FUNCTIONAL ASPECTS OF PLACOID SCALES IN THE BONNETHEAD SHARK
(*Sphyrna tiburo*)

A Thesis

by

MARTIN ANDREW DONLEY

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This thesis meets the standards for scope and quality of
Texas A&M University-Corpus Christi and is hereby approved.

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ABSTRACT

There are two primary types of neuromasts in fishes: canal and superficial. While the canal neuromasts are positioned inside a protected canal, superficial neuromasts have been shown in the osteichthyians to be primarily unprotected. For chondrichthyians, superficial neuromasts have associated protective scales that have been proposed to function in directing water flow in the adjacent boundary layer. For this study, I determined what anatomical factors could lead to the proposed boundary layer control. Angles and dimensions of the scales surrounding the superficial neuromast where measured to aid in the construction of a model. I determined that the angles of the scales around the superficial neuromast do not vary regionally as had been previously suggested. However, it was found that maturity could play a role in the determination of scale angles surrounding the superficial neuromast. Using the average scale angles, I built and tested a model in a flume with inconclusive results. While identifying the superficial neuromasts, I discovered the modified basal plates of two scales associated with the superficial neuromast. These modified basal plates could provide structural support to the pit of the superficial neuromast. I also present a uniform anatomical reference for the various parts of the placoid scale to unify future research.

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1. INTRODUCTION

Most predatory fishes have evolved a fusiform shape that increases the efficiency at which they capture prey. The fusiform shape of different species varies along a continuous spectrum based on environmental selection pressures that favored various locomotory modes. For example, an elongated fusiform shape promotes long-term swimming efficiency, and a compact fusiform shape accommodates larger musculature and allows greater short-term swimming speeds. Like the situation in most other fishes, the need for efficient locomotion produces selection pressure to reduce drag caused by the protective scales of the sharks.

The placoid scales of sharks are composed of enamel-coated dentin with a thin layer of acellular bone on the basal surface (Reif, 1980). Placoid scales have four primary functions: protection, drag reduction, accommodation of sensory organs, and bioluminescence (Raschi & Tabit, 1992; Reif, 1978a). The function that has most recently garnered attention is drag reduction (Bechert, Bruse, & Hage, 2000; Dean & Bhushan, 2010; Magin, Cooper, & Brennan, 2010). The u-shaped valleys (Bechert, Hoppe, & Reif, 1985; Bechert, Bartenwerfer, Hoppe, & Reif, 1986) and v-shaped ridges (Walsh & Weinstein, 1978; Walsh, 1982) have shown to reduce viscous drag by up to 7.3% (Bechert et al., 2000). This reduction of viscous drag is primarily due to the shape of the exposed crown of the scale (Bechert et al., 2000; Dean & Bhushan, 2010).

1.1 Shark mechanoreception

Although drag reduction may be their primary function, placoid scales are also associated with external sensory organs called superficial neuromasts, and are thought to affect the flow of water around each superficial neuromast (Johnson, 1917; Peach & Marshall, 2000; Reif, 1978a; Reif, 1982; Reif, 1985; Raschi & Tabit, 1992). The superficial neuromast is a mechanoreceptor that translates movement in the water into an electrochemical signal (Boord & Campbell, 1977; Tester & Nelson, 1967).

Mechanoreception in the superficial neuromast is affected by two physical properties of fluids, the boundary layer and the fluid-structure interaction (McHenry, Strother, & Van Netten, 2008). A boundary layer is formed as an object moves through a continuous medium or fluid such as water, and the fluid element has a no-slip velocity condition at the surface of that object. This creates a viscous drag and a flow velocity gradient surrounding the object. This flow velocity gradient starts at free stream velocity and gradually reaches the same velocity of the object at the surface-water interface. The thickness of this layer varies with the speed of the organism, the movement of the organism out of a linear track, and any external flow patterns that are not directly associated with the organism. This makes determining relevant stimuli, i.e., movement of conspecifics or prey, difficult due to the movement of an organism and how it changes direction in a complex fluid environment.

Two recent articles (Peach & Marshall, 2000; Peach & Marshall, 2009) allude to a lack of knowledge concerning the fluid mechanics of the scales surrounding the superficial neuromast structure. How the superficial neuromast receives stimuli from the surrounding environment is not completely understood. This mechanism could have a relation to the orientation of the scales surrounding the superficial neuromast. Reif (1985) suggested that these scales function to channel the boundary layer based on the patterning of the scales. This study aims to determine if Reif (1985) was correct in his suggestion by determining how the scales surrounding the superficial neuromast affect the boundary layer through the fluid structure interaction.

Placoid scale nomenclature is incomplete. The current nomenclature only describes the basic features; basal plate, ridges (keels), cusps, and valleys (Mello, De Carvalho, & Brito, 2013; Raschi & Tabit, 1992; Reif, 1985). Here, I also propose a common nomenclature combining the previously used terminology and terminology being adapted from dental terminology. This nomenclature is adaptable to the various scale adaptations that are present in current Chondrichthyes.

While most of the scales possess hydrodynamic ridges, the scales immediately surrounding the superficial neuromast organ are modified and have reduced ridges (Peach & Marshall, 2000). In addition, the scales surrounding the superficial neuromast are angled inward toward the superficial neuromast and appear to channel the flow of the surrounding boundary layer (Reif, 1985). This leads to the first proposed mechanism of activation, that the altered angle of the scales surrounding the superficial neuromast organ create lateral vortices. The lateral vortices would be created by the water molecules colliding with the scale ridges changing their trajectory by launching them away from the shark. Once enough water molecules have pushed out of the boundary layers near surface flow there would be a low-pressure region at the surface. The low-pressure region would allow some of the water molecules from the nearby surface to move laterally to maintain the pressure equilibrium at the surface. Once back at the surface the molecules would collide with the u-shaped valley of the scale and continue in a circular path. This would lead to a short term lateral vortex for each channel or linear line of valleys on the surface. Because water translates force due to its polarity, a stimulus from a dipole source (prey or conspecific) could push these lateral vortices into the protected superficial neuromast. This would lead to the activation of the superficial neuromast and then the vortex would carry away the stimulus, priming the superficial neuromast for the next activation.

The second mechanism being proposed is based on Reif's (1985) observations and how airfoils function. The scales surrounding the superficial neuromast drive a highly laminar flow at a faster rate over the superficial neuromast to increase the rigidity of the fluid directly over the superficial neuromast. This leads to a greater probability of stimulation at lower speeds and reduced chances of stimulation at greater speeds.

These hypotheses will be tested through the construction of a biomimetic model that is based on data gathered in a morphological survey of the scales surrounding the superficial neuromast. Testing a physical model in a controlled environment of a flume will eliminate most of the confounding variables that are found in a biological environment. To accurately represent "life," the model must reflect the physical morphology of the object, i.e., geometric similarity, and if the model is constructed on a different scale than the original, then scaling effects must also be considered (Haldane, 1985). Maintaining a constant Reynolds number minimizes or eliminates these scaling errors; conversely it satisfies the dynamic similarity requirements of model studies. A Reynolds number is a dimensionless number that is used to determine the equivalency of a model to real life, and is determined by the formula $Re_{dc} = \rho a V_{dc}/\mu$ (Van Netten, 2006). When the Reynolds number is determined for the original object, and the scale of the model relative to the original object is known, then the fluid system in the flume (viscosity of fluid, velocity of fluid, or a combination of both) can be adjusted to compensate for the scale difference.

1.2 Objectives

1. To determine the angular configuration of the two rows of scales and two lateral scales immediately surrounding the superficial neuromast.
2. To build a model of the scales covering the superficial neuromast, the two lateral scales, and the two rows of scales surrounding the superficial neuromast. This model will be used to determine if the observed, altered angles of the scales change the flow of water over the superficial neuromast.
3. To relate the angular configuration of the scales surrounding the superficial neuromast to changes in flow around the superficial neuromast.

2. MATERIALS AND METHODS

Tester and Nelson (1967) documented distribution and prevalence of the superficial neuromast organ in various shark species, including the bonnethead shark *Sphyrna tiburo* (Linnaeus, 1758), and scalloped hammerhead shark, *Sphyrna lewini* (Griffith & Smith, 1834). Shark species in the family Sphyrinidae typically have 400–600 superficial neuromasts per specimen; the second largest number of superficial neuromasts was found in the Carcharhinidae with only 100–200 superficial neuromasts per specimen. Based on these data, sphyrinid sharks would be the ideal family of sharks to use for this study due to their relatively high number of superficial neuromast organs and the availability of a baseline for comparison.

Of the two species, the International Union for the Conservation of Nature (IUCN) listed the bonnethead shark as a species of least concern; Tester and Nelson (1967) reported that the species averages over 400 superficial neuromasts that are concentrated laterally from the cephalofoil to the tip of the caudal fin. Although the scalloped hammerhead averages over 600 superficial neuromasts (Tester & Nelson, 1967), it is listed by the IUCN as an endangered species. Even though the total number of neuromasts per individual is greater in scalloped hammerheads, their density is greater on bonnethead sharks because they are smaller (64–124 cm vs 40–420 cm) than scalloped hammerheads. Thus, even if scalloped hammerheads were not endangered, bonnethead sharks would still be a better model species to address the research question.

Bonnethead sharks used in this study were donated by recreational anglers on Padre Island National Seashore, or were collected in routine fisheries-independent monitoring by the Rockport division of the Texas Parks and Wildlife Department. A total of 19 sharks were collected between March and May of 2013 in Corpus Christi Bay, South of the Highway 361 bridge and North of the John F. Kennedy Memorial Causeway. Catch data (e.g., capture location, capture method, and select abiotic factors) are provided in Appendix 1. From the 19 sharks, I determined that 5 of the sharks should be removed (n=14) do to errors in processing that led to over-processing and the loss of morphological integrity.

2.1 Measurements and determination of sex and maturity

I collected the following measurements (cm) from sharks used in this study (Appendix 1): fork length, total length, girth just posterior to the dorsal fin, girth at the fifth gill slit, girth just anterior to the dorsal fin, girth at the caudal peduncle, width of the cephalofoil, dorsal leading edge of the caudal fin, ventral leading edge of the caudal fin, leading edge of the dorsal fin, and the length of both pectoral fins, length from the posterior insertion of the dorsal fin to the caudal peduncle, length from the last gill slit to the caudal peduncle, and length from the middle of the pectoral fin to the caudal peduncle.

I determined the sex of each shark based on the presence or absence of claspers, which are found only in males. If the shark was male, claspers were measured to determine sexual maturity. Male bonnethead sharks are usually sexually mature when clasper length is 8% of the total length (Parsons, 1993). To confirm male sexual maturity, the testes were examined for the presence of mature sperm. Sexual maturity of females was determined based on total length (≥65 cm) and confirmed by determining the presence of ovarian or uterine eggs, or evidence of a recent birthing event.

2.2 Placoid scale terminology used in this study

While terminology regarding structures like the basal plate and the cusp have been used fairly consistently in the literature (Hertwig, 1874; Mello et al., 2013; Reif, 1978a; Reif, 1980; etc.) some descriptive terms such as neck or crown are not used consistently. Previous studies have referred to various structures of the placoid scale; the basal plate (Reif, 1980), the cusp of the scale (Mello et al., 2013), the ridges of the scale (Hertwig, 1874; Mello et al., 2013; Reif, 1978a; Reif, 1980; Bechert et al., 2000; Dean & Bhushan, 2010; Magin et al., 2010), the u-shaped valleys (Bechert et al., 1985; Bechert et al., 1986), and v-shaped ridges (Walsh & Weinstein, 1978; Walsh, 1982).

Through visual comparison of cross-sectional views of the placoid scales from Reif (1985), Meyer and Seegers (2012), Hertwig (1874), and this study as well as a review of the literature, I standardized my definitions of several features or components of placoid scales, and propose definitions for some regions of the placoid scale for which I could find no clear definitions (Figure 1, Table 1):

- I noted that placoid scales have three primary regions; the crown, the neck, and the basal plate.
- Both the neck and the basal plate are embedded in the integument to support the crown.
- The neck is the region of the scale that is above the acellular bone of the basal plate, but below the surface of the epidermis.
- The crown is the exposed portion of the scale that is bent to allow for overlapping of the scales.
- The bend has an anterior portion (AB) that is partially covered by the scale just to its anterior.
- The bend also has a posterior portion (PB) that is facing the integument.
- The cusp begins just anterior to the first termination of the u-shaped valleys (Mello et al., 2013).

Four primary scale types were observed on the bonnethead shark; three-ridge scales, five-ridge scales, the anterior modified scale, and the posterior modified scale. The three-ridge scales have three predominant ridges with smooth, gently sloping

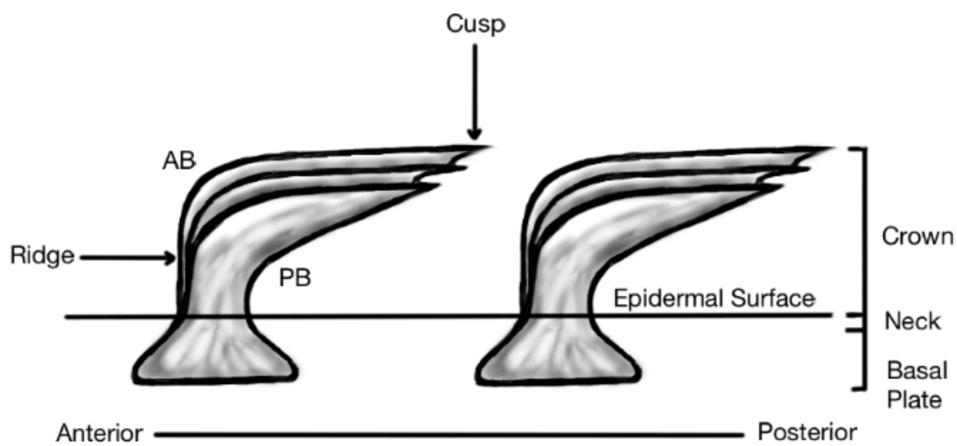

FIGURE 1. Diagram of the naming system for the generalized placoid scale. AB=Anterior Bend, and PB=Posterior Bend.

TABLE 1. Placoid scale nomenclature, new vs old terminology.

Regions of placoid scales		Parts of placoid scales	
New term	Old term	New term	Old term
Crown	Crown, Foil, Wing	Ridge	Ridge, Tine
Neck	Neck-canal	Valley	Valley
Basal Plate	Basal Plate, Base	Anterior Bend	None
		Posterior Bend	None
		Cusp	Cusp, Crown
		Process	Process

extensions off either side. The five-ridge scales have five predominant ridges with a steeper sloping side extension on either side. The anterior modified scale only has four ridges, the ridges are paired with one on each side of the scale. Both paired ridges angle inward as they progress to the posterior of the scale. For the two ridges that are medial, they terminate together at the posterior end of the scale as the central cusp. The posterior modified scale is identical to the anterior modified scale with two exceptions, the central cusp is elongated and the two lateral cusps start more anterior on the scale.

2.3 Collecting and preparing skin/scale samples for morphological analysis

I cut samples of skin from freshly caught bonnethead sharks within a trapezoidal template to preserve the orientation of the samples relative to the body of the shark using scalpel and shearing scissors. The trapezoidal shape consisted of a 45° angle posteriorly and a 145° angle anteriorly. I cut the trapezoidal skin samples from three different regions of the shark's body (Figure 2):

- The Anterior Dorsal sample from just behind the left ventral end of the fifth gill slit, to just anterior of the pectoral fins and this cut was then mirrored on the right side of the specimen creating the trapezoidal shape described above.
- The Posterior Ventral sample from the posterior edge of the Anterior Dorsal sample with the posterior corner of the sample touching the posterior margin of the dorsal fin on both sides.
- The Posterior Dorsal sample from the posterior edge of the Posterior Ventral sample to the pelvic fins; the posterior corner of the trapezoid touched the anterior insertion of the pelvic fins.

After the trapezoidal shape was cut, I removed the strap of skin by cutting into the muscle leaving approximately 0.5 cm of muscle attached to the back of the skin strap. I cut small trapezoids (1.5 cm anterior edge and 2.0 cm posterior) from the posterior ends of samples (both left and right) on three of the best-preserved specimens (sharks 13, 14, and 15) in preparation for scanning electron microscopy (Figures 3 and 4). These

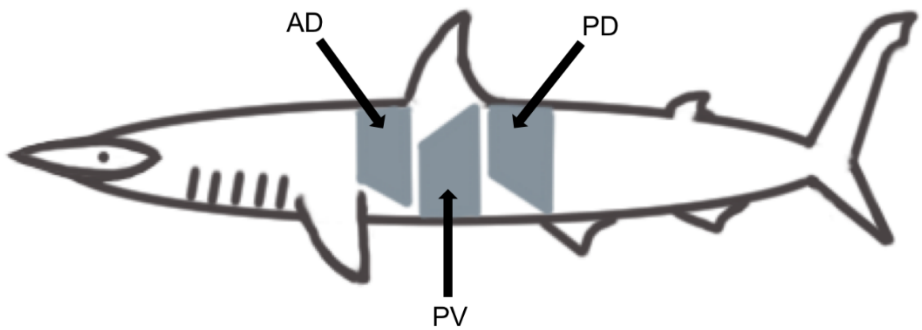

FIGURE 2. Bonnethead shark skin sample position. AD – Anterior Dorsal, PV – Posterior Ventral, and PD – Posterior Dorsal.

FIGURE 3. Bonnethead shark skin sample subsamples. PS – Primary sample, and SEM – Scanning electron microscope sample.

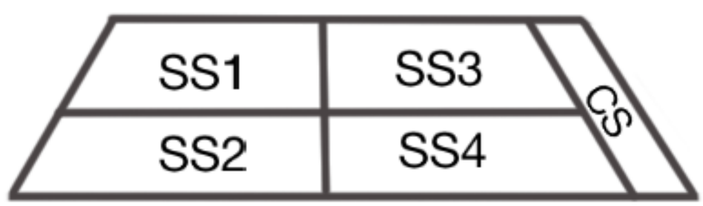

FIGURE 4. Scanning electron microscope (SEM) sample subsamples. SS1 – Subsample 1, SS2 – Subsample 2, SS3 – Subsample 3, SS4 – Subsample 4, and CS – Cross-sectional sample.

subsamples were immediately fixed in half-strength Karnovsky's fixative (Karnovsky, 1965) with 0.1 M Sørenson's phosphate buffer at 7.2 pH (Pease, 1964) for one hour at 4 °C. All other samples (which were destined for clearing and staining) were immediately fixed in 10% neutral buffered formalin (Carson, Martin, & Lynn, 1973) using Sørenson's phosphate buffer at 7.2 pH (Pease, 1964).

I prepared the rest of the primary sample using a whole-mount clearing and staining procedure for examination by light microscopy. The size of the cleared and stained specimens made it difficult to position them for side views using light microscopy. To accomplish this, I removed samples from the edges and mounted in the proper orientation on glass slides using petroleum jelly (Equate Bentonville, AR) formed into a circular well that would be filled with glycerin. I examined the resulting thick mounts using light microscopy. For a secondary side view, I removed small strips from the SEM samples and mounted small strips on their side for viewing.

2.3.1 Whole-mount clearing and staining

After fixation, I washed the large samples in deionized water to remove excess fixative, and processed the samples using a modification of the procedure of Taylor and Van Dyke (1985). I cleared the samples in a 2% aqueous potassium hydroxide for two weeks, and then stained them using alizarin red ($1x10^{-6}$ M) in a 2% potassium hydroxide solution for one week. I modified the Taylor and Van Dyke (1985) procedure by removing the trypsin maceration; this prevented excess tissue removal allowing the sample to more closely reflect in vivo composition. I then passed the stained samples through a graded series of 2% aqueous potassium hydroxide: glycerin solutions (3:1, 1:1, 1:3) and finally into pure glycerin for long-term storage. Once in the three parts glycerin and one part 2% potassium hydroxide solution, I examined and photographed the tissue on an Olympus SZ-PT stereo dissecting microscope with a SZ60 lens (Olympus, USA) equipped with a Spot Insight digital camera and Spot Advanced software (Spot Imaging Solutions, Sterling Heights, MI).

While the scanning electron microscope (SEM) can show the scales, there is a likelihood of distortion due to the intense dehydration. To aid in the elimination of artifacts, I viewed side views of the whole mounted samples with a light microscope and compared to the SEM samples. I cut this sample with the aid of the stereo dissecting microscope using shearing scissors to cut a superficial neuromast. I placed the thin strip into a well created on the slide using petroleum jelly filled with glycerin. I then positioned the sample for viewing through a compound light microscope using forceps. I initially spread a thin layer of petroleum jelly across the bottom of the well to ensure that the skin would remain in place after being positioned with the forceps.

2.4 Microscopy

I analyzed samples using two different types of microscopes. For large-scale scanning of the samples, I used an Olympus SZ-PT stereo dissecting microscope with a SZ60 lens (Olympus, USA) equipped with a Spot Insight digital camera and Spot Advanced software (Spot Imaging Solutions, Sterling Heights, MI). The dissecting scope allowed me to scan the large trapezoidal skin samples for superficial neuromast structures. Once I found a superficial neuromast structure the orientation of the sample was noted and I took a photograph for later analysis using the Image J image processing and analysis software (National Institute of Health). I took six photographs per sample with three on each side (left and right). With three samples per shark and six photographs per sample, I collected a total of 18 photographs per shark for later analysis. In total, I photographed 252 superficial neuromasts for this study (Appendix 2). I used these photographs to determine the pattern, orientation, characteristics, and the dimensions of the exposed scales surrounding the superficial neuromast.

Because of the limited magnification of the dissecting scope (63x), I used a Neoscope-JCM 5000 scanning electron microscope (JEOL Tokyo, Japan) to analyze the finer detail of the scales surrounding the superficial neuromast. This also provided me a secondary method to eliminate some of the processing artifacts that could be found using either method independently. I primarily used the photographs from the scanning electron microscope to determine scale characteristics and dimensions. I then compared the scanning electron micrographs to the photographs taken with the dissecting microscope to determine if the pattern or orientation of the scales had been altered due to the processing of the skin samples. From these photographs, I was able to determine the current nomenclature for placoid scales and propose a new common nomenclature.

2.4.1 Scanning electron microscopy

After fixation, I washed the small skin subsamples from shark specimens 13, 14, and 15 in 0.1 M Sørenson's buffer solution (pH 7.4) for 12 hours. Then I cut the samples longitudinally from anterior to posterior and horizontally from dorsal to ventral creating four pieces with unique shapes that allowed for directionality to be determined. From the ventral edge of the posterior ventral section of the SEM sample, I cut one thin strip to allow for a cross-sectional view of the placoid scales in the SEM. I post-fixed the samples in 1% aqueous osmium tetroxide (OsO_4) and dehydrated through an ethanol series from 10% to 100% in increments of 10% for one hour each. I then infiltrated the samples with liquid CO_2, freeze dried (Labconco FreezeZone 4.5L freeze dryer Kansas City, MO), and mounted them on SEM stubs using carbon dots (Ted Pella, Inc. Redding, CA). I mounted the four pieces flush with the surface of the stub and the thin strips with the lateral edges facing up to expose the side of the scale. Then I coated the mounted samples with gold-palladium for 45 seconds at 20 mA using a Mini Sputter Coater SC7620 (Quorum Technologies Lewes, UK). I viewed and photographed the coated specimens on a Neoscope-JCM 5000 scanning electron microscope (JEOL Tokyo, Japan). If the specimen was not coated adequately and I saw charging then I coated the sample again for 30 seconds at 20 mA.

2.5 Image analysis

I analyzed digital images from the whole mount samples using Image J (National Institute of Health). I used the line tool to measure approximately 650 pixels (±5 pixels) from the anterior edge of the basal plate of the anterior modified scale. I marked both ends of the line using the paintbrush tool to make squares around the boxes at the ends of the line. Using the angle tool, I placed the first two points in the boxes that were made using the paintbrush tool. I used the third point to align the line between the second and third point with the direction of the scale. If the scale was not within the rotational reach of the line, I used a tool that I designed to extend the reach of the line. The line reach extender consists of two long parallel sticks of the same length that were bolted to two more short parallel sticks of the same length. To extend the line over the gap between the line and the scale, I placed one of the long parallel sticks or the short parallel sticks (distance dependent) in line with the scale angle. Then I aligned the other parallel stick with the posterior square that was previously marked using the paintbrush tool. Using the third point of the angle tool, I aligned the line between the second and third points with the parallel stick that was aligned with the posterior square. I tabulated the measurements in Excel (Microsoft Redmond, WA) as a comma separated values (CSV) file for later analysis using the IBM SPSS statistical package (Version 22).

For later construction of the model, I needed to delineate general scale positions. Figure 5 shows the pattern that was generally representative of the basal plate pattern in all samples in this study. If scales were missing, I measured the angle of the scale that overlapped the region where the scale would have been in the place of the missing scale. If the scale was paired or doubled in the position, I measured and averaged the angle of the two scales for that position.

To determine the dimensions of the scales to aid in building model scales, I used the magnification tool on the software included with the JEOL Neoscope SEM to measure ridge length (mm), scale width (mm), and scale height (mm). I used the magnification tool to measure the height of the unmodified scales (i.e., above the epidermis), the depth that the scale was embedded in the epidermis, and the dimensions of the three primary scale types observed including the ridge lengths (mm) and the width of the scale both posteriorly and anteriorly (mm).

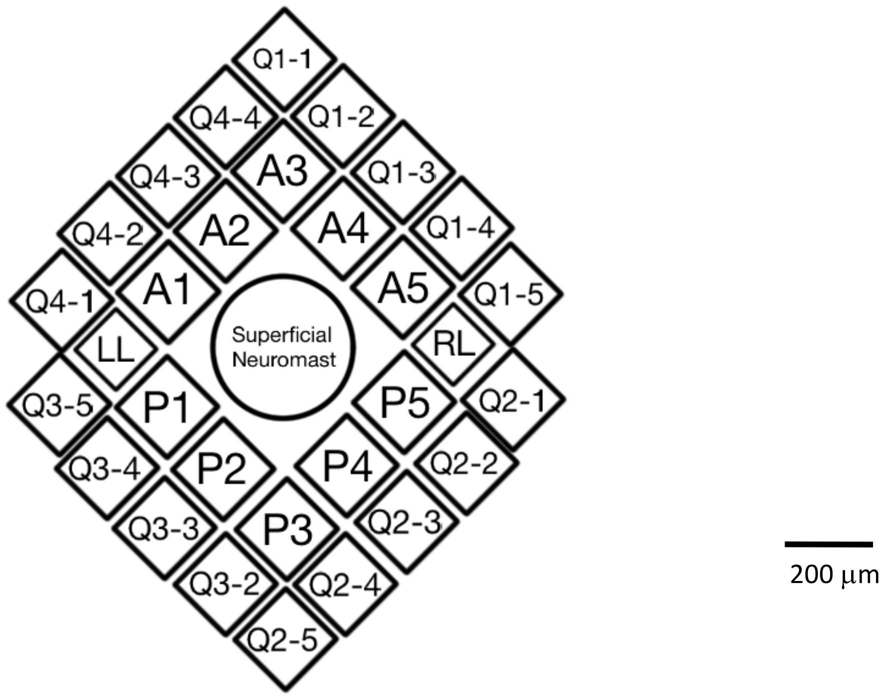

FIGURE 5. Diagram of the general scale angle sample positions. A=Anterior; P=Posterior; Q=Quarter; LL=Left Lateral; and RL=Right Lateral.

2.6 Statistical analysis

I averaged the angles measured on the scales from three superficial neuromast scale groups from each side of the sample together to account for variations within one superficial neuromast scale group. After getting the means of the three samples, I needed to determine if statistical analyses needed to be separated by side, by sample location, or if side and sample interacted. To accomplish this, I ran a 2-way ANOVA with side and sample location as factors, and tested for an interaction between side and sample location. I used an appropriate post-hoc test was used to determine the source of differences when needed.

To determine if the sex of the shark influenced the angles of the scales surrounding the superficial neuromast, I used a Levene test to check for equal variances and a t-test to determine if the mean of one sex was significantly different from the mean of the other sex. I applied the same statistical approach to determine if the maturity of the shark influenced the angles of the scales.

2.7 Model construction and testing

The second objective was to determine if the altered scales surrounding the superficial neuromast changed the flow within the boundary layer and how the flow pattern was being altered. Based on the data that was collected from the first objective, I constructed a variable model. With a variable model the scale angles can be changed to represent different situations, the first of which being a biologically accurate model, followed by other representative models based on the sample demographics, and finally a control with all the scales in a linear orientation (non-biological). I molded models using oven bake clay (Sculpey 301 Tan, Polyform Products Co. Elk Grove Village, IL) and clay forming tools based on measurements of the scales taken from the SEM data.

Model scales were made according to measurements from photographs that were taken using the SEM (Figure 6). I took all the scale measurements with the cusps being posterior (South) and the anterior bend being anterior (North). The left lateral ridge was left of the central ridge (West), the left outer ridge was left of the left lateral ridge (West), the right lateral ridge was right of the central ridge (East), and the right outer ridge was right of the right lateral ridge (East). I measured the ridge from the anterior bend to the tip

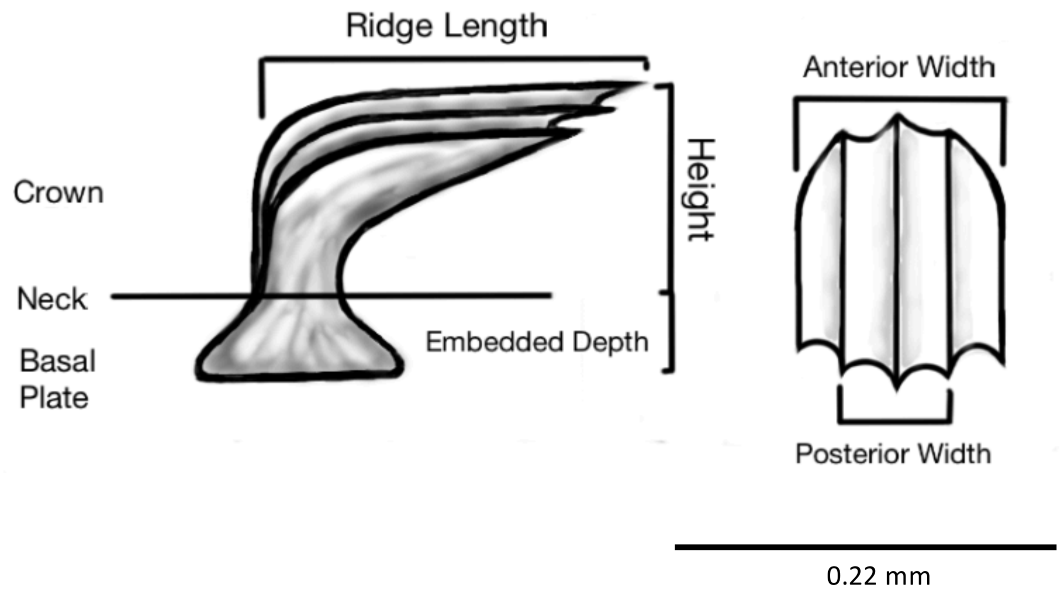

FIGURE 6. Scale measurement diagram for the generalized placoid scale.

of the cusp. I then scaled up the average measurements ten times to create the scale model (Figure 7).

Based on flume size and available resources I determined that the model should be a 1:100 scale model. I then used these hardened clay models to create molds using Amazing Mold Putty (Alumilite Corp., Kalamazoo, MI) according to the manufacturer's instructions. I poured the Amazing Casting Resin (Alumilite Corp., Kalamazoo, MI) into the molds to create identical copies of the model scales. While the resin hardened, I inserted a stainless steel 8-24 nut into the resin using a stainless steel 8-24 by 3/4" bolt with a 1-inch wide washer to ensure that the head of the bolt would stay outside of the resin. Once the resin had hardened, I removed the scales and I trimmed the basal plate of the scale, and sanded it to a uniform height using an orbital sander with 60-grit sand paper.

FIGURE 7. Model scales with compass coordinates to indicate directionality. Scales 1-4 are clay models of the four types of scales surrounding the superficial neuromast, number five is the mold for the three-ridge scale, and number six is the resin product of the mold from number four. Number one is the three-ridge model, number two is the five-ridge model, number three is the modified posterior scale, and number four is the modified anterior scale.

I mounted the finished resin scales to a plate of Lexan (Sabic Riyadh, Saudi Arabia) with a 1cm × 1 cm grid drawn using permanent marker. I used the grid to maintain relative spacing while mounting the scales. I set the angle of the scale using a digital angle tool (Johnson Digital Angle Finder 7 in. #1888-0700 Mequon, WI) to match the average angle measurement that was found from the morphological survey.

2.7.1 Flume testing

To test the fluid-altering flow of the scale model, I used a low-velocity flume (Figure 8). A low-velocity flume is a channel that has a water input on one end and a water outlet on the other end. Between the water input and water outlet there are grids that promote laminar flow by separating the flowing water into layers that flow in one direction. These grids decrease the turbulent flow of the water in the flume allowing for the delineation of an alteration of the flow when a contrasting media is introduced. The

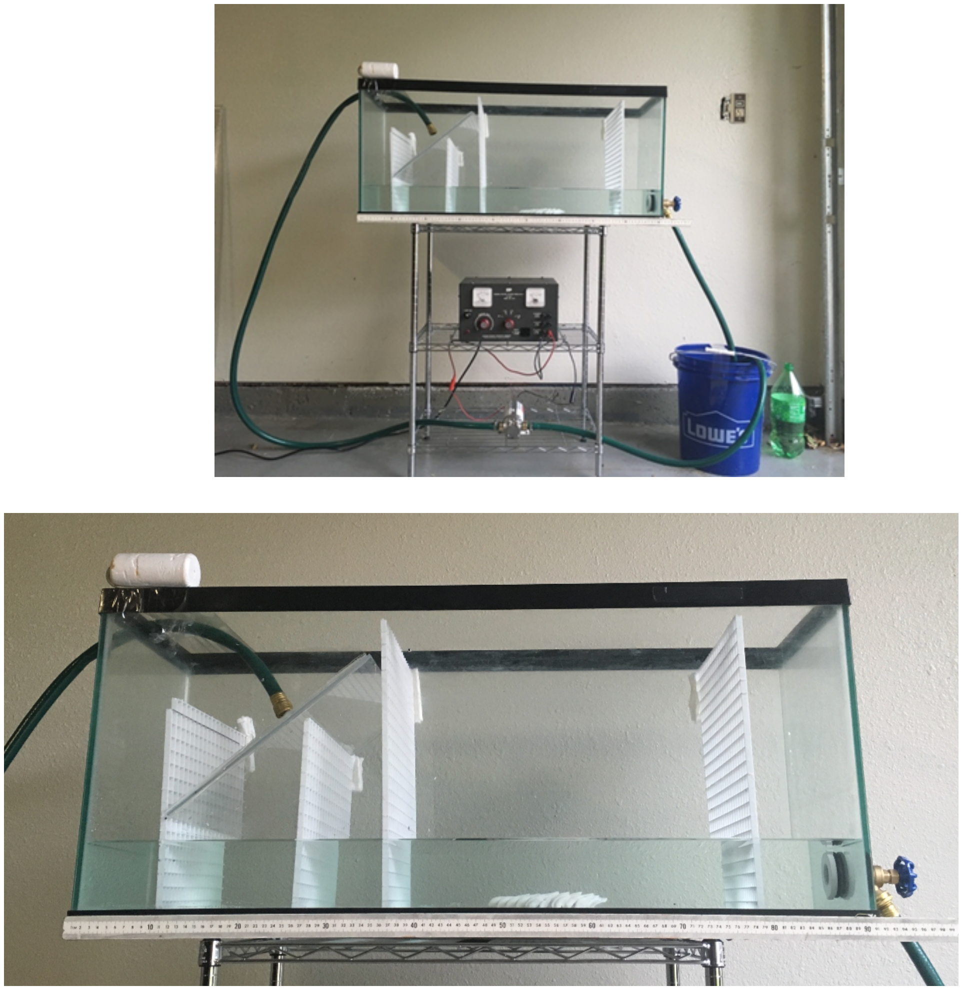

FIGURE 8. Low-velocity flume for the fluid dynamic testing. Top: full set up ready to test the fully submerged model. Bottom: closeup of the flume tank, screen, inflow and outflow. Construction details are listed in Appendix 3.

contrasting media for these tests consisted of gel food coloring (Wilton #601-2425), serial dilutions of gel food colorings (1:100, 1:500, and 1:1000), India ink (Bombay #090385480719), disarticulated dental floss (CVS un-waxed # 102384), and all-purpose black sewing thread (Coats & Clark #235.0002). I attached the dental floss and the thread to a thin rigid wire at 1 cm intervals. I then submerged this wire at varying levels to determine the effect. For the ink and dyes, I constructed an injection apparatus using a disposable pipet and 1/4” clear hose. I bent the clear hose at a 90° angle with a large radius allowing the dye to be injected parallel to the laminar flow of the tank. I injected the dye after the first two grids, but before the third grid to reduce the effect of the hose on the laminar flow of the flume.

In the flume, I tested the model using five different methods in two different orientations. One of the orientations was based on the average scale angle determined by the survey of the scales surrounding the superficial neuromast and the other was with all the scales in a linear orientation to act as a control. I used the digital angle tool (Johnson Digital Angle Finder 7 in. #1888-0700) to check the alignment of the scales based on the grid lines. Once adjusted, I placed the model in the flume behind the third grid and in front of the fourth grid, resting on the bottom of the flume.

While maintaining the proper Reynolds number I set the flow rate in the flume to best represent typical conditions. I used the swimming speed of the bonnethead shark (Parsons & Carlson, 1998) to calculate the Reynolds number required for the scale model. I recorded the outcomes of the tests using two cameras at a 90° angle from each other. I captured an overhead view using an iPhone 6s (Apple Cupertino, CA) and a lateral view using a Lumix FZ150 (Panasonic Osaka, Japan). I evaluated the videos from the flume tests visually to determine if the scales surrounding the superficial neuromast altered the flow of the boundary layer of water moving over the model.

3. RESULTS

Throughout the results, diamond-shaped diagrams are used to depict scale positions and their arrangement around the neuromast to visually convey data that are relevant to their geometric arrangement and angular configuration.

3.1 Scale characteristics

Figure 9 shows the relationship between the median ridges of the scales and the underlying basal plates. This relationship can also be seen in Figure 10, which shows the posterior modified medial scale with a partially exposed basal plate. The partially exposed basal plate of the posterior modified scale appears to have the same structure as the cleared and stained basal plate in Figure 9. These modified basal plates are concave and convex with the radii of both curvatures pointing inward toward the superficial neuromast. The modified basal plates are thicker toward the midline and taper outward. This was initially found in the clearing and staining of photographs (Figure 9) and later confirmed in the SEM photographs (Figure 10).

The average height above the epidermis for the crown was 0.10 mm and the average height of the scale that was embedded was 0.025 mm (neck and basal plate). The scales appear to be fairly symmetrical with regard to the length of the ridges (Table 2). There lengths of left and right outer ridge are essentially identical as are the lengths of the left and right lateral ridges. The primary differences are with regard to the widths between the anterior and posterior ridges on the 5-ridge scale, modified anterior scale, and modified posterior scale; with widths varying by as much as ~ 60%. The other item to note is that the anterior widths are the larger widths in all cases.

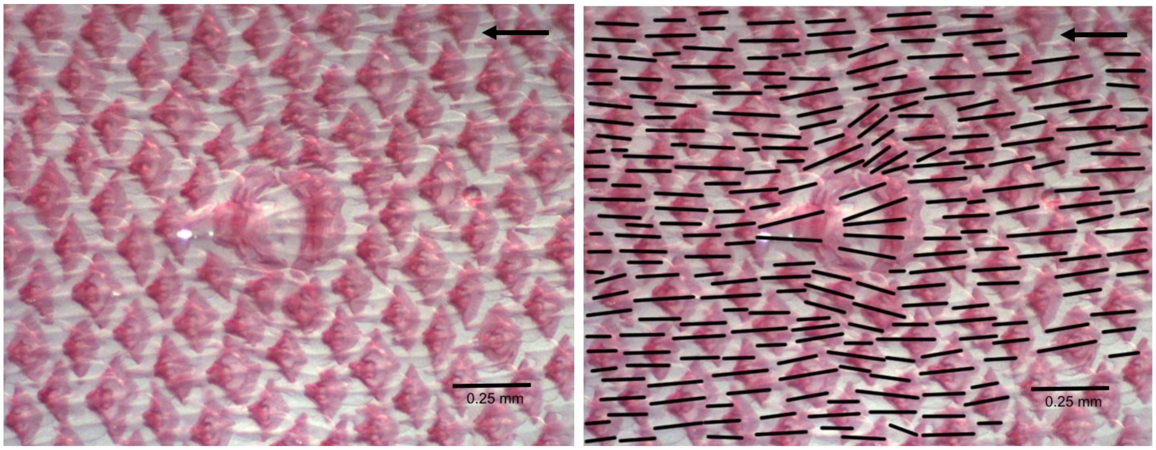

FIGURE 9. Images of cleared and stained scales showing ridges and basal plates. On the left is a cleared and stained sample showing the pronounced basal plates of the scales surrounding the superficial neuromast organ (at 63x magnification). On the right, the scale ridges are marked with a line. The arrow in the upper right shows the direction of the flow movement would be in the opposing direction. This sample was taken from the anterior dorsal region of a sexually mature female.

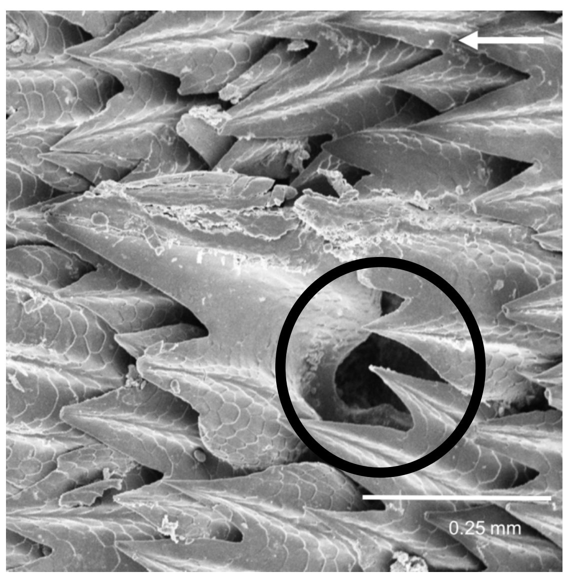

FIGURE 10. SEM of exposed basal plate of the modified posterior scale. The midline posterior modified scale is partially disarticulated exposing the modified basal plate in the encircled region. The arrow in the upper right corner shows the flow direction, movement would be opposing. This sample was taken from the anterior dorsal region of a sexually mature female.

TABLE 2. Average measurements (mm) and standard deviation (in parenthesis) of scale features. Below are the average measurements and standard deviation of the length of the scale ridges and the distance between ridges for four placoid scale types found in the vicinity of superficial neuromasts in bonnethead sharks.

Scale Type	Outer ridge		Lateral ridge		Central ridge	Width between ridges	
	L	R	L	R		Anterior	Posterior
Five Ridges	0.12 (0.02)	0.12 (0.02)	0.17 (0.02)	0.18 (0.02)	0.22 (0.02)	0.21 (0.02)	0.12 (0.02)
Three Ridges	N/A	N/A	0.16 (0.01)	0.15 (0.01)	0.20 (0.01)	0.13 (0.01)	0.12 (0.01)
Modified Anterior	0.12 (0.02)	0.13 (0.02)	0.17 (0.03)	0.18 (0.02)	N/A	0.21 (0.02)	0.14 (0.01)
Modified Posterior	0.14 (0.02)	0.14 (0.02)	0.23 (0.02)	0.23 (0.03)	N/A	0.21 (0.03)	0.17 (0.02)

3.3 Scale patterns and angles from SEM micrographs

Figure 11 shows the predominant scale pattern that surrounds the superficial neuromast of a bonnethead shark. The two modified central scales enclose the superficial neuromast sense organ (Peach & Marshall, 2000; Reif, 1985). Surrounding the two modified scales are two primary types of scales, one with three predominant ridges and one with five predominant ridges. The scales surrounding the two modified scales are angled toward, the modified scales with some exceptions. The scale ridges of the surrounding scales are marked in Figure 9 which aligns with the flow pattern seen in Figure 12.

Figure 13 shows the general pattern of scales not associated with a sensory organ with a maximum angle of 20° and a minimum of 0° based on the median ridge of the scale. The average angle of the scales in Figure 13 is -0.03°, which is well below that of

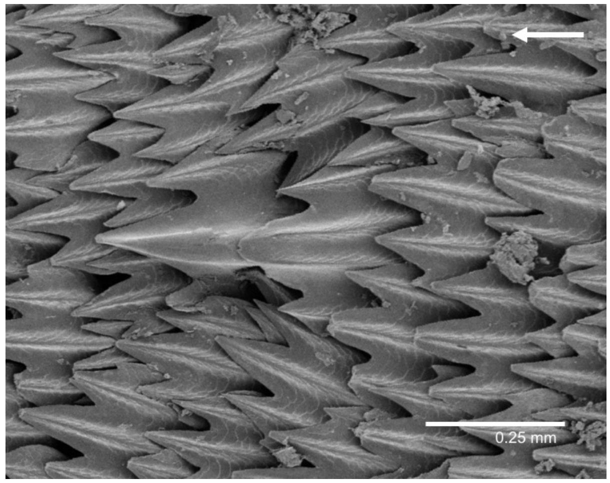

FIGURE 11. SEM of scales surrounding the superficial neuromast organ. The arrow in the upper right-hand corner points toward the caudal fin showing the direction of the flow. This sample is from the anterior dorsal region of a sexually mature female.

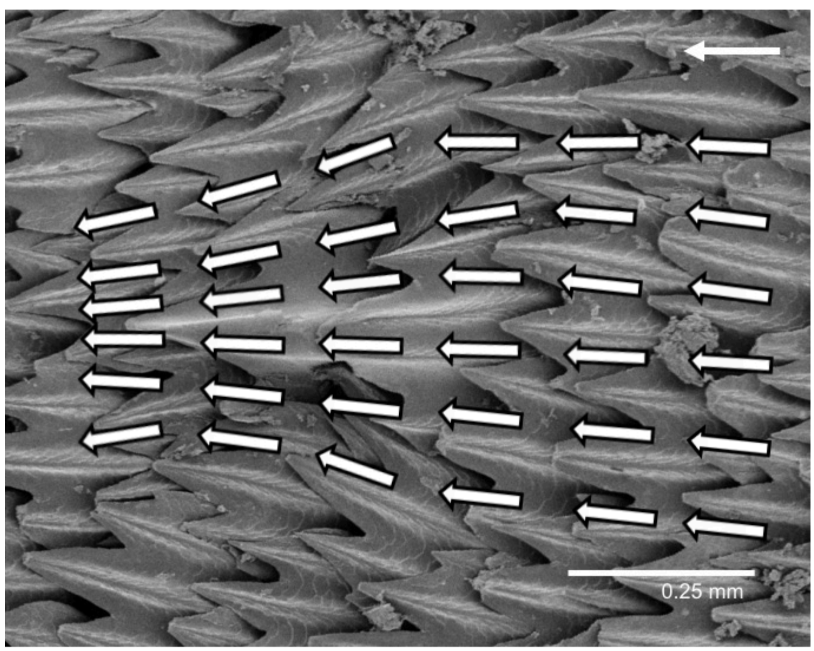

FIGURE 12. SEM of the superficial neuromast with proposed flow redirection. The arrows show the proposed redirection of fluid flow in the near-surface boundary layer (~40% redirected flow). This sample was taken from the anterior dorsal region of a sexually mature female bonnethead shark (*Sphyrna tiburo*).

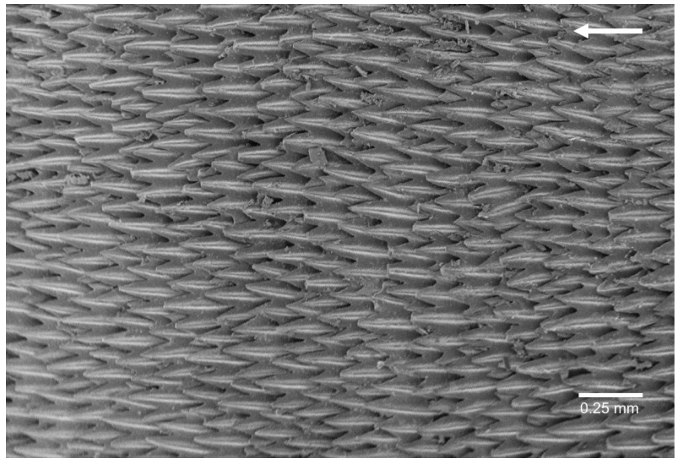

FIGURE 13. SEM of the general linear pattern found on *Sphyrna tiburo*. The arrow in the upper right-hand corner shows the direction of the flow, movement would be in the opposing direction. This sample was taken from the anterior dorsal region of a sexually mature female.

the angled scales surrounding the superficial neuromast (Figure 14). This linear pattern can also be seen in the cross-sectional sample in Figure 15. However, it should be noted that due to the dehydration required for SEM, the depth of the basal plate in the photograph could have been altered.

3.4 Scale angles

The overall mean angle of scales varied from as steep as +18° or -17° of the two center scales, to nearly flat (≤2° positive or negative) in several outer ring scales (e.g., Q2-5, Q4-4) (Table 3, Figure 14). Negative angles are concentrated on the right side of the sampling grid whereas those on the left side are positive. This pattern holds true whether looking at the overall means or the means by sex or maturity (Table 3). There were no significant differences ($p<0.05$) between scale angles measured on either side of

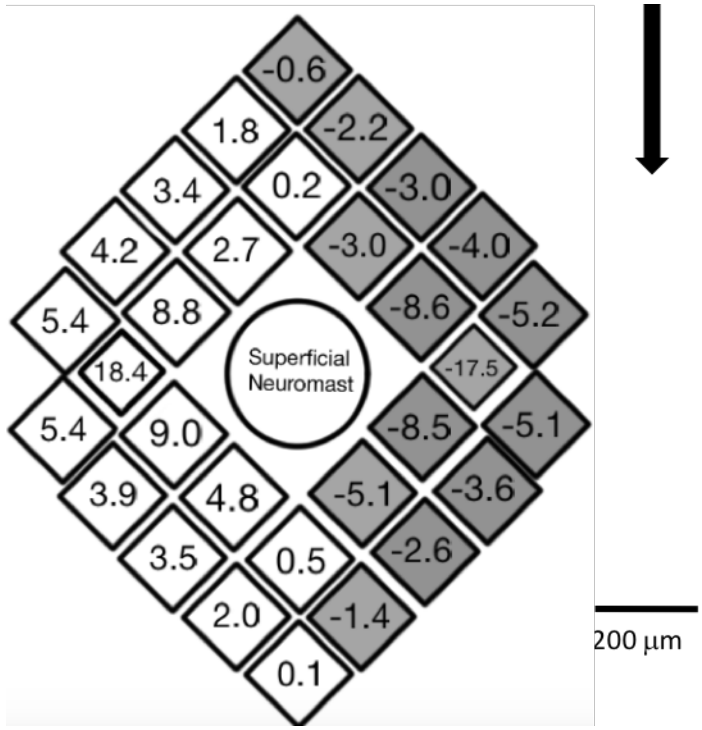

FIGURE 14. General scale positions with the average angle of the sample. Negative angles are indicated with grey shading. Arrow denotes direction of fluid flow; shark motion is in the opposing direction.

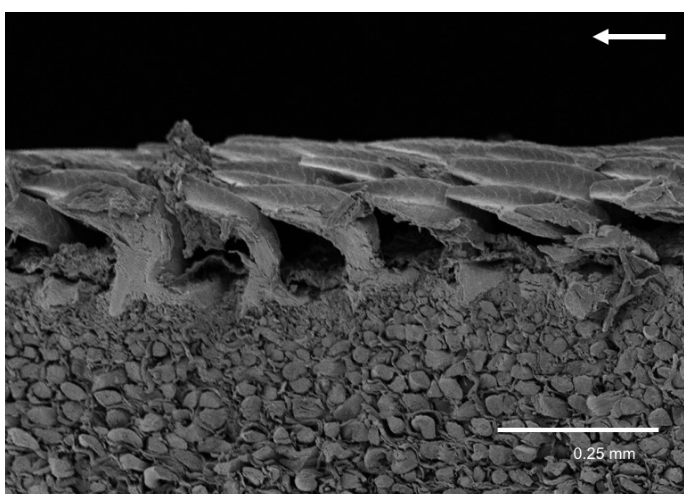

FIGURE 15. SEM of scale vertical section, exposing the basal plate. The arrow in the upper right-hand corner shows the flow direction movement would be in the opposing direction. This sample was taken from the anterior dorsal region of a sexually mature female.

TABLE 3. Average angles with standard error (in parenthesis) for scales surrounding the superficial neuromasts. These average angles of the bonnethead shark are overall, and by sex and maturity. See Figure 5 for a map of the scale positions in relation to the superficial neuromasts and Appendix 4 for a list of the scale name abbreviations. Scale positions Q3-1 and Q4-5 were initially thought to be viable sampling positions, after reviewing the first shark it was apparent that they were not viable and were removed from the sample.

Scale position	Sex		Maturity		Overall
	M (n=30)	F (n=54)	J (n=48)	A (n=36)	(n=84)
LL	20.15	17.48	18.60	18.22	18.43
	(1.18)	(0.70)	(0.87)	(0.91)	(0.63)
RL	-16.91	-17.86	-16.40	-19.01	-17.52
	(0.77)	(0.59)	(0.56)	(0.75)	(0.47)
A1	8.43	9.05	8.33	9.50	8.83
	(0.75)	(0.57)	(0.58)	(0.72)	(0.45)
A2	2.61	2.77	1.92	3.79	2.72
	(0.72)	(0.50)	(0.58)	(0.52)	(0.41)
A3	0.20	0.16	-0.21	0.69	0.18
	(0.46)	(0.37)	(0.39)	(0.43)	(0.29)
A4	-2.05	-3.57	-2.98	-3.09	-3.03
	(0.60)	(0.52)	(0.51)	(0.66)	(0.40)
A5	-8.45	-8.70	-8.74	-8.44	-8.61
	(0.61)	(0.56)	(0.49)	(0.73)	(0.42)
P1	10.25	8.35	9.07	8.97	9.03
	(0.86)	(0.57)	(0.70)	(0.64)	(0.48)
P2	5.22	4.54	4.89	4.64	4.78
	(0.62)	(0.42)	(0.47)	(0.52)	(0.35)
P3	0.41	0.49	0.20	0.80	0.46
	(0.54)	(0.39)	(0.41)	(0.49)	(0.32)
P4	-5.27	-5.04	-5.75	-4.28	-5.12
	(0.68)	(0.51)	(0.55)	(0.57)	(0.40)
P5	-9.12	-8.19	-8.97	-7.92	-8.52
	(0.86)	(0.54)	(0.65)	(0.65)	(0.46)
Q1-1	-0.63	-0.57	-1.03	-0.01	-0.59
	(0.48)	(0.33)	(0.38)	(0.36)	(0.27)
Q1-2	-2.50	-1.99	-2.37	-1.91	-2.17
	(0.49)	(0.37)	(0.35)	(0.51)	(0.30)
Q1-3	-2.88	-3.03	-3.04	-2.90	-2.98
	(0.65)	(0.44)	(0.51)	(0.51)	(0.36)
Q1-4	-3.16	-4.44	-3.42	-4.73	-3.98
	(0.71)	(0.47)	(0.53)	(0.58)	(0.40)

TABLE 3. Continued.

Scale position	Sex		Maturity		Overall
	M (n=30)	F (n=54)	J (n=48)	A (n=36)	(n=84)
Q1-5	-4.66 (0.73)	-5.45 (0.53)	-4.82 (0.56)	-5.63 (0.66)	-5.17 (0.43)
Q2-1	-4.03 (0.72)	-5.75 (0.50)	-5.18 (0.66)	-5.08 (0.43)	-5.14 (0.42)
Q2-2	-2.39 (0.91)	-4.26 (0.52)	-3.56 (0.68)	-3.64 (0.62)	-3.59 (0.47)
Q2-3	-1.84 (0.85)	-3.00 (0.47)	-2.57 (0.66)	-2.60 (0.49)	-2.58 (0.43)
Q2-4	-2.23 (0.60)	-0.87 (0.48)	-2.07 (0.48)	-0.41 (0.58)	-1.36 (0.38)
Q2-5	0.64 (0.55)	-0.22 (0.39)	0.28 (0.41)	-0.17 (0.51)	0.08 (0.32)
Q3-2	2.06 (0.59)	2.01 (0.37)	2.00 (0.45)	2.06 (0.43)	2.03 (0.31)
Q3-3	3.04 (0.60)	3.69 (0.40)	3.35 (0.45)	3.60 (0.50)	3.46 (0.33)
Q3-4	3.97 (0.69)	3.79 (0.48)	3.51 (0.52)	4.31 (0.59)	3.85 (0.39)
Q3-5	5.47 (0.72)	5.41 (0.51)	5.30 (0.56)	5.60 (0.63)	5.43 (0.41)
Q4-1	5.02 (0.68)	5.66 (0.47)	4.92 (0.50)	6.11 (0.58)	5.43 (0.38)
Q4-2	3.96 (0.64)	4.41 (0.56)	3.73 (0.49)	4.94 (0.74)	4.25 (0.43)
Q4-3	3.13 (0.60)	3.58 (0.45)	2.75 (0.43)	4.32 (0.58)	3.42 (0.36)
Q4-4	1.69 (0.56)	1.86 (0.45)	1.33 (0.48)	2.42 (0.50)	1.80 (0.35)

the body, or among scale angles measured in the three different sample locations on the shark's body, and no interaction between the factors.

I also wanted to determine if there were significant differences between scale angles by sex or maturity. T-tests indicated that there was a significant difference between sexes for the left lateral scale angle (df = 82; t=2.072, 2-tailed significance =

0.04) with the males exhibiting a steeper overall mean angle (males = 20.1° vs females = 17.4°). There were a number of significant differences by maturity, RLC, A2, Q2-4, and Q4-3 (Table 4). For three of the four positions, the mature shark possessed a larger angle (1-3° larger). However, Q2-4 has a 2° larger angle in immature sharks (Table 4).

3.5 Flume tests

I then applied the average angles of the scales to the corresponding scale position on the model (Figure 16). I set scale spacing to ensure that the measured regions were exposed to the flow and that there was minimal overlap. I tested the model in two different orientations using six different media to determine if there was a qualitative change to the fluid flow due to the orientation of the scales (Figure 17). In the context of these tests, a qualitative change would be an identifiable change in the flow that corresponds to the expected outcome of a directional change in the flow of the boundary layer.

For the gel food coloring, if a large amount of gel food coloring was added to the flume large spheres of gel that were denser than the water resulted, and they sank. Since the gel sphere was large it took longer to dissolve which did allow it to be easily tracked. One of these spheres collided with the ridge of an angled scale and then continued to collide with scale ridges along the predicted path. While this could show how the angles of the scales alter the flow of the boundary layer, the results could not be replicated.

When observing the additions of serial dilutions of the gel food coloring (1:100, 1:500, and 1:1000) and India ink, I noted that only very small fluctuations in the flow could be detected for a very brief time before the solutions dissipated. I attributed all the small fluctuations to turbulent flows due to the small fluctuation being followed by

TABLE 4. Results of significant t-tests for maturity (df=82). Significant results to determine differences between mean scale angles by maturity of bonnethead shark.

Scale	T	2-tailed significance	Difference
RL	2.85	0.005	Mature (-19.01) > immature (-16.40)
A2	-2.32	0.023	Mature (3.79) > immature (1.92)
Q2-4	-2.21	0.03	Mature (-0.041) < immature (-2.07)
Q4-3	-2.22	0.03	Mature (4.32) > immature (2.75)

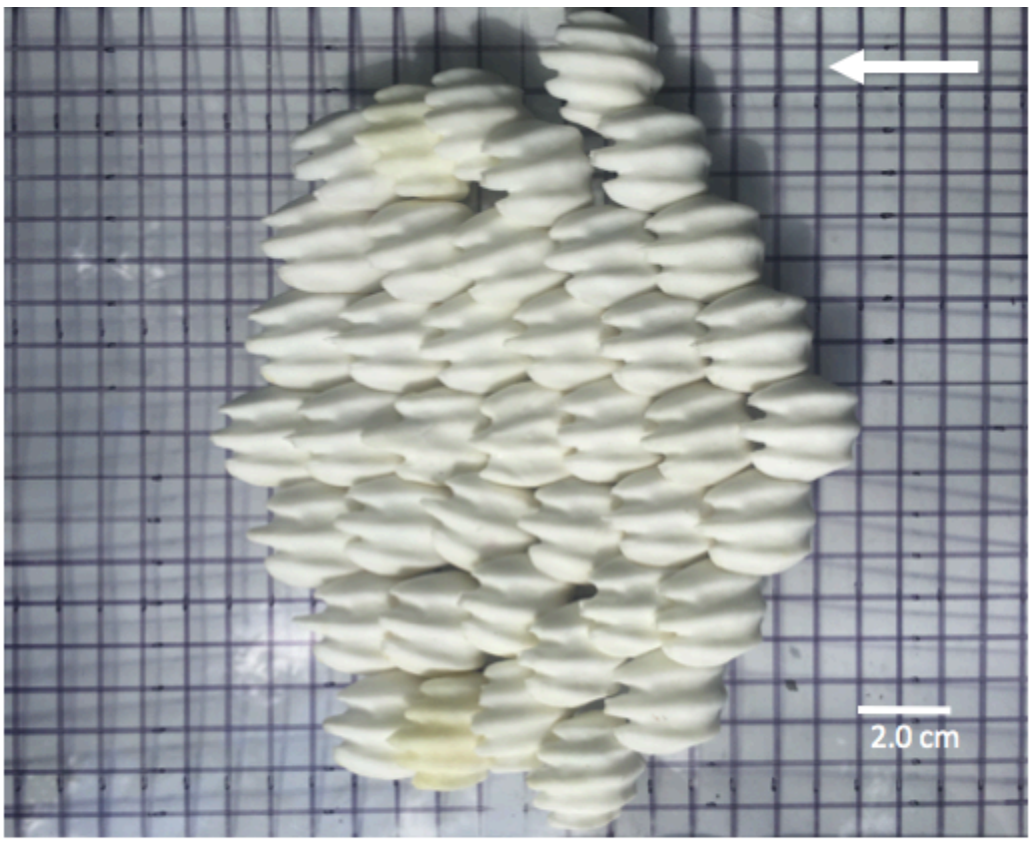

FIGURE 16. Model of the scales surrounding the superficial neuromast. Scales are made of resin and mounted to a sheet of Lexan on a 1 cm × 1 cm grid.

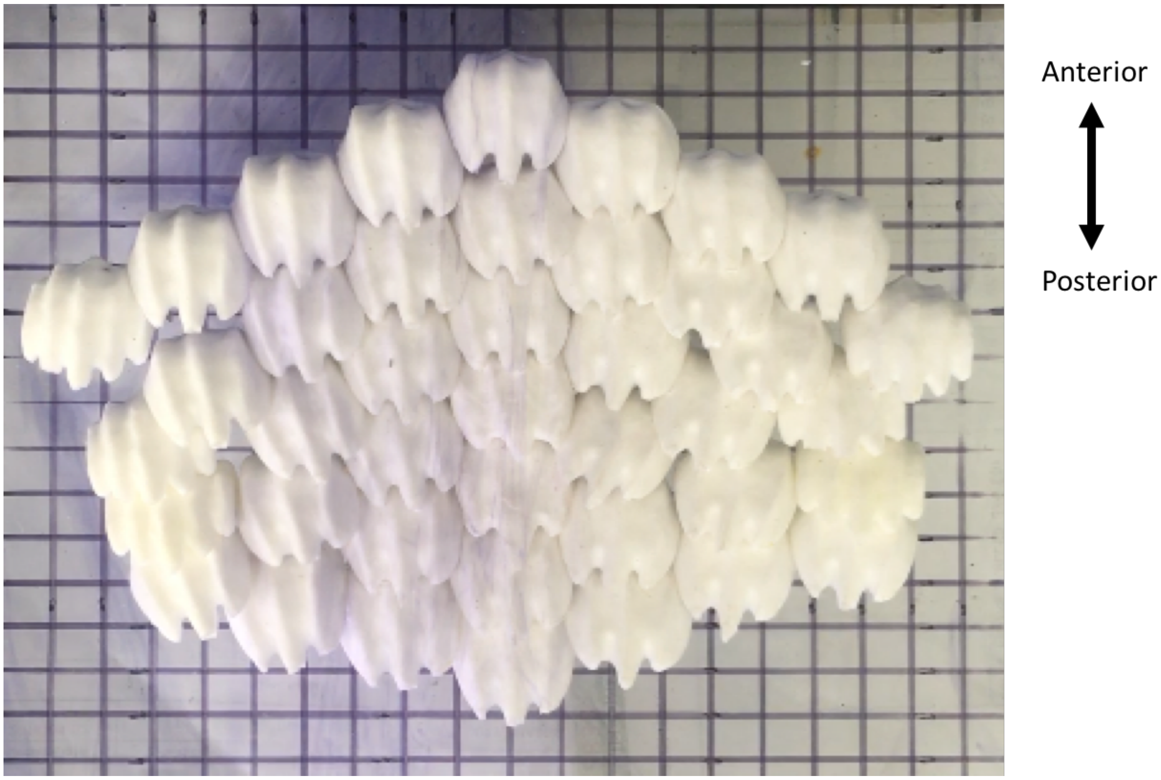

FIGURE 17. Flume test using gel dye showing slight directional change of dye. Purple dye is moving from anterior to posterior with a slight directional change from outside (left side of picture) to inside (right side of picture) of the structure.

cyclical motion that went against the flumes directional flow. Upon insertion of the disarticulated dental floss, and all-purpose black sewing thread I noted that the velocity of the water in the flume was too low to suspend the strands above the model thereby making the results inconclusive.

From these observations, I determined that none of the methods used to test the model produced a verifiable qualitative difference that could be attributed to the position or angle of the scales. I tested the model in both the average biological representation that was representative of the angles sampled in this study and in a control orientation where all scales were positioned in line with the flow. Neither orientation produced observations that were useful in evaluating the function of the scales.

4. DISCUSSION

Peach and Marshall (2000, 2009) and Reif (1985) noted that the scales surrounding the superficial neuromasts exhibited a pattern that could have effects on the boundary layer. After analyzing six samples from 14 bonnethead sharks, I have confirmed that these scales do exhibit a quantifiable pattern (Figure 14) that varies from what might be considered a normal linear arrangement.

From this study, there are three biologically relevant observations: the modified basal plate of the scales just anterior and posterior to the superficial neuromast, the average angles of the scales directly surrounding the superficial neuromast, and that the superficial neuromast of the bonnethead shark does not vary significantly by side or sample location. This study also shows that sex and maturity could influence the angles of the scales surrounding the superficial neuromasts.

I also show that the modified basal plate of the scales just anterior and posterior to the superficial neuromast has a crescent shape that has gone unnoticed. The crescent shaped basal plates seem to create a gap in the normal crosshatch pattern that is created by the diamond shaped basal plates of the unmodified scales and the weave of collagen fibers. When compared to the work of Peach (2009) on the grey reef shark (*Carcharhinus amblyrhynchos)*, it appears that the modified basal plates are what provide the structural support for the pit where the superficial neuromast resides and allow for the innervation of the superficial neuromast by the hair cell nerves or the insertion of the hair cells.

I delineated the average angles of the scales directly surrounding the superficial neuromast for the bonnethead shark. These average angles can be used to determine what effect the angles could have on the boundary layer of a moving shark. It is also interesting that Reif (1978a; 1985) noticed that the scales surrounding lateral line pores exhibited angles that are in direct contrast to the angles observed in this study. This supports my assertion that the altered scale angles surrounding the superficial neuromasts must alter the boundary layer.

The angles of scales associated with the superficial neuromast of the bonnethead shark do not vary significantly by side or sample location. This shows that the scales surrounding the superficial neuromasts across the whole body of the bonnethead shark are likely uniform with only minor variations. This indicates that there could be modifications in the collagen fiber weave of the skin (Meyer & Seegers, 2012) and/or the developmental pattern of the scales (Meyer & Seegers, 2012; Reif, 1980).

Based on the t-test results for maturity, I have shown that some of the scales surrounding the superficial neuromast vary significantly depending on the maturity of the shark. This significant variation could be due to the ontogenetic variability noted by Reif (1985). The variability could also be due to injuries to the epidermis that has been noted to disrupt the scale pattern (Bullard, Frasca, & Benz, 2000; Reif, 1978b).

When looking at the scales individually, it is hard not to notice that the two lateral scales have roughly the same magnitude of angles however they are opposing in direction. The lateral scales are essentially set in opposition with one another with the absolute value of the scale angles being very similar, but with the left positive and the right negative. The opposing directions of the scales may imply that only one scale could substantially alter water flow on the sides of the shark's body.

The results of the flume tests were inconclusive, likely due to deficiencies in the flume's design. The negative results obtained could be due to several factors, including relatively high flume velocity of about 0.0136 m/s with a target range of 0.00045 m/s to 0.00053 m/s. Another source of error could be the design of the model scales. Since they were made by hand, the microstructures that are present in the skin and scales of members of the Sphyrnidae are absent (Mello et al., 2013). Evidence of this microstructure can be seen in Figures 10, 11, 12, and 15. This microstructure that was observed by Mello et al. (2013), could function in the same way that the dimples work on a golf ball to further reduce drag at the fluid structure boundary (Choi, Jeon, & Choi, 2006). Sampling method could also have been an issue due to the nature of gill netting and the time needed to process the samples could have led to loss of microstructural integrity. Both could have led to the observed broken cusps seen in Figures 10, 11, and 12.

4.1 Future research

While the data I present is biologically relevant, the relevance of placoid scale microanatomy is not limited to biology (Bechert et al., 2000; Magin et al., 2010). With the data from this study as a baseline, a non-biological idealized model could be created to determine if the function of the scales can be utilized in drag reduction or applied to other areas within physics and engineering. This technology could be used in the development of a sensor that can be integrated into the anti-fouling skins that are currently being investigated. These sensors could provide vessels with a close-range "sniffing" sensor for an underway vessel that would allow for the detection of trace compounds, radioactive release, or other sampling applications. Depending on the functional mechanism of the superficial neuromast, this technology could also be used on a micro-level to restrict waves of undesirable frequencies, amplitudes, or from specific directions.

This study was primarily focused on determining the arrangement and function of the scales surrounding the superficial neuromast, but there is another aspect of the fluid-structure interaction, the cupula. The existence of a cupula in chondrichthians has been debated for some time however recent studies suggest that the cupula encases the hair cells and that the cupula is protected under the placoid scales (Peach & Marshall, 2009). If this cupula is found, then the size, shape, and flexural stiffness could aid in the illumination of the mechanism by which it is activated.

While fluid mechanical studies for chondrichthian cupulae do not exist, a recent study by McHenry et al. (2008) experimentally determined the fluid mechanics of the superficial neuromast in the zebrafish (*Danio rerio*). This information is relevant and applicable to Chondrichthyes; however, it does not account for the altered structure-fluid interaction that occurs in chondrichthians due to the presence of modified placoid scales surrounding the superficial neuromast.

The modified placoid scales that surround the superficial neuromast appear to protect the gelatinous cupula from non-relevant stimuli and at the same time alter the flow of the boundary layer to aid in detection of relevant stimuli. This agrees with

McHenry et al. (2008) who determined that the superficial neuromast of the zebrafish functions as a band-pass filter that relayed relevant stimuli to the brain within a specific range. This range is directly linked to the composition of the cupula, the number of kinocilia, and the length of the kinocilia. The variation in the previous three parameters are what determine the flexural stiffness of the cupula and hence the sensitivity of the superficial neuromast. While the composition and the fluid mechanics of the cupula in sharks is relevant to this study, it was determined that the focus of this study should be how the scales surrounding the superficial neuromast are positioned and how the scales function.

4.2 Future studies

The scope of the current study was limited due to equipment deficiencies, nevertheless, I laid the groundwork for future studies. One of the most consequential limitations in this study was the accuracy of the model. This problem could have been eliminated by using a three-dimensional scanner paired with a three-dimensional printer, with a 1.00 mm accuracy and only scaling the model up 10 times. This model could then be tested using a qualitative form of analysis called Digital Particle Image Velocimetry (DPIV). This would show a more accurate representation of what is happening where the fluid-structure interaction occurs in the boundary layer.

Processing samples for the scanning electron microscope has been noted to led to a distortion of the tissue surrounding the scales, however it was not noted to have affected the orientation of the scales. This can be seen when you compare the clearing and staining photograph (Figure 9) and the SEM micrograph (Figure 11). For future studies, this means that either method would be justified if the study was not directly affected by the loss of tissue integrity.

One of the more contested aspects of the superficial neuromast in sharks is the presence of a gelatinous cupula. To date only two studies have been conducted to show the presence and morphology of a gelatinous cupula in chondrichthians (Peach & Marshall, 2009; Tester & Nelson, 1967). The mechanism by which the superficial neuromast is activated cannot truly be understood until the morphology and composition of the cupula is determined. It was speculated at the beginning of this study that the cupula could be visualized using Periodic acid-Schiff's reaction staining to show the gelatinous cupula, but due to limitations in time and funding it was removed from the current study. Visualization of the cupula would be the first step in determining how the cupula functions. If the mechanical aspects of how the cupula functions could be determined and if the flow altering properties of the scales surrounding the superficial neuromasts were determined, then the exact mechanism of activation could be determined for the superficial neuromast.

In conclusion, this study lays the foundational work for the study of the scales surrounding the superficial neuromast of a common species, the bonnethead shark (*Sphyrna tiburo*). Here I presented three biologically relevant observations; the description of the modified basal plate of the scales just anterior and posterior to the superficial neuromast, the average angles of the scales directly surrounding the superficial neuromast, and that the superficial neuromast of the bonnethead shark does not vary significantly by side or sample location. I show that sex and maturity could influence the angles of the scales surrounding the superficial neuromasts. These observations will help further studies of the unique structures and functions of the shark neuromast by providing angular information for comparison, an analysis of the possible contributing factors to the observed variation, and the identification of a novel structure, the two basal plates that surround the superficial neuromast.

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APPENDICIES

APPENDIX 1. Shark catch data. All measurements are given in centimeters (cm).

Specimen Length Measurements					
Specimen	Total length	Fork Length	Posterior Dorsal to Caudal Peduncle	Last gill to peduncle	Mid-Pectoral to Peduncle
1	81	64.5	29.5	44	42
3	81.3	63.6	29.5	41	39.3
5	60.1	47.8	20.5	30.7	29.6
6	74	58.3	26.2	38.4	37.1
9	97.8	77.9	35.4	50.8	49.3
10	109.3	85.9	38.6	55.8	54.3
11	97.7	79.4	34.8	52.3	49.4
12	98.5	78.4	35.8	51.9	50.4
14	107.2	86.6	37.6	56.1	55
15	78.1	62	27.1	39.1	37.9
16	105.1	84.1	38.3	56.8	51.9
17	103.3	82	35.8	52.9	51.2
18	84	67.5	31.2	44.1	42.6
19	87.7	70.7	32.1	45.9	45.3
Average	90.4	72.1	32.3	47.1	45.4

Specimen Girth Measurements					
Specimen	Girth at gills	Girth anterior to Dorsal fin	Girth posterior to Dorsal fin	Girth at Peduncle	Head width/girth
1	23.5	25	26	11	13.5
3	21.9	23.1	22.4	9	13.2
5	18.2	20	17.9	7.6	10.6
6	21.1	22.2	21.2	8.1	11.8
9	29.3	32	30.4	11.9	15.5
10	30.9	35.1	35.3	12.8	16.7

11	28.9	32.3	30	11.7	15.3
12	28.9	30.9	29.9	12.3	15.6
14	32.4	39.4	36	13.6	16.6
15	22.2	24.8	22.8	9.5	12.9
16	34.3	38.4	36.1	13.1	16.3
17	32.9	36.5	35.3	12.6	15.6
18	22.3	26.9	25.8	10.9	13.5
19	22.7	25	25.3	10	13.1
Average	26.4	29.4	28.2	11.0	14.3

Specimen Fin Measurements and Sexual Maturity Data

Specimen	Caudal dorsal length	Caudal ventral length	Pectoral length (midline)	Dorsal length (leading edge)	Sex/ Clasper length	Oocytes/ Sperm
1	21.5	6.5	9	12	F	N
3	18.3	3.3	9	12	M/4	N
5	12.7	2.2	6.5	8.4	M/3	N
6	16.3	2.9	8.2	10.5	F	N
9	21.9	3.8	11.2	15.1	F	Y
10	22.7	4.6	13.4	17.3	F	Y
11	19.9	4.7	11.4	15.6	F	N
12	21	3.6	11	14.7	F	Y
14	23.2	4.8	13.4	17.5	F	Y
15	16.6	3.8	9.7	12.5	M/5.3	N
16	21.7	4.6	12.9	14.7	F	Y
17	22.7	4.5	13.3	16.8	F	Y
18	16.4	3.7	10.4	13.6	M/3.9	N
19	19.1	4	9.9	12.6	M/5.2	N
Average	19.6	4.1	10.7	13.8		

Specimen Collection Location and Method

Specimen	Source	Latitude	Longitude	Capture method

1	Local Fisherman PINS	NA	NA	Rod and Reel
3	TPWD Rockport	27-50-11	97-14-25	Gill net
5	TPWD Rockport	27-42-54	97-19-08	Gill net
6	TPWD Rockport	27-42-54	97-19-08	Gill net
9	TPWD Rockport	27-48-58	97-08-57	Gill net
10	TPWD Rockport	27-51-05	97-07-11	Gill net
11	TPWD Rockport	27-51-05	97-07-11	Gill net
12	TPWD Rockport	27-51-05	97-07-11	Gill net
14	TPWD Rockport	27-51-05	97-07-11	Gill net
15	TPWD Rockport	27-51-05	97-07-11	Gill net
16	TPWD Rockport	27-51-05	97-07-11	Gill net
17	TPWD Rockport	27-51-05	97-07-11	Gill net
18	TPWD Rockport	27-51-05	97-07-11	Gill net
19	TPWD Rockport	27-51-05	97-07-11	Gill net

Specimen Collection Water Conditions and Soak Time Data

Specimen	Water Temperature (Celcius)	Dissolved Oxygen (PPM)	Salinity (PPT)	Gill net - Start time	Gill net - End time	Date Captured
1	NA	NA	NA	NA	NA	NA
3	23.8	6.2	32.2	1923	722	4/30/13
5	22	6.2	34.6	1916	837	5/6/13
6	22	6.2	34.6	1916	837	5/6/13
9	22.3	6.4	33.2	1940	840	5/7/13
10	25.7	6.4	32.1	1910	853	5/15/13
11	25.7	6.4	32.1	1910	853	5/15/13
12	25.7	6.4	32.1	1910	853	5/15/13
14	25.7	6.4	32.1	1910	853	5/15/13
15	25.7	6.4	32.1	1910	853	5/15/13
16	25.7	6.4	32.1	1910	853	5/15/13
17	25.7	6.4	32.1	1910	853	5/15/13
18	25.7	6.4	32.1	1910	853	5/15/13
19	25.7	6.4	32.1	1910	853	5/15/13

APPENDIX 2. Scale angle data. All scale angles are given in degrees.

Shark 1 Lateral Scale Angles			
Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	17	-17.427
AD	L	12.423	-8.31
AD	L	19.456	-19.347
AD	R	7.765	-8.224
AD	R	12.063	-9.561
AD	R	7.872	-8.538
PV	L	11.414	-21.347
PV	L	10.469	-14.895
PV	L	9.494	-23.554
PV	R	22.883	-14.809
PV	R	21.231	-29.256
PV	R	24.924	-8.07
PD	L	15.462	-11.969
PD	L	17.885	-13.741
PD	L	28.166	-15.622
PD	R	10.551	-13.813
PD	R	23.787	-16.139
PD	R	21.306	-16.492

Shark 1 Anterior Scale Angles						
Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	16.348	13.383	3.781	-6.72	-15.024
AD	L	11.297	1.933	2.449	-0.736	-6.62
AD	L	9.473	2.469	-1.2	-3.873	-20.477
AD	R	6.215	1.795	-1.953	-3.155	-4.842
AD	R	4.012	4.592	0.58	-1.869	-3.424
AD	R	12.219	0.484	-4.112	-3.36	-2.519
PV	L	2.882	0.654	0.731	-8.272	-9.464
PV	L	10.876	1.297	-1.006	-5.189	-14.895
PV	L	5.098	3.166	-6.542	-16.05	-15.056
PV	R	4.651	2.592	-1.232	1.017	-6.185
PV	R	5.576	-3.979	-4.288	-7.341	-19.105
PV	R	7.068	-1.449	-0.998	-0.73	-6.596
PD	L	12.36	2.732	1.267	-1.437	-5.753
PD	L	15.277	11.558	8.671	4.822	-6.635
PD	L	9.171	6.952	1.684	-2.948	-8.058
PD	R	3.305	2.623	-2.642	-3.917	-15.889
PD	R	4.002	3.937	-0.927	-8.998	-14.597
PD	R	2.224	-4.711	-4.992	-5.273	-6.65

Shark 1 Posterior Scale Angles						
Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	9.099	5.5	2.201	-8.867	-12.675
AD	L	4.793	3.6	1.466	-9.266	-7.809
AD	L	5.56	2.629	0.033	-9.913	-17.709
AD	R	8.872	6.978	0.186	-8.731	-12.532
AD	R	12.232	6.239	1.4	-12.254	-11.622
AD	R	4.74	9.632	1.564	-9.36	-3.375
PV	L	5.518	4.494	-4.177	-7.86	-23.02
PV	L	6.072	6.072	3.69	-9.847	-13.097
PV	L	5.503	5.503	-2.384	-8.895	-11.876
PV	R	9.459	10.938	7.415	-9.365	-6.592
PV	R	13.93	10.835	1.588	-10.612	-16.995
PV	R	12.799	10.857	-4.695	-2.716	-9.629

PD	L	9.202	4.863	-2.249	-13.965	-11.042
PD	L	6.14	11.469	4.361	-0.81	-1.821
PD	L	4.91	2.014	-2.975	-11.906	-2.122
PD	R	4.043	0.894	-0.999	-2.176	2.136
PD	R	19.501	8.387	0	-5.153	6.705
PD	R	14.952	0.421	-1.276	-3.529	-12.23

Shark 1 Quarter 1 Scale Angles						
Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	-0.98	-3.616	-9.951	-16.78	0
AD	L	0.278	-4.444	-3.398	-0.815	-0.815
AD	L	-2.415	-1.806	-8.749	-5.588	-4.003
AD	R	-1.095	-5.714	-7.71	5.879	-1.184
AD	R	0.128	-1.964	-2.46	1.242	-1.378
AD	R	0.143	-3.573	-5.686	-3.722	-5.961
PV	L	-3.574	-3.223	-12.83	-16.859	-15.043
PV	L	-4.379	-4.46	-5.345	-4.178	-12.675
PV	L	-7.825	-11.746	-11.746	-6.794	-20.149
PV	R	2.721	-1.096	11.034	-0.633	-1.508
PV	R	2.687	-6.469	-10.454	-2.02	-5.91
PV	R	1.546	-1.935	2.532	8.164	-0.855
PD	L	0.564	-2.389	-1.437	-6.937	-1.039
PD	L	1.618	0.615	1.457	2.025	2.025
PD	L	-1.418	-0.66	-1.096	-2.079	-2.247
PD	R	0.166	-10.731	-6.79	-6.08	-6.602
PD	R	0.958	-2.607	-1.085	3.838	-2.528
PD	R	0.24	9.715	-7.208	-1.785	2.001

Shark 1 Quarter 2 Scale Angles						
Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-20.722	-17.971	-15.826	-13.585	-4.34
AD	L	-6.374	-6.554	-3.842	-5.126	-1.829
AD	L	-16.595	-12.076	-6.416	-8.031	-4.574
AD	R	-8.474	-13.553	-6.743	-2.95	2.607
AD	R	-5.675	-13.242	-11.322	-2.461	2.393
AD	R	-5.563	-2.458	-5.131	-6.229	2.777

PV	L	-21.337	-22.666	-20.951	-8.735	-4.585
PV	L	-15.416	-4.336	-4.249	-7.384	-0.689
PV	L	-19.367	-6.027	-3.527	-6.201	-1.941
PV	R	-6.649	5.971	-4.981	-2.669	2.744
PV	R	-19.234	-8.318	-1.912	-4.442	-5.026
PV	R	-1.554	6.892	-1.678	-1.699	3.212
PD	L	-6.98	-3.664	-1.437	6.553	-4.832
PD	L	0.811	-2.853	6.983	3.851	-2.236
PD	L	-7.742	-7.081	-5.447	-1.999	-1.987
PD	R	-3.631	-2.262	2.136	-4.211	-5.857
PD	R	1.205	-1.503	4.323	3.001	-1.806
PD	R	-2.486	-1.034	-1.108	2.049	4.825

Shark 1 Quarter 3 Scale Angles

Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	8.107	5.458	5.794	14.264
AD	L	3.313	4.079	5.959	5.8
AD	L	3.301	6.219	3.33	6.212
AD	R	6.201	3.9	11.124	5.117
AD	R	8.334	11.392	11.427	16.504
AD	R	10.11	8.136	-6.781	4.747
PV	L	1.558	0.893	-3.993	3.164
PV	L	4.584	5.7	1.87	1.496
PV	L	-2.685	2.828	-3.393	17.634
PV	R	11.45	4.69	4.416	4.468
PV	R	4.121	4.676	12.75	2.847
PV	R	12.577	17.925	2.335	2.383
PD	L	-3.245	-2.015	4.243	7.624
PD	L	6.057	3.173	6.617	3.898
PD	L	3.838	8.28	1.317	0.747
PD	R	2.907	8.181	6.132	4.455
PD	R	2.972	7.341	3.985	4.402
PD	R	1.221	1.182	14.476	3.932

Shark 1 Quarter 4 Scale Angles

Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4

AD	L	3.85	5.272	3.808	3.404
AD	L	8.727	7.659	5.83	4.496
AD	L	4.275	5.48	4.155	5.301
AD	R	5.675	6.524	-2.429	3.861
AD	R	19.921	10.651	8.666	5.697
AD	R	4.851	10.23	6.303	1.495
PV	L	0.386	-0.949	-2.773	-2.891
PV	L	5.518	-2.809	-3.235	-3.234
PV	L	12.756	1.278	-2.236	1.632
PV	R	7.908	4.312	2.096	1.524
PV	R	1.305	0.294	0.445	0.445
PV	R	7.506	4.752	0.535	-3.462
PD	L	2.107	0.718	1.09	0.415
PD	L	16.151	14.006	13.294	10.332
PD	L	0.844	0.844	2.045	5.959
PD	R	0.392	-0.8	2.77	5.153
PD	R	3.21	-1.809	-0.512	0.386
PD	R	4.327	2.711	4.146	9.181

Shark 3 Lateral Scale Angles

Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	22.316	-8.864
AD	L	6.637	-20.009
AD	L	19.617	-12.513
AD	R	33.535	-14.213
AD	R	36.552	-10.951
AD	R	24.97	-9.956
PV	L	25.79	-26.243
PV	L	29.581	-20.954
PV	L	30.903	-23.421
PV	R	19.093	-13.05
PV	R	18.837	-16.955
PV	R	12.023	-20.364
PD	L	48.338	-18.073
PD	L	32.367	-6.394
PD	L	32.123	-7.884
PD	R	30.892	-11.058

PD	R	28.81	-17.908
PD	R	17.067	-21.44

Shark 3 Anterior Scale Angles						
Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	24.262	12.723	7.619	6.493	-10.946
AD	L	-1.57	1.824	-0.276	-2.592	-12.94
AD	L	15.616	2.567	-0.221	-2.251	-7.091
AD	R	13.753	2.515	0.671	7.651	-8.408
AD	R	10.549	1.381	3.76	11.166	-6.904
AD	R	5.827	3.381	0.577	1.889	-6.155
PV	L	8.417	1.786	4.953	2.115	-0.881
PV	L	4.003	1.161	-4.695	-10.504	-4.379
PV	L	9.025	1.717	-2.314	-6.432	-0.876
PV	R	-1.064	-2.04	-2.705	-4.683	-4.387
PV	R	21.172	6.582	0.404	4.962	-12.646
PV	R	7.546	-1.688	-0.755	-1.2	-15.911
PD	L	22.494	-1.489	4.224	-1.336	-9.14
PD	L	10.118	-8.46	-5.395	-7.64	-11.8
PD	L	11.46	-7.594	-6.865	-9.165	-9.825
PD	R	13.474	10.607	5.59	9.582	-7.186
PD	R	10.189	1.036	-10.412	-7.802	-10.314
PD	R	16.352	-3.35	-0.924	-2.936	-4.045

Shark 3 Posterior Scale Angles						
Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	4.748	8.26	2.87	-9.889	-7.762
AD	L	-1.13	2.137	0.6	-2.648	-15.683
AD	L	6.105	3.896	-2.68	-6.229	-11.321
AD	R	14.926	10.227	5.404	4.251	-1.718
AD	R	26.241	18.336	11.405	7.852	11.514
AD	R	13.059	11.13	3.879	3.688	5.48
PV	L	14.286	11.661	6.299	-17.22	-19.375
PV	L	1.571	-2.683	-1.613	-4.648	-13.25
PV	L	8.324	6.237	5.691	-0.74	-6.958
PV	R	26.458	12.387	2.878	-10.169	-24.298

PV	R	11.09	12.699	2.174	-3.652	-2.711
PV	R	1.821	-1.388	-3.111	-9.584	-18.182
PD	L	1.233	-2.827	-1.695	-6.855	-6.981
PD	L	17.103	12.191	2.237	-1.372	-5.4
PD	L	15.169	11.812	0.357	-3.54	-8.399
PD	R	24.158	11.94	13.392	8.914	-6.644
PD	R	10.913	4.185	-2.107	-1.744	-2.493
PD	R	-4.95	4.367	-3.005	-2.56	-20.006

Shark 3 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	-2.932	2.202	-4.679	-0.282	-2.674
AD	L	-7.639	-7.182	-5.587	-12.531	-23.371
AD	L	0.524	-6.359	-2.62	-11.768	-17.699
AD	R	0.266	-1.784	3.347	-0.745	-2.19
AD	R	11.279	8.922	0.823	8.601	4.694
AD	R	4.164	5.409	-2.195	4.37	-0.81
PV	L	4.411	8.117	9.498	-1.03	0.662
PV	L	-3.38	-16.533	-7.025	-10.341	0.813
PV	L	-0.399	-14.112	-3.7	-6.975	-6.975
PV	R	-0.531	-6.17	-4.02	-4.568	-3.473
PV	R	-0.561	-7.879	-3.72	-4.585	-5.428
PV	R	-4.966	-5.805	-3.708	-8.264	-11.128
PD	L	-1.488	2.116	-0.847	1.891	2.318
PD	L	-1.071	-3.27	-3.189	-3.039	-4.663
PD	L	-2.198	-5.097	-7.386	-5.109	-14.956
PD	R	4.082	4.234	4.103	-8.46	-1.179
PD	R	-1.163	-7.165	-5.476	-11.893	-5.744
PD	R	-2.362	-3.85	-6.614	-7.826	-17.899

Shark 3 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-2.387	1.12	1.357	-3.601	-2.32
AD	L	-15.851	-14.438	-7.954	-5.065	0.777
AD	L	-18.324	-9.848	-6.194	-2.474	-1.585
AD	R	-3.904	7.034	10.628	8.831	3.005

AD	R	-5.878	3.739	7.998	3.742	8.389
AD	R	8.529	7.773	3.033	1.346	3.276
PV	L	-6.24	-22.646	-11.23	7.62	9.848
PV	L	0.813	-1.252	-1.216	-2.063	-6.907
PV	L	-0.412	7.628	-2.784	-1.495	-2.832
PV	R	-8.288	-6.425	7.247	5.013	1.685
PV	R	-5.014	-3.093	2.72	1.378	13.786
PV	R	-10.327	-15.632	-7.08	-12.792	-3.659
PD	L	1.348	1.052	-4.319	-4.373	1.768
PD	L	-1.48	-3.318	4.739	3.998	3.424
PD	L	-3.863	-5.46	-2.987	3.502	1.946
PD	R	-2.652	2.96	3.058	4.165	6.527
PD	R	-3.301	4.614	2.674	-3.487	-3.356
PD	R	-2.621	-0.431	1.581	-4.913	-4.129

Shark 3 Quarter 3 Scale Angles

Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	1.162	7.284	0.754	15.333
AD	L	6.241	-3.187	-2.171	-6.552
AD	L	-3.253	5.22	5.72	5.386
AD	R	10.028	15.173	5.99	3.654
AD	R	10.139	11.407	15.383	18.782
AD	R	3.457	3.077	21.873	15.219
PV	L	12.948	8.031	16.151	14.033
PV	L	-9.748	-4.651	-7.419	4.314
PV	L	1.506	1.506	0.923	11.371
PV	R	2.097	1.983	2.098	15.858
PV	R	6.277	1.791	0.689	0.627
PV	R	-3.639	-10.83	0.598	0.289
PD	L	8.498	2.003	1.082	0.96
PD	L	4.16	1.212	1.941	0.945
PD	L	3.719	-1.878	1.322	-1.437
PD	R	4.466	8.205	5.098	24.679
PD	R	5.758	4.058	9.511	12.924
PD	R	1.494	-4.003	-4.493	-4.899

Shark 3 Quarter 4 Scale Angles					
Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4
AD	L	13.807	3.502	4.775	1.965
AD	L	4.99	5.913	1.246	-1.476
AD	L	12.23	3.668	2.557	2.174
AD	R	7.19	8.769	6.053	1.712
AD	R	18.538	13.999	11.813	12.072
AD	R	12.541	9.569	9.155	9.727
PV	L	7.941	7.207	3.522	0.628
PV	L	0.693	-0.359	2.314	-2.964
PV	L	3.695	5.798	9.117	0.694
PV	R	5.207	3.328	1.607	1.167
PV	R	12.861	9.044	5.005	2.996
PV	R	0.438	-1.285	-3.818	4.981
PD	L	8.202	12.985	8.624	3.864
PD	L	6.616	11.961	2.517	1.157
PD	L	3.679	7.608	0.464	1.262
PD	R	14.82	2.979	13.499	9.581
PD	R	9.984	8.067	3.308	-3.157
PD	R	20.857	1.656	1.389	2.56

Shark 5 Lateral Scale Angles			
Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	35.68	-16.112
AD	L	16.255	-4.746
AD	L	12.493	-17.319
AD	R	13.173	-17.406
AD	R	12.206	-8.728
AD	R	19.347	-22.258
PV	L	22.426	-19.443
PV	L	23.824	-18.968
PV	L	16.268	-13.706
PV	R	14.597	-7.858
PV	R	16.16	-17.13
PV	R	34.624	-3.144
PD	L	5.963	-16.191
PD	L	35.864	1.84

PD	L	22.649	-16.227
PD	R	17.698	-21.169
PD	R	18.416	-7.779
PD	R	21.613	-8.833

Shark 5 Anterior Scale Angles						
Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	12.228	3.6	-8.266	-7.489	-9.789
AD	L	10.609	7.449	-7.455	-7.251	-7.312
AD	L	0.317	4.475	-2.477	2.391	-6.54
AD	R	12.529	2.734	0.597	-1.875	-5.367
AD	R	6.253	16.507	1.523	-4.482	-3.873
AD	R	24.735	7.099	0.9	-1.55	-21.471
PV	L	12.865	6.53	1.94	-2.595	-5.519
PV	L	12.809	0.832	-2.664	-1.711	-5.43
PV	L	13.831	0.917	-2.918	-2.043	-6.778
PV	R	15.923	7.866	2.258	-1.645	-2.321
PV	R	5.281	-4.304	-1.12	-2.778	-14.93
PV	R	16.432	2.292	4.755	-2.76	-4.279
PD	L	-19.36	4.229	2.908	-4.165	-3.602
PD	L	3.601	19.937	1.673	-1.477	-13.607
PD	L	15.814	2.811	1.843	3.119	2.178
PD	R	-5.803	1.224	3.812	-9.811	8.151
PD	R	12.2	-3.745	-3.299	-6.596	3.938
PD	R	4.295	4.179	3.382	-3.333	-5.665

Shark 5 Posterior Scale Angles						
Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	16.001	2.805	-0.972	-3.462	-10.466
AD	L	7.135	4.077	-1.679	-8.005	-20.12
AD	L	-4.922	2.114	-3.372	3.466	8.552
AD	R	7.153	2.49	-1.107	-4.191	-7.094
AD	R	17.12	5.543	7.509	3.986	-2.448
AD	R	8.929	-4.516	-2.406	-12.753	-10.253
PV	L	1.661	6.878	7.974	9.985	-8.411
PV	L	25.87	-2.477	-5.812	-11.976	-4.77
PV	L	24.476	1.837	-4.577	-12.195	-6.33
PV	R	21.713	3.713	5.725	-9.413	-13.105
PV	R	12.175	11.426	2.042	-2.822	1.217
PV	R	18.333	20.851	12.002	3.177	-9.117

PD	L	5.038	-8.854	-1.276	-9.949	-13.718
PD	L	13.762	7.012	-2.199	-4.704	-7.033
PD	L	3.886	3.135	-8.102	-11.001	-12.886
PD	R	26.453	1.445	-2.109	-2.266	4.592
PD	R	18.431	14.609	15.355	2.58	2.481
PD	R	13.166	15.551	-0.785	-8.324	-16.462

Shark 5 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	-2.745	-1.409	-8.194	-2.632	-3.104
AD	L	-6.901	-3.481	1.34	3.005	-1.575
AD	L	-2.167	-3.14	-13.628	-8.268	-8.673
AD	R	-1.225	-8.193	1.339	8.246	6.777
AD	R	14.887	13.992	9.252	12.086	11.651
AD	R	1.913	-2.673	1.727	-3.756	-2.536
PV	L	-2.379	-5.421	-5.737	-6.843	-11.647
PV	L	-6.88	-8.076	-7.65	2.611	-9.319
PV	L	-7.333	-7.715	-3.086	-6.35	-1.032
PV	R	1.583	-0.208	-1.356	-4.436	6.05
PV	R	-1.932	-7.528	2.563	3.244	-3.731
PV	R	2.846	0.536	-1.136	5.748	-7.67
PD	L	-3.553	-7.683	-11.613	2.584	4.017
PD	L	-3.256	1.771	4.085	-5.939	-0.993
PD	L	4.892	-1.288	2.523	3.528	-0.825
PD	R	1.388	3.444	17.313	5.936	3.755
PD	R	-0.578	-6.522	2.212	4.616	4.772
PD	R	-4.06	4.668	3.96	-6.518	-3.753

Shark 5 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-0.631	-0.865	-2.332	-1.919	-1.541
AD	L	-1.029	-0.995	3.742	-3.108	-2.02
AD	L	-0.871	4.048	-2.555	-3.378	-3.576
AD	R	9.169	10.081	5.194	-1.953	9.66
AD	R	10.596	7.92	14.75	5.5	4.781
AD	R	-5.911	-2.367	-2.855	3.107	1.804

PV	L	-5.922	-5.108	3.362	1.744	-1.5
PV	L	-1.471	-1.155	-7.258	-6.719	-6.836
PV	L	-2.962	-1.368	-13.885	-8.118	-12.816
PV	R	-1.172	3.646	3.451	7.608	2.109
PV	R	-2.001	4.508	7.081	1.791	1.134
PV	R	3.804	3.565	8.741	-7.309	8.953
PD	L	-8.548	-2.01	-2.631	-3.917	-4.104
PD	L	4.794	9.375	8.605	5.963	10.417
PD	L	-8.439	-1.05	-5.139	-3.178	4.749
PD	R	7.053	15.388	3.417	6.696	2.317
PD	R	-1.936	10.284	8.686	2.563	7.629
PD	R	2.553	4.05	11.035	7.171	4.664

Shark 5 Quarter 3 Scale Angles

Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	-4.943	-4.63	-1.186	17.271
AD	L	2.808	2.453	-2.802	9.528
AD	L	-3.488	1.609	2.629	3.002
AD	R	7.001	4.086	14.201	11.272
AD	R	7.72	17.989	8.408	15.236
AD	R	2.548	1.561	5.372	8.999
PV	L	-3.468	17.868	2.977	7.882
PV	L	-6.719	2.077	0.787	-5.725
PV	L	-8.171	-3.901	-1.746	-2.931
PV	R	1.427	19.599	9.395	5.793
PV	R	2.771	-3.06	17.935	9.944
PV	R	-1.383	11.101	12.775	6.133
PD	L	3.333	-11.804	5.242	5.717
PD	L	8.182	4.504	5.739	9.599
PD	L	5.575	4.059	4.2	5.413
PD	R	13.766	11.645	2.542	24.676
PD	R	3.068	5.412	-3.578	9.335
PD	R	1.856	1.089	2.036	3.547

Shark 5 Quarter 4 Scale Angles

Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4

AD	L	8.952	6.459	-0.902	2.52
AD	L	11.141	-8.028	4.918	0.466
AD	L	1.12	2.893	12.102	7.586
AD	R	11.86	12.025	13.636	6.244
AD	R	5.644	5.912	17.464	14.555
AD	R	5.331	6.873	2.792	7.818
PV	L	4.399	15.321	4.401	0.285
PV	L	-4.455	1.792	-4.644	-4.537
PV	L	2.219	-3.684	-1.741	-3.976
PV	R	23.943	14.388	12.489	4.774
PV	R	2.142	-1.508	1.951	-2.27
PV	R	-2.128	15.573	16.291	10.157
PD	L	-6.343	-4.05	-1.006	-8.197
PD	L	7.71	1.884	3.222	2.827
PD	L	3.735	3.246	6.729	3.521
PD	R	-2.122	-4.389	-1.432	1.951
PD	R	12.973	4.468	-6.722	-9.192
PD	R	-2.098	-1.915	-1.246	-0.966

Shark 6 Lateral Scale Angles

Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	13.557	-20.882
AD	L	18.653	-16.39
AD	L	12.575	-14.759
AD	R	12.726	-10.313
AD	R	7.364	-30.638
AD	R	10.421	-9.162
PV	L	15.915	-10.26
PV	L	20.708	-15.813
PV	L	18.917	-11.501
PV	R	15.971	-14.559
PV	R	13.767	-11.056
PV	R	14.589	-8.595
PD	L	29.897	-14.997
PD	L	29.582	-19.345
PD	L	5.422	-23.7
PD	R	22.653	-15.532

PD	R	9.893	-15.605
PD	R	18.867	-11.577

Shark 6 Anterior Scale Angles

Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	7.06	1.688	-3.361	-7.203	-17.263
AD	L	10.724	9.758	8.627	-10.081	-8.018
AD	L	1.495	-0.837	2.565	-5.592	-11.573
AD	R	14.692	-2.618	1.947	-2.054	-1.091
AD	R	0.997	-22.045	-14.636	-13.591	-18.179
AD	R	2.795	-2.783	-5.072	-2.467	-2.613
PV	L	6.261	-11.556	-12.632	-13.373	-16.091
PV	L	25.822	-2.383	1.232	2.552	-2.755
PV	L	6.09	7.416	9.844	12.883	-5.306
PV	R	-2.551	-8.766	4.906	-5.329	-5.191
PV	R	3.3	-4.675	-3.334	-13.21	-11.052
PV	R	7.856	-7.702	-2.97	-5.412	-17.755
PD	L	12.578	10.826	4.473	3.502	2.282
PD	L	10.324	5.198	-10.234	-9.741	-7.505
PD	L	-4.995	-8.378	-7.182	-13.515	-11.735
PD	R	12.057	-1.749	9.13	6.349	-20.235
PD	R	13.791	0.394	-4.622	-12.137	-12.941
PD	R	15.444	7.411	6.911	3.871	2.099

Shark 6 Posterior Scale Angles

Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	4.747	1.076	-8.146	-11.647	-8.615
AD	L	13	11.049	-7.56	-12.875	-3.763
AD	L	8.7	1.822	-1.474	-1.32	-17.516
AD	R	5.543	7.595	-4.043	-2.937	-8.008
AD	R	-2.84	2.792	-2.238	-18.017	-24.779
AD	R	-4.064	5.96	1.972	2.846	-6.949
PV	L	2.626	-3.144	-11.92	-20.726	-15.06
PV	L	4.193	2.161	-1.736	-2.07	-14.918
PV	L	21.952	5.185	-7.834	-6.997	-13.676
PV	R	-2.587	-5.034	1.715	3.712	-5.68

PV	R	1.005	-2.509	-6.018	-1.943	-10.461
PV	R	-3.25	1.259	4.279	4.724	2.43
PD	L	20.791	14.963	14.392	-15.147	-4.697
PD	L	16.805	14.113	6.163	-4.391	-10.03
PD	L	8.096	-7.361	-11.164	-23.36	-17.559
PD	R	2.95	-3.697	0.976	-4.48	-8.923
PD	R	10.19	-3.914	-4.237	-2.679	-7.236
PD	R	6.546	16.477	0	-3.883	-11.539

Shark 6 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	-7.636	-4.43	-2.774	-3.758	-3.895
AD	L	5.262	5.829	-3.659	-4.517	3.347
AD	L	-3.561	-4.36	-5.15	-10.471	-12.401
AD	R	6.503	-2.92	12.229	7.33	-2.724
AD	R	-16.765	-7.759	-6.007	-8.771	-13.177
AD	R	4.568	2.19	5.711	4.239	0.526
PV	L	-23.628	-13.899	-16.402	-13.424	-15.932
PV	L	1.612	-0.994	-2.153	2.296	3.429
PV	L	3.747	1.918	-0.723	-2.626	-8.253
PV	R	4.542	4.505	-8.054	-5.575	-1.871
PV	R	-2.609	-5.467	-4.725	-4.726	-6.446
PV	R	-12.572	-2.609	-5.313	-9.391	-2.389
PD	L	2.706	1.745	2.701	-1.12	1.625
PD	L	-14.573	2.039	-4.493	-12.452	-7.328
PD	L	-9.381	-11.723	-13.818	-17.266	-25.29
PD	R	-0.781	6.732	4.157	3.969	-4.212
PD	R	-3.859	-7.049	-19.49	-12.695	-2.803
PD	R	0.864	-1.621	-1.338	-3.493	1.621

Shark 6 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-14.146	-8.432	-9.175	-2.046	-3.408
AD	L	-1.979	-1.492	-5.095	-3.3	7.661
AD	L	-13.31	-11.002	-1.084	-2.038	-2.698
AD	R	-4.367	-3.052	-5.708	-3.43	11.011

AD	R	-11.321	-18.008	-6.192	-7.187	-5.757
AD	R	-12.164	-2.936	7.772	10.114	-3.849
PV	L	-1.634	-8.131	-18.085	-14.386	-11.27
PV	L	-6.491	-6.745	3.508	-2.789	-1.642
PV	L	-4.368	-4.819	10.138	8.196	4.963
PV	R	-2.049	-3.45	2.159	5.492	9.332
PV	R	-4.934	-4.098	-6.044	-1.139	-3.373
PV	R	-2.521	1.977	-4.199	-2.785	-3.334
PD	L	-15.02	10.862	2.902	6.816	2.918
PD	L	-9.718	-12.04	-19.203	-11.852	-10.162
PD	L	-18.811	-10.054	-11.2	-8.271	-11.256
PD	R	-12.714	-6.954	-6.618	5.24	2.747
PD	R	-5.16	-8.349	-8.36	-6.932	-8.153
PD	R	-4.717	-8.23	-10.413	-9.125	4.792

Shark 6 Quarter 3 Scale Angles

Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	-4.035	1.583	-3.667	3.391
AD	L	1.436	9.347	5.89	10.373
AD	L	2.175	9.691	2.698	6.223
AD	R	-3.207	3.635	-5.189	4.448
AD	R	3.203	4.59	-11.065	-13.257
AD	R	1.318	10.252	1.954	8.787
PV	L	-12.598	-15.828	-10.896	-5.131
PV	L	3.004	13.235	10.385	15.799
PV	L	5.767	10.222	10.28	14.469
PV	R	-3.375	-3.194	1.713	3.271
PV	R	-3.421	-3.337	1.112	-1.992
PV	R	3.445	7.867	3.359	1.193
PD	L	12.325	10.453	4.566	1.543
PD	L	-3.466	6.396	19.212	6.719
PD	L	-9.268	-13.511	-9.612	-3.432
PD	R	-4.002	-2.153	2.957	4.369
PD	R	-6.853	4.691	1.933	-2.02
PD	R	10.33	7.153	5.01	2.588

Shark 6 Quarter 4 Scale Angles					
Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4
AD	L	6.315	4.619	4.312	-5.04
AD	L	9.443	4.781	7.486	4.184
AD	L	4.008	-1.639	-1.44	-2.787
AD	R	1.824	6.891	7.657	-2.587
AD	R	-13.201	-15.166	-14.145	-16.616
AD	R	5.475	3.988	6.484	-4.665
PV	L	8.339	-11.134	-3.339	-9.946
PV	L	12.745	1.19	6.294	-1.695
PV	L	4.593	5.809	7.069	7.309
PV	R	0.725	10.236	2.152	-3.292
PV	R	-3.517	-3.041	-3.257	-6.257
PV	R	9.736	2.302	4.128	2.3
PD	L	4.24	-5.939	2.613	3.389
PD	L	9.382	4.784	1.584	-6.937
PD	L	-4.542	5.854	3.218	1.758
PD	R	5.439	2.885	-7.669	-3.136
PD	R	-2.02	7.715	1.92	-4.717
PD	R	4.912	2.228	0.256	-3.932

Shark 9 Lateral Scale Angles			
Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	15.558	-7.813
AD	L	16.353	-18.335
AD	L	21.386	-16.524
AD	R	12.309	-11.956
AD	R	21.508	-18.391
AD	R	14.869	-37.756
PV	L	18.625	-19.237
PV	L	14.668	-27.489
PV	L	26.908	-26.602
PV	R	24.979	-22.082
PV	R	23.202	-12.774
PV	R	23.378	-16.456
PD	L	4.704	-14.655
PD	L	23.739	-25.62

PD	L	24.6	-15.58
PD	R	23.251	-23.281
PD	R	15.763	-21.585
PD	R	7.014	-4.69

Shark 9 Anterior Scale Angles

Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	14.245	3.798	2.377	-7.344	-10.284
AD	L	22.66	9.262	8.559	7.505	-17.218
AD	L	3.597	1.779	1.585	-1.369	-3.416
AD	R	3.961	0.76	3.054	6.097	2.972
AD	R	19.468	10.654	3.004	-1.721	2.843
AD	R	6.79	4.891	-1.429	-8.974	-17.889
PV	L	17.763	17.263	5.239	4.937	-11.315
PV	L	2.771	-3.405	-5.088	-16.14	-11.94
PV	L	20.412	14.953	8.867	5.953	-15.398
PV	R	3.906	-6.416	1.81	-2.264	-1.304
PV	R	14.55	15.194	7.852	-3.293	-8.847
PV	R	7.062	-1.667	-2.803	-3.385	-10.215
PD	L	16.457	11.721	-5.499	-7.119	-7.155
PD	L	14.4	5.925	1.979	-1.795	-11.409
PD	L	21.285	2.994	-5.098	-7.065	-14.466
PD	R	9.055	5.014	-3.769	-4.718	-5.657
PD	R	4.453	0.886	-1.872	-2.422	-5.791
PD	R	4.181	-0.951	1.183	-4.945	-3.727

Shark 9 Posterior Scale Angles

Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	17.353	7.184	11.767	-8.483	-12.409
AD	L	7.06	4.823	6.763	-6.654	-3.63
AD	L	3.384	1.39	4.631	-14.589	-14.669
AD	R	9.195	11.76	-5.466	-9.721	-8.912
AD	R	12.654	21.876	6.663	7.314	3.004
AD	R	11.411	3.12	-3.808	-11.342	-15.6
PV	L	10.594	6.393	10.998	-3.209	-7.997
PV	L	1.771	3.053	2.27	-13.907	-12.244
PV	L	11.6	6.936	4.687	-1.798	-6.184
PV	R	20.655	5.726	-4.993	-4.261	-12.48
PV	R	14.818	13.548	2.407	-0.806	-9.806
PV	R	9.053	1.526	-2.878	-4.737	-6.667

PD	L	0.994	4.106	1.817	-6.795	-10.567
PD	L	4.145	13.966	-1.455	-5.388	-8.03
PD	L	16.293	5.509	-1.167	-3.295	-7.178
PD	R	10.419	5.002	1.653	2.614	-13.642
PD	R	12.984	14.529	3.498	-1.913	-18.265
PD	R	13.784	4.54	1.893	-4.258	-7.924

Shark 9 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	7.526	-0.878	-2.897	-3.453	-1.758
AD	L	2.983	7.203	6.342	4.457	3.719
AD	L	1.158	3.988	3.299	2.067	4.047
AD	R	1.748	0.725	-5.138	-7.983	-11.914
AD	R	2.611	2.739	14.282	6.659	2.358
AD	R	-0.699	-4.636	-7.734	-8.325	-12.488
PV	L	4.359	4.874	3.13	3.946	-13.043
PV	L	-2.304	-2.465	-5.693	-7.429	-12.096
PV	L	1.867	7.728	6.371	-2.731	5.216
PV	R	1.173	-0.356	-1.194	1.216	1.215
PV	R	6.307	3.433	2.804	-1.943	-6.431
PV	R	-6.495	-1.316	-3.545	-4.26	-0.943
PD	L	-2.995	-4.376	-4.138	-5.21	-6.137
PD	L	-2.864	-3.106	-1.912	6.501	0.617
PD	L	-3.852	-10.308	-11.982	-7.077	-4.834
PD	R	0.682	-3.077	-4.948	-2.652	-2.707
PD	R	-0.468	-3.322	-3.596	-4.326	-4.304
PD	R	4.56	-3.582	-1.898	1.29	0.62

Shark 9 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-5.355	2.603	1.939	-2.557	-2.159
AD	L	-5.101	2.959	-1.208	3.322	4.217
AD	L	1.644	-3.775	-4.015	4.851	-1.95
AD	R	-5.601	-4.869	-1.398	-5.515	5.01
AD	R	2.549	3.683	7.089	10.451	9.238
AD	R	-8.451	-10.046	-5.943	-2.268	-1.786

PV	L	-3.46	-3.076	-6.983	5.87	-2.7
PV	L	-4.764	-1.381	-3.806	-1.232	-2.311
PV	L	-0.905	8.275	-1.257	5.918	4.164
PV	R	-1.202	-3.305	-5.565	2.283	-3.858
PV	R	7.486	6.178	9.028	7.796	5.192
PV	R	-4.591	-2.596	-9.44	-5.394	-7.204
PD	L	-8.417	-9.991	-7.106	-5.2	-4.098
PD	L	-5.004	-1.769	-5.903	5.488	-2.417
PD	L	-3.251	-2.365	0.711	2.354	4.315
PD	R	-13.818	2.921	7.164	-1.564	3.103
PD	R	-4.233	-3.303	1.939	3.581	7.389
PD	R	1.495	-4.39	1.351	-3.209	-3.294

Shark 9 Quarter 3 Scale Angles

Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	7.87	2.827	11.007	9.623
AD	L	5.936	9.436	8.528	8.071
AD	L	2.018	1.814	7.593	9.612
AD	R	5.742	2.376	6.705	6.557
AD	R	2.51	8.5	6.608	22.068
AD	R	3.097	4.442	1.59	14.651
PV	L	1.422	3.636	9.247	6.357
PV	L	0.806	2.385	3.387	1.145
PV	L	1.031	6.768	12.322	12.291
PV	R	2.984	3.425	-2.869	5.503
PV	R	11.414	9.923	13.872	9.028
PV	R	5.925	3.798	4.31	12.459
PD	L	-2.583	-1.702	1.468	1.087
PD	L	-3.406	7.711	4.534	1.787
PD	L	3.34	-3.176	11.036	17.721
PD	R	3.369	9.947	11.782	7.601
PD	R	2.963	9.894	8.579	9.877
PD	R	1.122	8.481	8.926	4.372

Shark 9 Quarter 4 Scale Angles

Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4

AD	L	7.747	8.322	3.934	2.422
AD	L	8.365	7.06	1.186	0.374
AD	L	8.7	2.867	4.017	4.505
AD	R	6.447	-5.819	-4.909	0.693
AD	R	19.135	7.648	7.692	7.521
AD	R	12.662	1.391	1.822	1.174
PV	L	5.87	7.338	16.805	12.018
PV	L	4.08	6.206	2.238	0.922
PV	L	9.455	7.099	13.682	13.374
PV	R	-2.73	3.489	2.781	-1.834
PV	R	15.128	11.768	12.436	11.517
PV	R	9.84	7.178	2.848	1.674
PD	L	4.275	3.621	5.723	4.435
PD	L	2.648	-3.398	-3.836	-7.482
PD	L	10.442	3.022	3.343	0.762
PD	R	10.235	6.459	8.904	4.214
PD	R	5.052	10.032	1.89	1.179
PD	R	6.79	4.577	-2.24	6.018

Shark 10 Lateral Scale Angles

Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	12.562	-20.612
AD	L	19.687	-16.105
AD	L	8.303	-9.874
AD	R	23.994	-16.553
AD	R	20.586	-28.683
AD	R	10.367	-15.21
PV	L	28.36	-18.033
PV	L	20.973	-29.691
PV	L	22.067	-19.164
PV	R	7.865	-38.126
PV	R	29.487	-15.67
PV	R	37.089	-38.908
PD	L	24.279	-21.675
PD	L	21.269	-19.442
PD	L	27.736	-19.662
PD	R	17.968	-10.361

PD	R	16.021	-28.164
PD	R	19.669	-29.985

Shark 10 Anterior Scale Angles						
Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	6.399	3.971	4.629	-5.405	-10.017
AD	L	19.136	14.941	6.416	3.283	-7.916
AD	L	11.846	7.74	1.753	-2.669	-9.504
AD	R	14.009	-1.442	-1.807	-3.695	-9.808
AD	R	2.23	5.549	-3.285	-8.021	-17.983
AD	R	1.88	-2.559	-7.071	-10.002	-15.838
PV	L	29.398	7.789	9.881	7.157	-18.949
PV	L	13.009	2.005	0.801	-8.852	-9.361
PV	L	10.936	1.632	0.635	-14.997	-19.164
PV	R	0.523	-3.417	-8.078	-6.72	-7.338
PV	R	8.146	2.637	4.573	-2.305	-12.812
PV	R	4.144	0.975	-1.19	-16.826	-16.386
PD	L	9.523	9.139	6.839	2.928	1.332
PD	L	23.144	7.878	-3.464	-3.334	-0.655
PD	L	8.331	9.665	0.934	-1.105	-6.297
PD	R	6.959	1.297	2.691	1.823	2.246
PD	R	22.337	15.253	-0.834	-1.858	-2.588
PD	R	15.297	8.437	8.437	-10.548	-19.693

Shark 10 Posterior Scale Angles						
Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	22.838	-2.221	-3.988	-2.823	-3.624
AD	L	24.73	8.717	9.116	-2.933	-1.528
AD	L	3.152	2.807	-2.545	-2.72	-1.766
AD	R	3.539	1.863	1.635	-3.624	-3.232
AD	R	-3.006	-1.762	-3.252	-2.599	-18.278
AD	R	26.445	3.875	1.127	-0.859	-0.673
PV	L	9.126	1.956	3.541	-0.87	-2.329
PV	L	12.924	3.547	8.062	-6.004	-4.751
PV	L	9.378	6.207	4.686	-1.639	-9.368
PV	R	9.271	-2.506	-3.48	-3.29	-10.77

PV	R	17.213	-3.056	-1.324	-4.513	-3.316
PV	R	16.602	15.244	1.665	-9.269	-10.548
PD	L	10.301	5.31	3.494	-2.115	3.897
PD	L	2.74	-1.821	-1.837	-1.497	-2.185
PD	L	7.032	4.62	3.275	-2.391	-1.045
PD	R	6.139	6.817	9.347	3.712	-7.586
PD	R	3.377	2.192	-0.595	-2.412	-4.837
PD	R	13.329	9.319	4.746	-1.225	-10.409

Shark 10 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	-2.765	-2.914	-3.865	-3.036	-7.182
AD	L	0.857	-0.309	0.986	-6.484	-10.082
AD	L	-1.067	-4.237	-7.151	-9.909	-3.896
AD	R	-1.618	-1.942	-8.222	-8.128	-12.334
AD	R	-3.999	-7.251	-9.179	-9.704	-10.253
AD	R	-1.604	-4.375	-4.388	-9.734	-9.243
PV	L	-0.537	9.507	1.709	-6.81	-5.787
PV	L	1.912	-0.732	-3.179	-10.585	-18.158
PV	L	-3.173	-3.022	-0.623	1.899	-6.082
PV	R	-9.811	-7.604	-6.646	-14.768	-6.168
PV	R	-1.402	-5.751	-1.96	-5.898	-2.489
PV	R	6.787	1.679	-2.09	-13.378	-11.708
PD	L	7.104	4.504	-1.141	5.413	3.278
PD	L	-2.716	-1.168	2.984	5.692	12.054
PD	L	0.953	4.002	-1.875	-2.536	-6.543
PD	R	1.452	1.188	-0.996	7.01	6.338
PD	R	-1.348	-2.144	-2.261	-1.897	-12.812
PD	R	3.124	-4.536	-7.837	-5.6	-13.157

Shark 10 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-3.76	-2.023	-3.776	2.739	-3.066
AD	L	-3.099	-2.905	-1.198	1.887	-2.586
AD	L	3.005	0.489	3.806	5.638	3.784
AD	R	-12.334	3.161	1.55	-2.556	2.27

AD	R	-11.283	-5.091	-5.506	-3.517	-4.899
AD	R	-7.504	1.813	-1.454	-2.587	-4.655
PV	L	-6.087	-2.805	-0.46	-1.003	7.685
PV	L	-13.522	-1.676	2.859	6.448	8.497
PV	L	1.709	4.107	-2.884	8.917	6.135
PV	R	-6.168	-5.184	-3.984	-5.697	-2.691
PV	R	-1.914	-1.533	-0.887	-3.398	-2.711
PV	R	-2.16	-3.674	2.226	-4.219	2.696
PD	L	-2.679	6.934	2.099	-2.803	10.462
PD	L	-3.835	-4.443	4.792	3.765	4.753
PD	L	-0.327	-1.251	-6.286	5.742	7.027
PD	R	-1.369	-4.149	-2.399	11.528	4.704
PD	R	2.138	-1.236	3.799	4.728	2.737
PD	R	-19.602	-8.397	-1.307	9.076	3.757

Shark 10 Quarter 3 Scale Angles					
Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	4.048	2.591	2.129	1.89
AD	L	1.804	4.518	4.206	11.456
AD	L	2.171	-1.957	1.009	-1.52
AD	R	-4.171	4.678	10.028	9.982
AD	R	-1.913	0.834	1.936	4.743
AD	R	8.895	15.528	15.865	7.729
PV	L	3.628	2.625	6.239	14.794
PV	L	9.473	15.131	3.659	3.165
PV	L	4.757	4.369	9.223	4.825
PV	R	2.078	-2.752	2.299	5.205
PV	R	1.51	-4.253	4.012	7.406
PV	R	5.675	7.87	7.966	12.547
PD	L	2.517	8.365	5.492	6.211
PD	L	5.335	4.6	4.743	2.579
PD	L	3.746	4.194	7.032	6.221
PD	R	3.491	8.874	3.141	2.548
PD	R	3.388	3.18	8.166	5.95
PD	R	3.683	8.607	6.172	5.789

Shark 10 Quarter 4 Scale Angles					
Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4
AD	L	11.661	15.152	13.034	5.615
AD	L	13.907	8.074	6.033	-1.616
AD	L	1.727	3.137	6.409	3.793
AD	R	11.617	10.492	7.598	4.024
AD	R	-3.445	2.859	2.417	1.164
AD	R	18.106	2.782	1.649	-1.937
PV	L	9.751	6.072	15.066	2.355
PV	L	6.358	5.889	8.991	3.095
PV	L	4.609	6.747	3.636	0.743
PV	R	4.263	0.937	0.806	-4.195
PV	R	3.653	6.19	7.592	2.376
PV	R	6.995	4.113	3.463	-2.868
PD	L	8.695	14.833	4.179	9.139
PD	L	1.295	12.271	13.146	1.374
PD	L	4.327	5.787	5.787	6.788
PD	R	4.413	14.199	10.397	4.767
PD	R	4.069	12.426	9.144	2.521
PD	R	13.244	7.535	4.217	6.512

Shark 11 Lateral Scale Angles			
Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	21.438	-13.274
AD	L	3.176	-18.43
AD	L	19.504	-12.834
AD	R	24.864	-14.578
AD	R	17.212	-7.659
AD	R	13.23	-13.567
PV	L	0.917	-18.2
PV	L	24.639	-13.99
PV	L	10.44	-16.479
PV	R	20.385	-16.436
PV	R	16.913	-15.834
PV	R	-3.854	-21.684
PD	L	16.948	-20.867
PD	L	21.873	-13.811

PD	L	19.895	-21.208
PD	R	19.037	-17.586
PD	R	13.468	-17.841
PD	R	18.973	-19.834

Shark 11 Anterior Scale Angles						
Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	13.556	3.637	1.471	-7.255	-9.277
AD	L	1.38	-2.907	-1.455	-3.339	-2.297
AD	L	10.809	0.778	2.219	-3.482	-6.347
AD	R	1.726	5.655	4.903	2.59	-3.74
AD	R	10.284	1.779	-1.249	-7.49	-7.474
AD	R	1.215	-1.091	0.996	-1.019	-1.875
PV	L	6.044	0.628	-0.512	-1.167	-2.491
PV	L	11.785	5.689	-0.439	1.684	-1.243
PV	L	12.323	-3.825	-10.753	-8.984	-23.746
PV	R	10.964	3.22	-2.425	-1.223	-8.435
PV	R	4.949	1.123	-6.798	-11.296	-12.363
PV	R	-3.224	-3.773	-4.862	-10.986	-26.888
PD	L	8.18	8.112	1.089	-10.903	-11.397
PD	L	9.867	-4.834	-2.232	-12.522	-8.131
PD	L	5.665	-2.983	-0.981	-9.03	-7.585
PD	R	33.713	1.562	2.631	-1.311	-9.346
PD	R	7.011	5.958	-5.804	-2.29	-2.177
PD	R	8.854	2.529	1.165	1.652	-5.941

Shark 11 Posterior Scale Angles						
Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	-5.909	4.396	5.213	-5.648	-13.087
AD	L	3.176	4.108	-0.883	-7.104	-4.213
AD	L	2.29	5.985	4.17	1.187	9.882
AD	R	20.343	5.069	-3.717	-7.321	-13.26
AD	R	-3.79	16.153	10.522	-4.884	-4.207
AD	R	10.639	2.424	3.553	-7.198	-2.538
PV	L	2.016	2.71	1.745	-7.402	-7.402
PV	L	14.388	13.823	7.792	-7.161	-8.478
PV	L	2.804	-3.002	-1.944	-8.247	-8.106
PV	R	15.316	9.127	1.638	-3.515	-14.82
PV	R	2.007	1.849	0.983	5.88	1.045
PV	R	16.132	-3.072	-2.309	-5.059	-2.603

PD	L	9.397	-1.907	-3.646	-5.888	-6.654
PD	L	5.103	1.296	2.305	-1.567	-3.307
PD	L	-1.977	-0.856	-2.09	-0.949	-3.254
PD	R	14.143	3.133	2.142	1.315	-8.886
PD	R	2.168	-0.757	-2.122	-17.728	-21.438
PD	R	4.298	4.328	1.042	-6.731	-7.135

Shark 11 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	-0.683	7.445	-0.887	-6.682	-18.47
AD	L	-4.273	7.838	4.838	2.006	-3.393
AD	L	-8.249	-6.278	-2.803	-2.768	-2.674
AD	R	-0.682	-2.922	-2.918	-3.775	-2.93
AD	R	1.103	1.473	-1.482	-2.079	2.11
AD	R	-2.012	-1.316	3.009	-0.684	-7.431
PV	L	-0.756	-2.012	-1.34	-1.476	-6.078
PV	L	-0.727	-1.708	-0.95	-3.385	-4.728
PV	L	0.944	-4.423	-10.13	-7.882	-1.793
PV	R	2.526	-1.496	1.538	-2.088	2.768
PV	R	-3.682	-5.313	-7.63	-1.566	-8.349
PV	R	-0.953	-4.235	-3.986	-11.227	-18.13
PD	L	2.081	-1.393	-2.584	-9.322	-10.838
PD	L	-3.074	-3.93	-2.612	-4.062	-5.374
PD	L	1.769	-0.829	-0.926	-3.429	-5.046
PD	R	2.905	-3.011	-1.981	-2.742	-3.919
PD	R	-1.409	-1.342	0.707	2.054	-4.273
PD	R	-0.848	0.884	2.29	-3.218	-2.531

Shark 11 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-2.392	-12.894	-5.592	12.787	7.485
AD	L	-4.266	2.831	-3.066	-3.518	-1.559
AD	L	3.236	8.493	2.204	-3.194	-4.164
AD	R	4.755	6.224	13.183	2.901	3.631
AD	R	-1.799	-8.746	8.461	8.243	10.112
AD	R	-4.222	-4.908	-4.892	-1.534	-2.499

PV	L	-8.599	-16.457	-14.952	4.462	3.018
PV	L	-4.728	-4.691	-13.207	3.122	3.354
PV	L	1.595	-3.654	1.6	-1.085	1.287
PV	R	-9.796	-4.582	-5.113	-2.649	-1.47
PV	R	-6.575	3.329	-4.011	-3.064	-1.962
PV	R	-9.618	-14.494	-3.751	-6.555	5.248
PD	L	-2.877	-1.572	-3.343	-5.512	-4.602
PD	L	-4.206	-5.302	-2.672	-1.958	3.121
PD	L	-3.134	-5.297	-2.788	-4.421	-1.89
PD	R	-6.507	4.08	3.14	4.196	5.471
PD	R	-9.518	-7.364	-7.104	-3.9	2.338
PD	R	-3.683	-14.581	3.021	3.715	-1.861

Shark 11 Quarter 3 Scale Angles

Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	3.564	2.257	-1.731	7.264
AD	L	2.605	-1.231	-3.811	-1.502
AD	L	3.575	2.378	-0.882	5.971
AD	R	2.179	-1.203	9.633	3.494
AD	R	2.548	7.712	7.605	1.957
AD	R	1.258	2.37	3.02	0.93
PV	L	1.98	17.405	1.881	6.315
PV	L	4.297	2.227	6.161	24.232
PV	L	2.966	-1.157	1.181	9.402
PV	R	3.43	3.363	5.732	7.822
PV	R	-2.736	7.532	4.782	19.544
PV	R	-2.355	-3.794	-6.009	-1.981
PD	L	-4.015	-2.043	1.168	2.291
PD	L	3.165	-2.037	1.011	2.671
PD	L	-2.452	-3.324	-2.479	-5.834
PD	R	1.219	2.797	3.527	6.048
PD	R	3.442	7.613	2.168	1.892
PD	R	1.388	5.185	2.602	13.742

Shark 11 Quarter 4 Scale Angles

Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4

AD	L	7.19	5.966	1.669	0.553
AD	L	-6.825	1.637	1.245	0.498
AD	L	6.367	1.819	0.541	-4.157
AD	R	3.494	3.831	2.551	2.791
AD	R	3.996	3.366	9.187	5.052
AD	R	6.64	2.725	4.078	2.3
PV	L	5.129	3.967	-5.247	1.34
PV	L	19.139	16.997	11.56	4.712
PV	L	10.405	12.198	5.146	3.684
PV	R	9.164	16.239	9.817	6.953
PV	R	7.839	0.967	-3.842	-1.488
PV	R	-5.729	-2.348	-3.756	-4.279
PD	L	3.119	1.983	-2.133	2.126
PD	L	9.08	5.317	4.81	0.672
PD	L	-4.674	-3.328	1.158	2.839
PD	R	3.211	8.689	3.396	13.504
PD	R	3.303	3.543	2.71	3.109
PD	R	2.543	2.674	1.619	1.995

Shark 12 Lateral Scale Angles

Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	13.781	-17.519
AD	L	9.192	-8.52
AD	L	14.056	-13.626
AD	R	12.596	-30.417
AD	R	23.687	-20.6678
AD	R	12.355	-8.767
PV	L	13.577	-14.92
PV	L	18.998	-17.549
PV	L	19.283	-23.534
PV	R	11.521	-9.474
PV	R	17.584	-22.682
PV	R	17.465	-22.992
PD	L	21.966	-17.474
PD	L	26.8	-15.175
PD	L	22.345	-23.62
PD	R	18.615	-11.578

PD	R	21.486	-18.274
PD	R	20.788	-23.475

Shark 12 Anterior Scale Angles						
Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	14.33	1.394	0.675	-1.484	-4.174
AD	L	9.394	4.022	13.169	11.494	-8.52
AD	L	19.929	4.559	-0.716	-0.981	-7.334
AD	R	15.432	7.494	-0.842	-4.058	-7.425
AD	R	6.606	3.371	1.452	2.21	-5.409
AD	R	5.97	3.029	-2.191	-10.249	-14.184
PV	L	10.047	1.838	0.707	-1.812	-18.478
PV	L	2.423	1.772	-0.568	-3.451	-6.868
PV	L	16.365	3.342	-5.592	-2.577	-8.031
PV	R	5.148	4.996	2.382	0.933	-2.839
PV	R	2.499	5.719	-3.063	-3.677	-5.65
PV	R	2.379	1.852	2.121	2.132	-2.07
PD	L	9.042	3.793	6.513	5.645	1.287
PD	L	2.415	-1.895	-3.869	1.993	0.837
PD	L	14.034	-1.15	0.631	-1.132	-10.012
PD	R	1.292	9.939	5.56	5.853	-6.723
PD	R	15.28	-1.741	-0.8	-1.886	-6.333
PD	R	5.557	-1.742	-1.114	-16.432	-14.205

Shark 12 Posterior Scale Angles						
Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	6.916	3.142	2.138	-1.055	-17.553
AD	L	5.245	3.215	-2.295	-12.26	-12.382
AD	L	6.608	2.205	-7.339	-12.867	-14.957
AD	R	9.759	-2.046	-4.343	-8.866	-24.082
AD	R	17.098	9.982	-3.019	-16.107	-22.313
AD	R	2.987	-2.497	-6.076	-10.283	-7.765
PV	L	5.454	1.469	4.946	-7.972	-14.92
PV	L	16.315	12.729	3.851	-4.295	-6.617
PV	L	5.737	1.124	-7.818	-14.856	-18.883
PV	R	16.002	17.663	11.066	-6.72	-9.474

PV	R	4.05	13.534	2.564	-9.063	-6.795
PV	R	7.657	7.461	2.802	-1.751	-5.153
PD	L	14.084	15.008	4.72	-5.533	-4.79
PD	L	10.275	11.311	-1.767	-16.295	6.025
PD	L	19.309	-1.385	-1.663	-14.163	-12.425
PD	R	5.926	10.531	-1.895	-4.013	-6.621
PD	R	12.913	9.913	4.707	-7.34	-14.565
PD	R	6.944	4.285	1.565	-7.109	-5.809

Shark 12 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	0.885	1.136	-2.311	-8.29	-5.293
AD	L	2.863	4.525	1.792	4.578	-3.595
AD	L	4.119	-3.373	-9.379	-9.815	-2.913
AD	R	-8.872	-18.369	-7.937	-17.058	-5.783
AD	R	-2.869	-4.619	-8.842	-12.74	-19.977
AD	R	-2.533	-5.048	-14.618	-11.753	-7.016
PV	L	-1.551	-3.525	-3.65	-9.254	-10.325
PV	L	1.707	-1.34	-2.203	-2.181	-9.835
PV	L	-4.156	-4.981	-4.26	-7.024	-8.131
PV	R	1.731	4.544	-5.123	-11.077	-8.367
PV	R	-0.856	-2.818	-7.928	-1.779	-7.613
PV	R	1.348	-3.433	-3.356	-3.114	-20.033
PD	L	5.698	3.413	4.642	1.452	-3.38
PD	L	8.055	4.657	1.022	1.401	-2.404
PD	L	0.99	0.424	-8.209	-15.571	-10.244
PD	R	5.679	-5.491	-3.806	-5.382	-4.463
PD	R	1.641	0.798	1.791	-1.642	-4.956
PD	R	1.406	-1.114	-0.666	-8.539	-4.035

Shark 12 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-1.944	-6.99	-4.608	-2.377	-2.174
AD	L	-5.507	-8.806	-4.442	-7.025	-2.544
AD	L	-2.158	-6.267	-7.237	-7.643	-3.336
AD	R	-9.754	-10.128	-11.856	-9.493	-6.361

AD	R	-5.958	-14.802	-5.318	-5.471	-2.821
AD	R	-6.491	-7.493	-5.775	-7.001	-13.3
PV	L	-7.191	-6.836	-4.566	4.453	1.953
PV	L	-7.698	-1.984	-3.555	-3.314	-2.574
PV	L	-8.444	-12.25	-9.727	-17.376	-4.799
PV	R	-3.563	-6.703	-9.99	-2.263	-2.216
PV	R	-7.42	-5.233	-4.825	-1.695	2.595
PV	R	1.865	1.95	5.028	4.283	2.671
PD	L	-1.74	-2.178	-3.814	-3.685	2.834
PD	L	-1.31	-2.261	-3.12	4.418	-1.787
PD	L	-11.744	-6.815	-11.237	-3.986	-6.066
PD	R	-2.393	-1.191	-3.346	-2.349	2.381
PD	R	-9.223	-1.639	-2.726	2.134	-2.165
PD	R	-10.771	-2.776	2.282	3.157	1.93

Shark 12 Quarter 3 Scale Angles					
Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	-1.322	2.974	3.694	3.995
AD	L	0.877	-1.762	-4.706	-1.348
AD	L	-4.078	2.122	1.328	7.593
AD	R	-4.218	2.366	-2.716	-1.363
AD	R	-2.179	-7.605	-6.732	-2.941
AD	R	-10.015	-7.978	-7.065	3.187
PV	L	2.27	2.539	1.074	2.401
PV	L	11.33	5.501	2.234	1.566
PV	L	-4.725	-5.843	1.917	7.366
PV	R	3.855	9.553	6.573	5.553
PV	R	-2.542	2.115	2.461	4.195
PV	R	3.003	6.26	12.488	13.144
PD	L	4.632	4.279	1.101	7.362
PD	L	1.813	6.33	2.358	2.926
PD	L	3.693	-1.892	6.746	4.883
PD	R	2.1	7.831	4.828	8.763
PD	R	4.999	3.303	8.27	9.912
PD	R	5.279	8.063	5.555	6.588

Shark 12 Quarter 4 Scale Angles					
Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4
AD	L	0.776	1.589	4.259	-0.698
AD	L	6.694	1.821	9.38	8.253
AD	L	9.795	4.778	1.952	1.351
AD	R	1.917	0.99	2.079	-5.91
AD	R	2.017	4.87	1.32	-1.309
AD	R	2.218	1.069	3.111	1.561
PV	L	8.588	6.328	9.731	1.104
PV	L	1.442	0.83	1.613	-0.705
PV	L	8.56	2.13	-0.974	-2.237
PV	R	5.681	3.192	1.107	5.169
PV	R	4.912	1.517	5.891	1.599
PV	R	11.227	5.777	4.697	-0.677
PD	L	10.788	5.374	6.777	3.478
PD	L	3.329	1.72	1.125	9.297
PD	L	5.774	2.069	1.21	1.872
PD	R	6.595	11.204	8.909	7.347
PD	R	7.977	14.468	6.596	6.98
PD	R	5.814	10.191	2.185	1.795

Shark 14 Lateral Scale Angles			
Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	24.375	-13.311
AD	L	23.523	-18.356
AD	L	23.794	-14.085
AD	R	24.434	-12.935
AD	R	24.15	-14.607
AD	R	15.515	-18.904
PV	L	14.22	-21.985
PV	L	24.992	-22.039
PV	L	21.199	-26.277
PV	R	16.869	-10.569
PV	R	25.08	-17.618
PV	R	15.567	-20.743
PD	L	17.732	-10.605
PD	L	26.535	-16.328

PD	L	15.627	-23.385
PD	R	12.374	-15.82
PD	R	14.525	-19.5
PD	R	21.321	-23.405

Shark 14 Anterior Scale Angles						
Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	8.928	3.14	8.026	7.639	-5.703
AD	L	12.117	3.097	2.659	1.62	-3.68
AD	L	8.85	5.968	0.743	2.408	-18.784
AD	R	6.681	0.78	1.323	-1.354	-12.504
AD	R	7.032	3.45	0.915	-2.1	-10.142
AD	R	10.698	1.795	4.318	-5.459	-8.227
PV	L	13.11	10.167	6.497	-1.637	-3.759
PV	L	28.177	8.605	0.81	-3.061	-6.612
PV	L	13.852	3.991	4.844	4.229	-11.021
PV	R	4.871	3.171	1.37	-4.545	-13.072
PV	R	10.633	4.785	0.734	-5.941	-13.058
PV	R	18.534	8.611	0.645	-11.297	-16.943
PD	L	3.037	6.698	-1.255	-2.287	-6.809
PD	L	5.479	11.441	2.87	7.951	-4.004
PD	L	2.318	1.3	0.44	-12.687	-16.707
PD	R	4.846	2.466	-2.534	-4.057	-10.979
PD	R	15.195	8.003	3.034	-2.152	-9.076
PD	R	2.003	-1.316	-1.049	-3.307	-2.909

Shark 14 Posterior Scale Angles						
Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	10.496	5.867	2.025	-1.89	-5.194
AD	L	9.975	9.498	7.268	2.968	-12.15
AD	L	3.616	3.111	-4.014	-1.928	-5.422
AD	R	7.96	5.608	6.162	1.379	-2.677
AD	R	3.027	4.351	1.254	2.005	-1.24
AD	R	6.932	8.391	5.902	4.296	-1.512
PV	L	2.574	-3.919	-4.966	-6.101	-18.792
PV	L	12.563	11.064	2.391	-2.077	3.266
PV	L	4.176	1.921	1.635	-4.84	-13.116
PV	R	1.234	1.097	-2.214	-10.909	-3.419
PV	R	11.782	3.086	-1.049	-2.655	-3.245
PV	R	6.579	2.731	1.441	-1.642	-9.359

PD	L	1.652	1.348	-1.144	-2.465	-3.785
PD	L	10.793	4.645	-0.549	-1.188	-7.136
PD	L	3.488	1.398	3.587	-4.883	-11.478
PD	R	8.336	11.211	2.613	-2.134	-5.458
PD	R	5.594	1.268	-2.567	-11.717	-9.233
PD	R	7.147	4.912	-1.254	-4.341	-20.361

Shark 14 Quarter 1 Scale Angles						
Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	0.469	-5.859	-1.727	-14.826	-10.094
AD	L	1.849	2.6	-1.321	-6.762	-13.713
AD	L	2.323	-2.249	4.115	-3.32	-6.801
AD	R	-4.66	-4.43	-4.56	-8.554	-6.49
AD	R	-0.299	-2.652	-3.083	-4.304	-1.4
AD	R	-1.494	-2.314	-2.098	-2.346	-3.887
PV	L	0.49	-6.027	1.055	-1.345	-9.229
PV	L	3.885	2.454	-5.594	-12.203	-1.892
PV	L	2.02	1.21	-2.545	-1.021	-1.658
PV	R	1.989	0.858	-3.602	-9.666	-2.219
PV	R	0.986	-0.6	3.425	-2.733	-1.097
PV	R	1.096	-2.371	-2.513	-3.468	-2.822
PD	L	-0.826	-8.713	-3.761	-3.441	-2.591
PD	L	-1.758	-6.617	-4.222	-4.103	-5.73
PD	L	-0.93	-0.962	-2.695	-8.569	-8.781
PD	R	-1.911	-6.061	-4.672	-7.785	-7.257
PD	R	0.914	-0.836	-3.698	-5.815	-2.685
PD	R	0.607	-2.391	-6.24	-2.243	-2.835

Shark 14 Quarter 2 Scale Angles						
Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-1.183	1.834	-4.797	2.233	3.359
AD	L	-5.27	3.16	-4.638	-3.826	2.138
AD	L	-4.14	4.636	-3.811	-12.475	1.671
AD	R	-5.877	-4.277	-2.239	2.725	-1.472
AD	R	-1.24	3.621	1.515	-2.674	1.025
AD	R	-5.053	-1.536	4.372	5.614	5.956

PV	L	-4.043	-3.097	-2.983	-1.642	1.779
PV	L	-1.892	10.899	8.483	11.859	12.256
PV	L	-2.522	-1.558	-2.473	-4.27	-2.158
PV	R	-1.771	-2.009	-5.043	-3.76	-2.538
PV	R	-4.837	-3.069	-3.257	7.701	4.46
PV	R	-3.382	-6.701	-3.473	-4.37	-3.432
PD	L	-2.428	-3.716	-5.527	2.036	-1.251
PD	L	2.346	-6.07	5.495	2.558	-3.004
PD	L	-8.73	-7.308	-2.246	5.509	1.836
PD	R	-2.472	-1.649	-0.892	-2.898	1.458
PD	R	-7.714	-9.274	-7.214	-1.652	-3.545
PD	R	-9.924	-12.634	-2.014	2.47	-1.469

Shark 14 Quarter 3 Scale Angles

Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	3.121	1.206	8.018	8.034
AD	L	5.59	6.446	8.156	7.751
AD	L	-3.246	2.97	5.362	9.23
AD	R	5.992	9.207	4.777	2.477
AD	R	1.54	3.379	2.393	4.604
AD	R	6.335	8.557	1.545	6.605
PV	L	1.736	2.321	-2.762	2.349
PV	L	14.025	10.554	14.887	21.266
PV	L	0.686	1.325	4.147	3.059
PV	R	2.536	2.694	4.308	6.594
PV	R	4.578	-2.944	8.58	12.872
PV	R	5.714	8.887	10.128	8.625
PD	L	-1.242	2.486	-1.925	-1.273
PD	L	2.803	3.593	1.17	1.286
PD	L	3.288	-2.195	0.94	-1.43
PD	R	3.265	3.596	4.52	4.828
PD	R	1.311	2.105	3.194	3.804
PD	R	-2.097	5.024	3.664	1.653

Shark 14 Quarter 4 Scale Angles

Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4

AD	L	3.687	10.007	5.119	5.987
AD	L	5.166	8.117	1.25	4.962
AD	L	11.227	12.794	11.2	4.445
AD	R	2.087	1.917	4.156	1.509
AD	R	7.583	5.372	2.207	1.875
AD	R	6.241	2.878	10.016	9.863
PV	L	2.349	6.891	14.956	7.895
PV	L	16.744	22.424	21.241	18.714
PV	L	4.447	2.662	10.348	3.796
PV	R	5.371	8.527	6.428	2.738
PV	R	11.116	1.658	1.448	5.199
PV	R	13.342	14.617	2.848	1.256
PD	L	1.966	6.587	1.49	4.31
PD	L	0.454	1.023	7.536	0.103
PD	L	1.084	-1.82	-1.435	1.335
PD	R	3.601	4.716	2.168	2.276
PD	R	6.834	5.903	7.599	2.962
PD	R	1.26	-1.842	1.912	4.915

Shark 15 Lateral Scale Angles

Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	13.859	-16.877
AD	L	23.105	-15.191
AD	L	18.098	-15.538
AD	R	20.539	-20.437
AD	R	12.211	-32.137
AD	R	22.624	-18.161
PV	L	28.469	-20.865
PV	L	14.888	-18.251
PV	L	12.205	-17.915
PV	R	20.771	-25.497
PV	R	26.315	-21.949
PV	R	20.179	-16.588
PD	L	13.928	-24.383
PD	L	23.944	-20.249
PD	L	21.099	-26.181
PD	R	19.122	-18.243

PD	R	20.099	-23.926
PD	R	13.83	-30.231

Shark 15 Anterior Scale Angles						
Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	15.92	3.211	1.124	-6.187	-12.183
AD	L	10.722	10.012	2.067	-3.134	-8.695
AD	L	3.605	2.597	0.375	-2.817	-6.251
AD	R	4.53	0.959	1.189	-5.164	-11.613
AD	R	-1.614	-2.476	-1.915	-4.314	-8.511
AD	R	-1.429	-1.67	-1.088	5.515	-9.343
PV	L	0.962	0.434	-0.49	-1.814	-14.487
PV	L	1.522	1.25	-1.201	-3.659	-5.846
PV	L	-2.26	-11.858	-4.938	-6.146	-5.049
PV	R	7.645	2.033	-1.492	-3.353	-12.727
PV	R	4.285	3.054	-0.604	1.713	-6.229
PV	R	11.106	4.073	0.69	1.969	-10.465
PD	L	13.619	8.4	-1.117	-1.622	-8.871
PD	L	4.706	4.253	-0.67	-5.718	-21.327
PD	L	7.791	8.21	1.407	3.567	-5.682
PD	R	7.334	-4.835	-9.769	-3.273	-14.278
PD	R	4.653	2.456	-2.629	-16.026	-1.785
PD	R	13.83	1.317	1.809	1.796	-12.521

Shark 15 Posterior Scale Angles						
Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	17.084	13.057	-5.267	-12.73	-17.779
AD	L	8.856	10.785	1.609	-12.325	-8.819
AD	L	9.029	8.144	-2.873	-9.699	-14.026
AD	R	3.352	1.559	-1.127	-4.374	-6.377
AD	R	6.851	6.21	-1.118	-3.202	-15.864
AD	R	14.746	4.111	-1.281	-3.611	-23.219
PV	L	4.653	3.532	1.411	-17.763	-7.608
PV	L	15.48	1.472	-9.239	-11.145	-19.315
PV	L	5.515	3.285	4.154	2.434	-3.721
PV	R	9.431	9.059	-1.733	-14.187	-2.011

PV	R	13.97	5.485	-1.755	-2.7	-6.712
PV	R	22.917	2.532	-2.217	-6.047	-11.81
PD	L	2.004	6.172	-4.829	-3.61	-16.63
PD	L	12.381	10.044	2.741	-2.748	-9.707
PD	L	7.745	1.632	-4.615	-4.751	-9.535
PD	R	16.288	5.714	-1.741	-5.806	-11.222
PD	R	20.898	2.018	-8.796	-5.21	-1.903
PD	R	4.876	0.919	-4.042	-7.706	-11.15

Shark 15 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	1.304	-0.547	-2.507	-1.87	-8.983
AD	L	0.97	2.008	1.87	2.886	-0.906
AD	L	-0.639	-2.72	-4.618	-3.489	-3.295
AD	R	-1.142	-9.684	-7.665	-11.84	-2.783
AD	R	1.627	1.838	-3.496	-6.711	-8.538
AD	R	1.143	-2.807	-2.93	-2.541	-18.386
PV	L	-0.48	-5.218	-4.642	-11.684	-8.815
PV	L	-1.235	-2.33	-4.449	-2.337	-5.433
PV	L	-0.991	-5.66	-2.882	-0.518	3.206
PV	R	-1.388	-4.09	-6.224	-10.398	-4.516
PV	R	-1.171	5.334	-4.84	-4.486	-7.16
PV	R	-0.516	-1.32	-4.476	-10.631	-9.85
PD	L	-0.77	-1.097	5.503	-5.606	-2.832
PD	L	1.082	-2.328	-5.912	-7.644	-3.236
PD	L	-0.486	-6.919	-6.454	-2.855	-13.631
PD	R	-0.707	-2.062	-11.312	-13.208	-8.565
PD	R	-1.111	-1.605	-11.613	-14.417	-11.963
PD	R	-0.808	-2.216	-3.7	-1.727	-2.584

Shark 15 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-11.533	-13.309	-6.731	-8.592	1.36
AD	L	-1.765	-3.725	-4.895	-3.229	1.134
AD	L	-9.548	-6.069	-4.044	-2.416	-1.14
AD	R	-8.777	-7.579	-8.479	-3.433	-2.304

AD	R	-3.619	-6.343	-7.738	-3.474	-1.245
AD	R	-15.296	-1.836	-6.782	-3.67	-1.995
PV	L	-1.285	-15.146	-13.816	-8.062	1.558
PV	L	-15.839	-16.609	-10.979	-13.925	-1.812
PV	L	-12.337	-5.876	-1.432	3.392	2.761
PV	R	-3.799	-3.935	-2.147	-10.739	-7.038
PV	R	3.052	1.814	-5.806	-6.673	-1.858
PV	R	-7.154	-11.924	-11.621	-9.878	-2.971
PD	L	3.068	-7.169	-4.69	-1.675	4.406
PD	L	-3.939	1.476	-2.406	-2.937	-0.943
PD	L	-10.392	-2.172	-4.751	-1.796	-1.392
PD	R	-0.543	-1.704	-3.018	-7.473	-1.667
PD	R	-7.402	-2.643	3.508	-13.252	-2.585
PD	R	-2.807	0.872	-3.773	-2.552	-0.86

Shark 15 Quarter 3 Scale Angles

Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	1.834	5.338	2.127	9.869
AD	L	8.393	2.596	4.678	1.714
AD	L	-3.837	-2.101	1.189	7.898
AD	R	2.775	-1.627	1.66	9.566
AD	R	2.523	2.885	-1.523	2.93
AD	R	4.998	7.563	12.275	10.339
PV	L	9.268	3.109	4.451	2.413
PV	L	1.894	1.474	3.956	2.56
PV	L	2.035	16.981	5.547	4.276
PV	R	-4.146	4.246	2.948	3.957
PV	R	2.25	10.421	8.301	-6.269
PV	R	-1.422	-1.492	11.463	1.441
PD	L	4.655	1.569	9.398	1.909
PD	L	2.394	5.425	3.027	7.192
PD	L	4.17	5.213	7.745	7.727
PD	R	1.925	0.758	-3.461	-1.409
PD	R	-5.477	2.726	1.181	2.18
PD	R	1.649	-3.089	10.774	0.698

Shark 15 Quarter 4 Scale Angles					
Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4
AD	L	5.116	4.236	3.002	3.007
AD	L	-0.895	6.106	4.177	4.896
AD	L	-2.368	1.012	2.266	2.888
AD	R	10.473	6.131	-2.732	-3.536
AD	R	-3.524	-4.683	2.906	4.875
AD	R	3.427	-0.92	1.397	0.646
PV	L	1.873	-2.64	-5.828	-2.861
PV	L	1.684	-2.338	-3.842	-1.712
PV	L	6.608	4.644	7.419	2.528
PV	R	3.649	4.465	3.689	2.832
PV	R	17.83	10.72	-2.103	1.951
PV	R	2.22	12.296	4.009	1.895
PD	L	5.456	3.982	2.235	1.78
PD	L	4.074	5.656	9.526	5.498
PD	L	3.278	1.128	3.403	0.647
PD	R	-1.756	3.661	2.319	3.641
PD	R	3.768	4.145	-1.76	-1.345
PD	R	3.932	3.547	1.689	0.977

Shark 16 Lateral Scale Angles			
Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	13.078	-20.771
AD	L	19.713	-23.092
AD	L	19.875	-20.856
AD	R	23.258	-12.309
AD	R	20.102	-15.845
AD	R	19.829	-22.591
PV	L	23.397	-22.009
PV	L	23.589	-24.422
PV	L	22.17	-23.936
PV	R	24.666	-27.942
PV	R	30.626	-24.032
PV	R	30.214	-28.387
PD	L	27.605	-22.077
PD	L	31.669	-16.764

PD	L	15.666	-32.608
PD	R	22.429	-35.573
PD	R	18.82	-18.793
PD	R	23.336	-25.056

Shark 16 Anterior Scale Angles						
Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	2.924	3.939	-0.88	-2.666	-11.789
AD	L	11.447	-2.595	-1.451	-7.269	-8.932
AD	L	15.603	-1.187	-0.758	-10.32	-8.614
AD	R	13.063	4.867	2.89	-2.193	-11.066
AD	R	8.028	8.617	4.824	6.49	-12.367
AD	R	12.582	11.295	7.388	4.587	-14.672
PV	L	10.974	5.602	-2.257	-13.599	-13.258
PV	L	8.678	1.171	0.631	-3.776	-12.467
PV	L	16.93	3.66	2.201	-7.919	-14.096
PV	R	5.34	5.114	1.006	1.567	-11.837
PV	R	17.481	4.346	0.434	-12.053	-19.713
PV	R	15.287	12.79	4.775	4.568	-3.194
PD	L	12.337	8.138	0.713	-7.465	-10.718
PD	L	5.644	-5.514	-4.524	-12.885	-16.764
PD	L	1.262	1.916	-0.791	-7.52	-5.024
PD	R	16.223	6.809	-1.602	-15.518	-21.728
PD	R	11.751	6.158	0.519	-12.734	-13.483
PD	R	5.532	-1.254	-0.719	-16.515	-13.022

Shark 16 Posterior Scale Angles						
Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	13.078	4.768	-3.146	-6.12	-20.771
AD	L	2.234	-1.737	-1.632	-4.206	-9.613
AD	L	2.783	-2.994	1.333	-1.342	-11.489
AD	R	18.639	-1.147	2.753	-2.226	-4.852
AD	R	7.939	2.105	-3.537	-1.576	-3.461
AD	R	20.029	-6.882	-1.497	-4.344	-2.713
PV	L	14.264	-1.754	-3.005	-3.765	-7.259
PV	L	7.927	6.479	2.813	-8.287	-4.908
PV	L	7.082	3.916	2.526	-3.221	-4.091
PV	R	5.15	-1.01	-3.976	-2.631	-19.501
PV	R	11.642	12.409	10.336	2.486	1.691
PV	R	10.236	2.367	-2.644	-1.729	-4.948

PD	L	17.914	7.965	3.553	-6.309	-6.658
PD	L	17.691	4.595	-3.474	-2.307	-5.726
PD	L	15.666	1.713	-2.217	-8.091	-4.013
PD	R	22.429	13.069	-4.059	-3.796	-14.745
PD	R	11.417	6.254	-3.612	-4.143	-3.83
PD	R	5.807	3.558	-2.756	-1.48	-5.675

Shark 16 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	-7.473	-3.23	-1.411	-3.179	-10.492
AD	L	-1.889	-13.029	-10.065	-6.592	-1.739
AD	L	-3.798	-10.751	-7.252	-2.61	-3.998
AD	R	-2.769	-2.029	-4.428	-5.391	-13.486
AD	R	3.87	3.379	-6.554	-15.704	-16.334
AD	R	3.213	6.382	0.81	-8.928	-12.103
PV	L	-1.339	-4.182	-4.989	-9.717	-10.393
PV	L	-0.569	-1.362	-8.415	-7.022	-11.906
PV	L	0.489	2.281	2.996	-5.751	-9.959
PV	R	-0.893	-3.14	-4.472	-10.322	-10.939
PV	R	2.365	-5.121	-6.244	-5.402	-5.32
PV	R	5.241	2.872	3.764	-4.854	-10.823
PD	L	-1.892	-1.437	-7.465	-2.042	-5.245
PD	L	-3.85	-7.423	-5.294	-5.018	-16.764
PD	L	-0.721	-6.847	-6.491	-3.138	-2.944
PD	R	0.879	-0.903	-6.995	-17.003	-14.658
PD	R	0.799	-2.111	-13.976	-8.958	-5.867
PD	R	-1.897	-1.703	-4.251	-3.194	-1.267

Shark 16 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-11.442	-20.771	-13.329	-5.29	-1.692
AD	L	-7.898	-7.36	-8.06	-3.195	-1.791
AD	L	-5.024	-4.88	-5.637	-1.409	-2.183
AD	R	-10.512	-4.78	-2.338	-1.703	-1.953
AD	R	-2.091	-2.741	-6.548	-3.072	-4.04
AD	R	-5.177	-1.35	-4.328	-5.365	-5.31

PV	L	-4.017	-8.058	-3.314	-2.119	-6.147
PV	L	-15.426	-9.005	-8.047	1.732	2.646
PV	L	-11.113	-3.356	-5.289	2.198	2.597
PV	R	-13.082	-13.952	-15.664	-2.863	-4.198
PV	R	-2.118	2.068	7.378	5.054	4.386
PV	R	-9.441	-7.14	-3.52	-2.827	-2.335
PD	L	-5.563	-3.271	-6.673	-4.98	-2.977
PD	L	-14.438	-3.502	-2.936	3.72	-2.115
PD	L	-5.175	-6.903	2.7	-1.199	-3.258
PD	R	-11.848	-9.871	-13.182	-1.596	-3.957
PD	R	-7.339	-3.12	-2.681	-1.747	2.218
PD	R	-4.328	-4.984	-1.558	4.099	3.928

Shark 16 Quarter 3 Scale Angles

Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	9.086	3.289	8.747	1.579
AD	L	-2.436	1.991	-1.68	0.923
AD	L	-1.861	2.067	1.63	2.272
AD	R	6.589	11.205	16.257	22.115
AD	R	-3.544	3.298	3.591	7.388
AD	R	-4.392	3.63	2.73	7.514
PV	L	1.951	5.088	1.732	1.216
PV	L	3.334	3.225	2.94	6.474
PV	L	2.321	1.917	4.019	6.778
PV	R	-7.616	-2.888	2.688	5.655
PV	R	9.342	8.285	17.749	14.352
PV	R	-3.33	6.715	5.594	13.902
PD	L	3.832	0.637	2.964	1.973
PD	L	8.035	9.945	12.52	13.741
PD	L	-1.453	-5.986	3.034	2.275
PD	R	-2.1	12.392	9.022	1.29
PD	R	4.435	6.655	9.278	6.85
PD	R	2.667	4.166	1.974	11.408

Shark 16 Quarter 4 Scale Angles					
Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4
AD	L	9.086	9.464	7.742	2.79
AD	L	12.17	3.727	0.606	-1.01
AD	L	10.934	8.37	1.504	0.571
AD	R	15.157	6.081	-3.016	2.863
AD	R	13.277	14.66	6.28	5.801
AD	R	10.043	15.227	8.331	7.002
PV	L	8.492	7.706	1.285	2.011
PV	L	8.72	5.64	3.069	1.074
PV	L	10.87	5.469	2.459	-0.835
PV	R	6.97	0.864	-2.555	1.007
PV	R	16.353	19.293	14.016	12.54
PV	R	12.776	11.76	12.595	4.614
PD	L	-2.825	-0.965	0.479	1.474
PD	L	12.731	5.043	3.009	-2.514
PD	L	2.092	1.105	0.976	0.022
PD	R	2.61	-1.45	0.781	2.258
PD	R	6.194	5.154	5.806	-2.165
PD	R	3.483	13.394	7.896	-2.127

Shark 17 Lateral Scale Angles			
Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	6.325	-6.955
AD	L	6.575	-24.28
AD	L	15.903	-9.207
AD	R	0.816	-9.134
AD	R	4.753	-10.608
AD	R	4.712	-4.482
PV	L	8.17	-20.849
PV	L	2.625	-22.65
PV	L	19.968	-9.343
PV	R	6.171	-22.024
PV	R	14.918	-10.72
PV	R	10.534	-8.913
PD	L	25.397	-21.221
PD	L	24.139	-21.714

PD	L	5.352	-7.027
PD	R	4.253	-10.66
PD	R	13.073	-18.326
PD	R	4.842	-20.756

Shark 17 Anterior Scale Angles

Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	6.325	8.245	1.476	7.236	8.52
AD	L	13.143	2.52	-1.435	-9.649	-12.965
AD	L	1.818	1.278	-0.231	4.626	2.121
AD	R	7.737	0.351	-0.372	3.713	1.436
AD	R	5.812	-1.906	1.823	2.834	7.606
AD	R	4.682	2.087	-3.245	-5.323	-6.987
PV	L	1.087	-1.908	-6.409	-6.993	-20.186
PV	L	3.716	1.377	-2.842	-6.43	-4.569
PV	L	9.678	8.227	6.559	-1.333	0.817
PV	R	1.04	-8.647	-13.46	-13.746	-15.962
PV	R	7.185	-4.797	-3.79	-5.075	-6.121
PV	R	-1.762	0.643	1.366	0.966	-1.051
PD	L	8.468	4.364	0.655	-1.651	-0.864
PD	L	6.027	-5.924	-3.242	-0.809	-2.1
PD	L	5.352	2.447	-7.487	-5.481	-5.238
PD	R	-0.573	3.941	1.377	0.736	2.093
PD	R	2.447	1.423	1.14	1.712	-1.526
PD	R	3.782	0.484	-0.929	-0.883	-2.984

Shark 17 Posterior Scale Angles

Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	10.765	3.147	0.335	-3.603	-1.426
AD	L	4.166	2.868	-2.534	-1.87	-15.532
AD	L	3.598	-1.49	1.244	-1.196	-4.776
AD	R	3.818	2.306	1.958	-9.137	-9.137
AD	R	11.892	8.683	-1.762	-14.965	-13.937
AD	R	-5.019	-4.169	1.255	-1.461	-0.901
PV	L	1.599	4.551	0.992	-7.645	-6.91
PV	L	1.478	1.606	-1.72	-5.156	-21.207

PV	L	5.857	7.216	17.781	14.086	-0.941
PV	R	9.022	5.018	-7.236	-7.651	-1.49
PV	R	19.032	13.132	2.738	-5.66	-5.146
PV	R	-1.791	0.999	-0.87	-5.697	3.779
PD	L	2.409	2.42	-3.079	5.526	-7.973
PD	L	-1.482	1.929	-5.172	-5.749	-5.616
PD	L	3.78	2.556	-5.159	-5.813	-10.652
PD	R	1.418	4.463	5.34	1.664	-7.617
PD	R	9.11	-1.407	-1.247	-3.933	-6.043
PD	R	2.922	2.144	4.315	5.824	-12.573

Shark 17 Quarter 1 Scale Angles

Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	2.048	3.129	6.853	4.607	3.466
AD	L	-1.213	-4.686	-8.37	-6.658	-2.882
AD	L	-1.303	-3.412	-2.239	-1.649	1.145
AD	R	-4.436	-1.103	-2.903	-3.489	-6.089
AD	R	9.695	4.82	8.629	11.066	3.853
AD	R	-7.85	-5.358	-12.222	-18.658	-4.564
PV	L	-4.813	-8.137	-5.483	-11.219	-7.239
PV	L	-2.024	-5.084	2.649	1.804	-9.122
PV	L	1.001	-0.37	13.78	5.973	-0.443
PV	R	-6.419	-7.796	-15.201	-5.673	-4.519
PV	R	-1.181	-3.187	-6.095	-8.441	-6.531
PV	R	1.119	-1.504	-3.165	-4.525	-0.864
PD	L	1.718	-2.226	-2.841	-1.369	3.842
PD	L	-4.623	-7.861	0.527	-3.18	-6.913
PD	L	1.346	0.381	-5.373	-1.152	-3.828
PD	R	-1.52	-2.865	1.82	2.52	5.65
PD	R	-0.702	-2.818	-0.689	-0.84	-0.912
PD	R	1.022	1.634	-0.727	-6.933	-5.196

Shark 17 Quarter 2 Scale Angles

Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	5.905	6.123	3.443	5.837	-1.313
AD	L	-8.274	9.58	9.032	4.28	-1.646

AD	L	-6.02	-10.892	1.608	4.424	2.284
AD	R	-5.146	-4.843	-1.392	-2.671	-1.028
AD	R	2.546	-2.917	-4.179	2.832	3.505
AD	R	-3.992	-7.339	-5.838	-8.939	-2.931
PV	L	-8.607	-1.762	-5.466	-12.57	-3.326
PV	L	-0.911	-9.541	-10.567	-2.817	-2.631
PV	L	-3.884	1.812	3.926	3.356	-1.868
PV	R	-5.992	-3.196	-8.245	-12.922	-11.017
PV	R	-5.803	-6.097	-6.478	-3.62	-1.62
PV	R	-2.354	-1.502	2.23	-1.256	5.194
PD	L	-2.119	-11.842	4.761	-0.628	-3.168
PD	L	-3.889	-7.055	-5.089	-5.53	-9.423
PD	L	-7.929	-17.474	-4.196	-2.693	-3.46
PD	R	-6.847	-5.842	-0.898	3.092	8.476
PD	R	-11.036	-7.937	-1.923	-0.5	-1.559
PD	R	-6.633	-6.523	-6.368	-2.559	-3.093

Shark 17 Quarter 3 Scale Angles					
Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	0.95	2.575	5.583	7.723
AD	L	1.783	-3.366	-4.025	-9.058
AD	L	-4.138	2.006	-0.978	0.807
AD	R	2.639	0.801	1.538	3.451
AD	R	11.29	-2.669	1.981	3.481
AD	R	-5.62	-5.598	-4.3	-5.823
PV	L	5.48	2.873	2.02	5.12
PV	L	-6.191	2.111	-1.543	-1.826
PV	L	9.986	13.71	3.441	7.519
PV	R	-12.059	1.118	1.759	1.651
PV	R	-3.608	6.489	3.685	0.959
PV	R	11.231	-4.458	-2.555	-5.377
PD	L	-3.398	4.598	3.776	1.596
PD	L	-5.447	-2.039	-1.44	1.456
PD	L	0.963	0.781	-10.406	-2.492
PD	R	4.956	4.487	9.856	9.903
PD	R	3.725	3.093	-1.012	-0.908
PD	R	-1.574	2.195	0.768	1.579

Shark 17 Quarter 4 Scale Angles					
Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4
AD	L	6.36	2.301	7.409	4.795
AD	L	-4.893	3.239	-0.581	-4.538
AD	L	0.558	-2.88	5.624	0.539
AD	R	1.949	-6.43	-1.577	-3.36
AD	R	1.364	-4.73	1.728	5.024
AD	R	1.326	-5.205	-4.897	-7.996
PV	L	-1.226	1.282	-1.474	1.669
PV	L	-1.223	-4.451	4.585	1.199
PV	L	9.683	7.609	1.32	-0.935
PV	R	1.696	-7.591	-10.486	-13.819
PV	R	-5.323	-9.932	-6.184	0.938
PV	R	-3.061	0.377	8.052	4.455
PD	L	1.454	0.317	-0.795	0.573
PD	L	2.312	-1.107	-0.971	0.857
PD	L	1.047	-1.673	-1.157	-1.927
PD	R	8.975	6.09	5.163	2.411
PD	R	2.298	5.693	9.666	5.512
PD	R	-0.946	-0.927	-3.585	1.11

Shark 18 Lateral Scale Angles			
Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	11.678	-16.695
AD	L	8.65	-11.507
AD	L	8.64	-17.472
AD	R	9.576	-8.146
AD	R	16.442	-18.264
AD	R	13.47	-9.894
PV	L	10.066	-18.577
PV	L	10.827	-18.378
PV	L	15.647	-19.966
PV	R	7.833	-6.73
PV	R	22.618	-19.436
PV	R	14.562	-24.506
PD	L	21.246	-23.157
PD	L	15.096	-9.034

PD	L	19.225	-11.133
PD	R	11.011	-25.117
PD	R	11.183	-11.047
PD	R	16.322	-18.477

Shark 18 Anterior Scale Angles

Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	6.453	5.037	2.367	1.671	-5.335
AD	L	9.025	-2.643	-0.61	-6.27	-8.266
AD	L	14.845	3.706	0.292	3.639	-8.35
AD	R	6.656	5.879	8.53	5.577	-7.812
AD	R	12.55	3.565	1.461	-2.248	-3.708
AD	R	10.714	10.08	9.947	-3.931	-9.997
PV	L	11.74	3.913	0.585	-2.073	-1.909
PV	L	11.365	4.109	0.516	-9.053	-5.39
PV	L	7.7	-5.42	2.632	-4.791	-9.98
PV	R	3.503	2.508	2.19	1.905	-0.585
PV	R	9.272	-12.632	-6.024	-5.72	-9.03
PV	R	6.941	-12.224	-0.405	-4.062	-9.289
PD	L	6.391	1.77	1.413	-6.291	-12.686
PD	L	11.945	4.032	-1.299	-1.974	-16.603
PD	L	5.371	6.186	3.982	7.745	-10.709
PD	R	13.904	7.951	-2.999	-11.928	-20.205
PD	R	8.384	0.882	-1.427	-1.681	-2.219
PD	R	4.279	-6.425	0.554	-4.897	-8.905

Shark 18 Posterior Scale Angles

Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	3.893	6.733	-1.859	-4.195	-7.292
AD	L	1.829	6.142	-5.943	-12.338	-7.424
AD	L	4.298	6.797	1.572	-4.204	1.083
AD	R	1.006	5.114	1.586	-3.645	-2.541
AD	R	9.299	3.311	1.241	-2.749	-2.052
AD	R	6.811	-1.23	-2.61	-6.085	-4.693
PV	L	10.066	0.956	1.744	-1.664	-10.583
PV	L	2.814	1.378	-1.676	-1.04	-7.618

PV	L	8.771	4.594	-1.349	-4.058	-6.349
PV	R	8.397	7.712	5.941	5.147	1.978
PV	R	2.115	5.412	3.732	-10.226	-7.548
PV	R	6.396	9.384	-2.088	-3.005	-5.188
PD	L	0.884	5.026	7.008	-0.867	-23.157
PD	L	6.971	6.79	-7.481	-11.505	-1.508
PD	L	15.063	1.273	0.759	-3.873	-5.451
PD	R	5.114	7.818	4.009	-6.358	-12.208
PD	R	2.907	2.203	-3.484	-10.51	-5.228
PD	R	4.374	-2.842	-2.015	-2.338	-19.387

Shark 18 Quarter 1 Scale Angles						
Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	-0.739	-2.622	-2.103	-0.667	-6.89
AD	L	-2.58	-3.837	-11.88	-8.425	-5.454
AD	L	-3.279	-4.334	-5.874	-4.056	0.765
AD	R	5.246	4.693	2.423	-4.517	-6
AD	R	-0.554	-2.812	1.087	3.41	-0.805
AD	R	1.45	2.846	-9.883	-5.472	-4.41
PV	L	-7.528	-5.878	-3.7	-1.282	-3.552
PV	L	-4.726	-9.558	-16.362	-10.177	-2.666
PV	L	1.678	-0.476	-2.956	1.643	-4.869
PV	R	-3.605	-5.292	1.953	3.934	-7.879
PV	R	-3.049	-6.946	-10.276	-10.621	-7.561
PV	R	-0.711	-5.371	1.426	-9.958	-4.114
PD	L	-0.399	-2.692	-4.333	-4.661	-10.877
PD	L	-2.997	-3.063	-5.018	-9.725	-2.225
PD	L	-0.17	-0.822	-0.051	5.158	-5.042
PD	R	-0.672	-1.885	-7.643	-6.092	-8.297
PD	R	-8.036	-3.346	2.097	3.445	4.616
PD	R	-3.818	-4.324	-4.363	-2.763	-4.018

Shark 18 Quarter 2 Scale Angles						
Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-5.005	-7.382	-12.407	-6.348	1.791
AD	L	-6.254	-7.672	-6.702	-5.824	1.279

AD	L	-3.22	-2.942	-5.554	-6.533	-3.01
AD	R	3.177	-1.448	-0.885	-2.565	1.357
AD	R	1.65	1.995	3.109	3.524	-1.797
AD	R	4.637	2.584	1.744	-3.562	6.52
PV	L	-2.17	-13.925	-1.664	-6.859	3.908
PV	L	-10.565	-4.328	-1.385	-1.422	-3.131
PV	L	-4.61	-5.31	-1.159	4.837	6.553
PV	R	1.051	-3.805	-1.085	-3.777	2.41
PV	R	-7.071	-4.262	-3.093	-1.521	-2.445
PV	R	-2.437	2.184	12.339	-2.473	-2.769
PD	L	-6.889	-3.134	-5.204	-0.989	2.015
PD	L	-4.57	-5.208	-6.918	-3.685	-2.379
PD	L	-1.135	1.479	-2.66	-4.85	-1.622
PD	R	-5.924	-4.275	1.948	-4.375	-2.521
PD	R	0.791	1.071	-9.493	-8.021	2.648
PD	R	-4.911	-2.962	4.278	6.636	4.543

Shark 18 Quarter 3 Scale Angles					
Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	3.129	6.401	5.846	2.422
AD	L	3.663	-4.835	1.111	5.882
AD	L	2.985	5.02	1.356	1.81
AD	R	2.185	2.191	2.382	2.962
AD	R	-4.121	-2.403	3.77	-1.245
AD	R	-2.424	-2.86	8.232	2.419
PV	L	1.726	6.053	8.795	6.156
PV	L	-8.039	-4.501	2.123	2.077
PV	L	4.593	5.378	6.901	4.127
PV	R	2.89	3.13	1.918	3.683
PV	R	10.455	-3.267	-1.482	-10.805
PV	R	-4.223	0.924	-4.551	1.831
PD	L	3.175	1.376	-2.418	3.677
PD	L	-3.087	1.932	-1.96	2.983
PD	L	-3.125	2.167	10.952	12.597
PD	R	0.886	2.406	-3.765	1.85
PD	R	3.513	4.82	2.392	5.16
PD	R	-1.581	-2.047	1.807	2.938

Shark 18 Quarter 4 Scale Angles					
Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4
AD	L	3.232	8.454	8.047	-4.651
AD	L	-2.797	-1.45	3.864	3.21
AD	L	5.307	0.747	1.01	1.667
AD	R	7.426	2.962	1.586	6.238
AD	R	2.527	1.97	2.236	4.872
AD	R	1.729	4.138	12.401	6.235
PV	L	3.665	-1.073	-1.812	-7.207
PV	L	10.62	15.934	4.912	-3.135
PV	L	10.423	1.228	9.064	-4.2
PV	R	1.184	1.294	2.296	5.582
PV	R	3.622	0.999	1.157	-4.614
PV	R	8.041	4.826	-0.632	1.292
PD	L	-2.061	6.973	6.57	4.64
PD	L	1.441	0.553	3.294	1.323
PD	L	8	13.303	4.314	3.693
PD	R	3.093	8.427	1.904	1.484
PD	R	5.971	9.969	2.346	1.467
PD	R	-1.071	0.986	2.186	0.157

Shark 19 Lateral Scale Angles			
Sample	Side	Left Lateral Center	Right Lateral Center
AD	L	20.655	-20.051
AD	L	22.258	-14.377
AD	L	25.691	-9.82
AD	R	23.089	-20.407
AD	R	22.778	-13.528
AD	R	18.528	-19.103
PV	L	39.906	-17.055
PV	L	21.8	-16.618
PV	L	30.859	-18.492
PV	R	20.619	-19.169
PV	R	22.917	-22.672
PV	R	29.218	-20.047
PD	L	25.658	-27.461
PD	L	25.931	-22.367

PD	L	20	-19.418
PD	R	4.404	-23.959
PD	R	3.525	-10.752
PD	R	17.383	-21.048

Shark 19 Anterior Scale Angles

Sample	Side	Anterior 1	Anterior 2	Anterior 3	Anterior 4	Anterior 5
AD	L	8.208	-2.977	-2.327	-8.827	-15.189
AD	L	9.007	1.609	0.745	-9.863	-16.923
AD	L	6.424	4.491	2.825	1.546	-15.027
AD	R	2.393	4.465	4.388	1.354	-4.491
AD	R	9.175	11.091	-1.869	-1.335	-11.266
AD	R	4.091	2.062	0.884	-5.478	-19.007
PV	L	10.741	-1.357	-2.17	-0.47	-2.94
PV	L	8.933	-2.645	-5.733	-1.022	-5.644
PV	L	17.991	7.844	1.957	1.859	-13.175
PV	R	12.595	-1.411	-2.6	-4.117	-8.659
PV	R	3.894	1.615	1.434	8.719	-8.498
PV	R	14.745	19.787	12.405	11.478	-4.589
PD	L	1.274	5.909	5.546	-4.872	-7.059
PD	L	8.565	6.815	4.701	0.848	-11.395
PD	L	12.33	11.987	5.592	7.677	-14.249
PD	R	-1.669	-2.566	-0.983	-8.935	-22.265
PD	R	2.736	8.917	0.569	-4.301	-3.383
PD	R	3.175	0.709	-2.118	-6.711	-4.29

Shark 19 Posterior Scale Angles

Sample	Side	Posterior 1	Posterior 2	Posterior 3	Posterior 4	Posterior 5
AD	L	4.69	3.019	-7.495	-16.607	-19.467
AD	L	5.947	3.516	-1.663	-15.839	-10.268
AD	L	5.011	3.234	6.365	-5.87	-6.425
AD	R	23.878	9.443	2.833	-4.922	-8.802
AD	R	1.669	1.456	-3.218	-9.196	-14.71
AD	R	7.799	7.687	1.537	-13.238	-9.383
PV	L	16.522	1.51	-2.095	-1.96	-4.372
PV	L	16.598	7.135	8.971	-16.766	-11.99

PV	L	9.735	5.993	4.731	-1.589	-18.29
PV	R	6.957	6.618	4.609	-6.525	-6.025
PV	R	11.895	5.79	-2.685	-8.353	-22.931
PV	R	10.616	12.062	16.429	14.757	12.498
PD	L	9.844	-1.058	1.017	-6.706	-20.045
PD	L	5.07	1.908	-2.992	-6.222	-9.808
PD	L	8.616	7.761	-1.588	-3.643	-14.306
PD	R	10.881	-7.904	-1.585	-16.259	-15.66
PD	R	22.66	5.912	-3.235	-11.041	-10.867
PD	R	19.536	1.173	-0.98	-1.552	-27.832

Shark 19 Quarter 1 Scale Angles						
Sample	Side	Quarter 1-1	Quarter 1-2	Quarter 1-3	Quarter 1-4	Quarter 1-5
AD	L	-7.525	-4.201	-5.533	-12.194	-16.355
AD	L	-3.314	-11.853	-8.99	-7.981	-15.567
AD	L	-1.281	-2.184	-8.745	-1.823	-0.521
AD	R	2.995	0.787	-1.545	2.171	0.647
AD	R	2.84	1.071	-3.029	-8.54	-3.742
AD	R	0.152	-4.2	-6.415	3.556	-17.097
PV	L	0.692	-2.403	-2.757	-5.621	-7.872
PV	L	-2.221	-3.612	3.821	5.881	4.008
PV	L	0.563	0.49	1.317	2.706	3.213
PV	R	1.409	-6.548	-8.78	-3.569	-7.304
PV	R	-1.844	-4.868	0.706	2.282	-8.728
PV	R	13.542	11.46	6.479	5.483	3.86
PD	L	1.811	1.841	2.451	1.994	3.891
PD	L	-1.807	-4.061	-5.053	-7.778	-11.197
PD	L	2.677	-0.51	0.552	-2.191	-3.947
PD	R	-3.565	-2.258	-10.987	-7.14	-5.824
PD	R	-1.778	-0.882	-1.985	-1.596	-3.36
PD	R	-0.73	-3.073	-5.801	-4.321	-8.306

Shark 19 Quarter 2 Scale Angles						
Sample	Side	Quarter 2-1	Quarter 2-2	Quarter 2-3	Quarter 2-4	Quarter 2-5
AD	L	-8.097	-10.673	-6.352	-4.686	-2.96
AD	L	-7.7	-6.423	-5.227	-5.304	-1.344

AD	L	-5.071	-2.675	-2.025	-3.347	-4.202
AD	R	-9.6	8.997	3.288	4.918	5.463
AD	R	0.464	-3.469	-5.996	-1.852	5.697
AD	R	-4.801	-7.238	-3.849	-2.994	1.641
PV	L	-8.886	-6.792	-3.197	-3.926	1.776
PV	L	-3.07	-4.433	-3.243	-4.207	0.825
PV	L	-4.445	-2.661	-5.543	-2.512	-5.211
PV	R	-13.937	-4.542	-3.392	-1.187	2.291
PV	R	-3.979	1.968	-6.218	-4.448	-2.231
PV	R	2.189	6.469	1.371	3.286	13.827
PD	L	-8.554	-10.946	-7.847	-3.596	-2.504
PD	L	-4.189	-5.487	-9.641	-6.518	-3.536
PD	L	-3.752	-1.742	-7.181	-3.656	2.532
PD	R	-6.954	-10.925	-1.793	-3.746	-2.253
PD	R	-9.876	-10.852	-10.127	-4.667	-1.285
PD	R	-15.971	4.528	3.471	-5.799	-3.581

Shark 19 Quarter 3 Scale Angles					
Sample	Side	Quarter 3-2	Quarter 3-3	Quarter 3-4	Quarter 3-5
AD	L	1.537	3.273	2.491	1.13
AD	L	-6.582	1.57	-1.241	5.16
AD	L	6.365	0.916	7.837	3.505
AD	R	2.415	6.493	14.305	7.794
AD	R	1.504	5.486	2.163	2.577
AD	R	1.208	2.069	1.178	2.308
PV	L	1.756	4.047	4.55	9.688
PV	L	1.266	-2.498	2.953	8.277
PV	L	3.059	1.402	1.219	3.254
PV	R	5.177	3.455	7.485	10.446
PV	R	2.282	7.582	2.312	6.529
PV	R	18.462	18.854	14.241	11.186
PD	L	2.023	-2.449	1.261	1.188
PD	L	1.955	1.43	-0.899	7.33
PD	L	2.447	2.008	-1.662	2.918
PD	R	-6.509	-2.983	-2.321	2.152
PD	R	-1.604	6.79	4.296	6.338
PD	R	2.667	3.799	8.129	4.764

Shark 19 Quarter 4 Scale Angles					
Sample	Side	Quarter 4-1	Quarter 4-2	Quarter 4-3	Quarter 4-4
AD	L	0.748	2.473	-3.811	-2.934
AD	L	-4.733	0.76	1.906	3.777
AD	L	4.911	-2.384	3.792	2.137
AD	R	3.966	1.592	5.66	3.92
AD	R	6.385	5.014	-0.659	-2.041
AD	R	-6.174	-8.233	-2.493	-4.891
PV	L	-4.523	-6.268	-4.704	3.902
PV	L	8.607	8.081	2.35	2.066
PV	L	9.614	3.773	5.605	3.334
PV	R	10.688	7.032	2.03	5.665
PV	R	3.407	1.127	-3.648	-3.15
PV	R	16.597	15.333	12.052	12.879
PD	L	6.445	0.778	2.967	1.484
PD	L	1.049	0.321	3.131	0.564
PD	L	3.136	7.871	4.84	-1.188
PD	R	3.66	-3.823	-3.962	-2.608
PD	R	1.884	2.859	-1.456	-2.534
PD	R	2.348	-3.049	0.42	2.397

APPENDIX 3. Flume Construction.

The testing required the construction of a flume, I constructed the flume using a 30-gallon fish tank (Aqueon #10030), on one end I drilled a 1 3/8” hole to accommodate a 3/4” bulkhead. Out of the bulkhead, I inserted a 3/4” boiler drain to allow for the adjustment of flow inside the flume. From the boiler drain, I used a water hose to route water back to an 18.9-liter tank. Using a water hose pump (TEEL #1P580) and a variable voltage supply (ETP #9115), water was then routed back to the tank where it could flow across a sheet of plastic (Lexan #1PC0081A). I fixed the sheet of plastic at a 45° angle with the bottom edge 10.0cm above the bottom and end of the tank using marine grade epoxy (DAP #00694). I cut four plastic grids (Plaskolite, Inc. White Louver Sheet) to fit inside the tank and I secured the grids using marine grade epoxy on the top two corners.

APPENDIX 4. List of scale name abbreviations.

Scale Abbreviations	
Abbreviation	Full name
LL	Left Lateral
RL	Right Lateral
A1	Anterior 1
A2	Anterior 2
A3	Anterior 3
A4	Anterior 4
A5	Anterior 5
P1	Posterior 1
P2	Posterior 2
P3	Posterior 3
P4	Posterior 4
P5	Posterior 5
Q 1-1	Quarter 1-1
Q 1-2	Quarter 1-2
Q 1-3	Quarter 1-3
Q 1-4	Quarter 1-4
Q 1-5	Quarter 1-5
Q 2-1	Quarter 2-1
Q 2-2	Quarter 2-2
Q 2-3	Quarter 2-3
Q 2-4	Quarter 2-4
Q 2-5	Quarter 2-5
Q 3-2	Quarter 3-2
Q 3-3	Quarter 3-3
Q 3-4	Quarter 3-4
Q 3-5	Quarter 3-5
Q 4-1	Quarter 4-1
Q 4-2	Quarter 4-2
Q 4-3	Quarter 4-3
Q 4-4	Quarter 4-4