302 | .002 | .458                | 1.000                   |
|       | plastron length | .557 <sup>b</sup>  | 4.292 | .000 | .557                | 1.000                   |
| 3     | carapace length | -.028 <sup>a</sup> | -.133 | .895 | -.021               | .398                    |
|       | carapace width  | -.002 <sup>a</sup> | -.014 | .989 | -.002               | .685                    |
|       | plastron width  | .010 <sup>a</sup>  | .042  | .967 | .007                | .332                    |

a. Predictors in the Model: (Constant), plastron length

b. Predictor: (constant)

c. Dependent Variable: weight

d. SEX = male

**SEX = female**

### Variables Entered/Removed<sup>c,d</sup>

| Model | Variables Entered | Variables Removed | Method                                                                                                                     |
|-------|-------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------|
| 1     | plastron length   |                   | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |
| 2     |                   | a plastron length | Remove                                                                                                                     |
| 3     | plastron length   |                   | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |

- a. All requested variables entered.
- b. All requested variables removed.
- c. Dependent Variable: weight
- d. SEX = female

### Model Summary<sup>c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1     | .742 <sup>a</sup> | .550     | .534              | 41.7990                    |
| 2     | .000 <sup>b</sup> | .000     | .000              | 61.2440                    |
| 3     | .742 <sup>a</sup> | .550     | .534              | 41.7990                    |

- a. Predictors: (Constant), plastron length
- b. Predictor: (constant)
- c. SEX = female

ANOVA<sup>c,d</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 59853.690      | 1  | 59853.690   | 34.258 | .000 <sup>a</sup> |
|       | Residual   | 48920.477      | 28 | 1747.160    |        |                   |
|       | Total      | 108774.17      | 29 |             |        |                   |
| 2     | Regression | .000           | 0  | .000        |        | .000 <sup>b</sup> |
|       | Residual   | 108774.17      | 29 | 3750.833    |        |                   |
|       | Total      | 108774.17      | 29 |             |        |                   |
| 3     | Regression | 59853.690      | 1  | 59853.690   | 34.258 | .000 <sup>a</sup> |
|       | Residual   | 48920.477      | 28 | 1747.160    |        |                   |
|       | Total      | 108774.17      | 29 |             |        |                   |

a. Predictors: (Constant), plastron length

b. Predictor: (constant)

c. Dependent Variable: weight

d. SEX = female

Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                 | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)      | -187.554                    | 135.312    |                           | -1.386 | .177 |
|       | plastron length | 62.939                      | 10.753     | .742                      | 5.853  | .000 |
| 2     | (Constant)      | 603.167                     | 11.182     |                           | 53.943 | .000 |
| 3     | (Constant)      | -187.554                    | 135.312    |                           | -1.386 | .177 |
|       | plastron length | 62.939                      | 10.753     | .742                      | 5.853  | .000 |

a. Dependent Variable: weight

b. SEX = female

Excluded Variables<sup>c,d</sup>

| Model |                 | Beta In            | t     | Sig. | Partial Correlation | Collinearity Statistics |
|-------|-----------------|--------------------|-------|------|---------------------|-------------------------|
|       |                 |                    |       |      |                     | Tolerance               |
| 1     | carapace length | .245 <sup>a</sup>  | 1.352 | .188 | .252                | .476                    |
|       | carapace width  | .039 <sup>a</sup>  | .222  | .826 | .043                | .528                    |
|       | plastron width  | -.035 <sup>a</sup> | -.248 | .806 | -.048               | .834                    |
| 2     | carapace length | .653 <sup>b</sup>  | 4.567 | .000 | .653                | 1.000                   |
|       | carapace width  | .530 <sup>b</sup>  | 3.310 | .003 | .530                | 1.000                   |
|       | plastron width  | .273 <sup>b</sup>  | 1.500 | .145 | .273                | 1.000                   |
|       | plastron length | .742 <sup>b</sup>  | 5.853 | .000 | .742                | 1.000                   |
| 3     | carapace length | .245 <sup>a</sup>  | 1.352 | .188 | .252                | .476                    |
|       | carapace width  | .039 <sup>a</sup>  | .222  | .826 | .043                | .528                    |
|       | plastron width  | -.035 <sup>a</sup> | -.248 | .806 | -.048               | .834                    |

a. Predictors in the Model: (Constant), plastron length

b. Predictor: (constant)

c. Dependent Variable: weight

d. SEX = female

SEX = juvenile

#### Variables Entered/Removed<sup>a,b</sup>

a. Dependent Variable: weight

b. SEX = juvenile

### Regression

SEX = male

# Variables Entered/Removed<sup>c,d</sup>

| Model | Variables Entered | Variables Removed              | Method                                                                                        |
|-------|-------------------|--------------------------------|-----------------------------------------------------------------------------------------------|
| 1     | carapace width    |                                | Stepwise (Criteria: Probability -of-F-to-enter <= .050, Probability -of-F-to-remove >= .100). |
| 2     | plastron width    |                                | Stepwise (Criteria: Probability -of-F-to-enter <= .050, Probability -of-F-to-remove >= .100). |
| 3     | a                 | plastron width, carapace width | Remove                                                                                        |
| 4     | carapace width    |                                | Stepwise (Criteria: Probability -of-F-to-enter <= .050, Probability -of-F-to-remove >= .100). |
| 5     | plastron width    |                                | Stepwise (Criteria: Probability -of-F-to-enter <= .050, Probability -of-F-to-remove >= .100). |

- a. All requested variables entered.
- b. All requested variables removed.
- c. Dependent Variable: AGE
- d. SEX = male

### Model Summary<sup>d</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1     | .721 <sup>a</sup> | .520     | .509              | 1.3612                     |
| 2     | .760 <sup>b</sup> | .578     | .557              | 1.2928                     |
| 3     | .000 <sup>c</sup> | .000     | .000              | 1.9421                     |
| 4     | .721 <sup>a</sup> | .520     | .509              | 1.3612                     |
| 5     | .760 <sup>b</sup> | .578     | .557              | 1.2928                     |

a. Predictors: (Constant), carapace width

b. Predictors: (Constant), carapace width, plastron width

c. Predictor: (constant)

d. SEX = male

### ANOVA<sup>d,e</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | 82.437         | 1  | 82.437      | 44.490 | .000 <sup>a</sup> |
|       | Residual   | 75.970         | 41 | 1.853       |        |                   |
|       | Total      | 158.407        | 42 |             |        |                   |
| 2     | Regression | 91.550         | 2  | 45.775      | 27.387 | .000 <sup>b</sup> |
|       | Residual   | 66.857         | 40 | 1.671       |        |                   |
|       | Total      | 158.407        | 42 |             |        |                   |
| 3     | Regression | .000           | 0  | .000        |        | .c                |
|       | Residual   | 158.407        | 42 | 3.772       |        |                   |
|       | Total      | 158.407        | 42 |             |        |                   |
| 4     | Regression | 82.437         | 1  | 82.437      | 44.490 | .000 <sup>a</sup> |
|       | Residual   | 75.970         | 41 | 1.853       |        |                   |
|       | Total      | 158.407        | 42 |             |        |                   |
| 5     | Regression | 91.550         | 2  | 45.775      | 27.387 | .000 <sup>b</sup> |
|       | Residual   | 66.857         | 40 | 1.671       |        |                   |
|       | Total      | 158.407        | 42 |             |        |                   |

a. Predictors: (Constant), carapace width

b. Predictors: (Constant), carapace width, plastron width

c. Predictor: (constant)

d. Dependent Variable: AGE

e. SEX = male

**Coefficients<sup>a,b</sup>**

| Model |                | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)     | -14.407                     | 3.284      |                           | -4.387 | .000 |
|       | carapace width | 2.765                       | .415       | .721                      | 6.670  | .000 |
| 2     | (Constant)     | -20.223                     | 3.992      |                           | -5.066 | .000 |
|       | carapace width | 1.948                       | .527       | .508                      | 3.695  | .001 |
|       | plastron width | 1.985                       | .850       | .321                      | 2.335  | .025 |
| 3     | (Constant)     | 7.453                       | .296       |                           | 25.167 | .000 |
| 4     | (Constant)     | -14.407                     | 3.284      |                           | -4.387 | .000 |
|       | carapace width | 2.765                       | .415       | .721                      | 6.670  | .000 |
| 5     | (Constant)     | -20.223                     | 3.992      |                           | -5.066 | .000 |
|       | carapace width | 1.948                       | .527       | .508                      | 3.695  | .001 |
|       | plastron width | 1.985                       | .850       | .321                      | 2.335  | .025 |

a. Dependent Variable: AGE

b. SEX = male

**Excluded Variables<sup>d,e</sup>**

| Model |                 | Beta In           | t     | Sig. | Partial Correlation | Collinearity Statistics |
|-------|-----------------|-------------------|-------|------|---------------------|-------------------------|
|       |                 |                   |       |      |                     | Tolerance               |
| 1     | carapace length | .270 <sup>a</sup> | 2.234 | .031 | .333                | .732                    |
|       | plastron length | .278 <sup>a</sup> | 2.232 | .031 | .333                | .685                    |
|       | plastron width  | .321 <sup>a</sup> | 2.335 | .025 | .346                | .558                    |
| 2     | carapace length | .168 <sup>b</sup> | 1.196 | .239 | .188                | .526                    |
|       | plastron length | .145 <sup>b</sup> | .809  | .423 | .128                | .331                    |
| 3     | carapace length | .571 <sup>c</sup> | 4.454 | .000 | .571                | 1.000                   |
|       | plastron length | .595 <sup>c</sup> | 4.746 | .000 | .595                | 1.000                   |
|       | plastron width  | .659 <sup>c</sup> | 5.606 | .000 | .659                | 1.000                   |
|       | carapace width  | .721 <sup>c</sup> | 6.670 | .000 | .721                | 1.000                   |
| 4     | carapace length | .270 <sup>a</sup> | 2.234 | .031 | .333                | .732                    |
|       | plastron length | .278 <sup>a</sup> | 2.232 | .031 | .333                | .685                    |
|       | plastron width  | .321 <sup>a</sup> | 2.335 | .025 | .346                | .558                    |
| 5     | carapace length | .168 <sup>b</sup> | 1.196 | .239 | .188                | .526                    |
|       | plastron length | .145 <sup>b</sup> | .809  | .423 | .128                | .331                    |

a. Predictors in the Model: (Constant), carapace width

b. Predictors in the Model: (Constant), carapace width, plastron width

c. Predictor: (constant)

d. Dependent Variable: AGE

e. SEX = male

**SEX = female**

# Variables Entered/Removed<sup>c,d</sup>

| Model | Variables Entered | Variables Removed | Method                                                                                                                     |
|-------|-------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------|
| 1     | carapace length   |                   | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |
| 2     | a                 | carapace length   | Remove                                                                                                                     |
| 3     | carapace length   |                   | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |

a. All requested variables entered.

b. All requested variables removed.

c. Dependent Variable: AGE

d. SEX = female

## Model Summary<sup>c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1     | .510 <sup>a</sup> | .260     | .233              | 2.0056                     |
| 2     | .000 <sup>b</sup> | .000     | .000              | 2.2907                     |
| 3     | .510 <sup>a</sup> | .260     | .233              | 2.0056                     |

a. Predictors: (Constant), carapace length

b. Predictor: (constant)

c. SEX = female

ANOVA<sup>c,d</sup>

| Model |            | Sum of Squares | df | Mean Square | F     | Sig.              |
|-------|------------|----------------|----|-------------|-------|-------------------|
| 1     | Regression | 39.549         | 1  | 39.549      | 9.832 | .004 <sup>a</sup> |
|       | Residual   | 112.626        | 28 | 4.022       |       |                   |
|       | Total      | 152.175        | 29 |             |       |                   |
| 2     | Regression | .000           | 0  | .000        |       | <sup>b</sup>      |
|       | Residual   | 152.175        | 29 | 5.247       |       |                   |
|       | Total      | 152.175        | 29 |             |       |                   |
| 3     | Regression | 39.549         | 1  | 39.549      | 9.832 | .004 <sup>a</sup> |
|       | Residual   | 112.626        | 28 | 4.022       |       |                   |
|       | Total      | 152.175        | 29 |             |       |                   |

a. Predictors: (Constant), carapace length

b. Predictor: (constant)

c. Dependent Variable: AGE

d. SEX = female

Coefficients<sup>a,b</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                 | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)      | -12.725                     | 6.444      |                           | -1.975 | .058 |
|       | carapace length | 1.574                       | .502       | .510                      | 3.136  | .004 |
| 2     | (Constant)      | 7.450                       | .418       |                           | 17.813 | .000 |
| 3     | (Constant)      | -12.725                     | 6.444      |                           | -1.975 | .058 |
|       | carapace length | 1.574                       | .502       | .510                      | 3.136  | .004 |

a. Dependent Variable: AGE

b. SEX = female

Excluded Variables<sup>c,d</sup>

| Model |                 | Beta In           | t     | Sig. | Partial Correlation | Collinearity Statistics |
|-------|-----------------|-------------------|-------|------|---------------------|-------------------------|
|       |                 |                   |       |      |                     | Tolerance               |
| 1     | carapace width  | .185 <sup>a</sup> | .695  | .493 | .132                | .381                    |
|       | plastron length | .254 <sup>a</sup> | 1.082 | .289 | .204                | .476                    |
|       | plastron width  | .085 <sup>a</sup> | .477  | .637 | .091                | .851                    |
| 2     | carapace width  | .471 <sup>b</sup> | 2.829 | .009 | .471                | 1.000                   |
|       | plastron length | .490 <sup>b</sup> | 2.974 | .006 | .490                | 1.000                   |
|       | plastron width  | .270 <sup>b</sup> | 1.481 | .150 | .270                | 1.000                   |
|       | carapace length | .510 <sup>b</sup> | 3.136 | .004 | .510                | 1.000                   |
| 3     | carapace width  | .185 <sup>a</sup> | .695  | .493 | .132                | .381                    |
|       | plastron length | .254 <sup>a</sup> | 1.082 | .289 | .204                | .476                    |
|       | plastron width  | .085 <sup>a</sup> | .477  | .637 | .091                | .851                    |

a. Predictors in the Model: (Constant), carapace length

b. Predictor: (constant)

c. Dependent Variable: AGE

d. SEX = female

SEX = juvenile

# Variables Entered/Removed<sup>c,d</sup>

| Model | Variables Entered | Variables Removed | Method                                                                                                                     |
|-------|-------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------|
| 1     | carapace width    |                   | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |
| 2     | a                 | carapace width    | Remove                                                                                                                     |
| 3     | carapace width    |                   | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |

a. All requested variables entered.

b. All requested variables removed.

c. Dependent Variable: AGE

d. SEX = juvenile

## Model Summary<sup>c</sup>

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1     | .768 <sup>a</sup> | .590     | .538              | .1074                      |
| 2     | .000 <sup>b</sup> | .000     | .000              | .1581                      |
| 3     | .768 <sup>a</sup> | .590     | .538              | .1074                      |

a. Predictors: (Constant), carapace width

b. Predictor: (constant)

c. SEX = juvenile

ANOVA<sup>c,d</sup>

| Model |            | Sum of Squares | df | Mean Square | F      | Sig.              |
|-------|------------|----------------|----|-------------|--------|-------------------|
| 1     | Regression | .133           | 1  | .133        | 11.490 | .010 <sup>a</sup> |
|       | Residual   | 9.236E-02      | 8  | 1.154E-02   |        |                   |
|       | Total      | .225           | 9  |             |        |                   |
| 2     | Regression | .000           | 0  | .000        |        | . <sup>b</sup>    |
|       | Residual   | .225           | 9  | 2.500E-02   |        |                   |
|       | Total      | .225           | 9  |             |        |                   |
| 3     | Regression | .133           | 1  | .133        | 11.490 | .010 <sup>a</sup> |
|       | Residual   | 9.236E-02      | 8  | 1.154E-02   |        |                   |
|       | Total      | .225           | 9  |             |        |                   |

a. Predictors: (Constant), carapace width

b. Predictor: (constant)

c. Dependent Variable: AGE

d. SEX = juvenile

Coefficients<sup>a,b</sup>

| Model |                | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)     | .295                        | .196       |                           | 1.501  | .172 |
|       | carapace width | .111                        | .033       | .768                      | 3.390  | .010 |
| 2     | (Constant)     | .950                        | .050       |                           | 19.000 | .000 |
| 3     | (Constant)     | .295                        | .196       |                           | 1.501  | .172 |
|       | carapace width | .111                        | .033       | .768                      | 3.390  | .010 |

a. Dependent Variable: AGE

b. SEX = juvenile

Excluded Variables<sup>c,d</sup>

| Model |                 | Beta In            | t     | Sig. | Partial Correlation | Collinearity Statistics |
|-------|-----------------|--------------------|-------|------|---------------------|-------------------------|
|       |                 |                    |       |      |                     | Tolerance               |
| 1     | carapace length | -.776 <sup>a</sup> | -.638 | .544 | -.234               | 3.749E-02               |
|       | plastron length | -.007 <sup>a</sup> | -.013 | .990 | -.005               | .186                    |
|       | plastron width  | .332 <sup>a</sup>  | .528  | .614 | .196                | .143                    |
| 2     | carapace length | .724 <sup>b</sup>  | 2.970 | .018 | .724                | 1.000                   |
|       | plastron length | .691 <sup>b</sup>  | 2.707 | .027 | .691                | 1.000                   |
|       | plastron width  | .758 <sup>b</sup>  | 3.289 | .011 | .758                | 1.000                   |
|       | carapace width  | .768 <sup>b</sup>  | 3.390 | .010 | .768                | 1.000                   |
| 3     | carapace length | -.776 <sup>a</sup> | -.638 | .544 | -.234               | 3.749E-02               |
|       | plastron length | -.007 <sup>a</sup> | -.013 | .990 | -.005               | .186                    |
|       | plastron width  | .332 <sup>a</sup>  | .528  | .614 | .196                | .143                    |

a. Predictors in the Model: (Constant), carapace width

b. Predictor: (constant)

c. Dependent Variable: AGE

d. SEX = juvenile

# Regression

Variables Entered/Removed<sup>c</sup>

| Model | Variables Entered | Variables Removed                   | Method                                                                                                                     |
|-------|-------------------|-------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| 1     | plastron length   |                                     | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |
| 2     | carapace length   |                                     | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |
| 3     | a                 | plastron length,<br>carapace length | Remove                                                                                                                     |
| 4     | plastron length   |                                     | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |
| 5     | carapace length   |                                     | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |

a. All requested variables entered.

b. All requested variables removed.

c. Dependent Variable: weight

### Model Summary

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1     | .875 <sup>a</sup> | .766     | .763              | 61.0497                    |
| 2     | .883 <sup>b</sup> | .780     | .774              | 59.6456                    |
| 3     | .000 <sup>c</sup> | .000     | .000              | 125.4110                   |
| 4     | .875 <sup>a</sup> | .766     | .763              | 61.0497                    |
| 5     | .883 <sup>b</sup> | .780     | .774              | 59.6456                    |

a. Predictors: (Constant), plastron length

b. Predictors: (Constant), plastron length, carapace length

c. Predictor: (constant)

### ANOVA<sup>d</sup>

| Model |            | Sum of Squares | df | Mean Square | F       | Sig.              |
|-------|------------|----------------|----|-------------|---------|-------------------|
| 1     | Regression | 951794.76      | 1  | 951794.756  | 255.374 | .000 <sup>a</sup> |
|       | Residual   | 290711.13      | 78 | 3727.066    |         |                   |
|       | Total      | 1242505.9      | 79 |             |         |                   |
| 2     | Regression | 968571.19      | 2  | 484285.593  | 136.127 | .000 <sup>b</sup> |
|       | Residual   | 273934.70      | 77 | 3557.594    |         |                   |
|       | Total      | 1242505.9      | 79 |             |         |                   |
| 3     | Regression | .000           | 0  | .000        |         | . <sup>c</sup>    |
|       | Residual   | 1242505.9      | 79 | 15727.923   |         |                   |
|       | Total      | 1242505.9      | 79 |             |         |                   |
| 4     | Regression | 951794.76      | 1  | 951794.756  | 255.374 | .000 <sup>a</sup> |
|       | Residual   | 290711.13      | 78 | 3727.066    |         |                   |
|       | Total      | 1242505.9      | 79 |             |         |                   |
| 5     | Regression | 968571.19      | 2  | 484285.593  | 136.127 | .000 <sup>b</sup> |
|       | Residual   | 273934.70      | 77 | 3557.594    |         |                   |
|       | Total      | 1242505.9      | 79 |             |         |                   |

a. Predictors: (Constant), plastron length

b. Predictors: (Constant), plastron length, carapace length

c. Predictor: (constant)

d. Dependent Variable: weight

### Coefficients<sup>a</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                 | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)      | -225.157                    | 47.457     |                           | -4.744 | .000 |
|       | plastron length | 67.091                      | 4.198      | .875                      | 15.980 | .000 |
| 2     | (Constant)      | -291.641                    | 55.561     |                           | -5.249 | .000 |
|       | plastron length | 50.390                      | 8.716      | .657                      | 5.781  | .000 |
|       | carapace length | 20.807                      | 9.582      | .247                      | 2.172  | .033 |
| 3     | (Constant)      | 525.338                     | 14.021     |                           | 37.467 | .000 |
| 4     | (Constant)      | -225.157                    | 47.457     |                           | -4.744 | .000 |
|       | plastron length | 67.091                      | 4.198      | .875                      | 15.980 | .000 |
| 5     | (Constant)      | -291.641                    | 55.561     |                           | -5.249 | .000 |
|       | plastron length | 50.390                      | 8.716      | .657                      | 5.781  | .000 |
|       | carapace length | 20.807                      | 9.582      | .247                      | 2.172  | .033 |

a. Dependent Variable: weight

### Excluded Variables<sup>d</sup>

| Model |                 | Beta In            | t      | Sig. | Partial Correlation | Collinearity Statistics |
|-------|-----------------|--------------------|--------|------|---------------------|-------------------------|
|       |                 |                    |        |      |                     | Tolerance               |
| 1     | carapace length | .247 <sup>a</sup>  | 2.172  | .033 | .240                | .221                    |
|       | carapace width  | .074 <sup>a</sup>  | .692   | .491 | .079                | .261                    |
|       | plastron width  | .094 <sup>a</sup>  | .678   | .500 | .077                | .159                    |
| 2     | carapace width  | -.059 <sup>b</sup> | -.477  | .634 | -.055               | .192                    |
|       | plastron width  | .007 <sup>b</sup>  | .049   | .961 | .006                | .145                    |
| 3     | carapace length | .827 <sup>c</sup>  | 12.989 | .000 | .827                | 1.000                   |
|       | carapace width  | .772 <sup>c</sup>  | 10.717 | .000 | .772                | 1.000                   |
|       | plastron width  | .818 <sup>c</sup>  | 12.539 | .000 | .818                | 1.000                   |
|       | plastron length | .875 <sup>c</sup>  | 15.980 | .000 | .875                | 1.000                   |
| 4     | carapace length | .247 <sup>a</sup>  | 2.172  | .033 | .240                | .221                    |
|       | carapace width  | .074 <sup>a</sup>  | .692   | .491 | .079                | .261                    |
|       | plastron width  | .094 <sup>a</sup>  | .678   | .500 | .077                | .159                    |
| 5     | carapace width  | -.059 <sup>b</sup> | -.477  | .634 | -.055               | .192                    |
|       | plastron width  | .007 <sup>b</sup>  | .049   | .961 | .006                | .145                    |

a. Predictors in the Model: (Constant), plastron length

b. Predictors in the Model: (Constant), plastron length, carapace length

c. Predictor: (constant)

d. Dependent Variable: weight

## Regression

### Variables Entered/Removed<sup>c</sup>

| Model | Variables Entered | Variables Removed | Method                                                                                                                     |
|-------|-------------------|-------------------|----------------------------------------------------------------------------------------------------------------------------|
| 1     | carapace length   |                   | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |
| 2     | a                 | carapace length   | Remove                                                                                                                     |
| 3     | carapace length   |                   | Stepwise<br>(Criteria:<br>Probability<br>-of-F-to-en<br>ter <=<br>.050,<br>Probability<br>-of-F-to-re<br>move >=<br>.100). |

a. All requested variables entered.

b. All requested variables removed.

c. Dependent Variable: AGE

### Model Summary

| Model | R                 | R Square | Adjusted R Square | Std. Error of the Estimate |
|-------|-------------------|----------|-------------------|----------------------------|
| 1     | .778 <sup>a</sup> | .606     | .601              | 1.8223                     |
| 2     | .000 <sup>b</sup> | .000     | .000              | 2.8853                     |
| 3     | .778 <sup>a</sup> | .606     | .601              | 1.8223                     |

a. Predictors: (Constant), carapace length

b. Predictor: (constant)

### ANOVA<sup>c</sup>

| Model |            | Sum of Squares | df | Mean Square | F       | Sig.              |
|-------|------------|----------------|----|-------------|---------|-------------------|
| 1     | Regression | 413.663        | 1  | 413.663     | 124.571 | .000 <sup>a</sup> |
|       | Residual   | 268.976        | 81 | 3.321       |         |                   |
|       | Total      | 682.639        | 82 |             |         |                   |
| 2     | Regression | .000           | 0  | .000        |         | <sup>b</sup>      |
|       | Residual   | 682.639        | 82 | 8.325       |         |                   |
|       | Total      | 682.639        | 82 |             |         |                   |
| 3     | Regression | 413.663        | 1  | 413.663     | 124.571 | .000 <sup>a</sup> |
|       | Residual   | 268.976        | 81 | 3.321       |         |                   |
|       | Total      | 682.639        | 82 |             |         |                   |

a. Predictors: (Constant), carapace length

b. Predictor: (constant)

c. Dependent Variable: AGE

### Coefficients<sup>a</sup>

| Model |                 | Unstandardized Coefficients |            | Standardized Coefficients | t      | Sig. |
|-------|-----------------|-----------------------------|------------|---------------------------|--------|------|
|       |                 | B                           | Std. Error | Beta                      |        |      |
| 1     | (Constant)      | -9.015                      | 1.419      |                           | -6.351 | .000 |
|       | carapace length | 1.307                       | .117       | .778                      | 11.161 | .000 |
| 2     | (Constant)      | 6.669                       | .317       |                           | 21.057 | .000 |
| 3     | (Constant)      | -9.015                      | 1.419      |                           | -6.351 | .000 |
|       | carapace length | 1.307                       | .117       | .778                      | 11.161 | .000 |

a. Dependent Variable: AGE

### Excluded Variables<sup>c</sup>

| Model |                 | Beta In            | t      | Sig. | Partial Correlation | Collinearity Statistics |
|-------|-----------------|--------------------|--------|------|---------------------|-------------------------|
|       |                 |                    |        |      |                     | Tolerance               |
| 1     | carapace width  | .307 <sup>a</sup>  | 1.904  | .061 | .208                | .182                    |
|       | plastron length | -.018 <sup>a</sup> | -.107  | .915 | -.012               | .169                    |
|       | plastron width  | .043 <sup>a</sup>  | .271   | .787 | .030                | .192                    |
| 2     | carapace width  | .760 <sup>b</sup>  | 10.521 | .000 | .760                | 1.000                   |
|       | plastron length | .706 <sup>b</sup>  | 8.981  | .000 | .706                | 1.000                   |
|       | plastron width  | .708 <sup>b</sup>  | 9.025  | .000 | .708                | 1.000                   |
|       | carapace length | .778 <sup>b</sup>  | 11.161 | .000 | .778                | 1.000                   |
| 3     | carapace width  | .307 <sup>a</sup>  | 1.904  | .061 | .208                | .182                    |
|       | plastron length | -.018 <sup>a</sup> | -.107  | .915 | -.012               | .169                    |
|       | plastron width  | .043 <sup>a</sup>  | .271   | .787 | .030                | .192                    |

a. Predictors in the Model: (Constant), carapace length

b. Predictor: (constant)

c. Dependent Variable: AGE

# Appendix V



## The National Park Service

### The Organic Act



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- [National Park Service Organic Act](#)
- Mantell, M. A., and P. C. Metzgar. 1990. [The Organic Act and the Stewardship of Resources within Park Boundaries](#). Chapter 2 in M. A. Mantell, ed. *Managing National Park System Resources: A Handbook on Legal Duties, Opportunities, and Tools*. The Conservation Foundation, Washington, D.C.

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### Introduction to the National Park Service Organic Act

*16 U.S.C. 1 et seq. (1988), Aug. 25, 1916, ch. 408, 39 Stat. 535*



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*There is created in the Department of the Interior a service to be called the National Park Service, which shall be under the charge of a director. The Secretary of the Interior shall appoint the director, and there shall also be in said service such subordinate officers, clerks, and employees as may be appropriated for by Congress. The service thus established shall promote and regulate the use of the Federal areas known as national parks, monuments, and reservations hereinafter specified, except such as are under the jurisdiction of the Secretary of the Army, as provided by law, by such means and measures as conform to the fundamental purpose of the said parks, monuments, and reservations, which purpose is to conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and by such means as will leave them unimpaired for the enjoyment of future generations.*

In 1916, the Department of the Interior was responsible for 12 national parks, 19 national monuments, and 2 reservations. The U.S. Forest Service managed the Grand Canyon and Mt. Olympus (Olympic National Park) mainly for timber harvest. The Army stationed a cavalry unit in Yellowstone year round and sent troops to Yosemite and Sequoia in the summer. The superintendents in charge of Interior lands had little or no experience managing natural areas and little or no help from the Department. Because of bad roads and scanty accommodations, comparatively few people visited the parks. Without public support, Congress would not allocate funding--parks in 1916 were run on less than a shoestring.

From 1911 to 1915, numerous bills to establish a bureau of national parks had been introduced, but none had gotten out of committee. In 1916, Stephen Mather joined the Department and with Horace Albright began an aggressive campaign to educate congressmen and the public concerning the value of the national parks. Their campaign worked. In the summer of 1916, Congress passed the Organic Act, establishing the National Park Service to manage and protect national parks, monuments, and reservations.

The authors of the Organic Act were well aware of the conflicts between use and preservation, but they also knew that Congress would never agree to exclude these areas from public use. Frederick Law Olmsted, Jr., came up with the language that defines the Park Service today. By law, the National Park Service is mandated to "conserve the scenery and the natural and historic objects and the wild life therein and to provide for the enjoyment of the same in such manner and

by such means as will leave them unimpaired for the enjoyment of future generations." This carefully-chosen language has weathered numerous lawsuits which have in general served to strengthen the National Park Service's resource protection powers.

By 1970, the National Park System included historical parks, scenic riverways, recreation areas, and a variety of other designations. Some units' enabling legislation included special provisions that permitted consumptive activities in that unit, such as fishing, hunting, trapping, and mining. To clear up any confusion of the overall mission for each unit, Congress amended the Organic Act with language that tied all units back to the purposes stated in the Organic Act. Thus, while each unit is to be administered according to its enabling legislation, each is also ultimately to be managed following the directives of the Organic Act. (Also see *General Authorities Act*, page 6.)

In 1974-76, the Sierra Club sued the National Park Service to take action against commercial loggers, whose activities outside the boundaries of Redwood National Park were damaging park resources. When Redwood was created, portions of the Redwood Creek watershed were left out of the original boundary for political reasons. Congress had authorized the Secretary to acquire easements and enter into management agreements with the timber companies, but the Park Service had not taken these actions, resulting in the lawsuit. The courts ruled that the Park Service had not taken the appropriate actions to protect the park, and the Park Service then asked Congress for help in taking such actions. (*Sierra Club v Department of the Interior*, 376 F. Supp. 90 (N.D. Cal. 1974); *Ibid.*, 398 F. Supp. 284 (1975); *Ibid.*, 424 F. Supp. 172 (1976).)

In response, Congress passed an amendment in 1978 to the Organic Act that addressed the problem. It also generically strengthened the National Park Service's protective function. This amendment states that "the protection, management, and administration of these areas shall be conducted in light of the high public value and integrity of the National Park System and shall not be exercised in derogation of the values and purposes for which these various areas have been established, except as may have been or shall be directly and specifically provided by Congress." Thus, Congress' intent for each park as established in the park enabling legislation is upheld by the Organic Act, as well as Congress' option of amending that legislation if necessary. (Also see *Redwood National Park Act*, page 7.)

As amended, the Organic Act allows the Secretary a great deal of latitude in making management decisions, and the courts have consistently upheld this latitude, especially if it is supported by careful study and planning. The Secretary can exclude a use that is detrimental to resources, or allow a use if it is determined to be appropriate. For example, commercial fishing is prohibited in Everglades National Park. When deciding a lawsuit brought by commercial fishermen challenging the regulation, the court carefully reviewed the planning and public information process and ruled that the Park Service was well within its administrative authority. (*Organized Fishermen v. Watt*, 590 F. Supp. 805 (S.D. Fla 1984); *affirmed*, 77 F.2d 1544 (11th Cir. 1985).) When the National Rifle Association challenged the Park Service's right to ban hunting and trapping (except where part of the unit's enabling legislation), the court ruled that the Organic Act clearly provided for the protection of wildlife and that the Park Service was acting within its authority. (*National Rifle Association v Potter*, 628 F. Supp. 903 (D.D.C. 1986).)

Alternatively, the Secretary can permit a use if it has been clearly proven not to threaten resources. For example, at Cape Cod the general management plan allows offroad vehicle (ORV) use under guidelines designed to protect the ecological integrity of the area. Environmental groups sued to stop ORV use altogether, on the assumption that any ORV use would permanently damage the ecosystem. The court ruled that the management plan adequately protected the ecosystem and that "Park Service decisions were the result of carefully designed, scientifically based studies and continued monitoring efforts." (*Conservation Law Foundation v Clark*, 590 F. Supp. 1467 (D. Mass. 1984).)

The Organic Act will undoubtedly continue to be tested and defined in the courts. As it stands, it provides a powerful weapon in the National Park Service's continued battle to protect the nation's natural and cultural resources.

## References



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- Albright, Horace. 1985. *The Birth of the National Park Service: The Founding Years, 1912-33*. Howe Brothers, Salt Lake City, Chicago.

- Mantell, Michael A., and Philip C. Metzger. 1990. The Organic Act and the Stewardship of Resources within Park Boundaries. Chapter 2 in Managing the National Park System: A Hand-book on Legal Duties, Opportunities, and Tools. The Conservation Foundation. Baltimore, Maryland.

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