Comparisons of Relative Fishing Powers of Selected SEAMAP Survey Vessels

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Introduction

One of the foremost considerations in any program involved with the collection of samples for estimating species abundance, distribution and trends, is the consistency in how samples are collected. Even small differences in how, when and where samples are taken can result in biases which might lead to incorrect conclusions regarding fluctuations in stock size. To avoid potential sources of uncertainty, most surveys are conducted during the same time frame each year, in the same area, using standardized survey design, techniques, gear, and vessels. This sampling philosophy works well when a single vessel is used as the sampling platform, but when multiple vessels are involved, it becomes necessary to ensure that the "fishing power" of multiple vessels does not differ.

The National Marine Fisheries Service (NMFS), Southeast Fisheries Science Center (SEFSC), Mississippi Laboratory has conducted annual Fall resource assessment surveys in the north-central Gulf of Mexico since 1972, and Summer surveys since 1981. These seasonal surveys, while differing to some extent in objectives and methods, have always used the same sampling gear (12.2-m shrimp trawl) and the same vessel (*NOAA Ship Oregon II*). Procedures and protocols for both surveys were standardized in 1987 to conform with newly established Southeast Area Monitoring and Assessment Program (SEAMAP) sampling requirements, and have remained constant since then.

When SEAMAP (a state, federal and university cooperative program for the collection, management and dissemination of fishery research data in state and federal waters of the Gulf of Mexico) was initiated in 1982, one of the primary objectives was to standardize sampling among

member agencies. During the early years of this program, a wide variety of vessels and gears was used and it was not until 1987 that SEAMAP protocol was developed and implemented to ensure consistency in sampling design, methods, and gear. Some sampling protocols were easily identified and subsequently standardized to enhance data comparability (e.g. net size and design, towing speed, and depth dependent length of towing warp). However, there are other sampling effects that are grossly grouped into a "vessel effects" (or "vessel differences") category, even though they may have nothing to do with the vessels themselves. These include the operator's style of deploying and retrieving nets, noise levels, vessel stability, and towing point (some vessels tow from outriggers while others tow off the stern). It is also important to note that although net size and design, towing speed, and length of towing warp were standardized, there are still subtle manufacturing differences in constructing nets and doors, differences in vessel speed (due to various speed sensors such as LORAN, GPS and Pcode; and the operator's abilities to maintain vessel speed), and differences in determining length of towing warp (some vessels use an electronic meter block while others mark cables at known distances). Thus the potential for inter-vessel differences is very real.

Most state and NMFS trawl data collections from 1987 onward used standardized SEAMAP protocol, and it was intended that these data be combined into a single data base for analysis and dissemination. The data files were never merged, however, because there was no analytical support for the hypothesis of no significant inter-vessel differences in catch rates. Until such differences are qualified and quantified, the State data files have been archived with the NMFS data, but have never been used for analysis of fisheries trends. To resolve the vessel comparability issue, paired comparison tows were conducted between SEAMAP vessels *NOAA*

Ship Oregon II (NMFS), *Research Vessel (R/V) Pelican* (Louisiana Department of Wildlife and Fisheries), *R/V Tommy Munro* (University of Southern Mississippi), and *R/V A.E. Verrill* (Alabama Department of Conservation and Natural Resources). Here we present the results of paired comparison analysis, including a detailed overview of the analytical approach employed.

Materials and Methods

The SEAMAP trawl survey data base contains records from a number of vessels and gears which are no longer being used. From 1982 through 1984, participation included *R/V Tommy Munro, NOAA Ship Oregon II*, several small vessels from Alabama, Louisiana and Texas, and two charter vessels (*R/V Jeff and Tina* and *R/V Suncoaster*). The charter vessels were used on a one-time basis with no paired tows to provide for comparisons of fishing power. The small vessels used 16-ft. nets and sampled shallow inshore waters.

In 1985, the *R/V Pelican* began sampling the offshore waters of Louisiana using a 12.2-m (40-ft) trawl. During 1985 and 1986, the state of Texas attempted unsuccessfully to use 12.2-m (40-ft) trawls on their relatively small vessels and instead adopted a 6.1-m (20-ft) net as their primary sampling gear in 1986. In 1991, the state of Alabama abandoned their small vessel and began using the *R/V A.E. Verrill* and a 12.2-m (40-ft) net.

Four time series of data from the SEAMAP data base appear comparable - *NOAA Ship Oregon II* (1972-present), *R/V Tommy Munro* (1982-present), *R/V Pelican* (1985-present), and *R/V A.E. Verrill* (1991-present). Texas data using a 6.1 m (20-ft) net were not included in the analysis although paired tows between 6.1 and 12.2-m (20 and 40-ft) nets were conducted in

1985. These paired tows provide information on the relationship between the two nets, but cannot be used to address the question of between-vessel variability.

NOAA Ship Oregon II is a 51.8-m (170-ft) steel hull trawler which displaces 952 tons and is powered by two 800-horsepower (hp) diesel engines. Trawls were towed from a 10.7-m (35-ft) outrigger located on the ship's port (left) side. *R/V Tommy Munro* is a 29.3-m (98-ft) steel hull trawler which displaces 159 tons and is powered by two 300-hp diesel engines. Trawls were towed from an 8.5-m (28-ft) outrigger on the vessel's starboard (right) side. *R/V Pelican* is a 32.0-m (105-ft) steel hull trawler powered by two 400-horsepower diesel engines with 244 tons displacement, and *R/V A.E. Verrill* is a 19.4-m (65-ft) steel hull trawler powered by a 235-hp diesel engine (displacement tonnage not available). Trawling on the latter two vessels was conducted off the vessel's stern.

All vessels used 12.2-m (40-ft) semi-balloon shrimp trawls with standard free tickler chains cut 106.7 cm (42 in) shorter than the footrope to stimulate benthic organisms into the paths of trawls. Towing warp-to-depth ratio (in fathoms) was approximately 5:1. All vessels except *R/V A.E. Verrill* used 2.4-m by 110.6-cm (8-ft by 40-in) chain bracketed wooden doors attached to 54.9-m (30-fm) bridles of 1.3 cm (0.5 in) diameter cable which was towed by a cable of 1.3 cm (0.5 in) diameter. Smaller doors, bridle and cable diameter were used on *R/V A.E. Verrill* because of limited power and deck equipment. Doors were 2.1m by 91.4 cm (7 ft by 36 in) and bridle length was 45.7 m (25 fms). Cable diameter for bridles and towing warp was 1.1 cm (7/16 in). Towing speed for all vessels except *R/V Pelican* was 5.6 km/hr (3.0 knots). *R/V Pelican* towed nets at 4.6 km/hr (2.5 kn) to maintain consistency with a prior sampling program.

Two hundred and four comparative tows were conducted among the following SEAMAP sampling vessels; 74 between *NOAA Ship Oregon II* and *R/V Tommy Munro,* 43 between *NOAA*

Ship Oregon II and *R/V Pelican*, 8 between *NOAA Ship Oregon II* and *R/V A.E. Verrill*, 49 between *R/V Tommy Munro* and *R/V Pelican*, and 30 between *R/V Tommy Munro* and *R/V A.E. Verrill*. The 74 tows between *NOAA Ship Oregon II* and *R/V Tommy Munro* were conducted during the Summer (3) and Fall (4) of 1987, Fall 1990 (4), Summer 1991 (3) and Fall 1996 (60). The *R/V Tommy Munro* and *R/V Pelican* experiment was conducted during the Summer of 1994. *NOAA Ship Oregon II* and *R/V Pelican* accomplished 43 tows during the Summer of 1987 (14), Fall 1989 (10), and Summers of 1990 (10) and 1991 (9). Thirty tows between *R/V Tommy Munro* and *R/V A.E. Verrill* were conducted during the Fall of 1987 (4), and Summers of 1990 (4) and 1993 (22); and 8 tows were conducted between *NOAA Ship Oregon II* and *R/V A.E. Verrill* during the Falls of 1987 (4) and 1990 (4).

Statistical analyses were performed on frequently caught species rather than on some meaningful groups of species. A consequence of combining species was the potential inability to detect significant differences due to behavior dissimilarities. One vessel may catch significantly greater numbers of one species while the other vessel may catch significantly greater numbers of another. Combining two such species would mask real differences in catch rates between vessels. Species analyzed were those comprising at least 90% of the numbers of all species caught during respective experiments.

Valid observations used in analyses were defined as paired tows in which a species of interest was caught by each vessel's net. Alternatively, paired tows where zero catch occurred in either or both nets could have been used; however, catch in both nets was considered a definite indicator that a species of interest was available for capture by each vessel's net. A concern in the analyses was that the catch of a species by one vessel's net and not the other's for a paired tow may be due to the patchy distribution of marine organisms rather than any real differences in

fishing power between vessels. The approach chosen was considered conservative in that it guarded against introducing bias into the data and minimized the amount of lost information since any differences in fishing powers between vessels should be evident in paired tows without zero catches as well as tows with zero catches. Catches were standardized to numbers caught per hour fished and were natural log transformed to stabilize heterogeneous variances. We also subjectively omitted observations in which catches in one net exceeded the other by a factor of ten. We determined that such a large difference could never be attributable to differences in vessels and could only result if one net was disabled, or if one net encountered a school of fish while the other did not. Our expectations for measurable differences in vessel fishing power were in the neighborhood of doubling or tripling of catch - a ten fold increase would be too large a difference to attribute only to differences in vessels.

Multiple regression with dummy variables representing species, was used to model catch rates between vessels. Regression analysis was used since the relationship between vessels was assumed to be linear (scatter plots confirmed this assumption). This approach allowed for the development of one model representing all targeted species, which could be resolved into component simple linear models for each individual species. More importantly, this approach provided greater control of experimentwise Type I error rate, α. Performing numerous regression analyses for individual species at a fixed level of α would have resulted in a considerably larger overall experimentwise error rate.

The overall model for *k* species had *k-1* dummy variables and was of the form,

$$\ln_e(C_{Oregon\ II}) = \beta_0 + \beta_1(\ln_e C_{Vessel}) + \beta_2 S_1 + \ldots + \beta_k S_{k-1} + \beta_{k+1}(\ln_e C_{Vessel})(S_1) + \ldots + \beta_{2k-1}(\ln_e C_{Vessel})(S_{k-1})$$

where

C represented the catch of the respective vessels. The k^{th} dummy variable was assigned the value of unity if a catch rate represented species *k*, otherwise S_k assumed a value of zero.

NOAA Ship Oregon II was deemed the dependent variable in all experiments in which this ship participated. SEAMAP's goal was to incorporate data collected by state agencies, with data collected by the National Marine Fisheries Service since 1972 using *NOAA Ship Oregon II*. Thus, if significant differences were found between vessels, the fitted models could be used to convert catch rates of state vessels to that of *NOAA Ship Oregon II*. *R/V Tommy Munro* was deemed the dependent variable in experiments with *R/Vs Pelican* and *A.E. Verrill* since it was centrally located of the three states and was better able to rendezvous for comparative towing. Then *R/V Tommy Munro* could be used as a proxy for all state vessels for comparative towing with *NOAA Ship Oregon II* if necessary.

The null hypothesis of no vessel effect was, H_0: $\beta_0=0$, $\beta_1=1$, $\beta_2=0,\ldots,\beta_{2k-1}=0$. If the null was rejected then statistical output was consulted to determine which regression coefficients caused the hypothesis rejection. Hypothesis testing was conducted at the $\alpha = 0.05$ level of significance.

Results

NOAA Ship Oregon II – R/V Tommy Munro

Twenty-seven species comprised 90.7% of all species caught during paired comparison towing between *NOAA Ship Oregon II* and *R/V Tommy Munro* (Table 1). The average distance between vessels during the experiment was 0.7 nautical miles (nm), and 74 tows yielded 755

observations for analysis. A significantly fitting full model was achieved ($p<0.0001$, $R^2=0.762$) which resulted in a significant difference in catch rates between vessels ($p<0.0001$). Of the 27 species analyzed, 10 resulted in significant differences between vessels (gray sea star, iridescent swimming crab, lesser blue crab, pink shrimp, brown shrimp, fringed flounder, red snapper, rock sea bass, bigeye searobin, and striped anchovy). In all cases, significant differences were due to y-intercept parameters and not slopes. Parameter estimates and associated 95% confidence bounds are listed in Table 2.

NOAA Ship Oregon II – R/V Pelican

Thirty taxa comprised 92.2% of all species caught during paired comparison towing between *NOAA Ship Oregon II* and *R/V Pelican* (Table 3). Species were grouped for five categories (Portunus swimming crab, Trachypenaeus shrimp., Squilla mantis shrimp., Syacium flounder, and Etropus flounder.) owing to identification inconsistencies between vessels (scientists on one vessel identified these groups to the species level but scientists on the other vessel did not). The average distance between vessels was again 0.7 nm, and 43 tows yielded 321 observations for analysis. A significantly fitting full model was achieved ($p<0.0001$, $R^2=0.782$) which resulted in a significant difference in catch rates between vessels ($p<0.0001$). Of the 30 taxa analyzed, 4 resulted in significant differences between vessels (lesser rock shrimp, Trachypenaeus shrimp, bigeye searobin, and silver seatrout). Significant differences were due to y-intercept and slope parameters for three taxa; lesser rock shrimp, Trachypenaeus shrimp, and bigeye searobin. The significant difference for silver seatrout was due to the slope parameter only. Parameter estimates and associated 95% confidence bounds are listed in Table 4.

NOAA Ship Oregon II – R/V A.E. Verrill

Nineteen species comprised 90.6% of all species caught during paired comparison towing between *NOAA Ship Oregon II* and *R/V A.E. Verrill* (Table 5). The average distance between vessels was 1.0 nm, and 8 tows yielded 49 observations for analysis. Five species were dropped from the analysis because they were sampled in only one paired tow (least puffer, fringed flounder, hardhead catfish, striped anchovy, and scaled sardine). A significantly fitting full model was achieved ($p<0.0001$, $R^2=0.932$) which resulted in a significant difference in catch rates between vessels ($p<0.0128$). Sand seatrout was the only species that resulted in a significant difference. Significant differences were due to both y-intercept and slope parameters. Parameter estimates and associated 95% confidence bounds are listed in Table 6.

R/V Tommy Munro – R/V Pelican

Twenty-nine taxa comprised 90.3% of all species caught during paired comparison towing between *R/V Tommy Munro* and *R/V Pelican* (Table 7). Once again species were grouped for two categories (Squid and Syacium flounder) owing to identification inconsistencies between vessels. The average distance between vessels was 0.3 nm, and 49 tows yielded 690 observations for analysis. A significantly fitting full model was achieved ($p<0.0001$, $R^2=0.769$) which resulted in a significant difference in catch rates between vessels ($p<0.0001$). Thirteen taxa resulted in significant differences between vessels (Squid., Atlantic brief squid, brown shrimp, pancake batfish, Syacium flounder, fringed flounder, bay whiff, blackedge cusk-eel, silver seatrout, bigeye searobin, southern hake, inshore lizardfish and bay anchovy). In all cases, significant differences were due to slope parameters and not y-intercepts. Parameter estimates and associated 95% confidence bounds are listed in Table 8.

R/V Tommy Munro – R/V A.E. Verrill

Twenty-six species comprised 90.9% of all species caught during paired comparison towing between *R/V Tommy Munro* and *R/V A.E. Verrill* (Table 9). The average distance between vessels was 0.5 nm, and 30 tows yielded 230 observations for analysis. A significantly fitting full model was achieved ($p<0.0001$, $R^2=0.788$) which resulted in a significant difference in catch rates between vessels ($p<0.0001$). Three species resulted in significant differences between vessels (Atlantic brief squid, fringed flounder, and Gulf butterfish). In all cases, significant differences were due to slope parameters and not y-intercepts. Parameter estimates and associated 95% confidence bounds are listed in Table 10.

Discussion

For vessel comparability studies when the sampling gear is a shrimp trawl, some discussion about the efficiency of the gear and the species that are being sampled is necessary. The otter trawl is a highly efficient commercial fishing gear, but it's effectiveness varies by species. The otter trawl does not sample everything in its path on an equal basis. Therefore, the first major consideration in using an otter trawl as the sampling device is that relative abundance of species in the catch may not be representative of the relative abundance of species in the area. Lack of representation in the catches can either imply that the species is not present or that it is avoiding capture. Net avoidance probably ranges from zero, for sessile organisms, to 100% for larger more mobile species, and probably varies over time and area for most species. Thus in

attempting to evaluate differences in catches between vessels, it is important to consider the biology of the species as well as observed differences in catches.

A second important consideration in gear or vessel comparisons is the spatial distribution of the species captured. Most groundfish species are not randomly distributed across the study area. In fact, most fish and shrimp exhibit clumped distributions, and it is often possible for one net to encounter schools of fish while a net fished from the other side of the vessel might miss the school entirely. Given a large enough number of samples, large catches in one or the other net should balance out if the nets are fishing equally, but with small sample sizes a large catch in one net can lead to erroneous conclusions regarding comparability of gear or vessels. As with the problem of net avoidance noted above, schooling behavior and clumped distributions of species must be considered in evaluating observed differences in catches between nets or vessels. It must always be remembered that the purpose of these comparisons is to identify differences attributable to vessels, not behavior of species. If the differences can be explained by known behavior of a species, extreme caution must be used in attributing observed differences to gear or vessels.

A third consideration in paired tow comparisons is the actual habitat encountered by each net. In a fifteen minute tow, the net covers approximately 0.75 nm of bottom. The bottom in the northern Gulf of Mexico is not uniform, but contains depression, high areas, occasional rocks or other relief, and consists of sand, mud, clay, shell rubble, or some combination of sediment types. Each of these micro-habitats may contain different species assemblages, and the size of these areas may range from a few square meters to hundreds of square meters. Therefore,

differences between vessels or nets may often reflect differences in the habitats sampled or time spent sampling each habitat rather than true differences in the performance of the vessels or gear. When sample sizes are adequate, these differences are assumed to equal out - with small sample sizes, large differences due to chance alone may be observed.

NOAA Ship Oregon II – R/V Tommy Munro

Ten species resulted in significant differences in catch rates between vessels (gray sea star, iridescent swimming crab, lesser blue crab, pink shrimp, brown shrimp, fringed flounder, red snapper, rock sea bass, bigeye searobin, and striped anchovy). We noticed that in all cases, significant differences were due to y-intercept parameters and not slopes. This caused us to question the appropriateness of the model form. We therefore re-analyzed the data restricting slope values to unity (equivalent to t-tests for dependent samples). Results were very different in that none of the above species persisted in showing significant differences between vessels but three other species did (roughback shrimp, Atlantic croaker, and bigeye searobin).

$$\begin{aligned} \textit{Roughback shrimp}: Catch_{Oregon\,II} &= (2.3)\, Catch_{Munro} \\ \textit{Atlantic croaker}: Catch_{Oregon\,II} &= (0.8)\, Catch_{Munro} \\ \textit{Bigeye searobin}: Catch_{Oregon\,II} &= (1.7)\, Catch_{Munro} \end{aligned}$$

We interpreted this as an indication of the importance of the proper model form, and weak evidence of true vessel differences. If vessel differences were indeed significant, then such differences should prevail under both model forms.

We found it difficult to conclude that there were real differences in fishing power between vessels considering the inconsistent results. Ten species resulted in significant differences between vessels employing models with y-intercepts and slopes. However, in all cases the slope parameter was not significantly different from one. Remodeling the data with

slopes set to unity resulted in none of the previous ten species indicating significant differences, but three additional species did. Such inconsistent results provided weak support to conclude real differences due to vessel effects. There were also inconsistencies in results among species exhibiting similar behavior. One species of shrimp resulted in significant differences between vessels but five other shrimp species did not (brown rock, white, pink, brown and common mantis shrimp). Figure 5 indicates that *NOAA Ship Oregon II* did indeed catch greater numbers of roughback shrimp but this may have been due to sampling more favorable habitat. Another factor worthy of consideration is the similarity in sub-sampling by scientists between ships. Over- or under-sampling of catches can result in over- or under-estimating of densities. Atlantic croaker resulted in significant differences between vessels but other sciaenid members spot and sand seatrout did not. Figure 16 shows rather puzzling results in that data points appear to be evenly distributed about the hypothesized line of no difference between vessels (except near the origin where *R/V Tommy Munro* sampled a greater number of individuals and the fitted line briefly exceeds the 95% confidence interval for the hypothesized line). And bigeye searobin resulted in significant differences between vessels but blackwing searobin did not. Figure 24 indicates that *NOAA Ship Oregon II* sampled greater numbers of bigeye searobin but this pattern did not persist throughout the range of data.

Furthermore, both vessels sampled very similar numbers of organisms upon combining species for the entire experiment (249,000 and 244,000 for *NOAA Ship Oregon II* and *R/V Tommy Munro* respectively). We found it difficult to conclude that there were true vessel differences when only three of twenty-seven species resulted in significant differences. We therefore concluded that the observed differences in catch rates between vessels, were due to the contagious distribution of organisms rather than to real vessel effects.

NOAA Ship Oregon II – R/V Pelican

Four of thirty taxa resulted in significant differences in catch rates between vessels (lesser rock shrimp, Trachypenaeus shrimp, bigeye searobin, and silver seatrout). Significant differences for the first three were due to y-intercepts and slopes while the latter was due to the slope only. Data for silver seatrout were therefore refitted with the line forced through the origin. Subsequent testing of the slope parameter resulted in a value not significantly different from zero.

$$\begin{aligned} \textit{Lesser rock shrimp}: Catch_{Oregon\,II} &= (0.071)\, Catch_{Pelican}^{1.344} \\ \textit{Trachypenaeus shrimp}: Catch_{Oregon\,II} &= (0.084)\, Catch_{Pelican}^{1.274} \\ \textit{Bigeye searobin}: Catch_{Oregon\,II} &= (0.157)\, Catch_{Pelican}^{1.271} \\ \textit{Silver seatrout}: Catch_{Oregon\,II} &= Catch_{Pelican}^{0.948} \end{aligned}$$

Again we found it difficult to conclude that there were true differences in fishing power between vessels. Only three of thirty species resulted in significant differences in catch rates. Lesser rock shrimp resulted in a significant difference between vessels but this was based on six observations that were highly variable (Figure 32). Also, the fitted line lay within the 95% confidence interval for the hypothesized, no-difference line. We question whether the observed differences between vessels would persist with increased sampling. The Trachypenaeus shrimp result was based on 13 observations which was still relatively small considering the inherent variation in fisheries catch data (Figure 33). Again, the fitted line lay within the 95% confidence interval of the hypothesized line except near the origin. The bigeye searobin result was similar to that of lesser rock shrimp in that it was based on six observations and the fitted line lay within the 95% confidence interval (Figure 55).

NOAA Ship Oregon II – R/V A.E. Verrill

One species (sand seatrout) of nineteen tested resulted in a significant difference in catch rates between *NOAA Ship Oregon II* and *R/V A.E. Verrill*. The significant difference was due to both the y-intercept and slope parameters. This result was based on only three observations and we again question this result in light of an increase in sample size. We also found it noteworthy that both vessels caught the same number of individuals in two of the three tows (Figure 67). Apparently the log transformation stabilized the variance to the extent that the observed significant difference was detectable.

$$Sand\ seatrout: Catch_{Oregon\ II} = (0.004)\, Catch_{Verrill}^{2.215}$$

R/V Tommy Munro – R/V Pelican

Thirteen of twenty-nine taxa resulted in significant differences in catch rates between vessels (Squid, Atlantic brief squid, brown shrimp, pancake batfish, Syacium flounder, fringed flounder, bay whiff, blackedge cusk-eel, silver seatrout, bigeye searobin, southern hake, inshore lizardfish and bay anchovy). In all cases significant differences were due to slope parameters and not y-intercepts; therefore, we re-analyzed the data forcing y-intercepts through the origin. Ten species resulted in significant differences between vessels but only bigeye searobin, southern hake, and bay anchovy repeated from the original analysis. Additional species resulting in significant differences were lesser rock shrimp, least puffer, ragged goby, Gulf butterfish, Atlantic cutlassfish, dwarf sand perch, and striped anchovy.

$$Lesser\ rock\ shrimp: Catch_{Munro} = Catch_{Pelican}^{0.938}$$
$$Least\ puffer: Catch_{Munro} = Catch_{Pelican}^{0.840}$$
$$Ragged\ goby: Catch_{Munro} = Catch_{Pelican}^{0.839}$$
$$Gulf\ butterfish: Catch_{Munro} = Catch_{Pelican}^{1.178}$$
$$Atlantic\ cutlassfish: Catch_{Munro} = Catch_{Pelican}^{1.088}$$
$$Dwarf\ sand\ perch: Catch_{Munro} = Catch_{Pelican}^{1.103}$$
$$Bigeye\ searobin: Catch_{Munro} = Catch_{Pelican}^{0.910}$$
$$Southern\ hake: Catch_{Munro} = Catch_{Pelican}^{0.839}$$
$$Bay\ anchovy: Catch_{Munro} = Catch_{Pelican}^{0.869}$$
$$Striped\ anchovy: Catch_{Munro} = Catch_{Pelican}^{0.857}$$

Results were inconsistent in that *R/V Pelican* sampled significantly greater numbers of seven species and *R/V Tommy Munro* sampled significantly greater numbers of three species. This result was difficult to explain since we expected one vessel to consistently "outfish" the other in experiments where significant differences were found.

Scatter plots indicated no significant difference between vessels for lesser rock shrimp and Atlantic cutlassfish since the fitted line lay within the 95% confidence interval for the hypothesized no-difference line for lesser rock shrimp (Figure 76), and the fitted line lay outside the limits for only a segment of the data range for Atlantic cutlassfish (Figure 89). Scatter plots for the remaining eight species agreed with results of hypothesis testing in that fitted lines lay almost exclusively outside of 95% confidence intervals (Figures 82, 87, 88, 95, 96, 97, 99, and 100).

R/V Tommy Munro – R/V A.E. Verrill

Three of twenty-three species analyzed resulted in significant differences in catch rates between vessels (Atlantic brief squid, fringed flounder, and Gulf butterfish). In all cases, significant differences were due to slope parameters and not y-intercepts. Re-modeling the data forcing lines through origins resulted in four species, other than the previous, with significant differences in catch rates (lesser blue crab, common mantis shrimp, dwarf sand perch, and largescale lizardfish).

$$\begin{aligned} \textit{Lesser blue crab} &: Catch_{Munro} = Catch_{Verrill}^{1.182} \\ \textit{Common mantis shrimp} &: Catch_{Munro} = Catch_{Verrill}^{1.763} \\ \textit{Dwarf sand perch} &: Catch_{Munro} = Catch_{Verrill}^{1.200} \\ \textit{Largescale lizardfish} &: Catch_{Munro} = Catch_{Verrill}^{0.889} \end{aligned}$$

R/V Tommy Munro sampled significantly greater numbers of three species (Figures 105, 109, and 119) and *R/V A.E. Verrill* sampled significantly greater numbers of one species (Figure 124). We considered this to be inconclusive evidence of true differences in sampling efficiencies of the respective vessels.

Summary

All five experiments resulted in significant differences in catch rates between vessels; however, relatively few species caused the observed differences. Four species or less caused significant differences in four experiments and ten species caused the observed significant difference in the fifth. These results were somewhat inconsistent as species exhibiting significant differences were dependent upon the form of the model tested. Results depended on whether models contained both y-intercept and slope parameters, or just one of the two parameters. Only three species gave similar results irrespective of model form. If true vessel

effects were present, we expected the observed significant differences to persist regardless of the model form tested.

Although hypothesis testing of y-intercept and slope parameters for some species resulted in significant differences in catch rates, scatter plots of fitted lines for most species were either exclusively or partially contained within 95% confidence intervals about the hypothesized line of no difference between vessels.

There also appeared to be no consistent evidence of one vessel consistently sampling greater numbers of individuals than the other. Within experiments, one vessel sampled significantly greater numbers of some species while the paired vessel sampled significantly greater numbers of other species. If true vessel effects were present, we expected to observe one vessel consistently catching greater numbers of individuals in comparison to it's paired counterpart.

We also question some of the observed differences because they were based on a relatively small number of observations. Some of the observed differences may disappear with increased sampling.

Although hypothesis testing resulted in significant differences in catch rates between vessels, the lack of consistency in results led us to conclude that observed differences were due to the contagious distribution of organisms rather than to real effects of vessels.

Table1. Species analyzed in comparing the relative fishing powers of *NOAA Ship Oregon II* and *Research Vessel Tommy Munro*. Scientific names are provided in Appendix 1. "Capture Frequency" is the number of paired tows in which a species was caught by each vessel's net and "number caught" is the sums of individuals caught by each vessel's net including only paired tows in which a species was caught by both nets.

	Name	Capture Frequency	Number Caught		Ratio of Respective Vessels Set to Unity
			NOAA Ship Oregon II	*Research Vessel Tommy Munro*	
1	Gray sand star	12	436	644	1.00 : 1.48
2	Iridescent swimming crab	43	5,048	3,485	1.45 : 1.00
3	Lesser blue crab	35	4,934	3,512	1.41 : 1.00
4	Brown rock shrimp	21	1,101	1,019	1.08 : 1.00
5	Roughback shrimp	15	1,424	488	2.92 : 1.00
6	White shrimp	32	1,291	1,699	1.00 : 1.32
7	Pink shrimp	25	848	872	1.00 : 1.03
8	Brown shrimp	48	3,008	2,791	1.08 : 1.00
9	Common mantis shrimp	24	1,584	1,244	1.27 : 1.00
10	Least puffer	22	1,424	743	1.92 : 1.00
11	Fringed flounder	22	618	616	1.00 : 1.00
12	Gulf butterfish	36	5,343	5,213	1.03 : 1.00
13	Harvestfish	22	1,604	1,500	1.07 : 1.00
14	Longspine porgy	26	22,416	17,404	1.29 : 1.00
15	Pinfish	17	1,716	1,504	1.14 : 1.00
16	Atlantic croaker	53	45,576	47,982	1.00 : 1.05
17	Spot	39	15,288	14,305	1.07 : 1.00
18	Sand seatrout	16	618	421	1.47 : 1.00
19	Red snapper	19	500	488	1.02 : 1.00
20	Atlantic bumper	47	103,658	113,525	1.00 : 1.10
21	Rock sea bass	20	650	514	1.26 : 1.00
22	Dwarf sand perch	16	2,348	1,622	1.45 : 1.00
23	Blackwing searobin	13	210	256	1.00 : 1.22
24	Bigeye searobin	44	15,744	8,568	1.84 : 1.00
25	Inshore lizardfish	33	1,190	931	1.28 : 1.00
26	Striped anchovy	32	5,646	8,900	1.00 : 1.58
27	Scaled sardine	23	4,507	3,928	1.15 : 1.00
	Sums	755	248,731	244,174	1.02 : 1.00

Table 2. Sample sizes, parameter estimates and associated 95% confidence bounds for species analyzed to compare the relative fishing powers of *NOAA Ship Oregon II* and *Research Vessel Tommy Munro*. Y-intercepts and associated confidence bounds were de-transformed to the arithmetic scale.

	Name	n	Lower Bound	$\hat{\beta}_0$	Upper Bound	Lower Bound	$\hat{\beta}_1$	Upper Bound
1	Gray sand star	12	0.7	6.6	65.2	-0.3	0.4	1.0
2	Iridescent swimming crab	43	1.2	3.3	8.7	0.5	0.8	1.0
3	Lesser blue crab	35	1.1	3.7	12.7	0.4	0.7	1.0
4	Brown rock shrimp	21	0.7	2.4	8.7	0.3	0.7	1.1
5	Roughback shrimp	15	0.2	1.3	9.5	0.6	1.2	1.8
6	White shrimp	32	1.1	2.9	8.2	0.4	0.6	0.9
7	Pink shrimp	25	1.8	3.9	8.7	0.3	0.6	0.8
8	Brown shrimp	48	1.7	4.1	10.3	0.4	0.6	0.9
9	Common mantis shrimp	24	1.3	3.4	9.1	0.5	0.7	1.0
10	Least puffer	22	0.5	2.8	15.7	0.2	0.8	1.3
11	Fringed flounder	22	2.2	7.0	22.2	-0.1	0.3	0.7
12	Gulf butterfish	36	0.4	1.5	5.2	0.6	0.9	1.2
13	Harvestfish	22	0.2	0.7	2.5	0.7	1.1	1.4
14	Longspine porgy	26	1.1	2.4	5.1	0.8	0.9	1.0
15	Pinfish	17	0.4	1.7	6.6	0.5	0.8	1.2
16	Atlantic croaker	53	0.4	0.9	1.8	0.9	1.0	1.1
17	Spot	39	1.4	2.4	4.3	0.7	0.8	1.0
18	Sand seatrout	16	1.0	5.2	27.9	-0.1	0.5	1.0
19	Red snapper	19	1.9	5.6	16.4	0.1	0.4	0.8
20	Atlantic bumper	47	0.8	1.7	3.5	0.8	0.9	1.0
21	Rock sea bass	20	5.6	17.5	55.0	-0.2	0.2	0.5
22	Dwarf sand perch	16	0.3	2.3	16.5	0.4	0.9	1.3
23	Blackwing searobin	13	1.1	4.6	19.3	-0.1	0.4	0.9
24	Bigeye searobin	44	1.1	2.7	6.5	0.7	0.9	1.1
25	Inshore lizardfish	33	0.8	2.0	4.7	0.5	0.8	1.1
26	Striped anchovy	32	2.4	6.5	17.3	0.4	0.6	0.8
27	Scaled sardine	23	1.0	2.7	8.2	0.6	0.8	1.1

Table 3. Species analyzed in comparing the relative fishing powers of *NOAA Ship Oregon II* and *Research Vessel Pelican*. Scientific names are provided in Appendix 1. "Capture Frequency" is the number of paired tows in which a species was caught by each vessel's net and "number caught" is the sums of individuals caught by each vessel's net including only paired tows in which a species was caught by both nets.

	Name	Capture Frequency	Number Caught		Ratio of Respective Vessels Set to Unity
			NOAA Ship Oregon II	*Research Vessel Pelican*	
1	Longfin squid	13	2,209	1,057	2.09 : 1.00
2	Atlantic brief squid	15	2,005	2,845	1.00 : 1.42
3	Portunus swimming crab	19	2,727	3,957	1.00 : 1.45
4	Lesser blue crab	18	3,381	10,802	1.00 : 3.19
5	Lesser rock shrimp	6	1,630	1,337	1.22 : 1.00
6	Trachypenaeus shrimp	13	39,602	38,756	1.02 : 1.00
7	White shrimp	8	126	162	1.00 : 1.29
8	Brown shrimp	22	4,105	4,114	1.00 : 1.00
9	Squilla mantis shrimp	14	12,427	14,840	1.00 : 1.19
10	Atlantic midshipman	5	101	76	1.33 : 1.00
11	Least puffer	5	247	647	1.00 : 2.62
12	Blackcheek tonguefish	7	358	344	1.04 : 1.00
13	Syacium flounder	9	650	2,305	1.00 : 3.54
14	Etropus flounder	12	313	839	1.00 : 2.68
15	Gulf butterfish	6	569	865	1.00 : 1.52
16	Atlantic cutlassfish	7	3,053	4,937	1.00 : 1.62
17	Bearded brotula	6	179	187	1.00 : 1.04
18	Longspine porgy	16	2,924	2,182	1.34 : 1.00
19	Atlanitic croaker	16	3,427	4,242	1.00 : 1.24
20	Silver seatrout	10	1,805	1,174	1.54 : 1.00
21	Sand seatrout	10	567	1,199	1.00 : 2.11
22	Lane snapper	6	162	78	2.08 : 1.00
23	Red snapper	8	210	335	1.00 : 1.59
24	Atlantic bumper	11	1,698	2,385	1.00 : 1.41
25	Rock sea bass	21	2,305	3,061	1.00 : 1.33
26	Blackear bass	6	1,081	572	1.89 : 1.00
27	Dwarf sand perch	12	1,114	1,596	1.00 : 1.43
28	Bigeye searobin	6	2,389	2,546	1.00 : 1.07
29	Hardhead catfish	5	3,984	2,102	1.90 : 1.00
30	Inshore lizardfish	9	248	500	1.00 : 2.02
	Sums	321	95,594	110,041	1.00 : 1.15

Table 4. Sample sizes, parameter estimates and associated 95% confidence bounds for species analyzed to compare the relative fishing powers of *NOAA Ship Oregon II* and *Research Vessel Pelican*. Y-intercepts and associated confidence bounds were de-transformed to the arithmetic scale.

	Name	n	Lower Bound	$\hat{\beta}_0$	Upper Bound	Lower Bound	$\hat{\beta}_1$	Upper Bound
1	Longfin squid	13	0.1	25.7	5,655.3	-0.9	0.3	1.6
2	Atlantic brief squid	15	0.4	1.6	7.6	0.5	0.8	1.2
3	Portunus swimming crab	19	0.4	1.4	5.0	0.5	0.8	1.0
4	Lesser blue crab	18	0.2	0.9	2.9	0.6	0.8	1.0
5	Lesser rock shrimp	6	0.0	0.1	9.8	0.4	1.3	2.3
6	Trachypenaeus shrimp	13	0.0	0.1	1.3	0.9	1.3	1.6
7	White shrimp	8	0.6	5.8	58.1	-0.5	0.3	1.1
8	Brown shrimp	22	0.3	0.8	2.1	0.8	1.0	1.2
9	Squilla mantis shrimp	14	0.2	0.4	0.9	0.9	1.1	1.2
10	Atlantic midshipman	5	0.0	0.3	2.4	0.6	1.4	2.2
11	Least puffer	5	13.7	387.6	10,934.6	-1.2	-0.5	0.2
12	Blackcheek tonguefish	7	0.0	1.8	475.0	-0.8	0.7	2.2
13	Syacium flounder	9	0.4	3.2	23.9	0.1	0.5	1.0
14	Etropus flounder	12	0.4	2.0	8.8	0.2	0.6	1.0
15	Gulf butterfish	6	0.0	2.3	677.8	-0.6	0.7	1.9
16	Atlantic cutlassfish	7	0.1	0.4	2.6	0.7	1.0	1.4
17	Bearded brotula	6	0.2	9.5	475.3	-0.9	0.3	1.4
18	Longspine porgy	16	0.1	0.8	5.0	0.6	1.0	1.4
19	Atlanitic croaker	16	1.2	3.4	9.4	0.5	0.7	0.9
20	Silver seatrout	10	0.0	0.2	6.3	0.5	1.3	2.2
21	Sand seatrout	10	1.5	3.7	9.6	0.4	0.6	0.8
22	Lane snapper	6	0.0	2.8	236.5	-1.1	0.7	2.5
23	Red snapper	8	0.0	0.3	9.2	0.2	1.2	2.2
24	Atlantic bumper	11	0.9	3.7	15.7	0.4	0.8	1.1
25	Rock sea bass	21	0.2	0.8	2.5	0.6	0.9	1.2
26	Blackear bass	6	0.0	5.1	6,528,682	-2.5	0.6	3.7
27	Dwarf sand perch	12	0.3	2.2	15.3	0.3	0.8	1.2
28	Bigeye searobin	6	0.0	0.2	9.8	0.5	1.3	2.1
29	Hardhead catfish	5	0.0	0.3	9.2	0.5	1.2	1.9
30	Inshore lizardfish	9	0.3	4.7	64.9	-0.3	0.4	1.1

Table 5. Species analyzed in comparing the relative fishing powers of *NOAA Ship Oregon II* and *Research Vessel A.E. Verrill*. Scientific names are provided in Appendix 1. "Capture Frequency" is the number of paired tows in which a species was caught by each vessel's net and "number caught" is the sums of individuals caught by each vessel's net including only paired tows in which a species was caught by both nets.

	Name	Capture Frequency	Number Caught		Ratio of Respective Vessels Set to Unity
			NOAA Ship Oregon II	*Research Vessel A.E. Verrill*	
1	Keyhole sand dollar	3	378	894	1.00 : 2.37
2	Atlantic brief squid	3	450	114	3.95 : 1.00
3	Iridescent swimming crab	4	464	310	1.50 : 1.00
4	Lesser blue crab	4	430	234	1.84 : 1.00
5	Brown rock shrimp	4	64	106	1.00 : 1.66
6	White shrimp	4	286	156	1.83 : 1.00
7	Brown shrimp	2	202	56	3.61 : 1.00
8	Least puffer	1	32	12	2.67 : 1.00
9	Fringed flounder	1	200	92	2.17 : 1.00
10	Gulf butterfish	2	12	28	1.00 : 2.42
11	Atlanitic croaker	4	3,680	3,836	1.00 : 1.04
12	Sand seatrout	3	66	42	1.00 : 1.57
13	Pigfish	3	112	164	1.00 : 1.46
14	Atlantic bumper	2	447	213	2.09 : 1.00
15	Rock sea bass	2	38	10	3.80 : 1.00
16	Atlantic threadfin	4	94	94	1.00 : 1.00
17	Hardhead catfish	1	3	3	1.00 : 1.00
18	Striped anchovy	1	87	63	1.37 : 1.00
19	Scaled sardine	1	9	5	1.67 : 1.00
	Sums	49	7,053	6,434	1.10 : 1.00

Table 6. Sample sizes, parameter estimates and associated 95% confidence bounds for species analyzed to compare the relative fishing powers of *NOAA Ship Oregon II* and *Research Vessel A.E. Verrill*. Y-intercepts and associated confidence bounds were de-transformed to the arithmetic scale.

	Name	n	Lower Bound	$\hat{\beta}_0$	Upper Bound	Lower Bound	$\hat{\beta}_1$	Upper Bound
1	Keyhole sand dollar	3	0.0	27.7	14,366,803	-2.2	0.3	2.8
2	Atlantic brief squid	3	0.0	12.2	977,700,000	-5.8	0.7	7.2
3	Iridescent swimming crab	4	0.0	6.1	15,582,457	-2.8	0.7	4.1
4	Lesser blue crab	4	0.0	1.8	229.8	-0.3	1.0	2.3
5	Brown rock shrimp	4	0.0	111.5	49,309157	-4.8	-0.7	3.4
6	White shrimp	4	0.8	92.2	10,612.9	-1.4	-0.1	1.3
7	Brown shrimp	2						
8	Least puffer	1						
9	Fringed flounder	1						
10	Gulf butterfish	2						
11	Atlanitic croaker	4	0.0	2.1	2,198.7	-0.2	0.9	2.0
12	Sand seatrout	3	0.0	0.4	4,173.7	-2.2	1.5	5.2
13	Pigfish	3	0.0	4.8	72,810,000,000	-7.7	0.5	8.6
14	Atlantic bumper	2						
15	Rock sea bass	2						
16	Atlantic threadfin	4	0.0	6.6	970.5	-1.2	0.4	2.0
17	Hardhead catfish	1						
18	Striped anchovy	1						
19	Scaled sardine	1						

Table 7. Species analyzed in comparing the relative fishing powers of *Research Vessels Tommy Munro* and *Pelican*. Scientific names are provided in Appendix 1. "Capture Frequency" is the number of paired tows in which a species was caught by each vessel's net and "number caught" is the sums of individuals caught by each vessel's net including only paired tows in which a species was caught by both nets.

	Name	Capture Frequency	Number Caught		Ratio of Respective Vessels Set to Unity
			Research Vessel Tommy Munro	*Research Vessel Pelican*	
1	Squid	15	400	485	1.00 : 1.21
2	Atlantic brief squid	41	13,680	15,805	1.00 : 1.16
3	Iridescent swimming crab	20	4,932	2,808	1.76 : 1.00
4	Lesser blue crab	25	4,672	3,336	1.40 : 1.00
5	Lesser rock shrimp	23	8,868	11,162	1.00 : 1.26
6	Roughback shrimp	32	115,416	92,556	1.25 : 1.00
7	Brown shrimp	34	1,164	873	1.33 : 1.00
8	Mantis shrimp	15	2,188	2,400	1.00 : 1.10
9	Common mantis shrimp	36	21,484	21,280	1.01 : 1.00
10	Pancake batfish	20	1,676	1,453	1.15 : 1.00
11	Least puffer	19	804	1,304	1.00 : 1.62
12	Syacium flounder	43	10,900	11,027	1.00 : 1.01
13	Fringed flounder	26	1,100	1,236	1.00 : 1.12
14	Bay whiff	8	208	196	1.06 : 1.00
15	Blackedge cusk-eel	16	1,032	1,412	1.00 : 1.37
16	Ragged goby	19	2,608	5,792	1.00 : 2.22
17	Gulf butterfish	25	8,036	2,176	3.69 : 1.00
18	Atlantic cutlassfish	20	9,380	6,023	1.56 : 1.00
19	Bearded brotula	12	372	708	1.00 : 1.90
20	Atlantic croaker	18	29,320	19,717	1.49 : 1.00
21	Silver seatrout	37	7,188	6,127	1.17 : 1.00
22	Sand seatrout	32	6,160	5,167	1.19 : 1.00
23	Rock sea bass	22	2,128	2,905	1.00 : 1.36
24	Dwarf sand perch	20	3,252	1,948	1.67 : 1.00
25	Bigeye searobin	39	11,572	16,179	1.00 : 1.40
26	Southern hake	21	1,008	2,328	1.00 : 2.31
27	Inshore lizardfish	19	456	436	1.05 : 1.00
28	Bay anchovy	13	1,884	4,575	1.00 : 2.43
29	Striped anchovy	20	4,228	9,093	1.00 : 2.15
	Sums	690	276,116	250,507	1.10 : 1.00

Table 8. Sample sizes, parameter estimates and associated 95% confidence bounds for species analyzed to compare the relative fishing powers of *Research Vessels Tommy Munro* and *Pelican*. Y-intercepts and associated confidence bounds were de-transformed to the arithmetic scale.

	Name	n	Lower Bound	$\hat{\beta}_0$	Upper Bound	Lower Bound	$\hat{\beta}_1$	Upper Bound
1	Squid	15	0.9	7.1	55.2	-0.3	0.3	0.9
2	Atlantic brief squid	41	1.9	4.2	9.3	0.6	0.7	0.9
3	Iridescent swimming crab	20	0.2	0.9	4.8	0.6	1.0	1.4
4	Lesser blue crab	25	0.4	1.5	6.0	0.6	0.9	1.2
5	Lesser rock shrimp	23	0.2	0.9	4.0	0.7	1.0	1.2
6	Roughback shrimp	32	0.0	0.3	2.2	0.9	1.2	1.4
7	Brown shrimp	34	2.3	7.1	21.8	0.0	0.4	0.7
8	Mantis shrimp	15	0.2	1.9	15.3	0.4	0.8	1.3
9	Common mantis shrimp	36	0.2	0.6	2.0	0.8	1.1	1.3
10	Pancake batfish	20	1.0	3.7	13.7	0.3	0.7	1.1
11	Least puffer	19	0.4	1.4	5.8	0.4	0.8	1.1
12	Syacium flounder	43	2.5	5.6	12.4	0.5	0.7	0.8
13	Fringed flounder	26	3.3	12.6	48.1	-0.1	0.3	0.6
14	Bay whiff	8	0.2	17.1	1,690.2	-1.5	0.0	1.5
15	Blackedge cusk-eel	16	3.3	7.9	18.9	0.3	0.5	0.7
16	Ragged goby	19	0.3	1.2	4.3	0.6	0.8	1.0
17	Gulf butterfish	25	0.4	1.2	4.3	0.8	1.1	1.4
18	Atlantic cutlassfish	20	1.6	6.5	26.0	0.5	0.7	1.0
19	Bearded brotula	12	0.8	2.3	6.6	0.3	0.7	1.0
20	Atlantic croaker	18	1.0	2.8	8.0	0.7	0.9	1.1
21	Silver seatrout	37	3.6	7.8	16.6	0.5	0.6	0.8
22	Sand seatrout	32	0.4	1.2	4.2	0.6	0.9	1.2
23	Rock sea bass	22	0.7	2.3	8.0	0.5	0.7	1.0
24	Dwarf sand perch	20	0.5	1.5	4.4	0.8	1.0	1.3
25	Bigeye searobin	39	0.9	2.2	5.8	0.6	0.8	0.9
26	Southern hake	21	2.5	6.7	17.9	0.2	0.4	0.6
27	Inshore lizardfish	19	0.8	0.4	34.7	-0.3	0.4	1.0
28	Bay anchovy	13	1.8	8.5	40.3	0.2	0.5	0.8
29	Striped anchovy	20	0.4	2.1	11.3	0.4	0.7	1.0

Table 9. Species analyzed in comparing the relative fishing powers of *Research Vessels Tommy Munro* and *A.E. Verrill*. Scientific names are provided in Appendix 1. "Capture Frequency" is the number of paired tows in which a species was caught by each vessel's net and "number caught" is the sums of individuals caught by each vessel's net including only paired tows in which a species was caught by both nets.

	Name	Capture Frequency	Number Caught		Ratio of Respective Vessels Set to Unity
			Research Vessel Tommy Munro	*Research Vessel A.E. Verrill*	
1	Gray sand star	14	1,120	909	1.23 : 1.00
2	Longfin squid	4	686	1,014	1.00 : 1.48
3	Atlantic brief squid	10	1,771	1,242	1.43 : 1.00
4	Iridescent swimming crab	8	316	248	1.27 : 1.00
5	Lesser blue crab	14	1,253	587	2.13 : 1.00
6	Blue crab	8	72	75	1.00 : 1.04
7	White shrimp	7	519	208	2.50 : 1.00
8	Brown shrimp	6	209	100	2.10 : 1.00
9	Common mantis shrimp	8	184	42	4.43 : 1.00
10	Shelf flounder	6	208	276	1.00 : 1.33
11	Fringed flounder	13	352	375	1.00 : 1.06
12	Gulf butterfish	10	2,094	3,928	1.00 : 1.88
13	Longspine porgy	11	20,832	14,008	1.49 : 1.00
14	Atlantic croaker	6	7,610	3,780	2.01 : 1.00
15	Sand seatrout	5	604	820	1.00 : 1.36
16	Red snapper	10	1,232	859	1.43 : 1.00
17	Atlantic bumper	8	1,963	2,447	1.00 : 1.25
18	Rock sea bass	8	74	104	1.00 : 1.41
19	Dwarf sand perch	12	930	401	2.32 : 1.00
20	Blackwing searobin	3	128	38	3.37 : 1.00
21	Bigeye searobin	11	317	402	1.00 : 1.27
22	Hardhead catfish	7	138	87	1.00 : 1.58
23	Inshore lizardfish	16	1,673	1,733	1.00 : 1.04
24	Largescale lizardfish	11	5,964	14,257	1.00 : 2.39
25	Striped anchovy	6	1,380	2,182	1.00 : 1.58
26	Scaled sardine	8	744	1,289	1.00 : 1.73
	Sums	230	52,373	51,411	1.02 : 1.00

Table 10. Sample sizes, parameter estimates and associated 95% confidence bounds for species analyzed to compare the relative fishing powers of *Research Vessels Tommy Munro* and *A.E. Verrill*. Y-intercepts and associated confidence bounds were de-transformed to the arithmetic scale.

	Name	n	Lower Bound	$\hat{\beta}_0$	Upper Bound	Lower Bound	$\hat{\beta}_1$	Upper Bound
1	Gray sand star	14	0.8	7.2	68.8	-0.1	0.5	1.1
2	Longfin squid	4	0.0	3.8	5,456.4	-0.8	0.7	2.1
3	Atlantic brief squid	10	3.2	43.1	589.7	-0.3	0.2	0.8
4	Iridescent swimming crab	8	0.0	0.4	12.9	0.1	1.2	2.3
5	Lesser blue crab	14	0.8	3.9	18.7	0.3	0.8	1.3
6	Blue crab	8	1.1	8.9	70.8	-1.0	0.0	0.9
7	White shrimp	7	8.6	239.0	6,635.6	-1.4	-0.4	0.6
8	Brown shrimp	6	0.1	8.6	981.6	-1.5	0.3	2.0
9	Common mantis shrimp	8	0.4	22.8	1,398.3	-2.6	-0.1	2.4
10	Shelf flounder	6	0.0	7.2	3,525.5	-1.3	0.4	2.0
11	Fringed flounder	13	1.1	7.7	56.1	-0.4	0.3	0.9
12	Gulf butterfish	10	1.5	6.2	25.9	0.3	0.6	1.0
13	Longspine porgy	11	1.7	26.5	421.7	0.2	0.6	1.0
14	Atlantic croaker	6	0.1	1.1	13.5	0.6	1.0	1.5
15	Sand seatrout	5	0.2	1.3	7.4	0.5	0.9	1.3
16	Red snapper	10	0.5	1.9	6.9	0.6	1.0	1.3
17	Atlantic bumper	8	0.0	1.5	58.8	0.2	0.8	1.5
18	Rock sea bass	8	0.3	2.8	26.6	-0.5	0.4	1.3
19	Dwarf sand perch	12	0.4	2.4	15.4	0.4	0.9	1.5
20	Blackwing searobin	3	0.0	2.0	8,494,500,000	-8.6	1.2	10.9
21	Bigeye searobin	11	0.1	1.9	23.7	-0.1	0.7	1.4
22	Hardhead catfish	7	0.1	2.5	51.7	-0.6	0.7	2.0
23	Inshore lizardfish	16	0.4	2.1	10.6	0.4	0.8	1.2
24	Largescale lizardfish	11	0.3	1.5	8.7	0.6	0.8	1.1
25	Striped anchovy	6	0.0	0.9	27.0	0.2	0.9	1.6
26	Scaled sardine	8	0.6	3.2	17.2	0.2	0.7	1.1

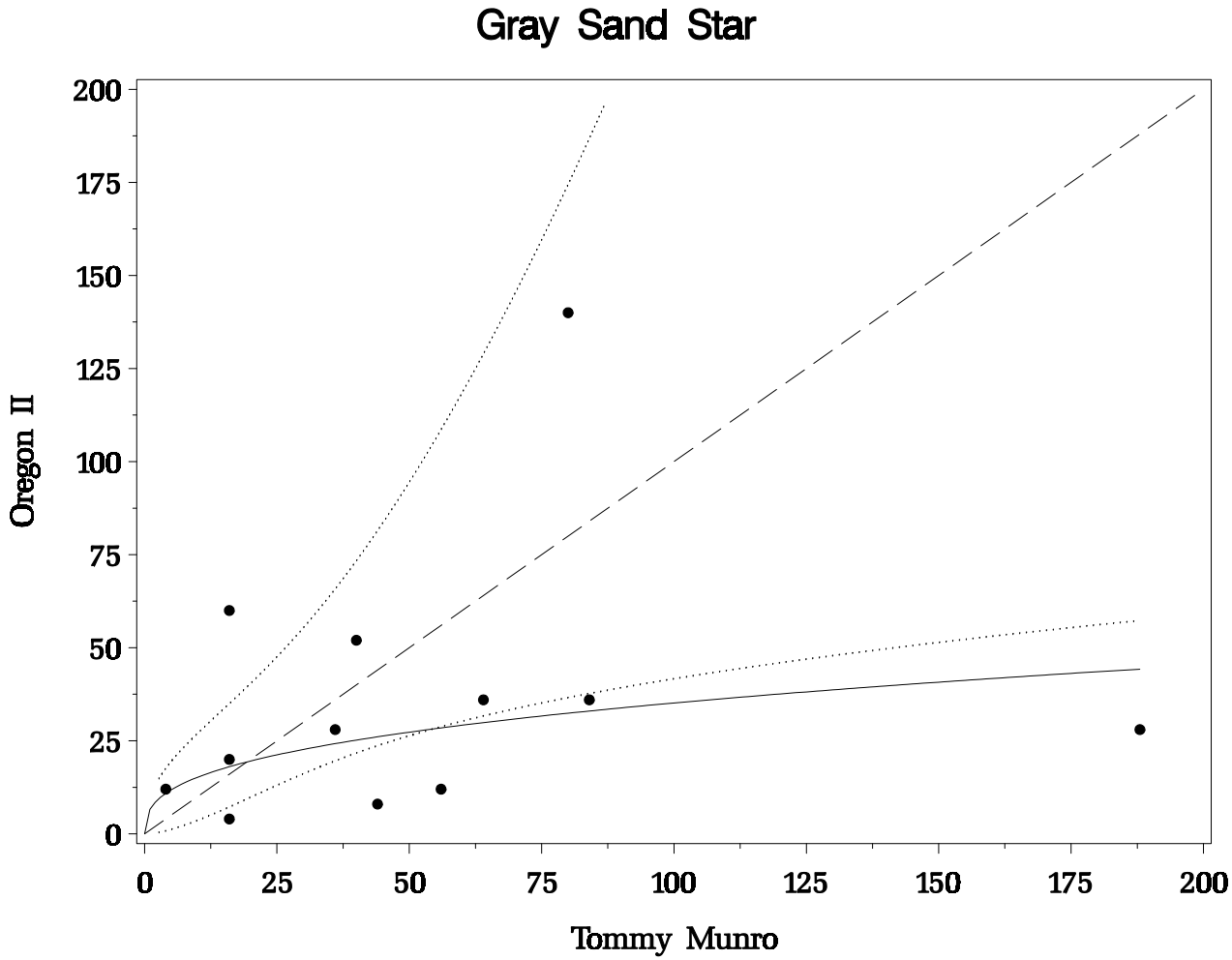

Figure 1. Scatter plot of catches of gray sand star by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=12). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

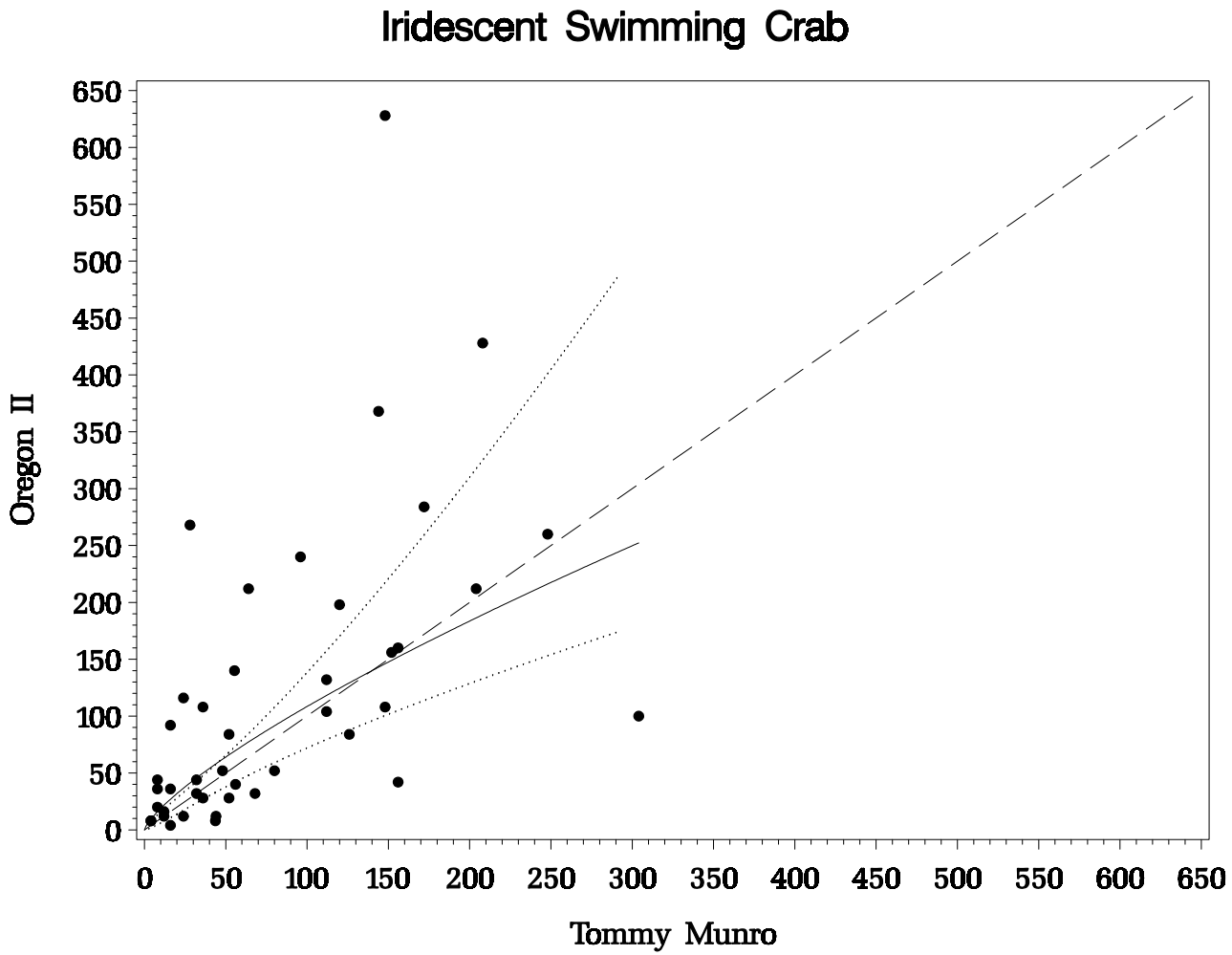

Figure 2. Scatter plot of catches of iridescent swimming crab by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=43). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

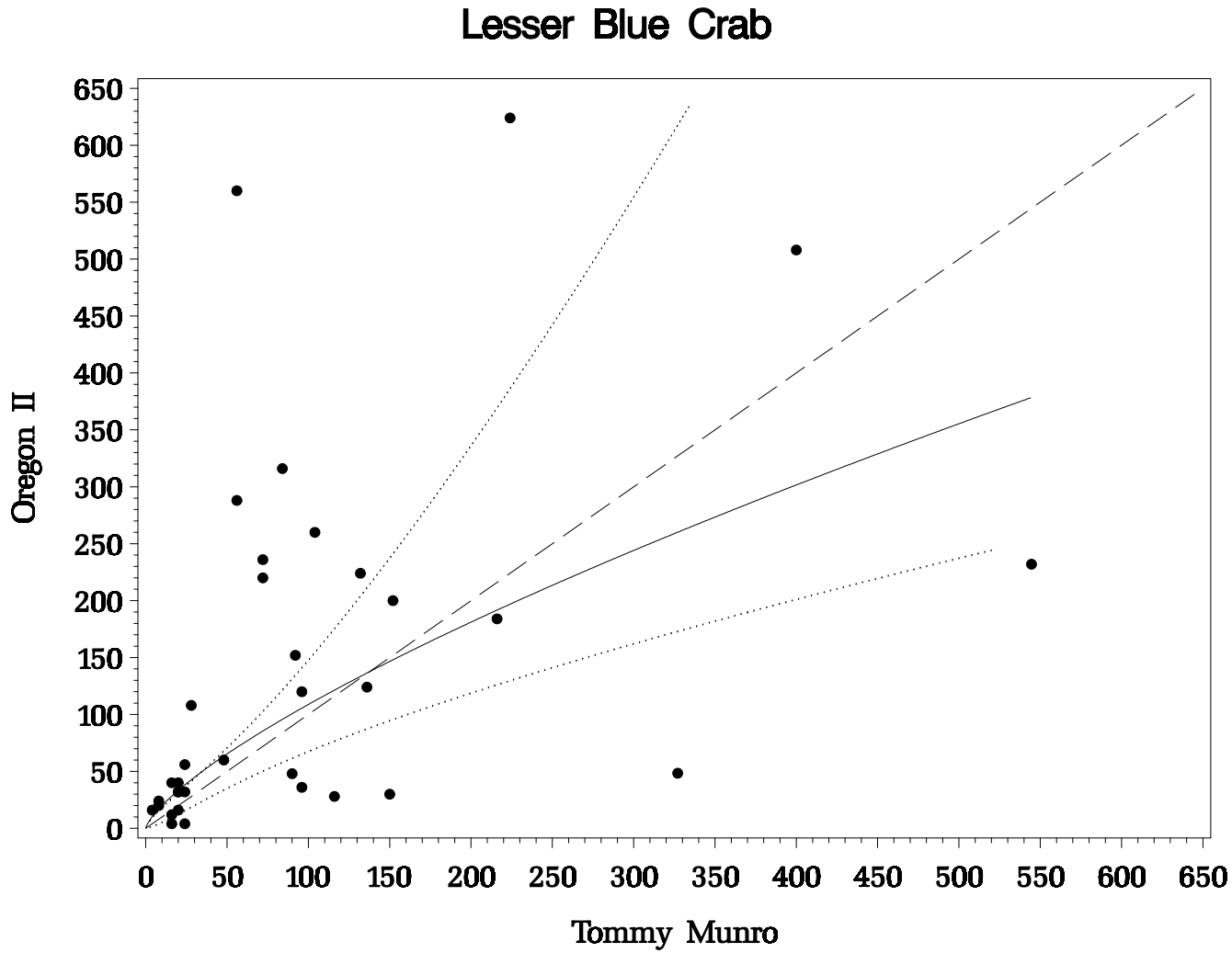

Figure 3. Scatter plot of catches of lesser blue crab by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=35). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

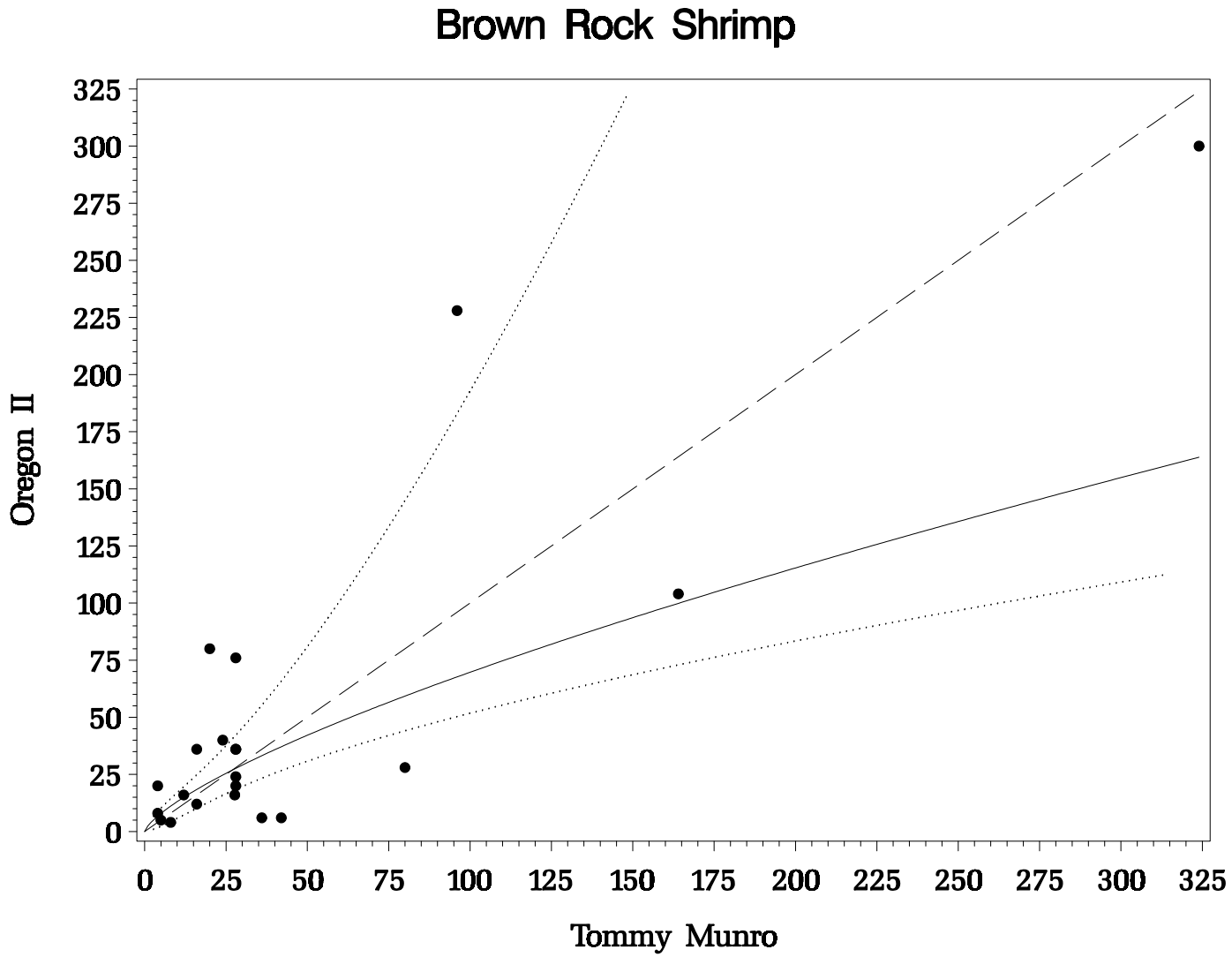

Figure 4. Scatter plot of catches of brown rock shrimp by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=21). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

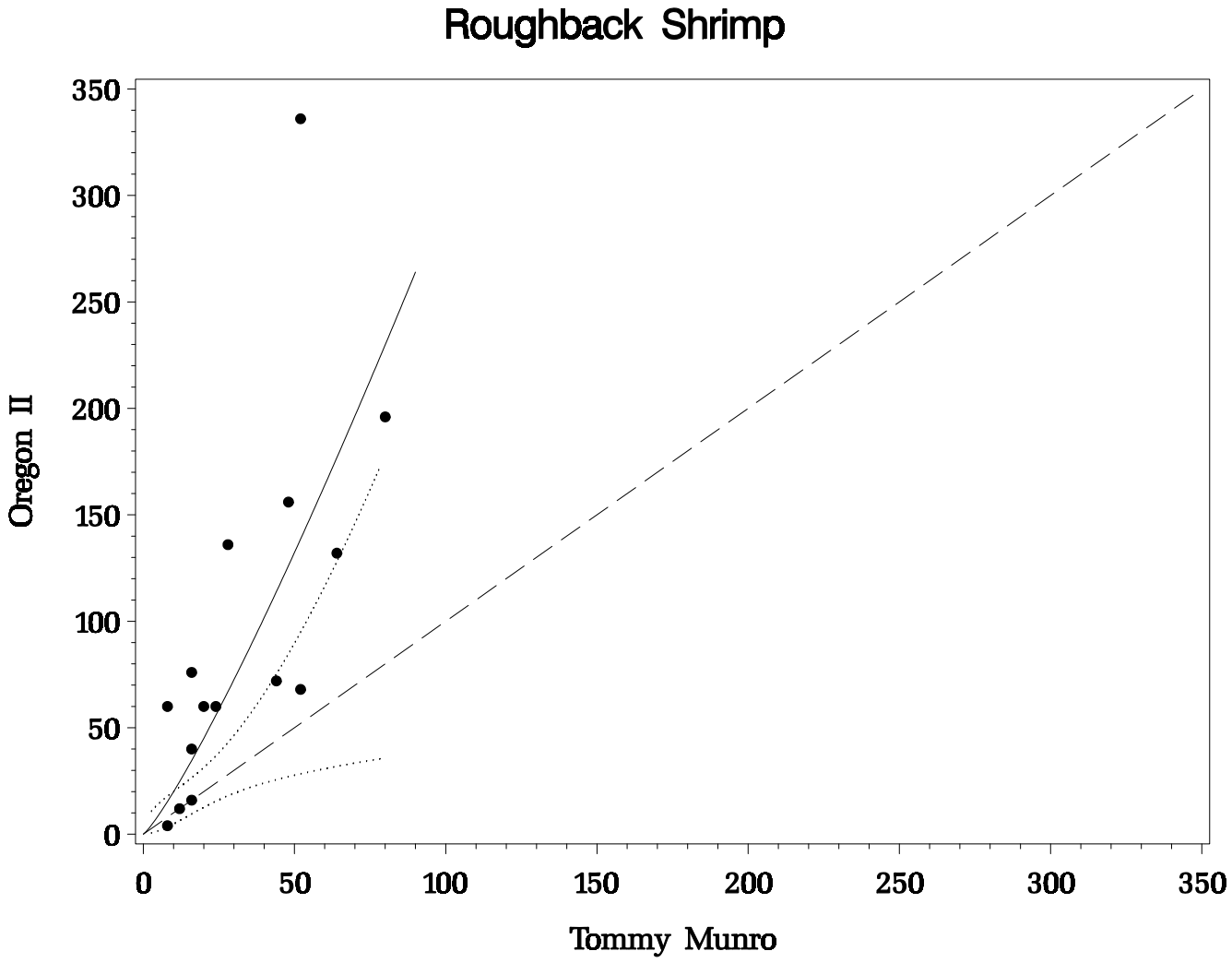

Figure 5. Scatter plot of catches of roughback shrimp by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=15). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

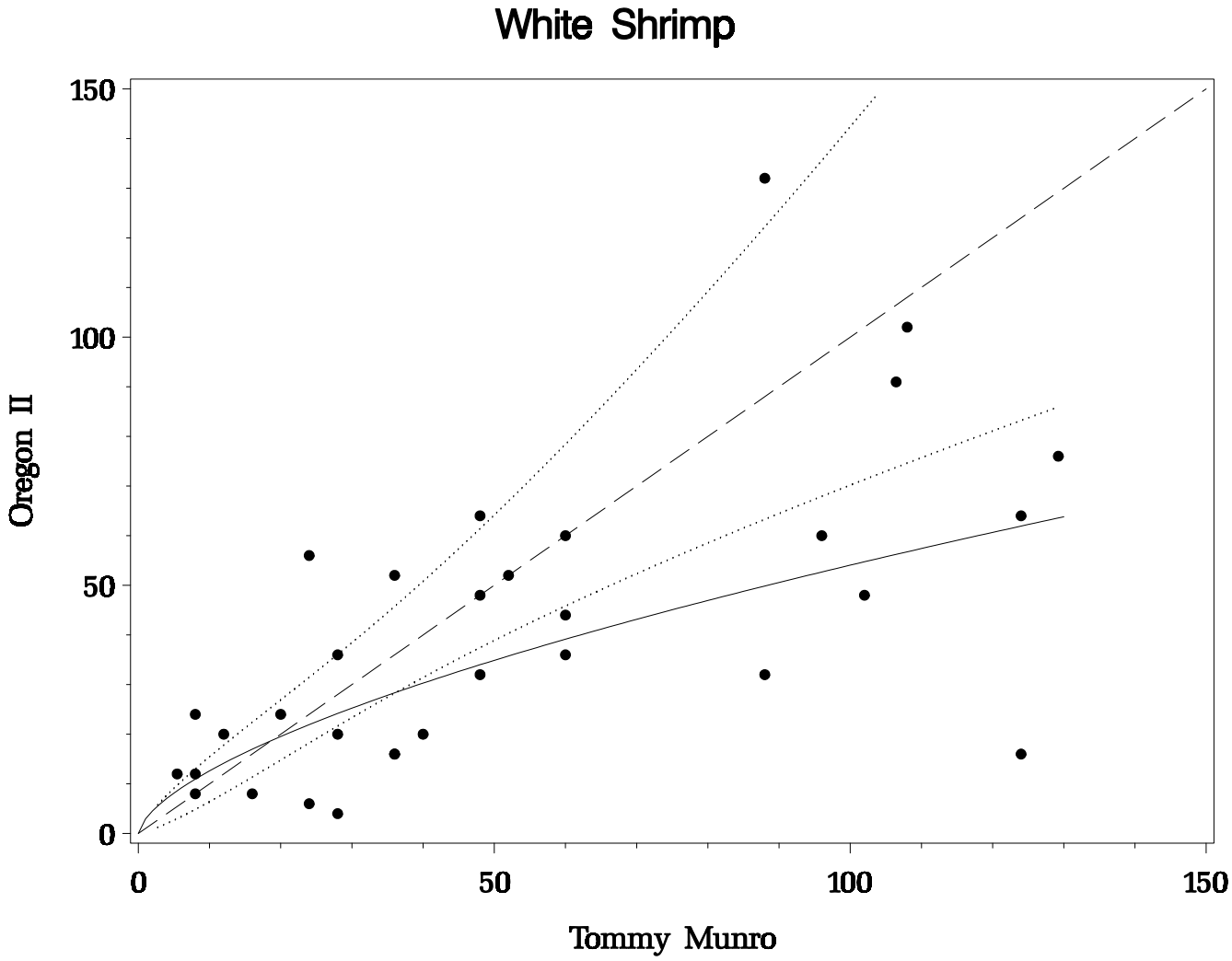

Figure 6. Scatter plot of catches of white shrimp by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=32). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

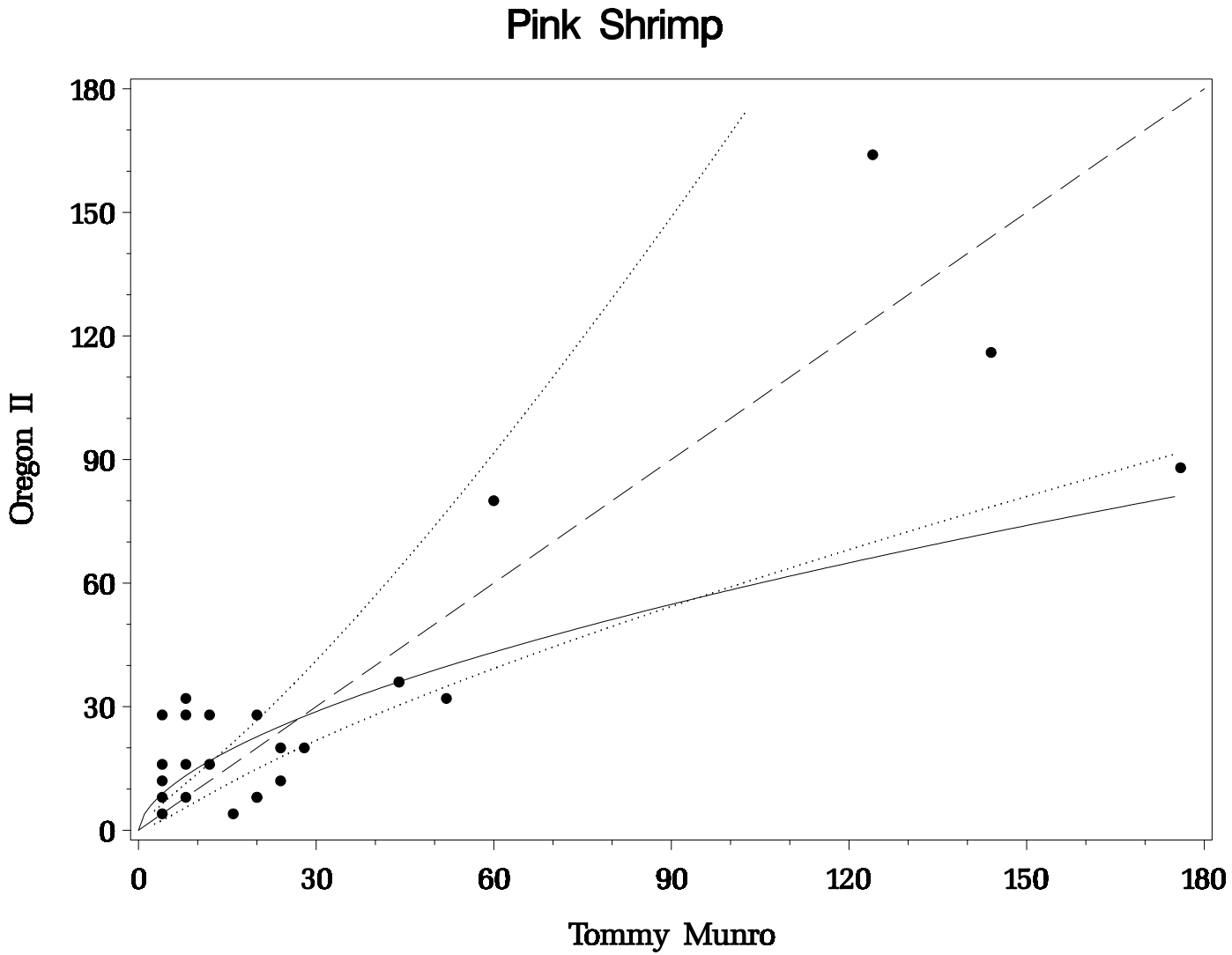

Figure 7. Scatter plot of catches of pink shrimp by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=25). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

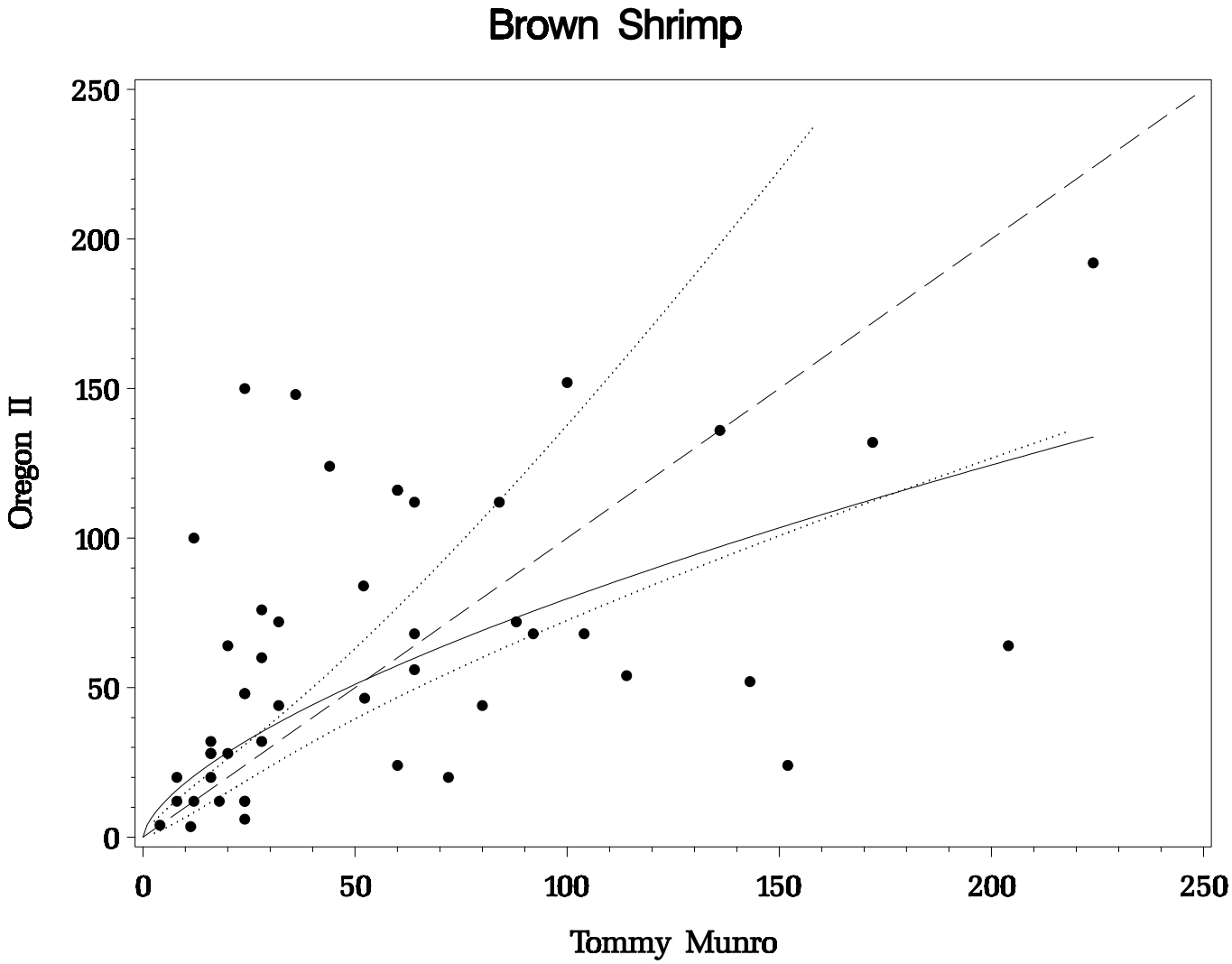

Figure 8. Scatter plot of catches of brown shrimp by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=48). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

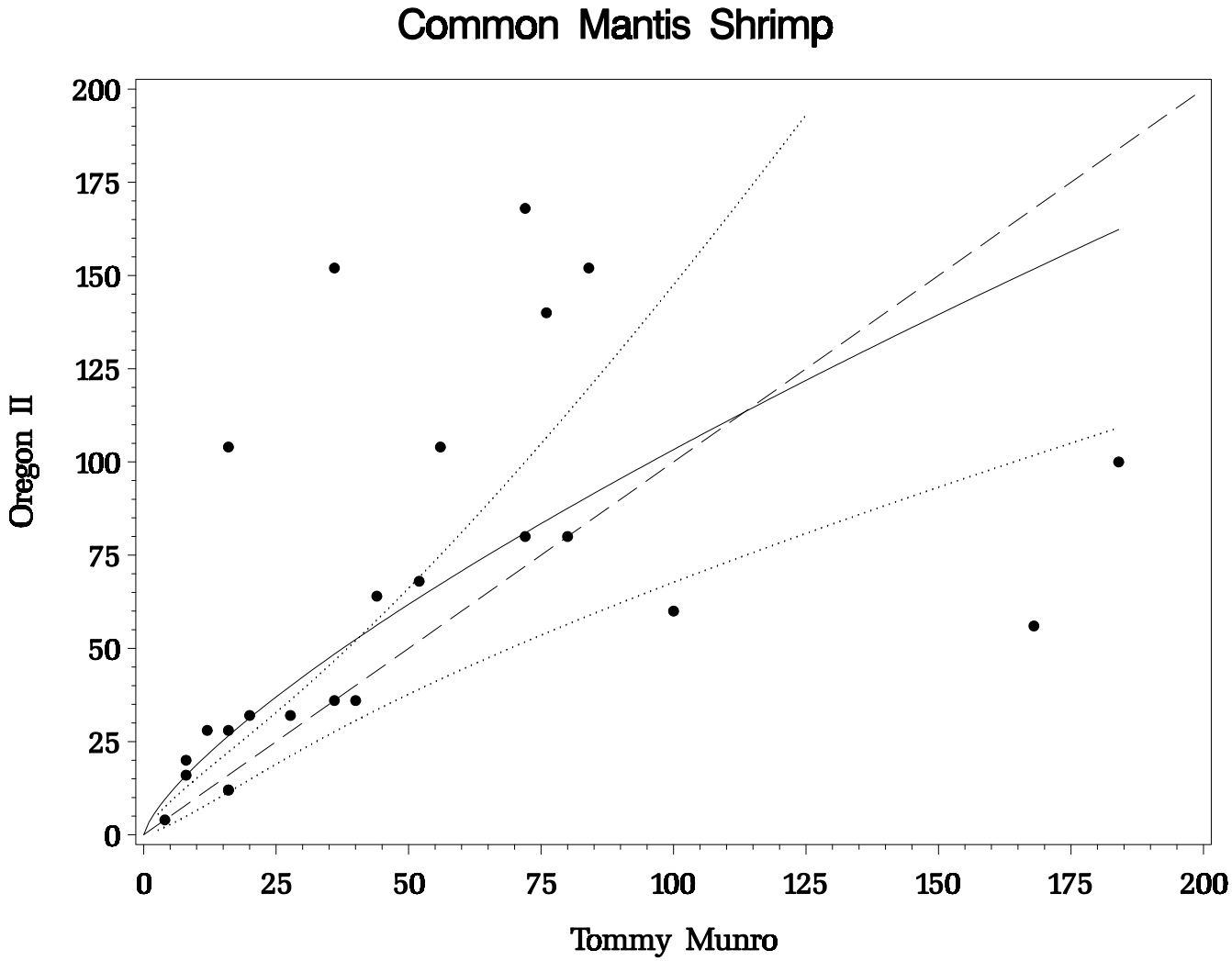

Figure 9. Scatter plot of catches of common mantis shrimp by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=24). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

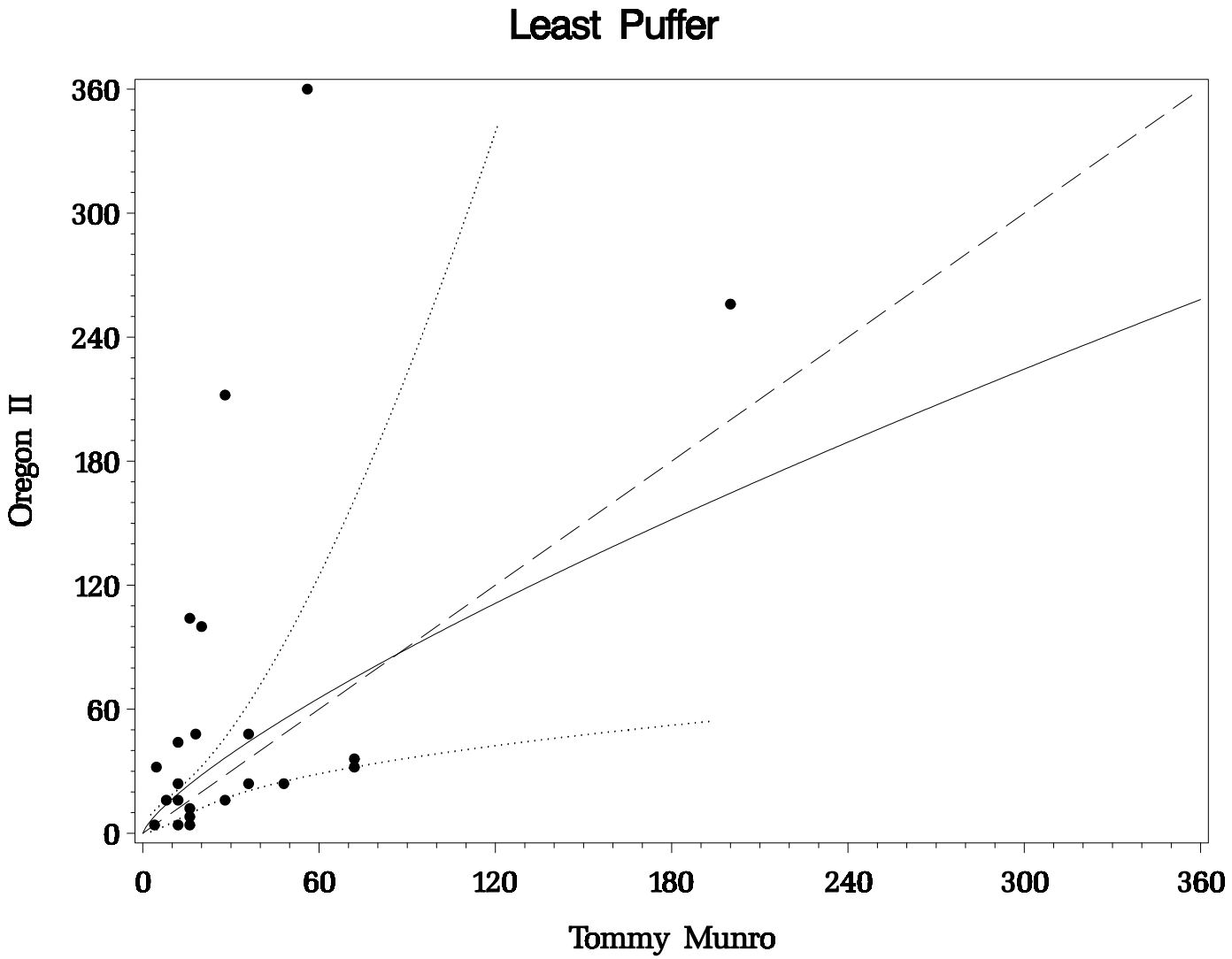

Figure 10. Scatter plot of catches of least puffer by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=22). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

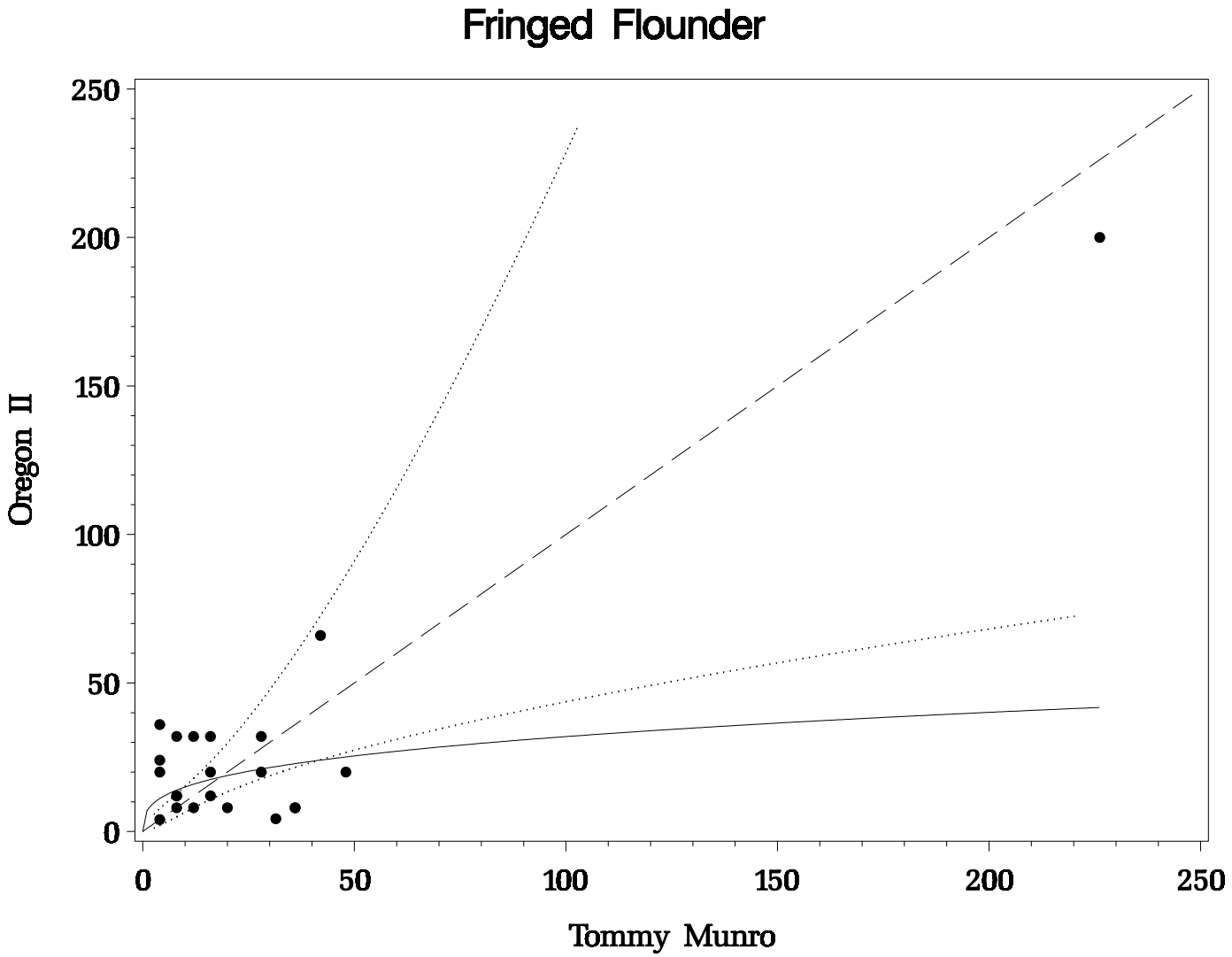

Figure 11. Scatter plot of catches of fringed flounder by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=22). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

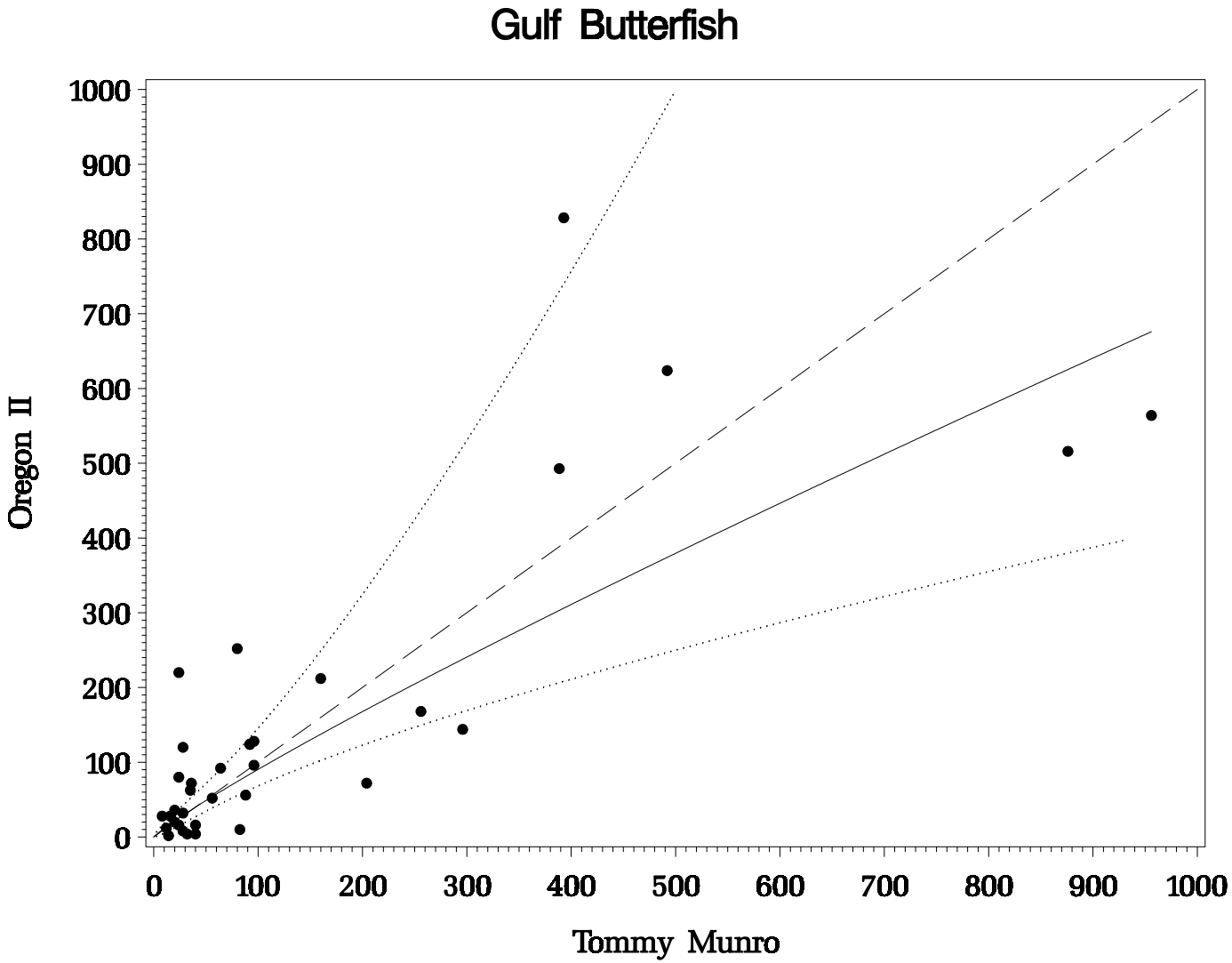

Figure 12. Scatter plot of catches of gulf butterfish by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=36). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

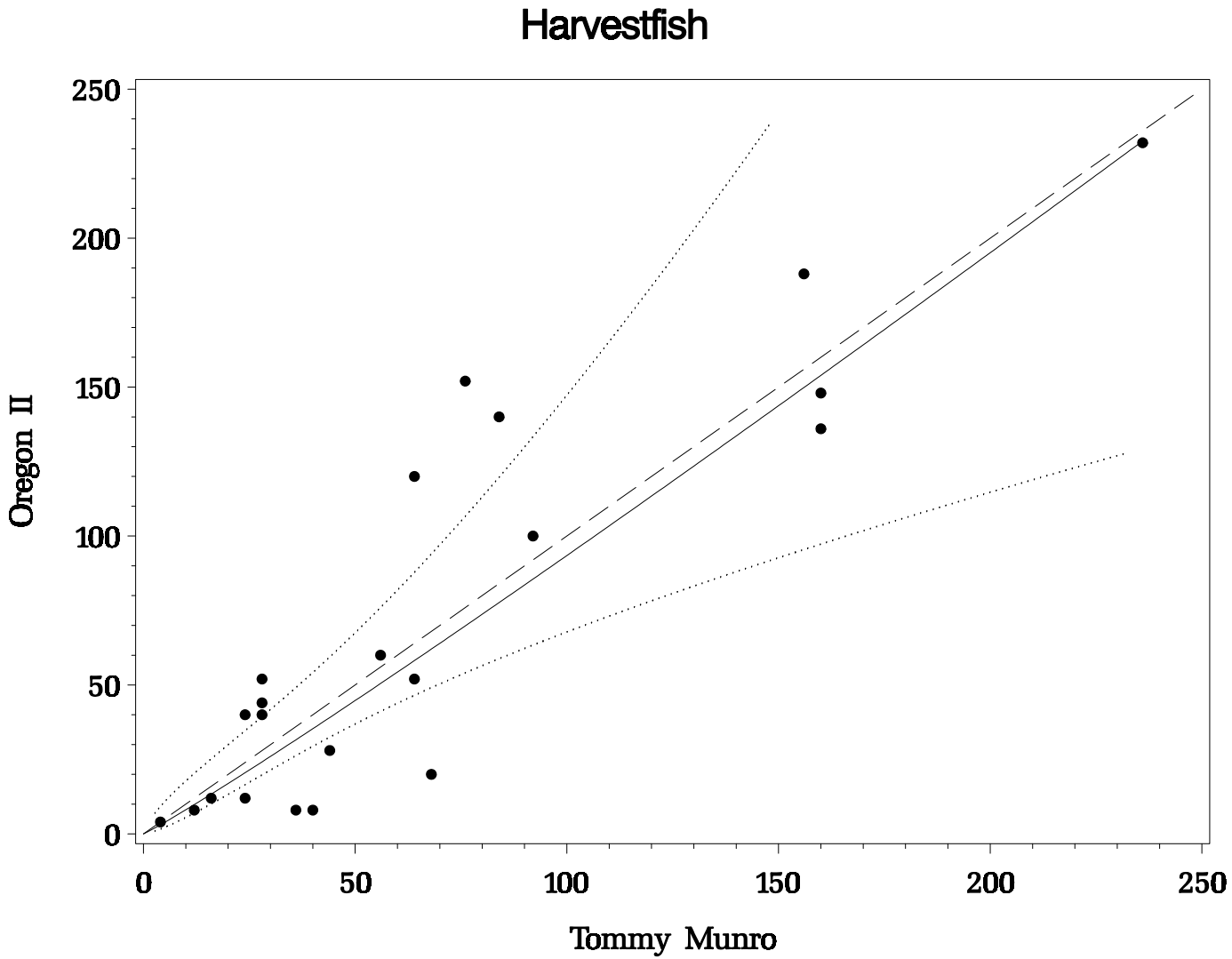

Figure 13. Scatter plot of catches of harvestfish by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=22). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

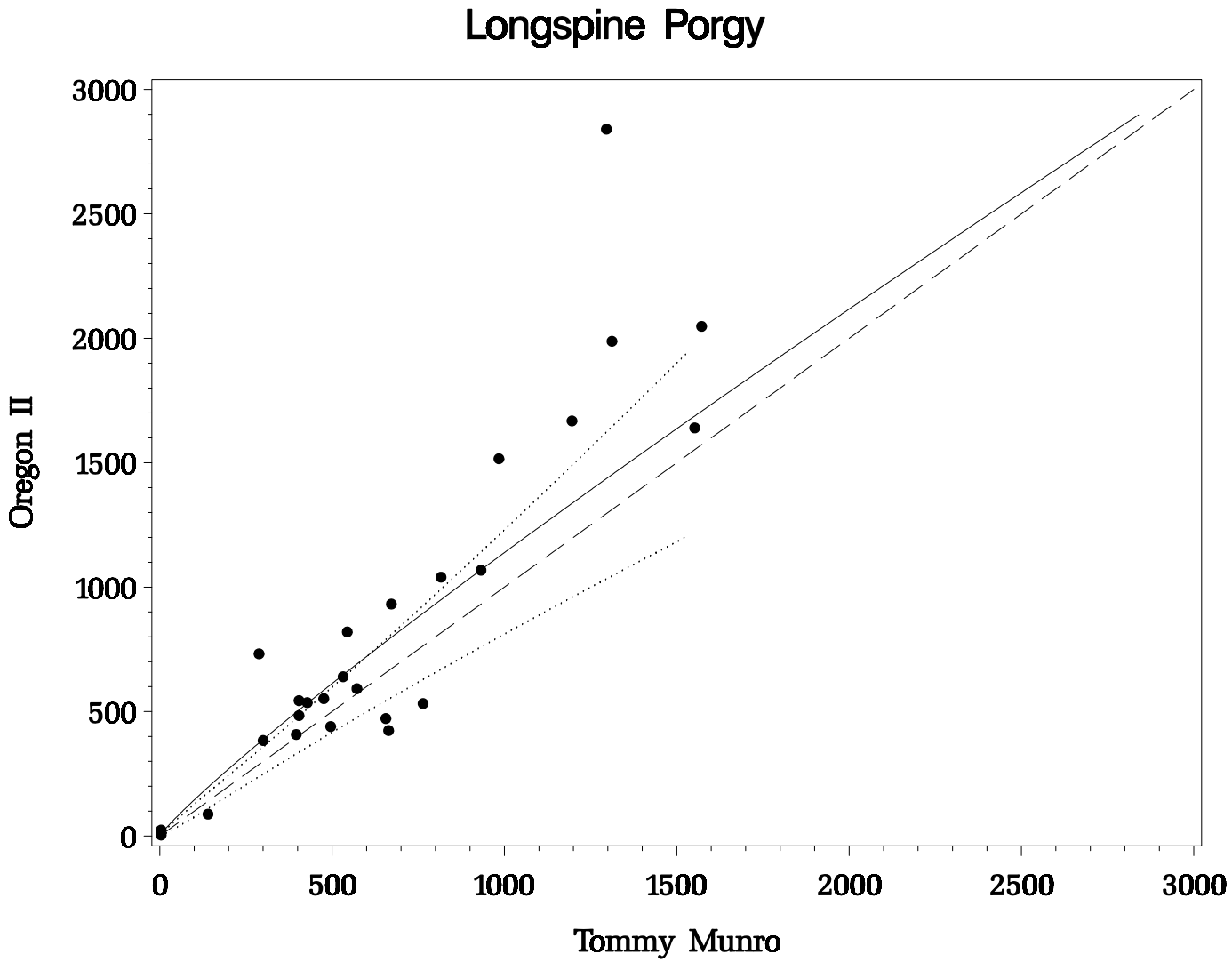

Figure 14. Scatter plot of catches of longspine porgy *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=26). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

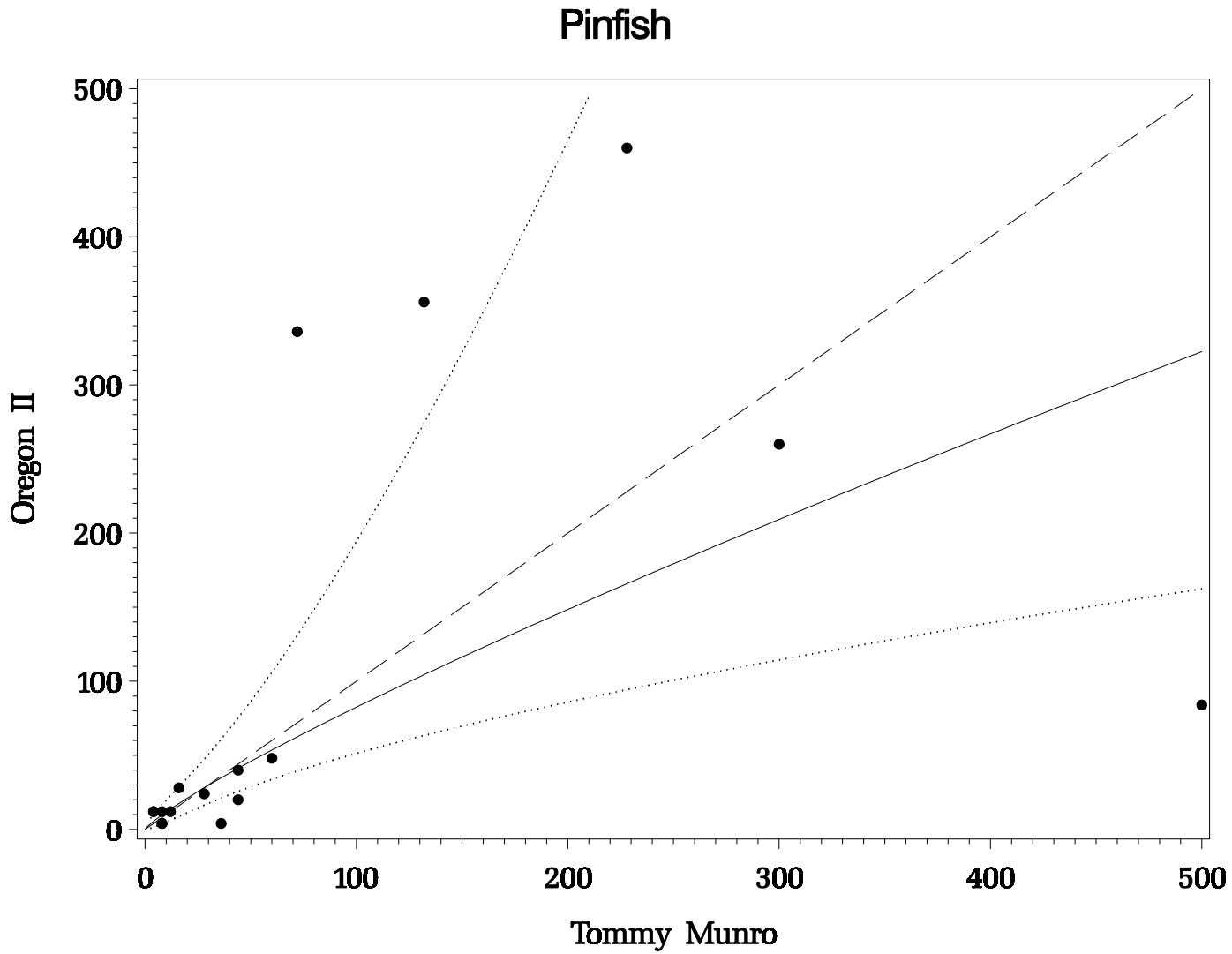

Figure 15. Scatter plot of catches of pinfish by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=17). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

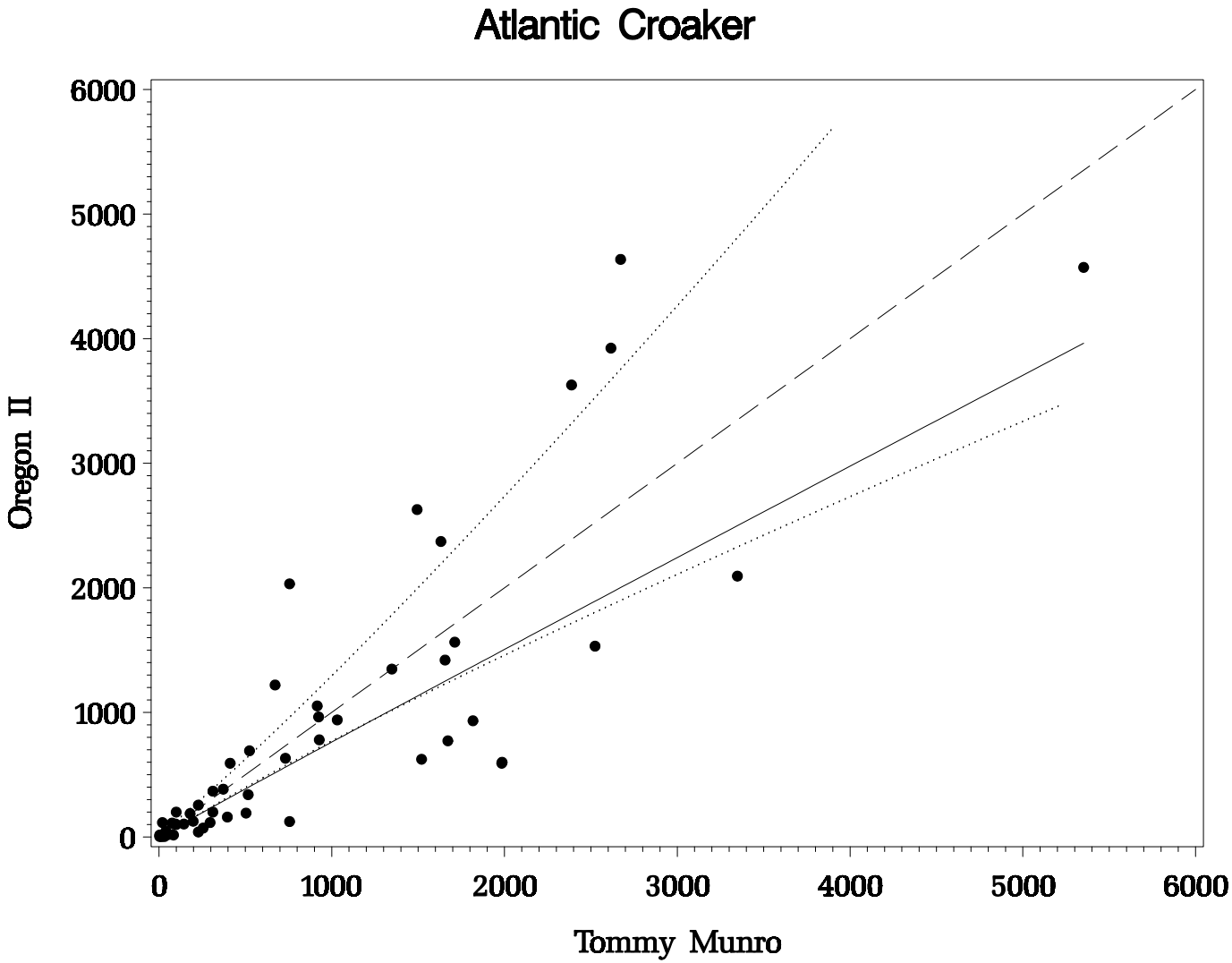

Figure 16. Scatter plot of catches of atlantic croaker by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=53). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

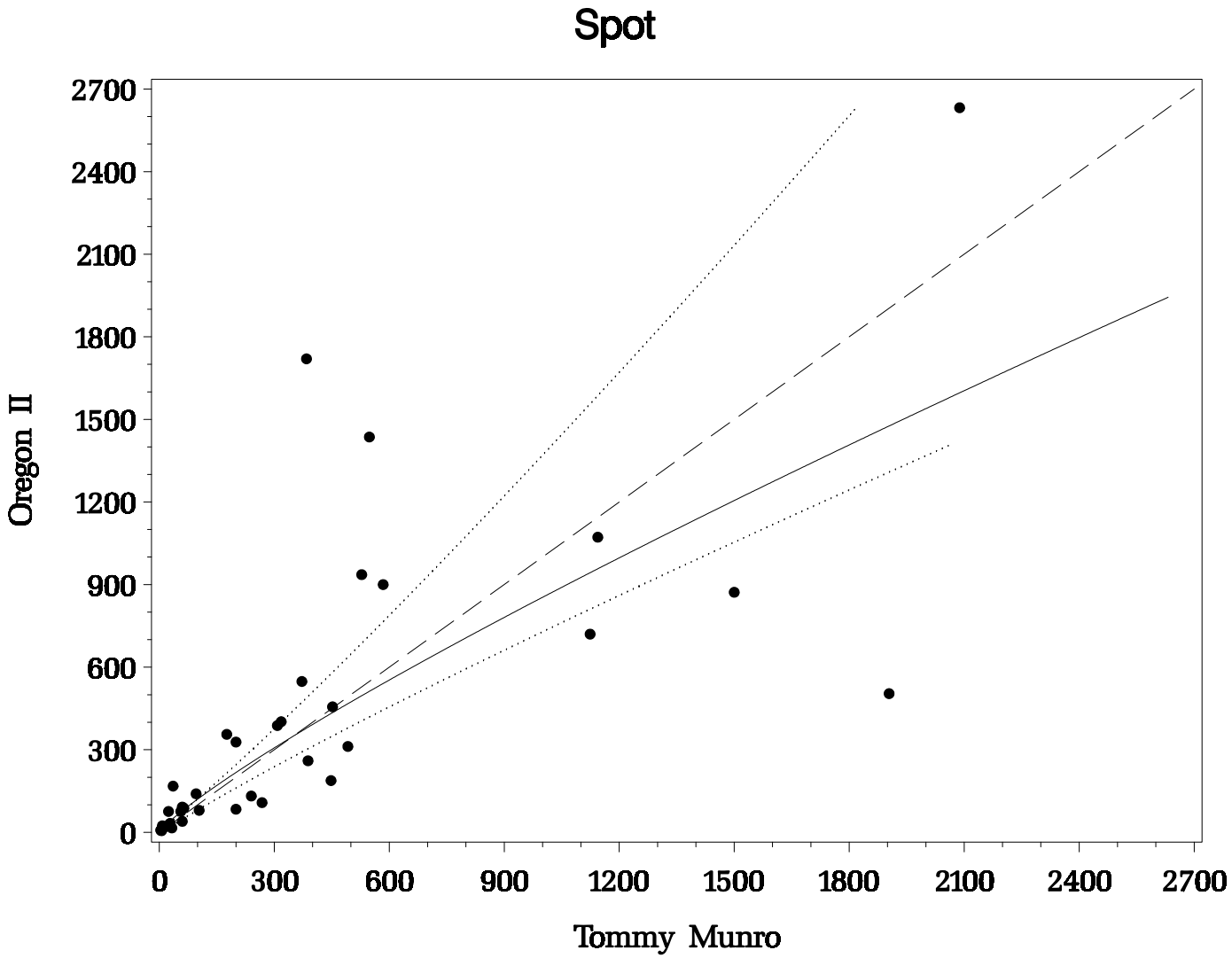

Figure 17. Scatter plot of catches of spot by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=39). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

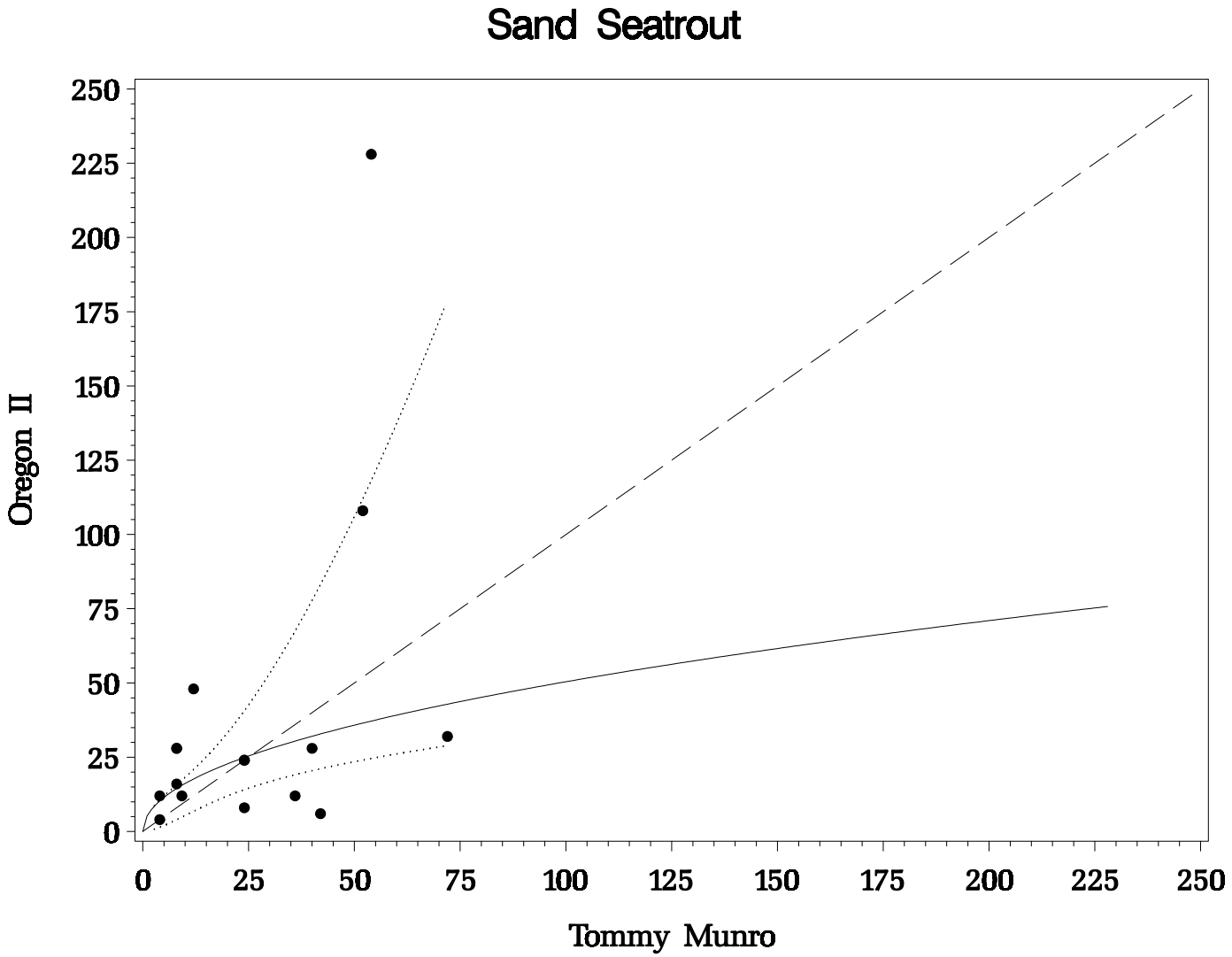

Figure 18. Scatter plot of catches of sand seatrout by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=16). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

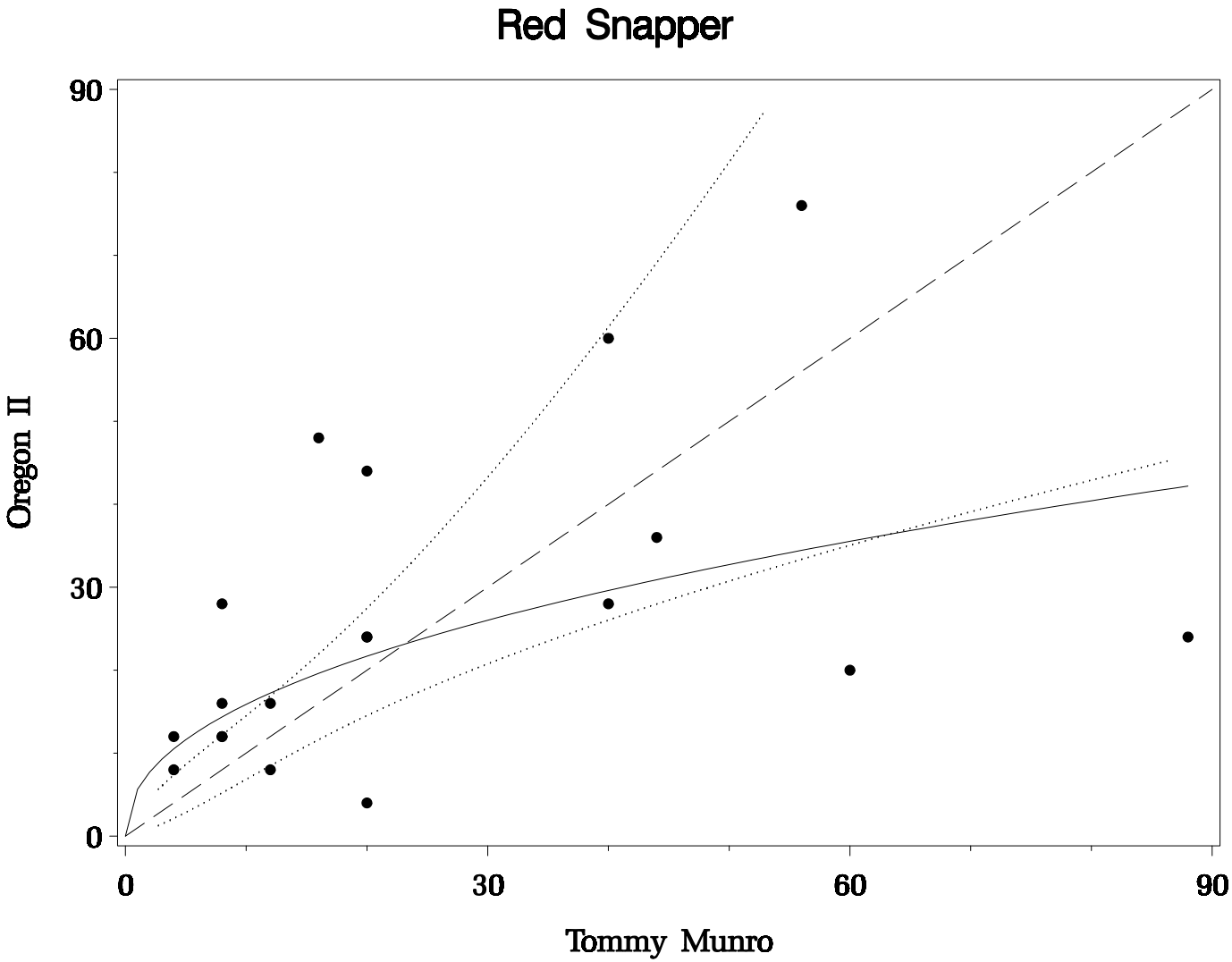

Figure 19. Scatter plot of catches of red snapper by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=19). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

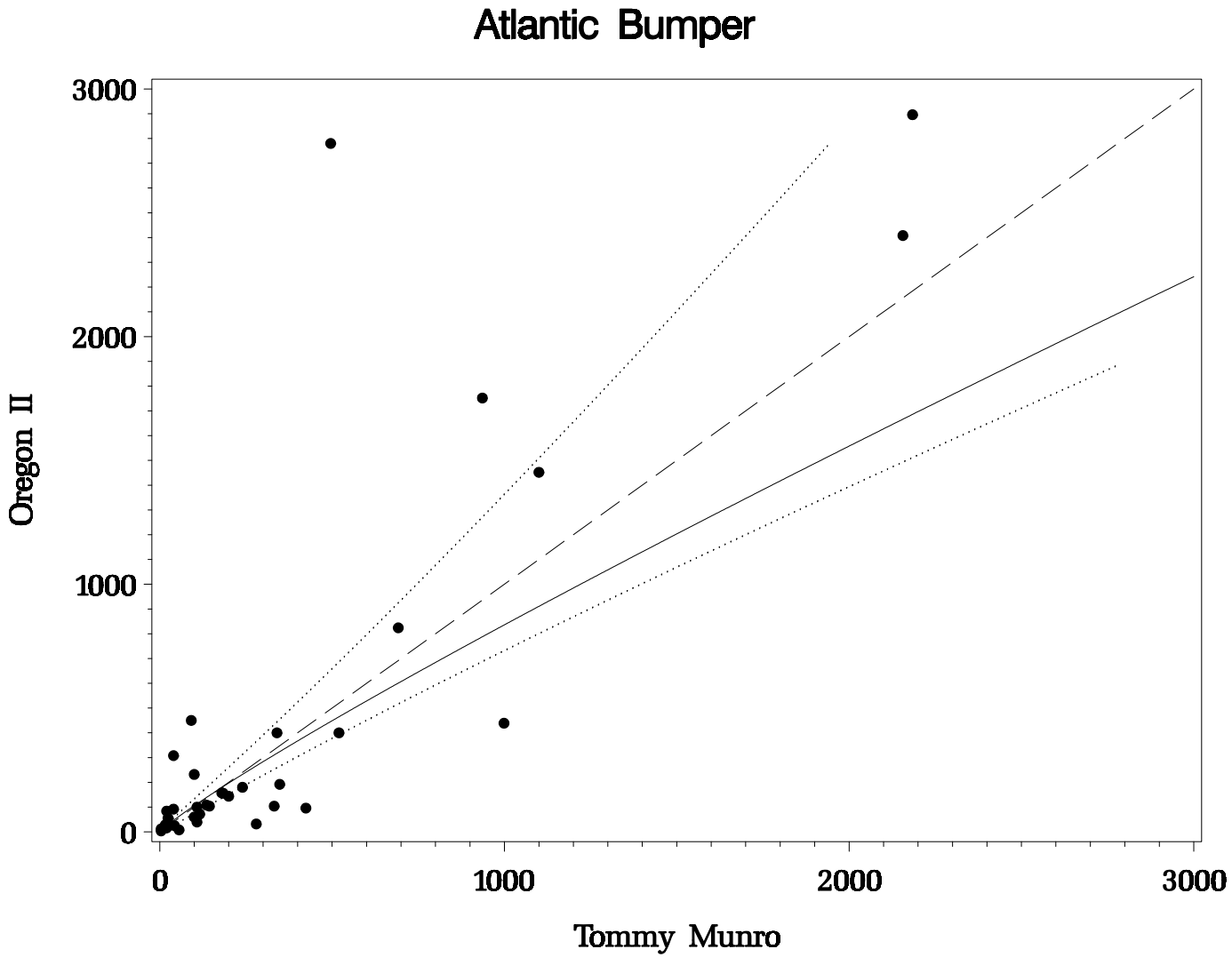

Figure 20. Scatter plot of catches of atlantic bumper by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=47). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

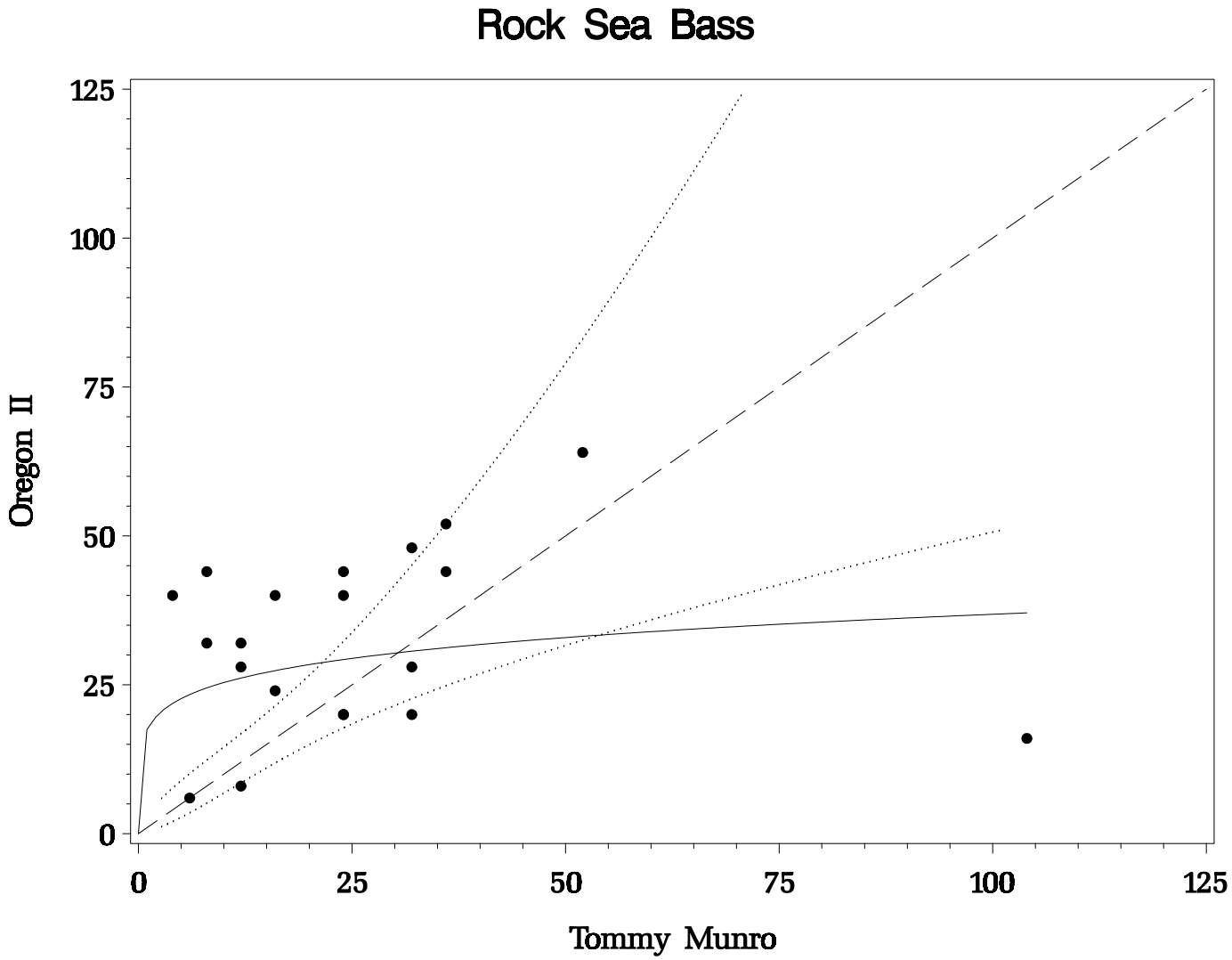

Figure 21. Scatter plot of catches of rock sea bass by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=20). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

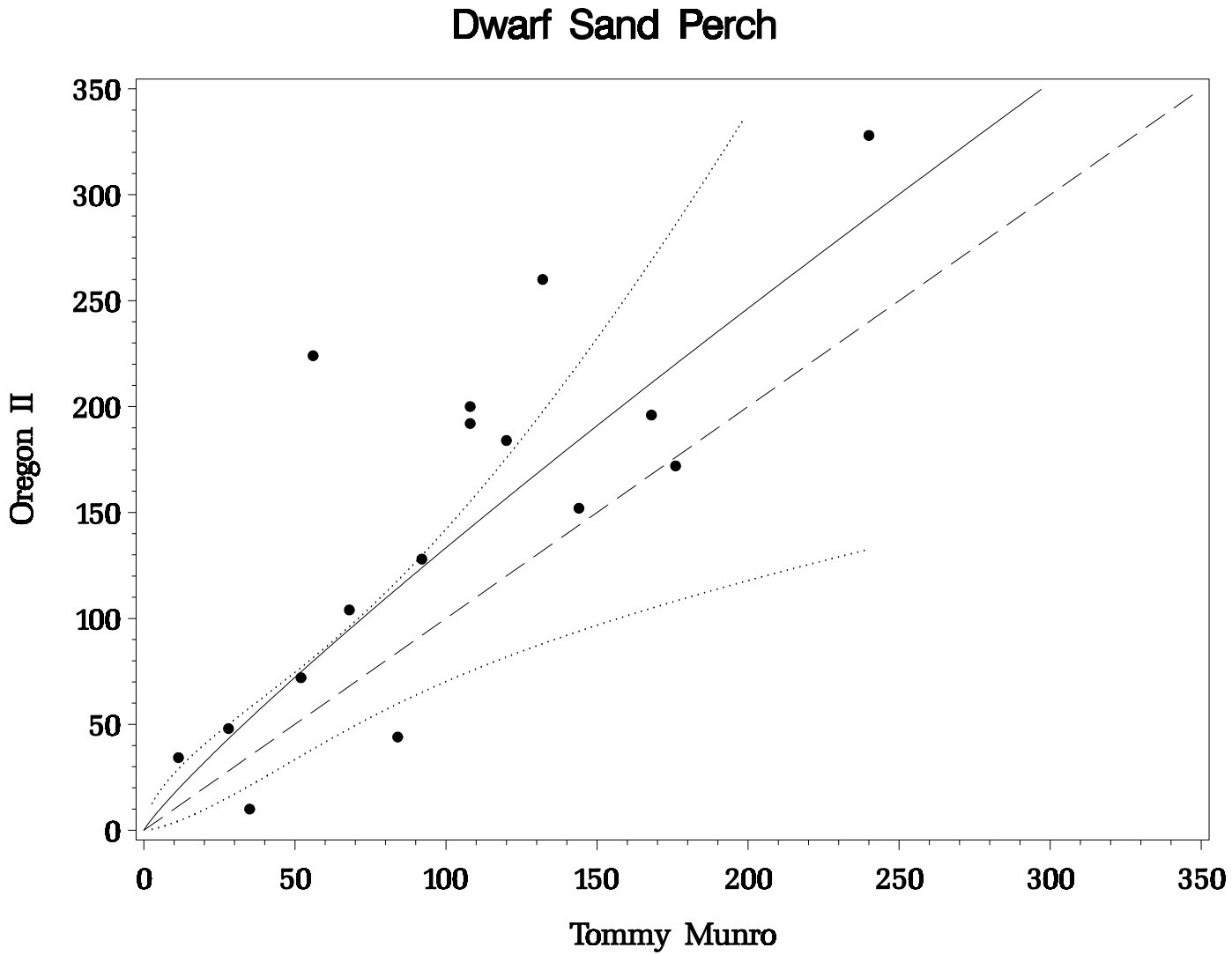

Figure 22. Scatter plot of catches of dwarf sand perch by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=16). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

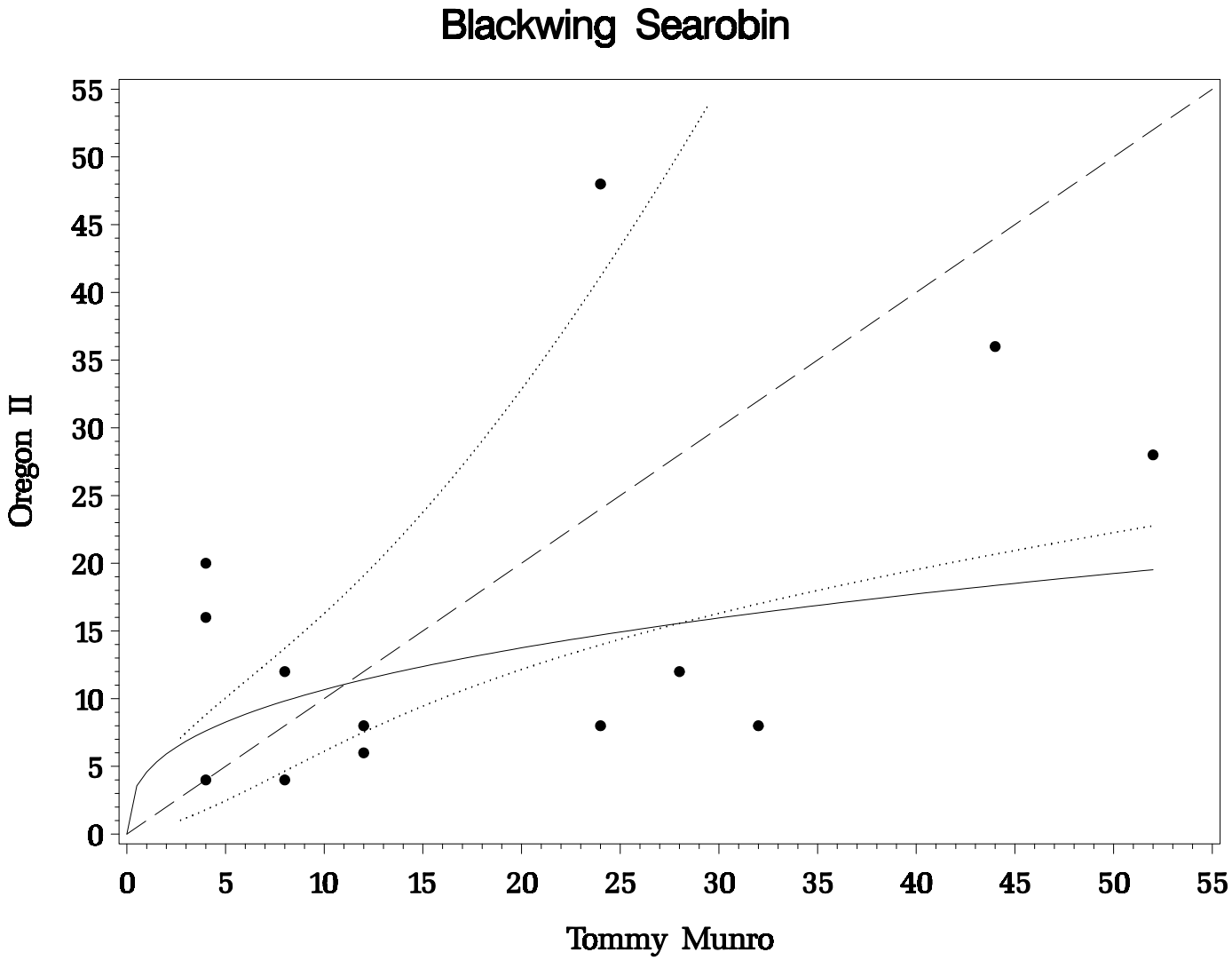

Figure 23. Scatter plot of catches of blackwing searobin by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=13). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

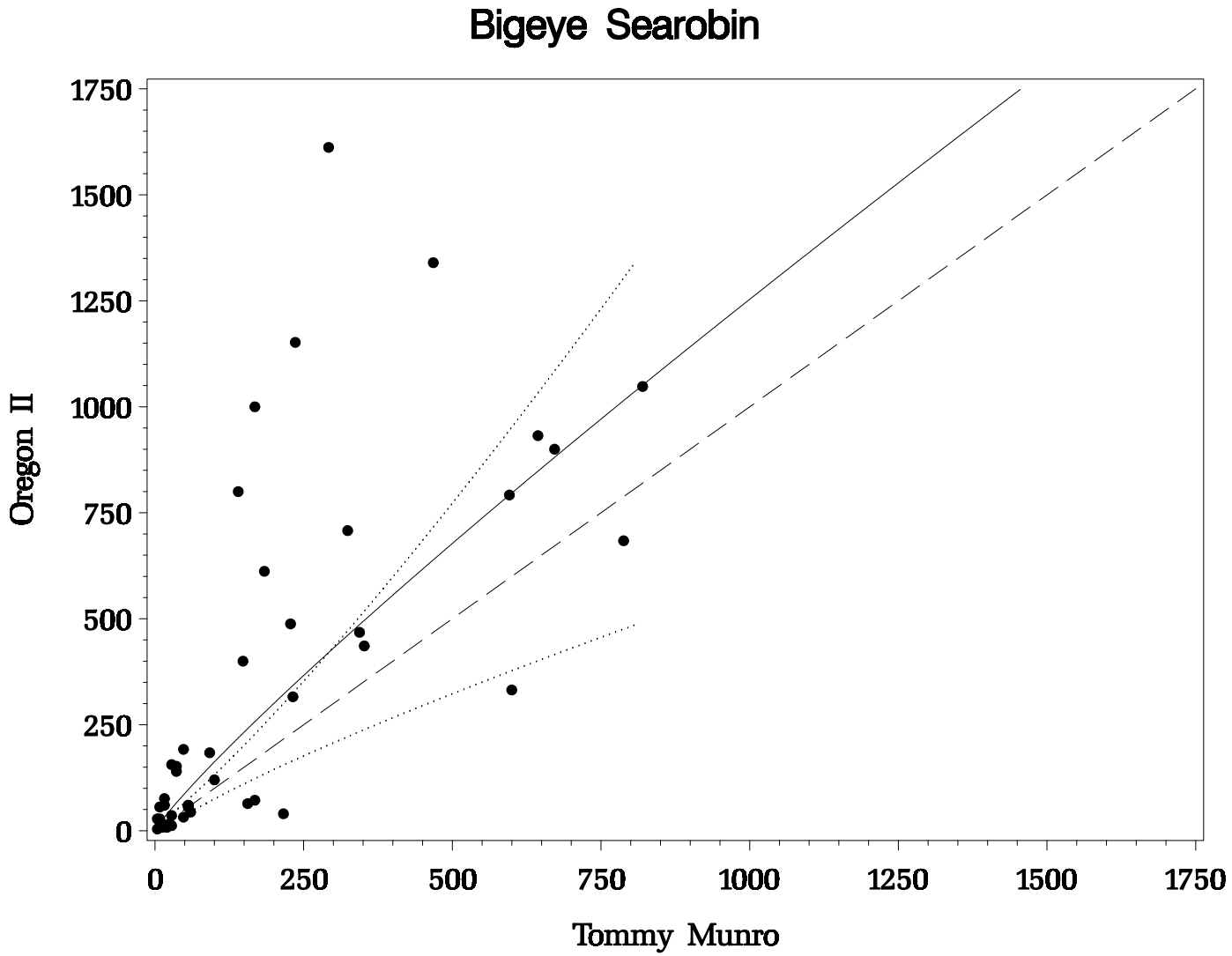

Figure 24. Scatter plot of catches of bigeye searobin by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=44). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

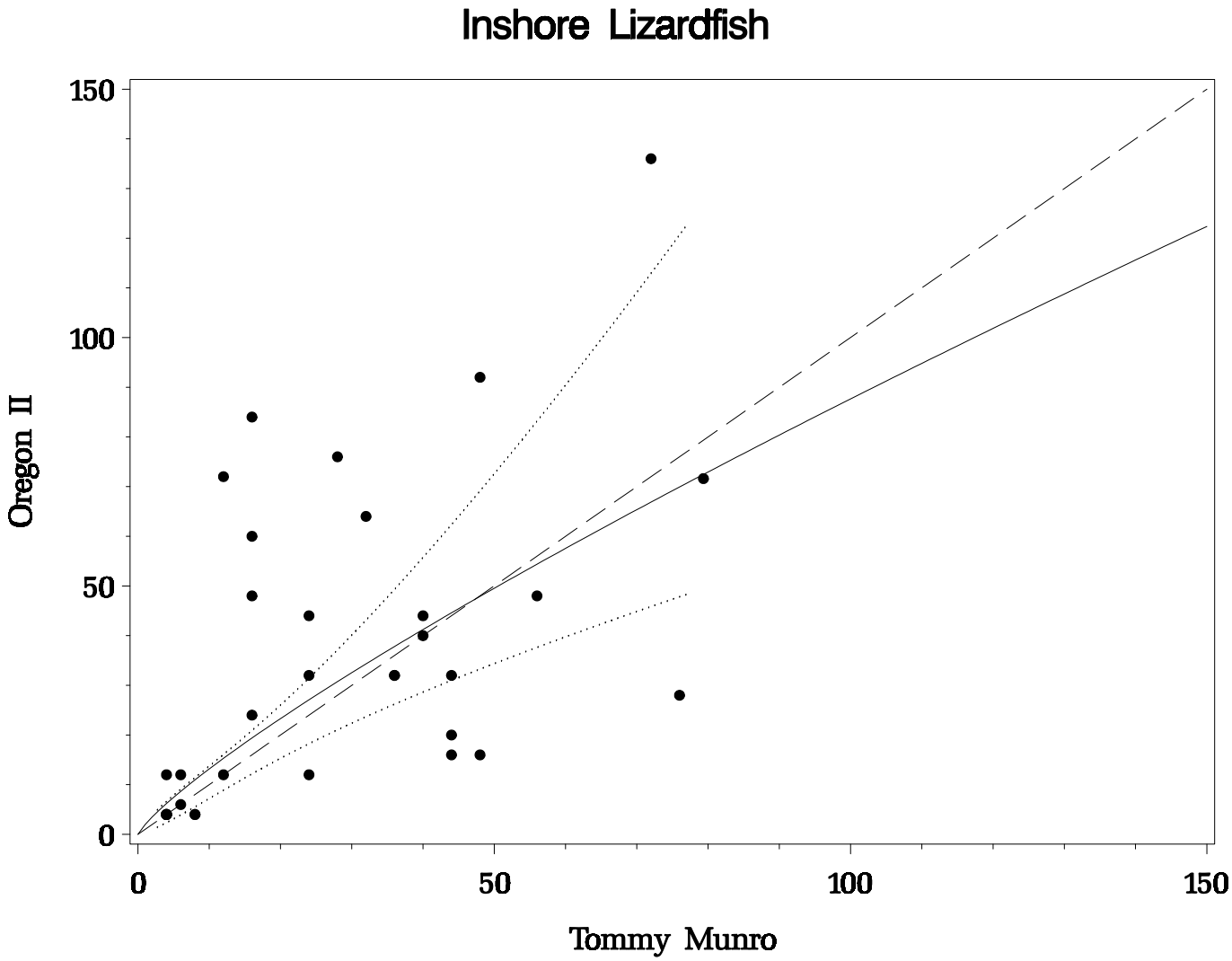

Figure 25. Scatter plot of catches of inshore lizardfish by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=33). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

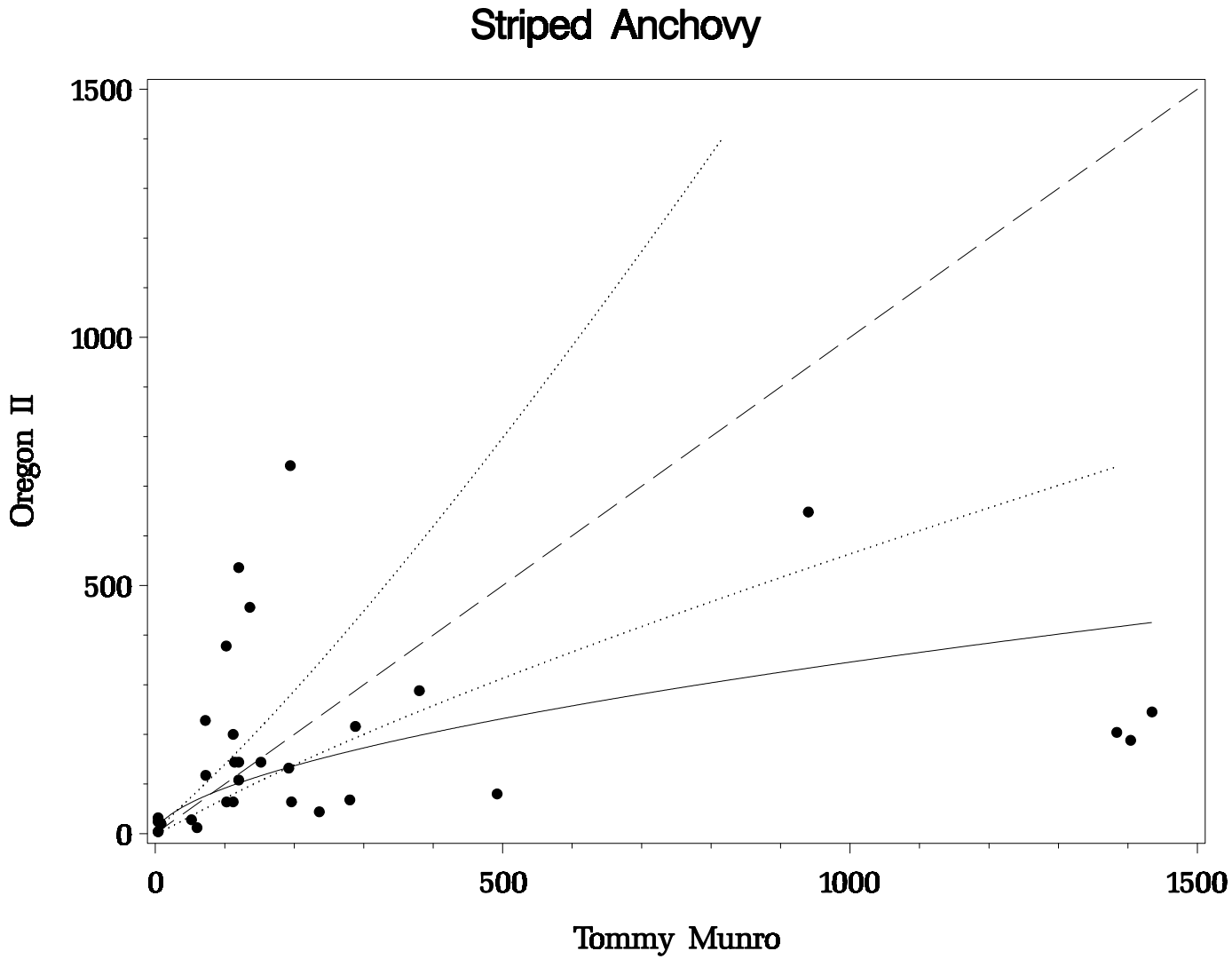

Figure 26. Scatter plot of catches of striped anchovy by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=32). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

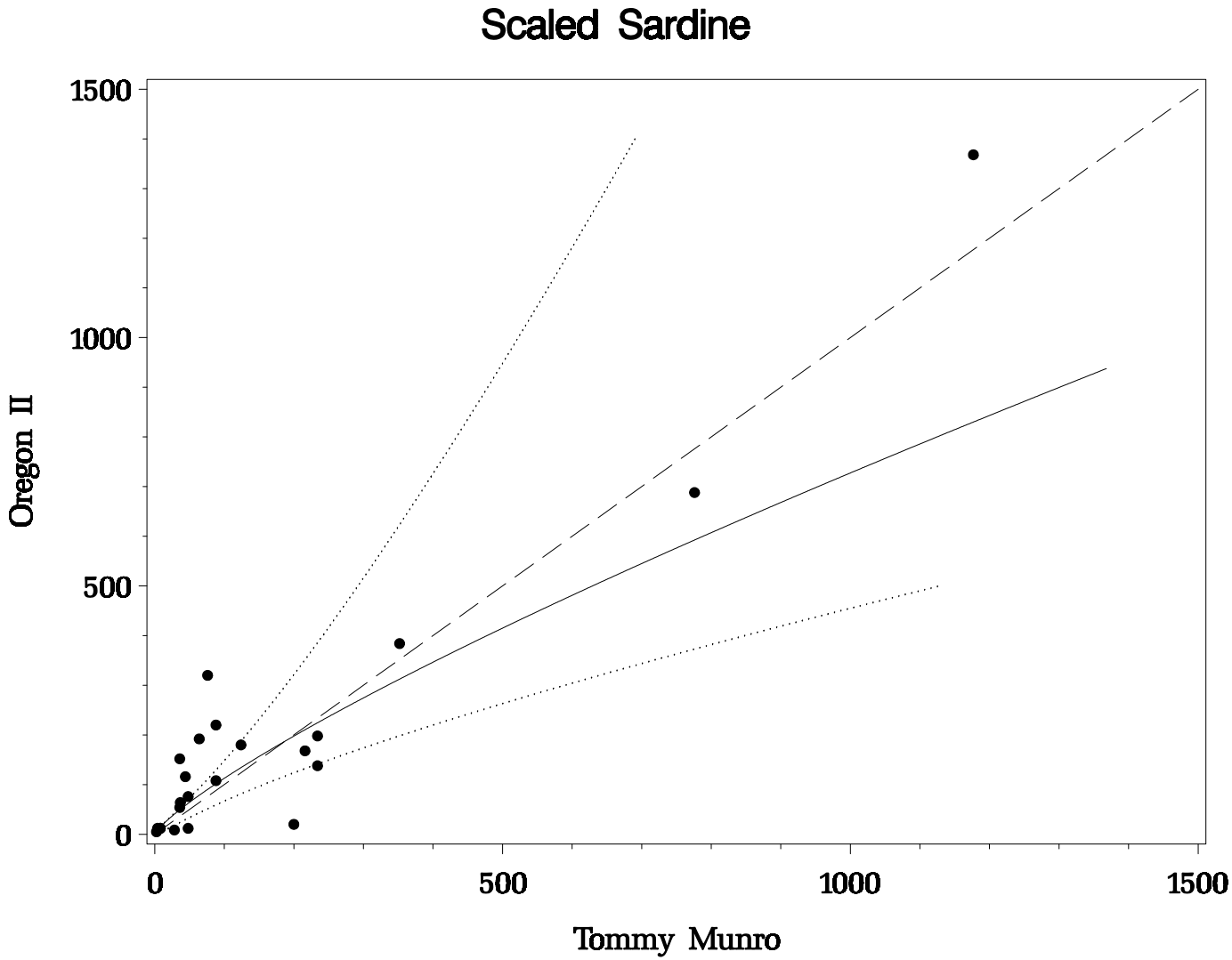

Figure 27. Scatter plot of scaled sardine catches by *NOAA Ship Oregon II* and *Research Vessel Tommy Munro* during paired comparison towing (n=23). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

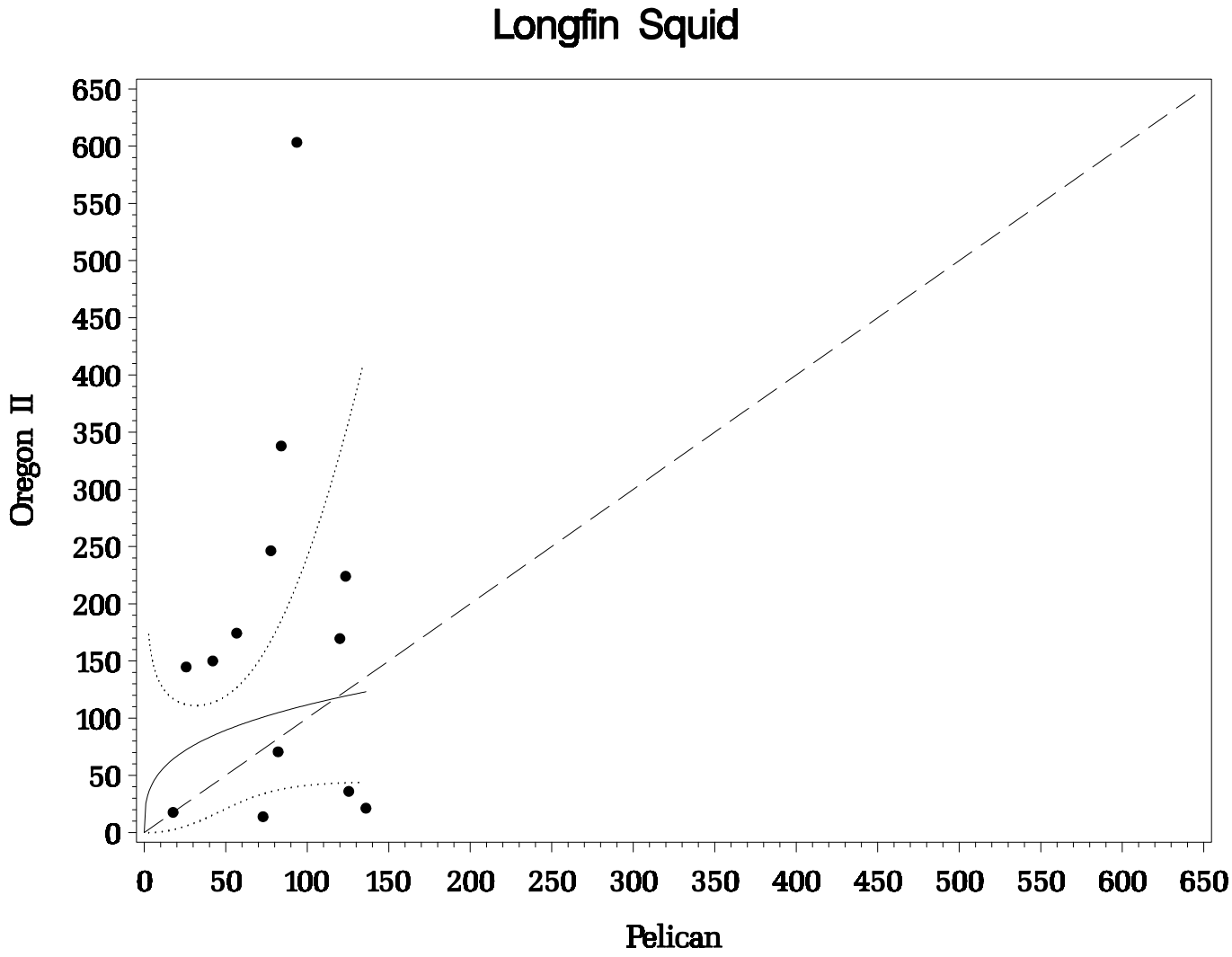

Figure 28. Scatter plot of longfin squid catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=13). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

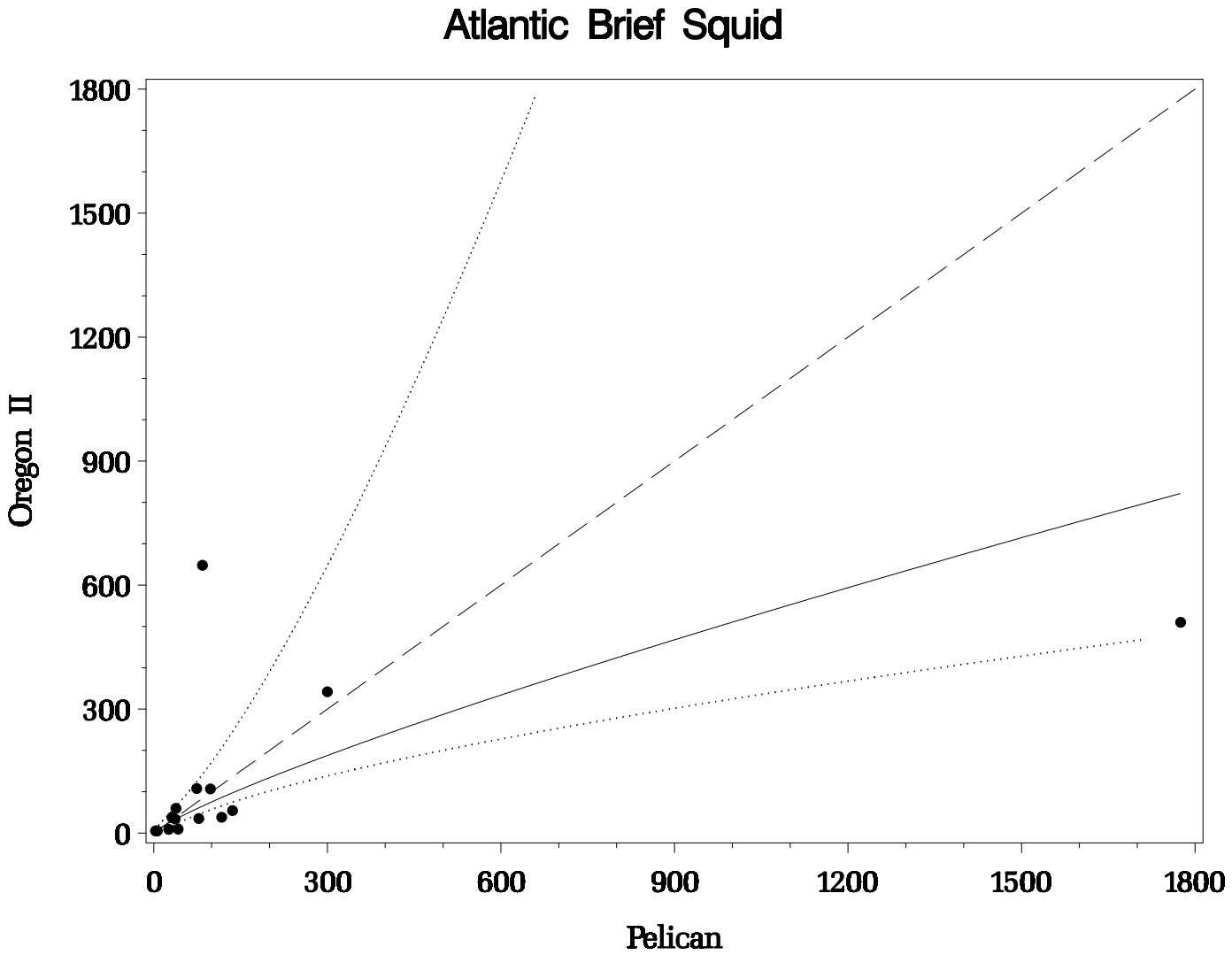

Figure 29. Scatter plot of Atlantic brief squid catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=15). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

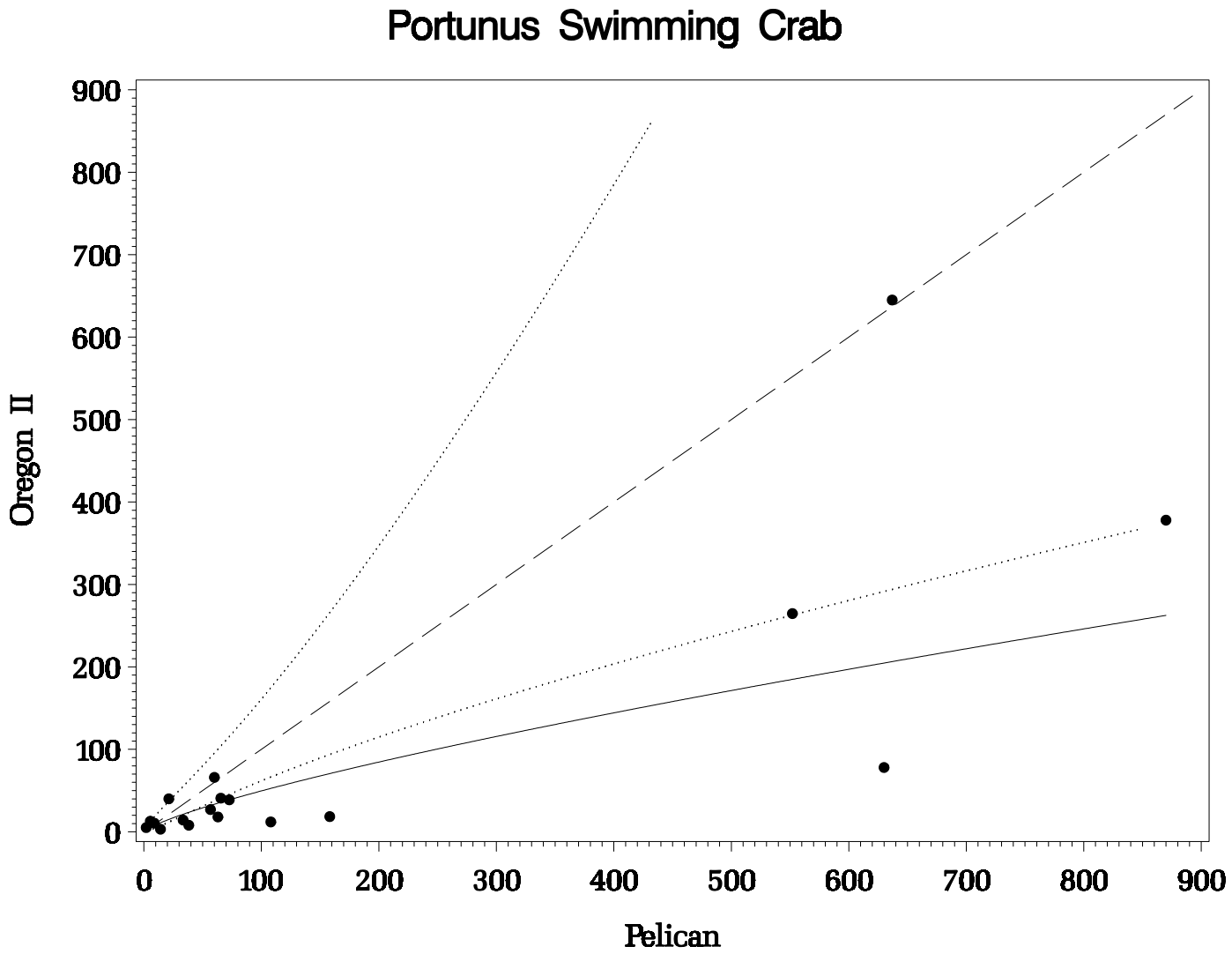

Figure 30. Scatter plot of Portunus swimming crab catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=19). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

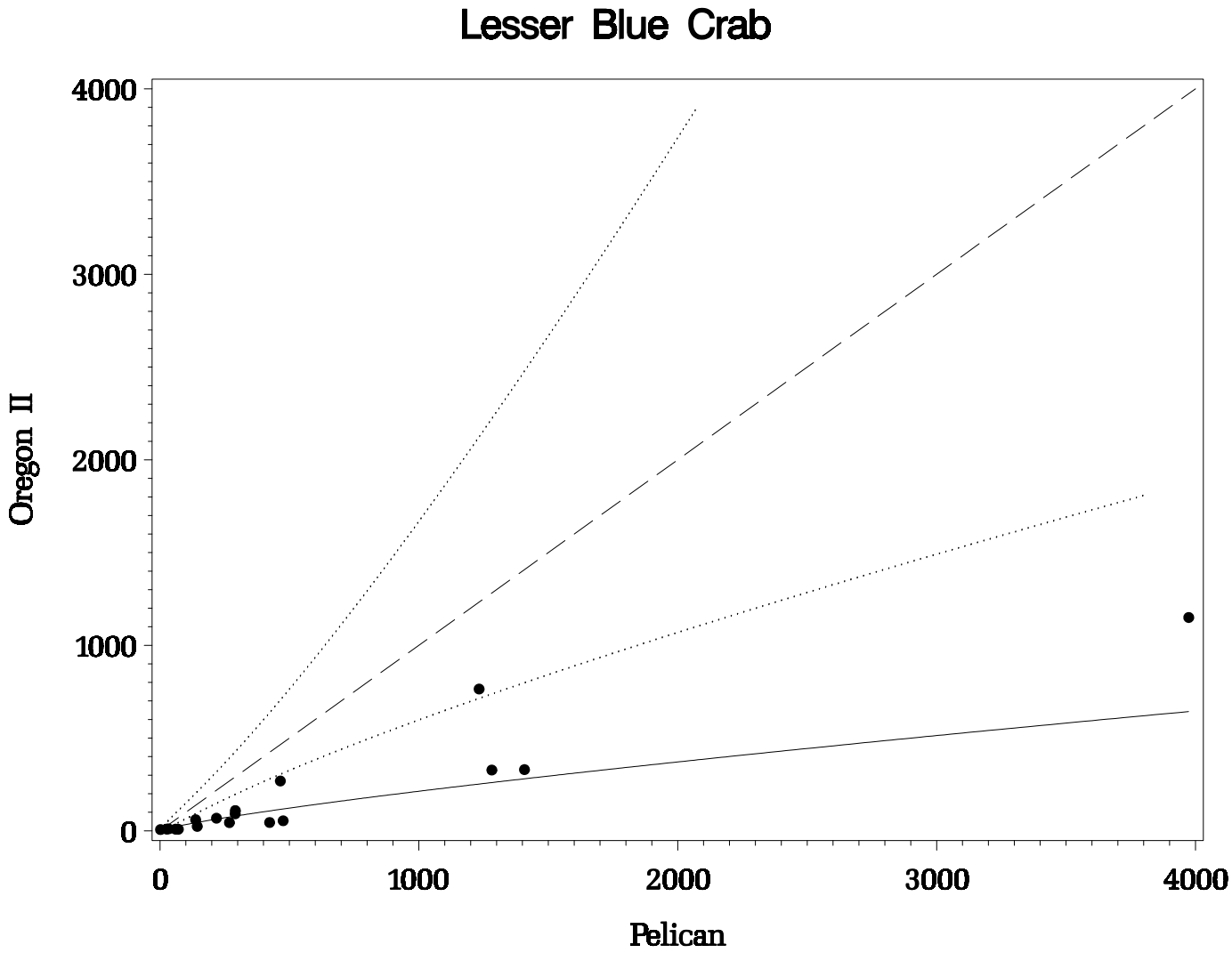

Figure 31. Scatter plot of lesser blue crab catches by *NOAA Ship Oregon II* and *Pelican* during paired comparison towing (n=18). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

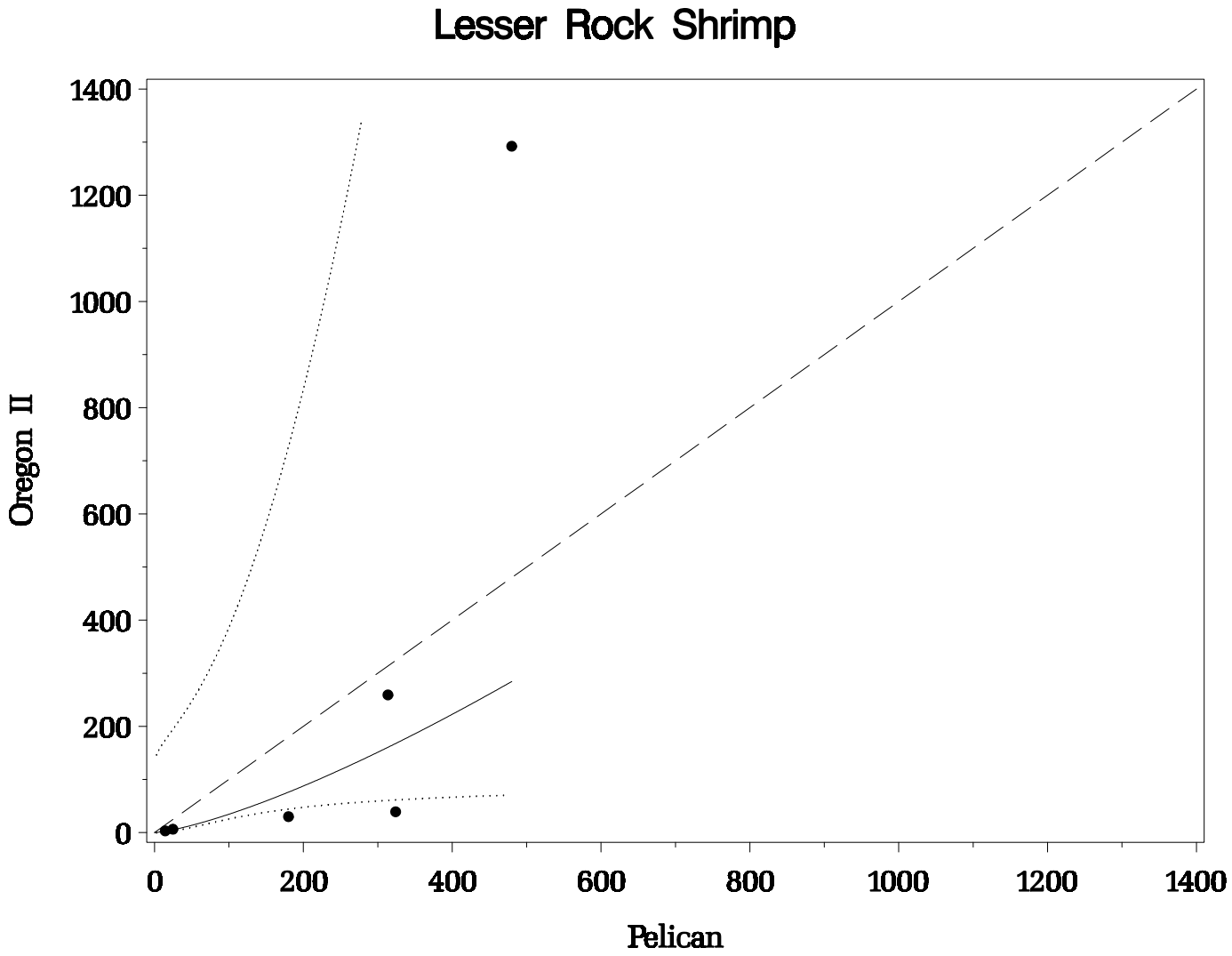

Figure 32. Scatter plot of lesser rock shrimp catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

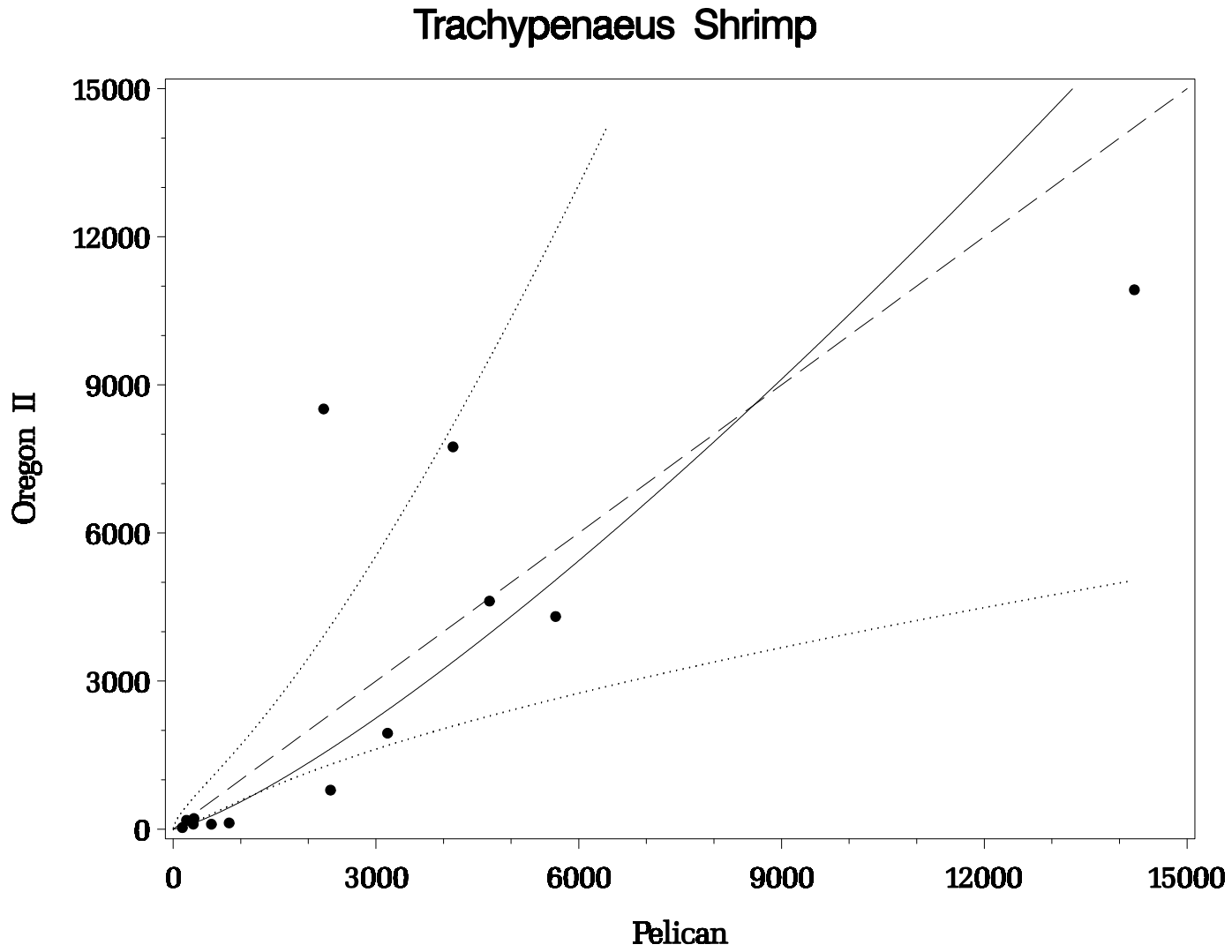

Figure 33. Scatter plot of Trachypenaeus shrimp catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=13). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

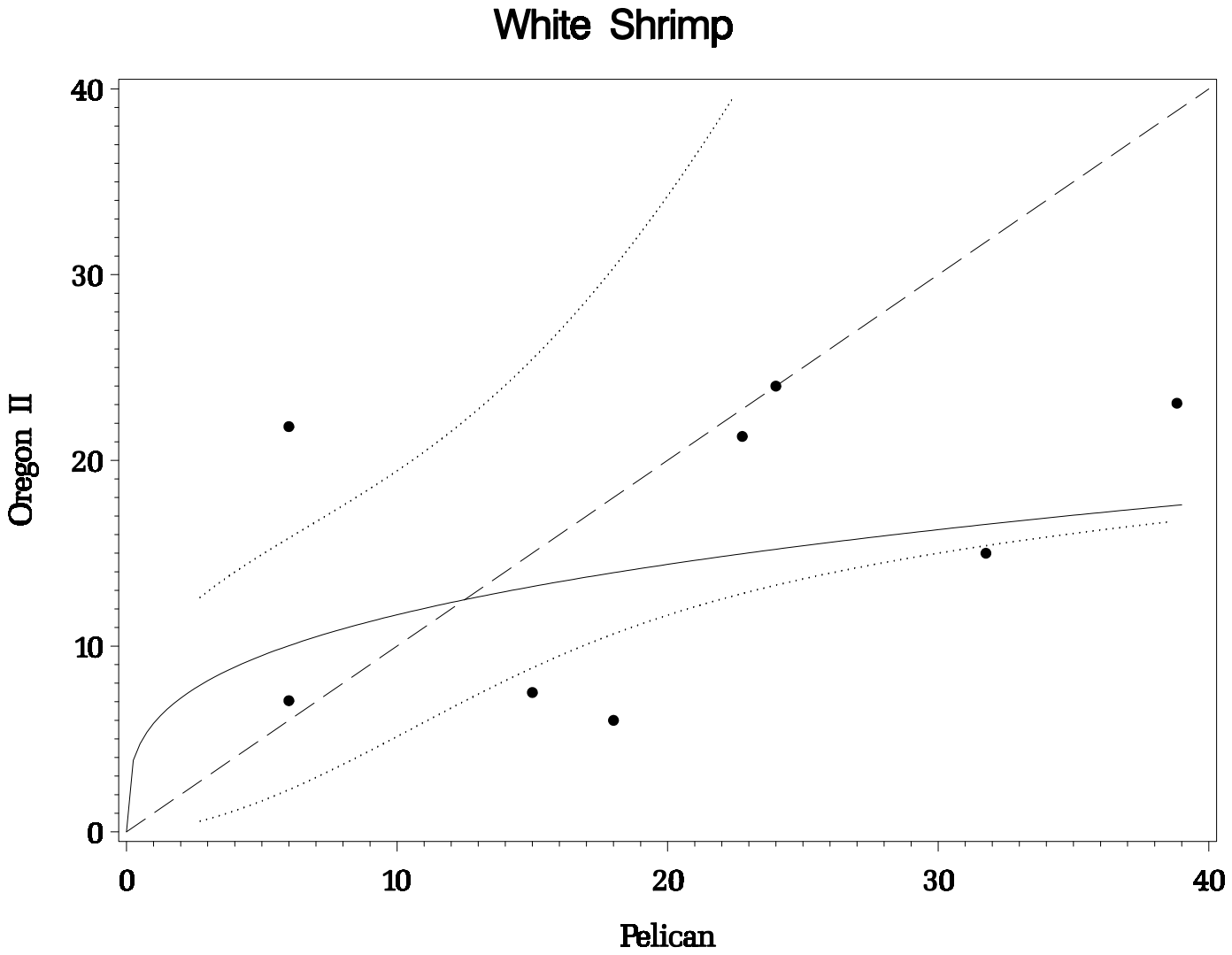

Figure 34. Scatter plot white shrimp catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=8). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

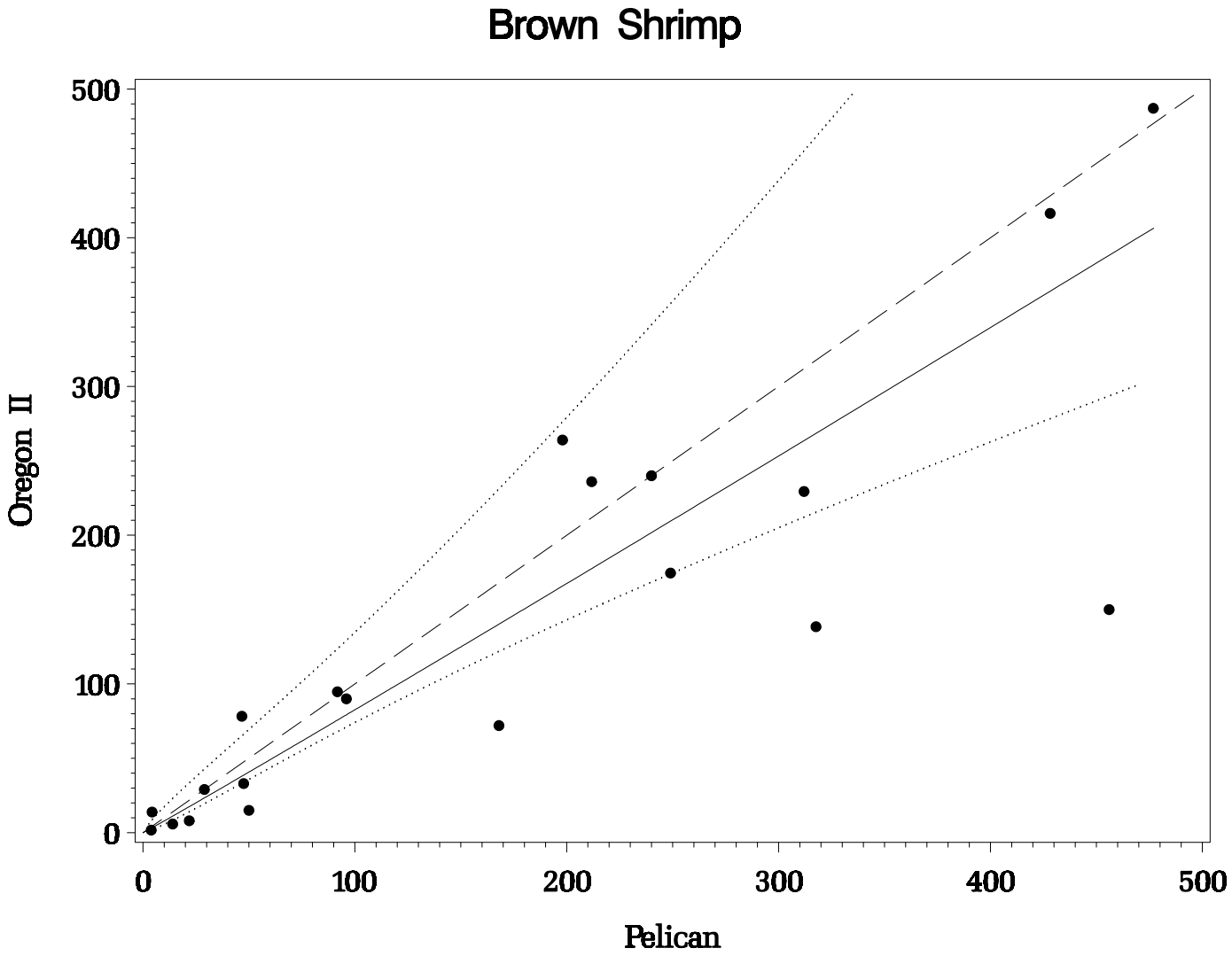

Figure 35. Scatter plot of brown shrimp catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=22). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

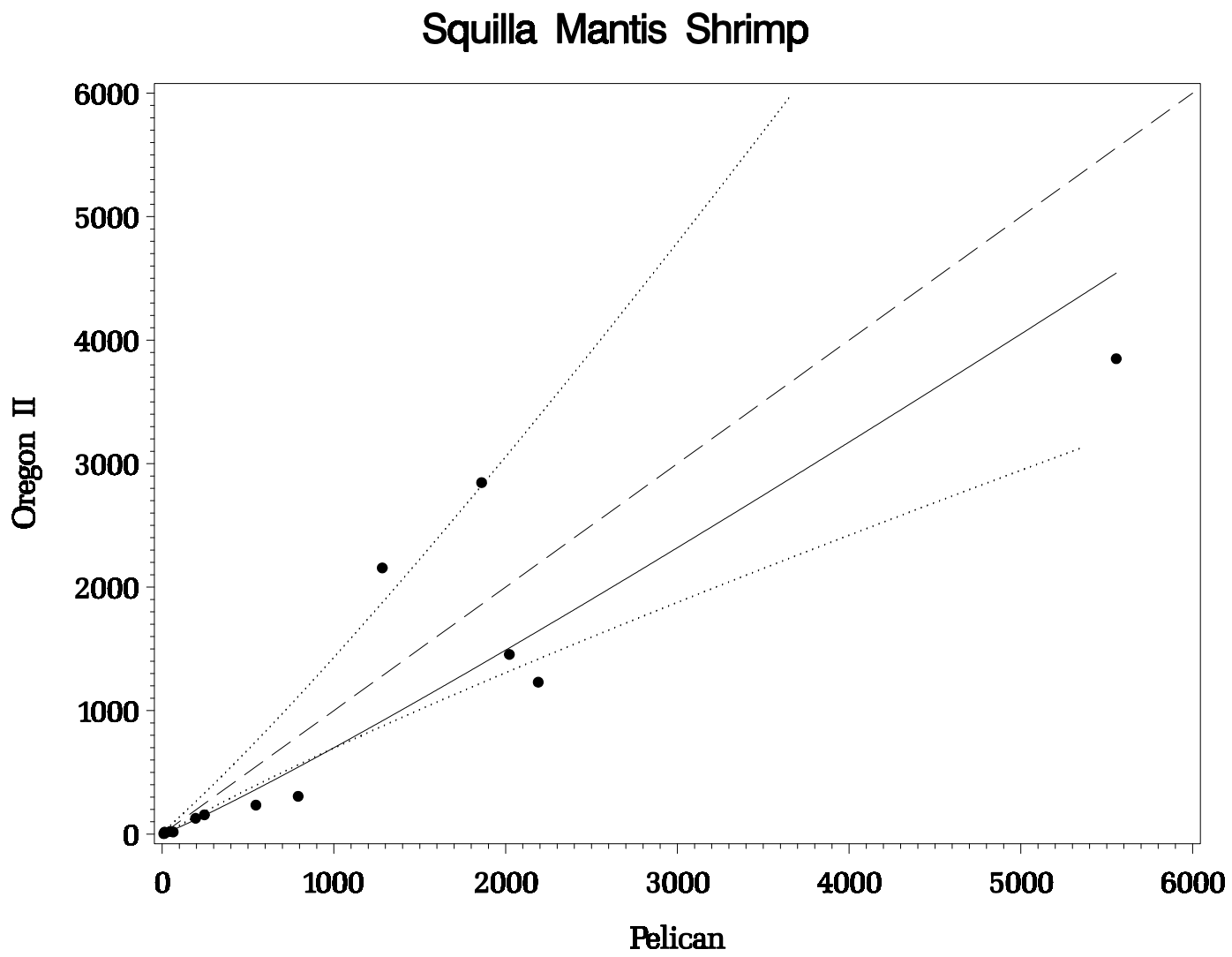

Figure 36. Scatter plot of Squilla mantis shrimp catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=14). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

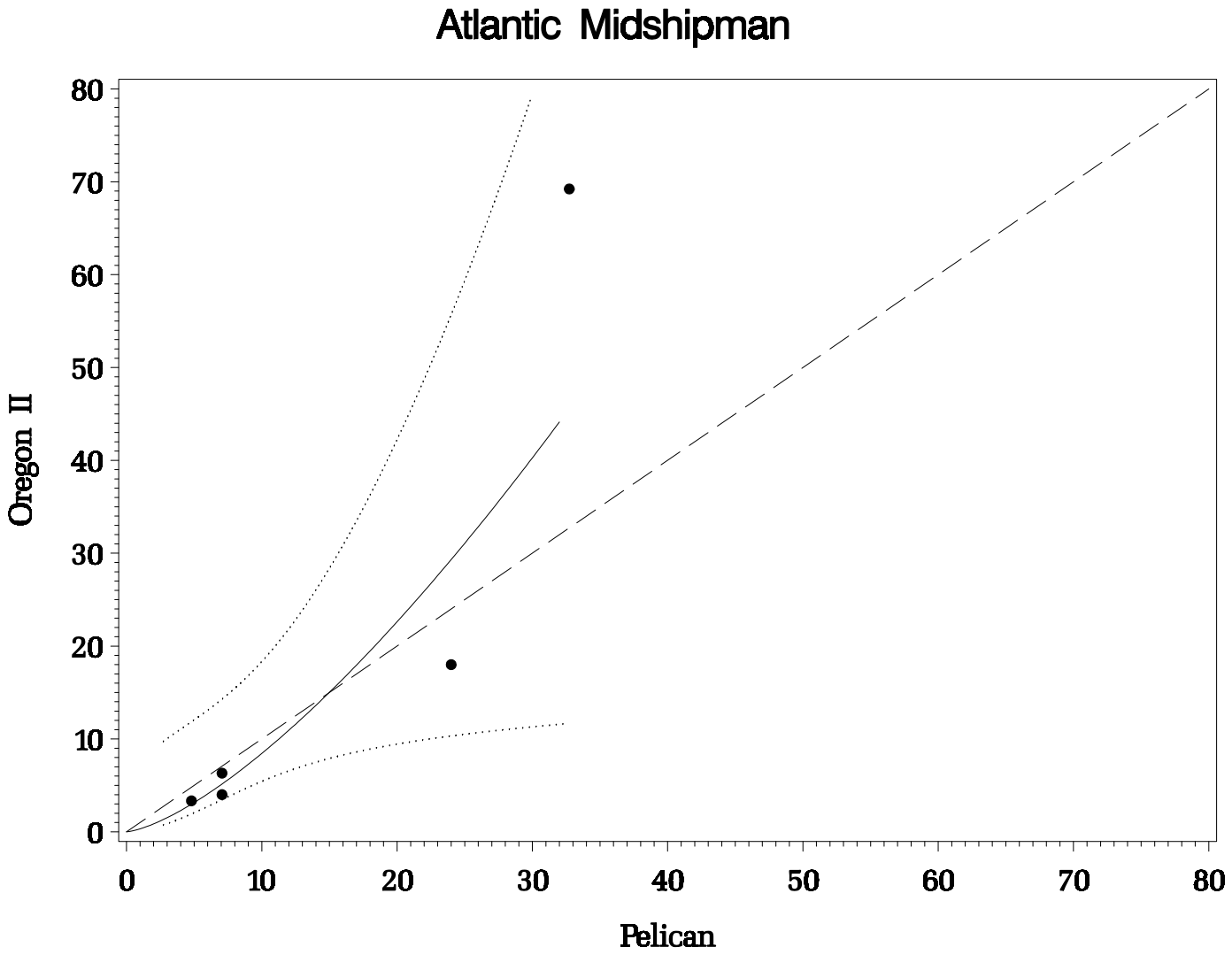

Figure 37. Scatter plot of Atlantic midshipman catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=5). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

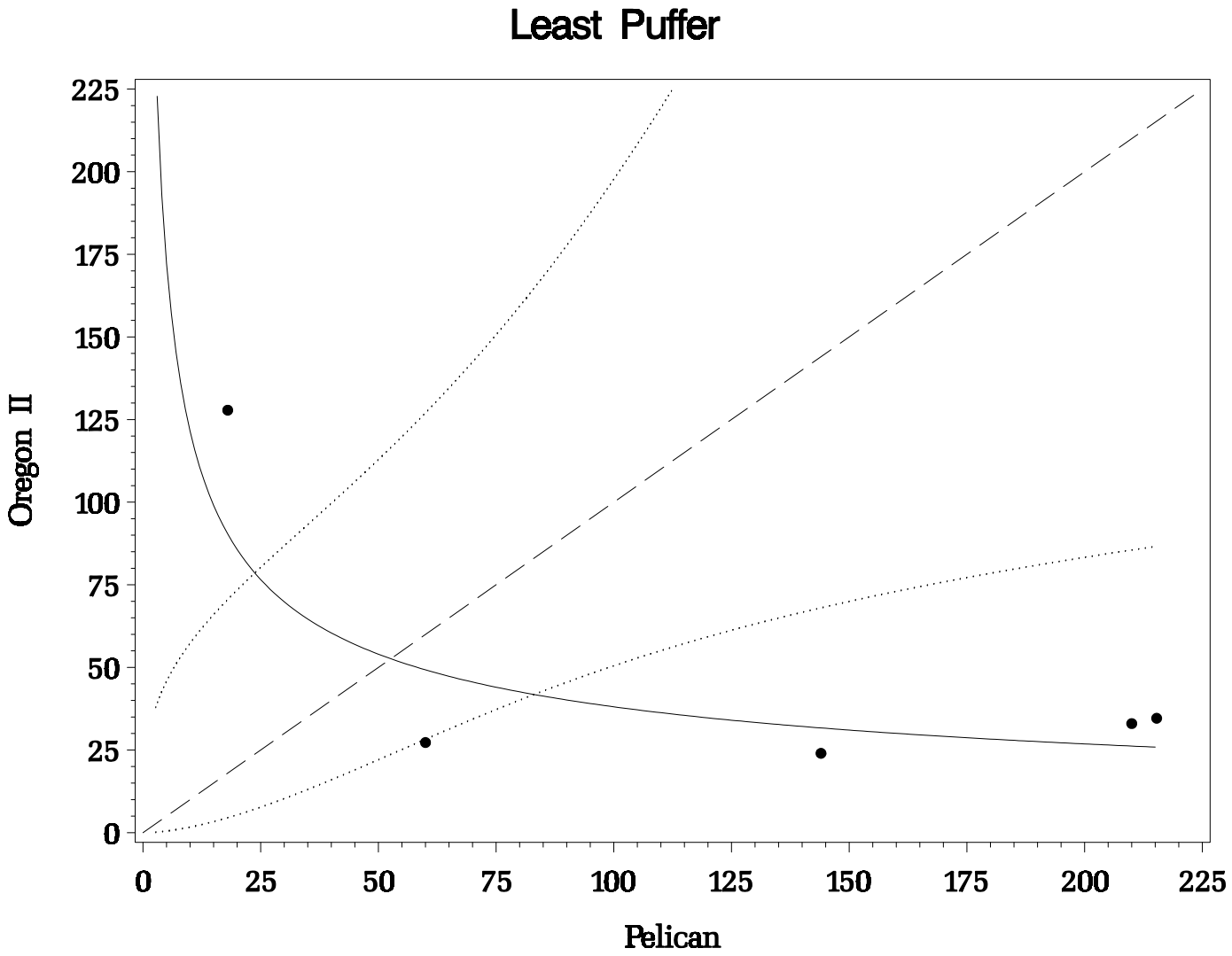

Figure 38. Scatter plot of least puffer catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=5). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

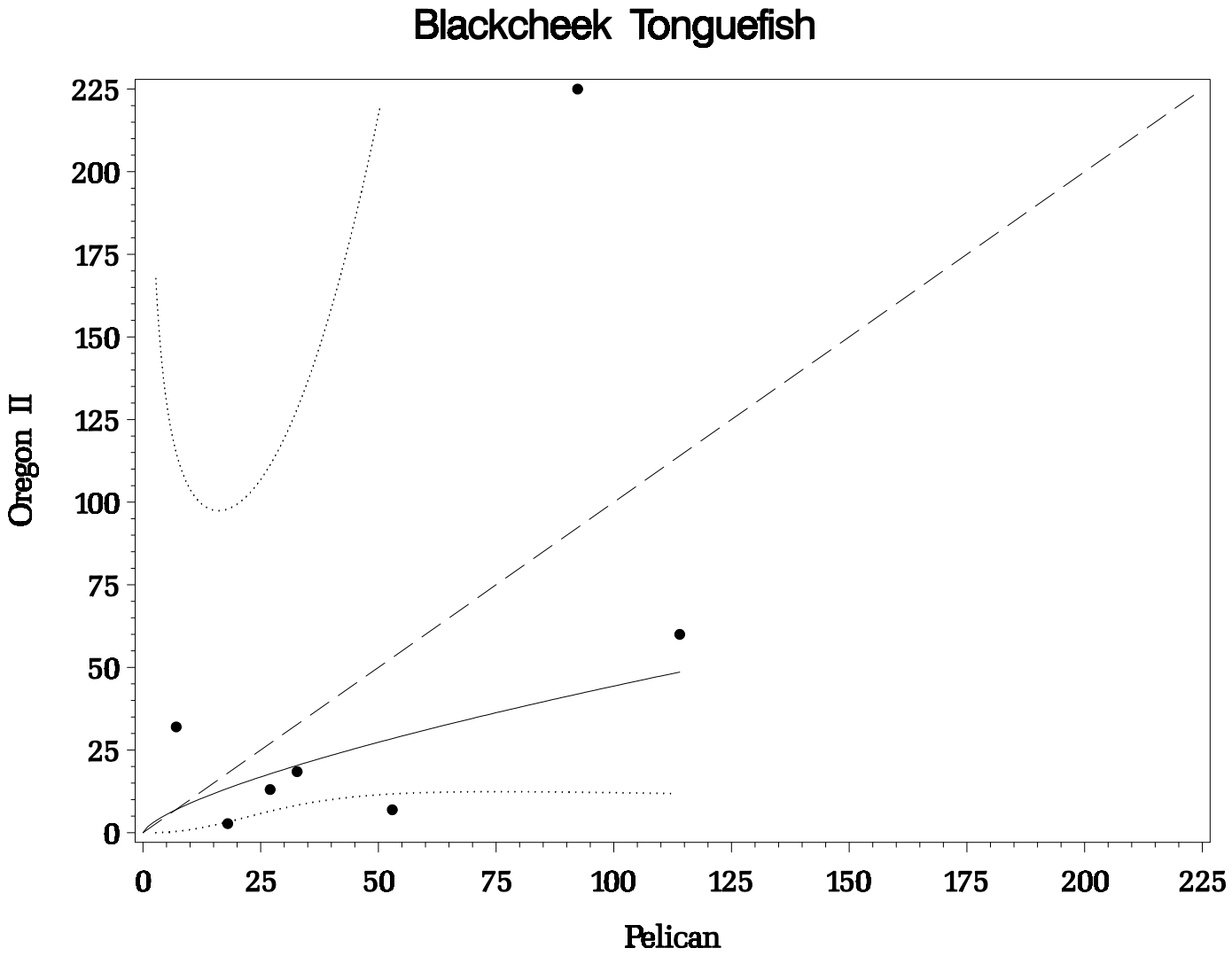

Figure 39. Scatter plot of blackcheek tonguefish catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=7). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

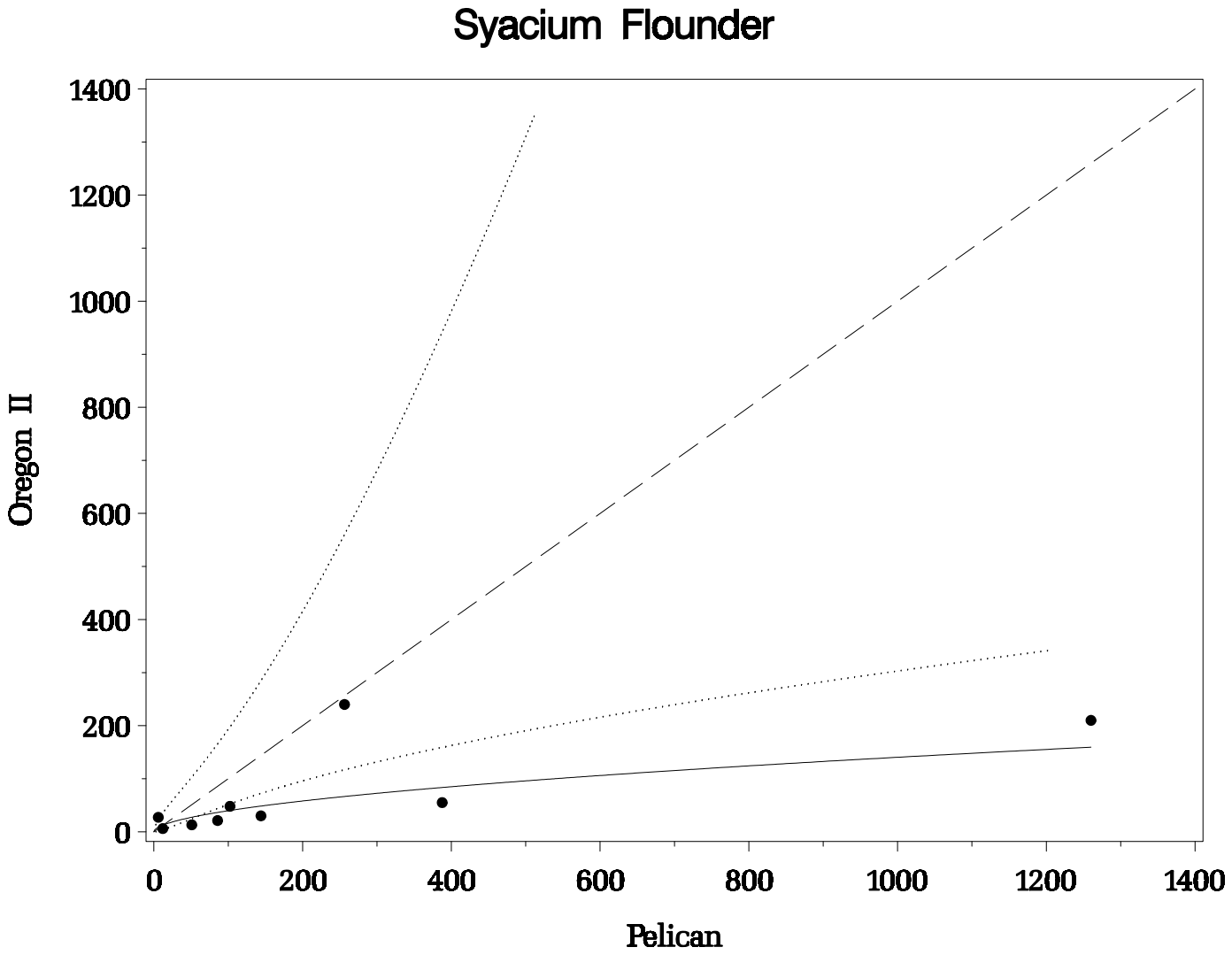

Figure 40. Scatter plot of Syacium flounder catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=9). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

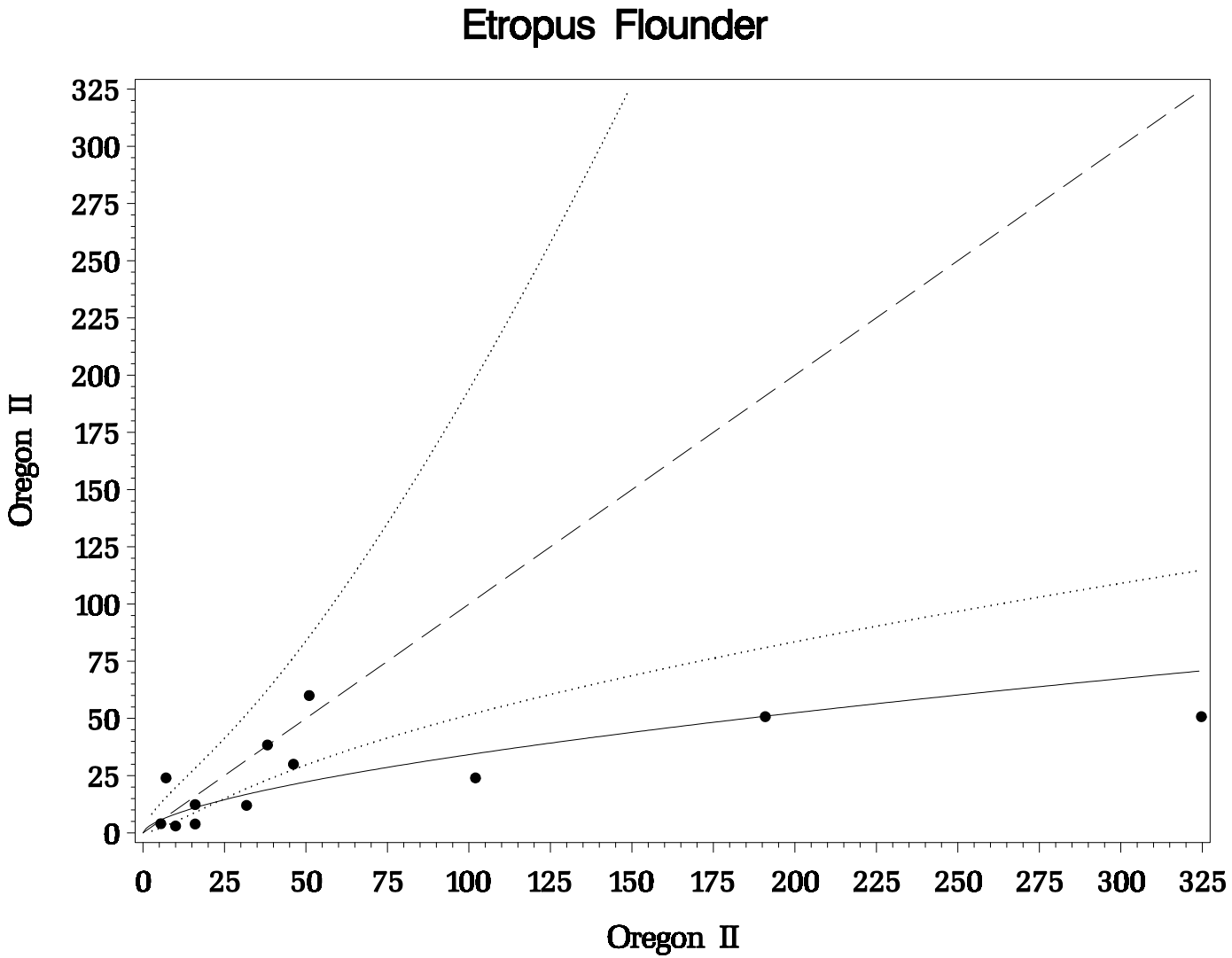

Figure 41. Scatter plot of Etropus flounder catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=12). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

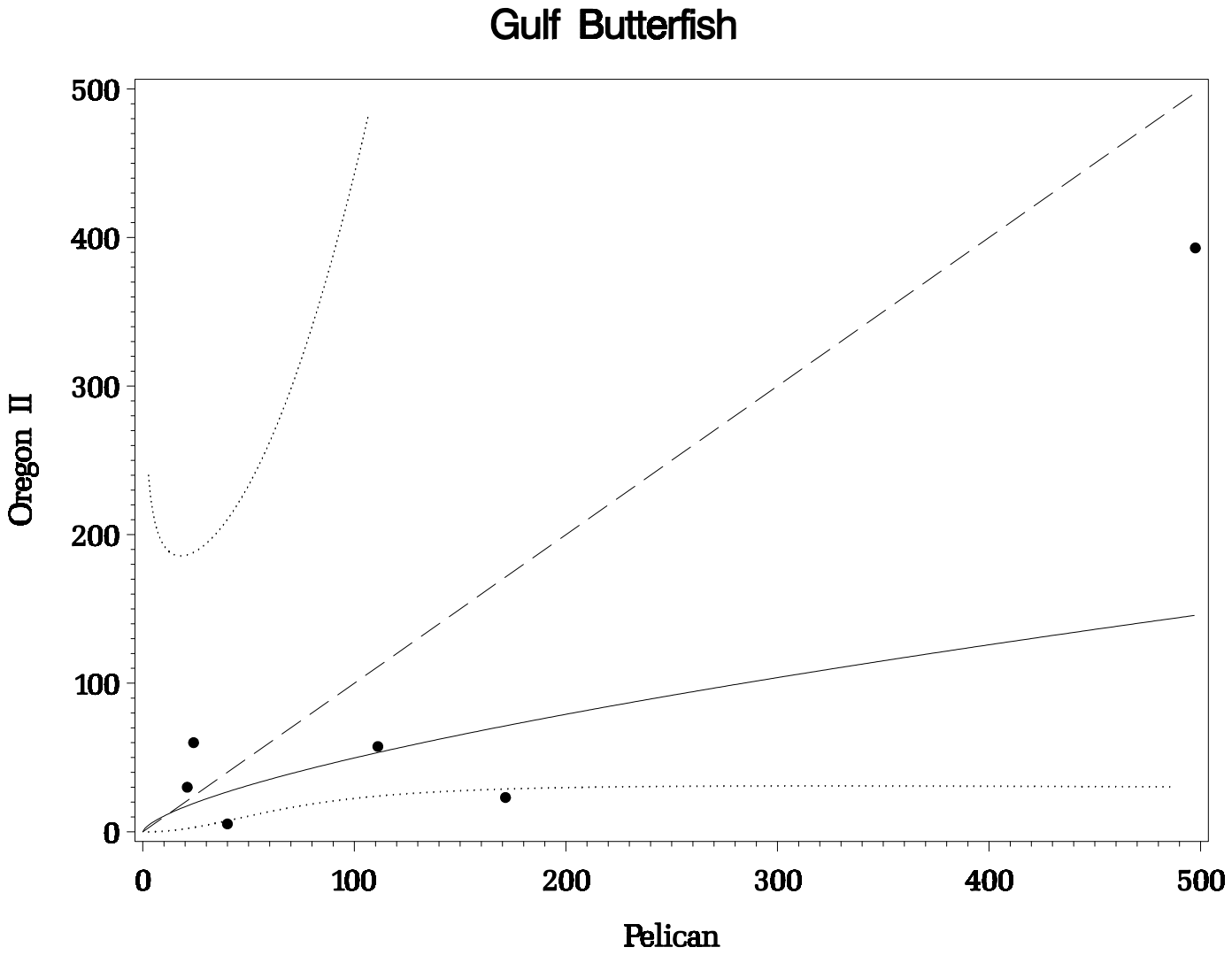

Figure 42. Scatter plot of Gulf butterfish catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

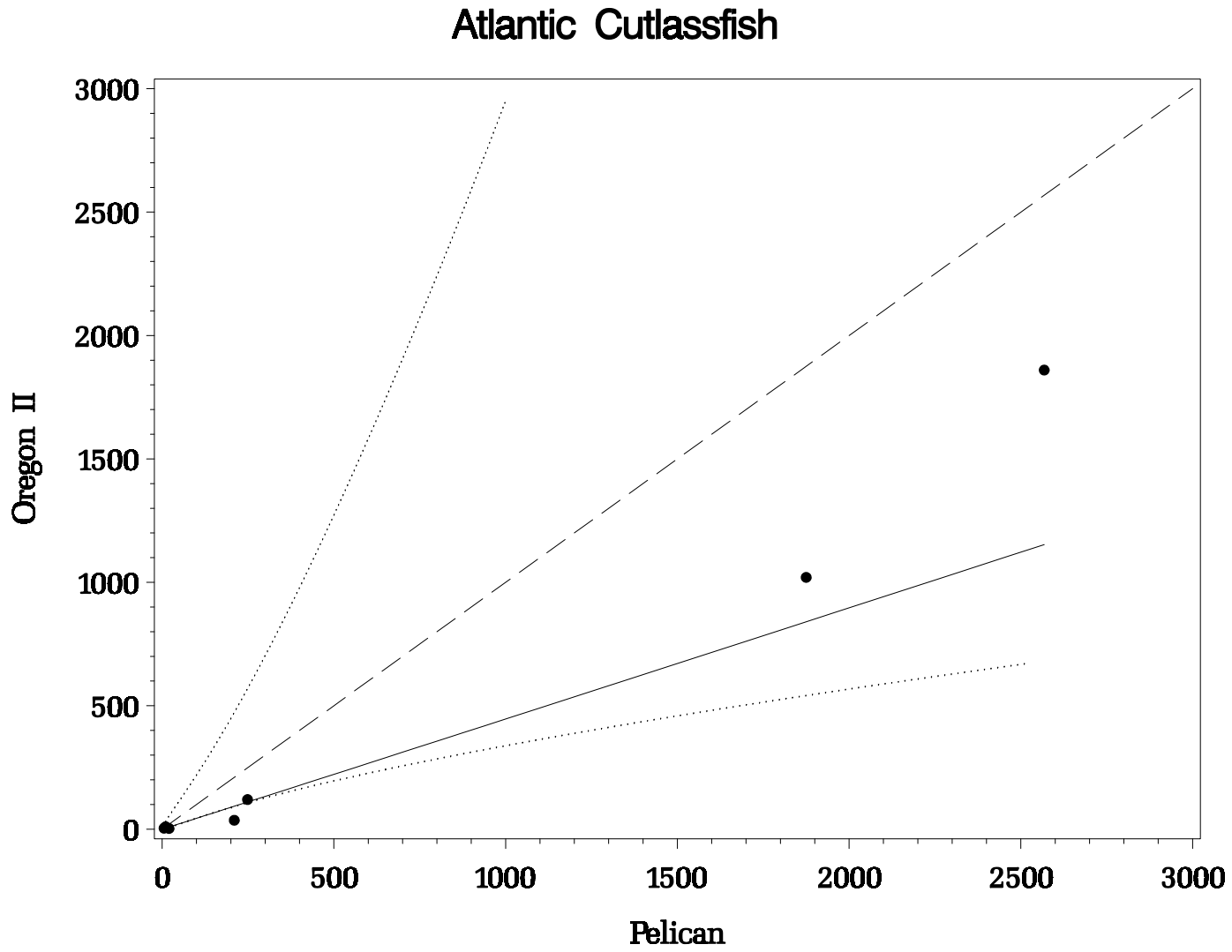

Figure 43. Scatter plot of Atlantic cutlassfish catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=7). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

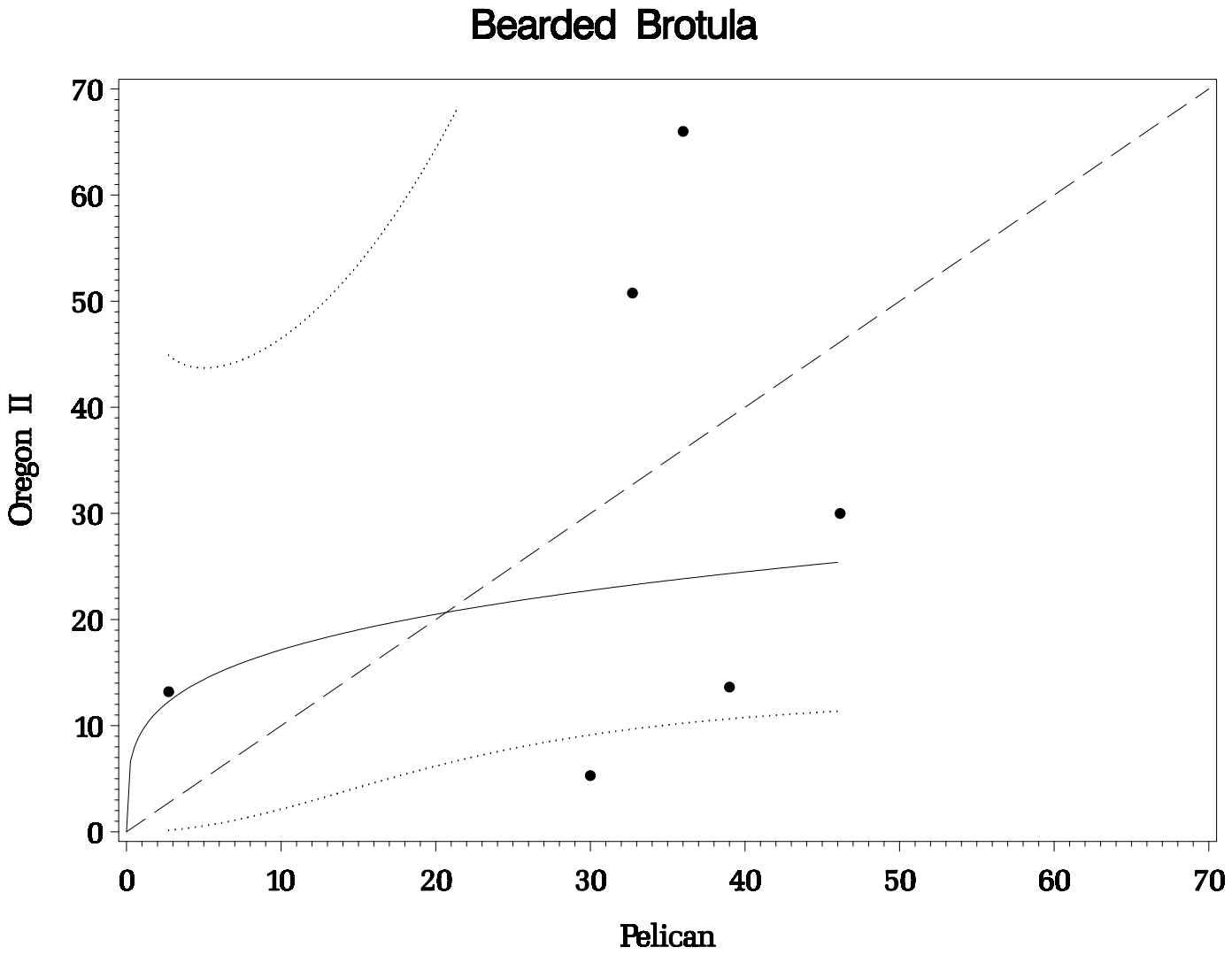

Figure 44. Scatter plot of bearded brotula catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

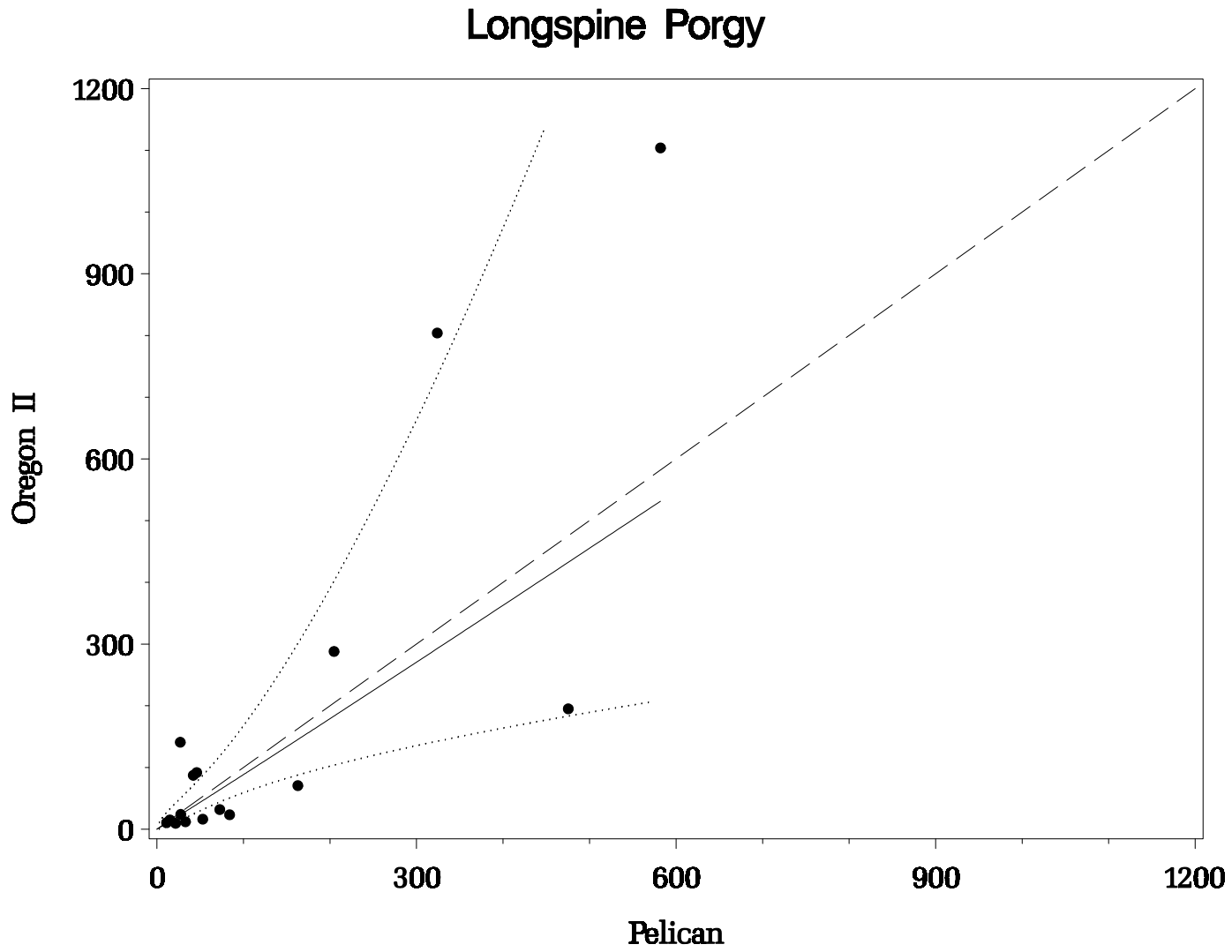

Figure 45. Scatter plot of longspine porgy catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=16). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

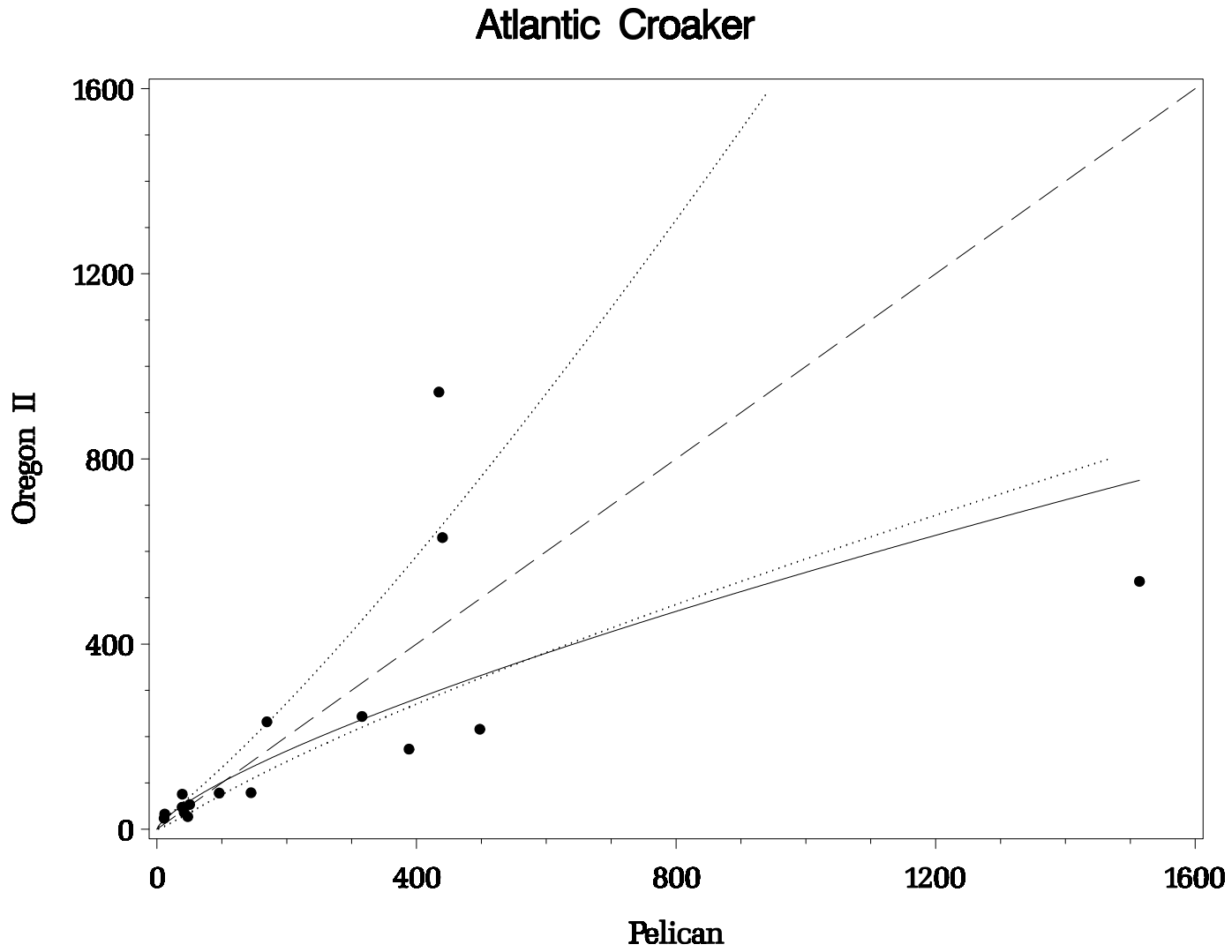

Figure 46. Scatter plot of Atlantic croaker catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=16). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

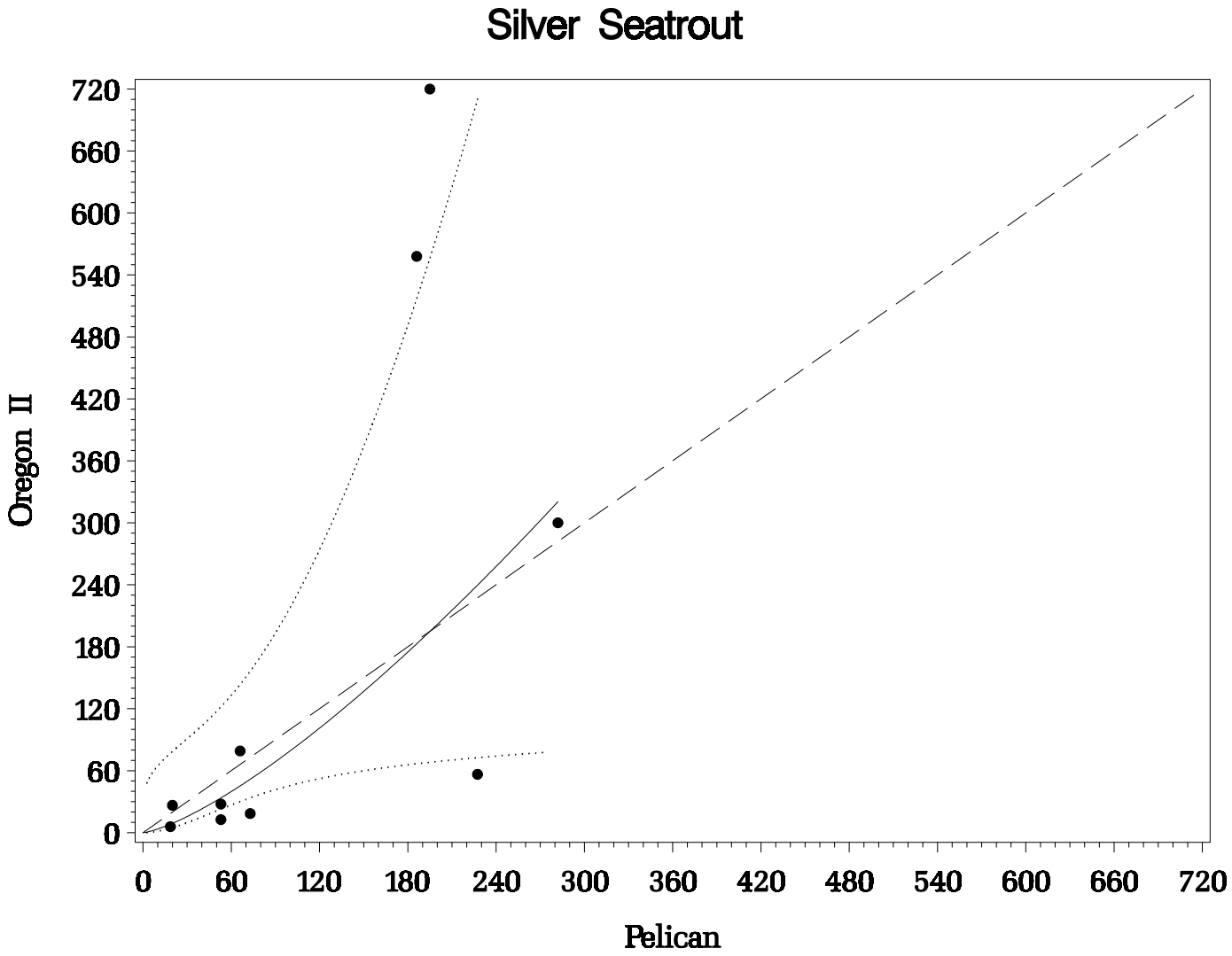

Figure 47. Scatter plot of silver seatrout catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=10). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

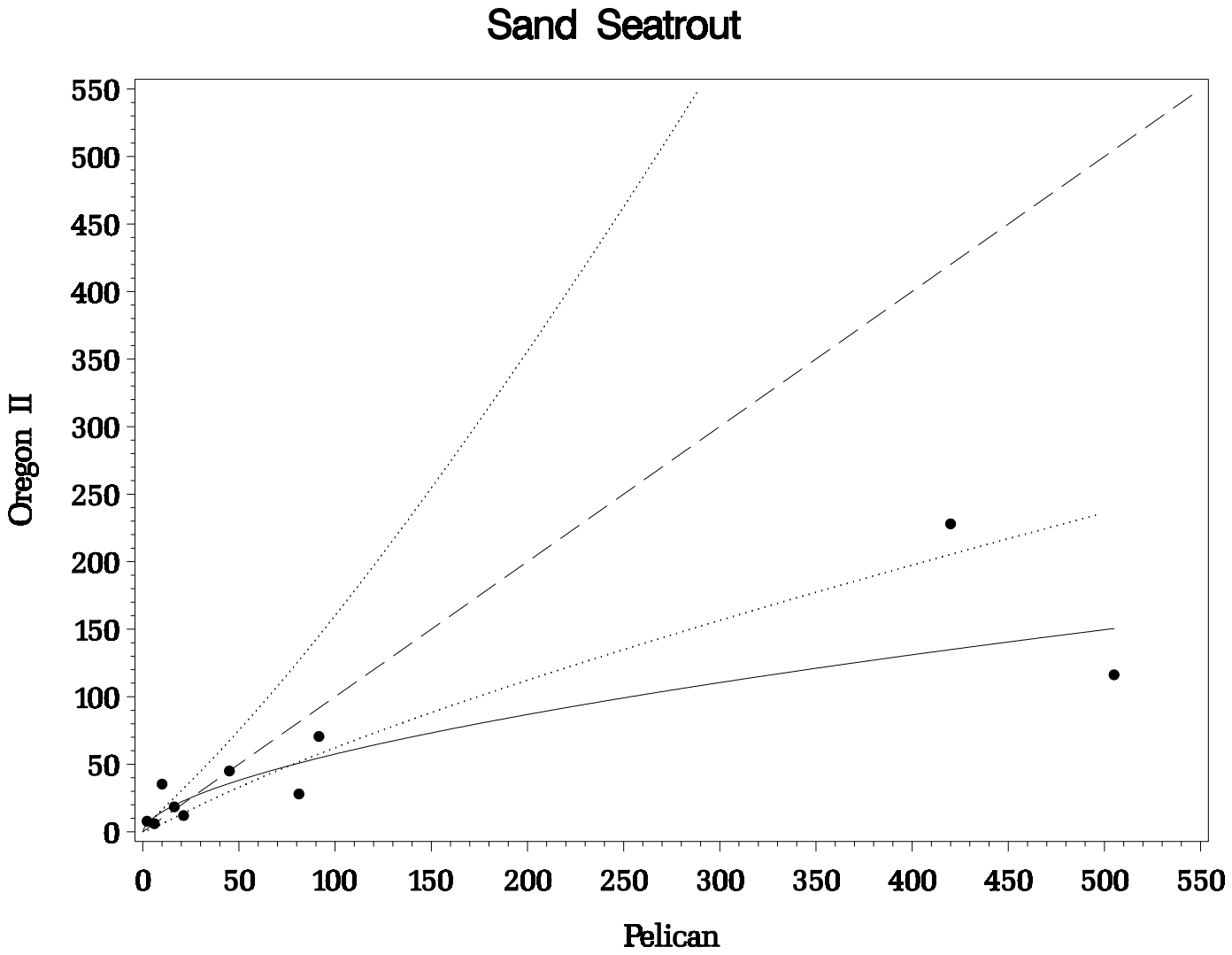

Figure 48. Scatter plot of sand seatrout catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=10). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

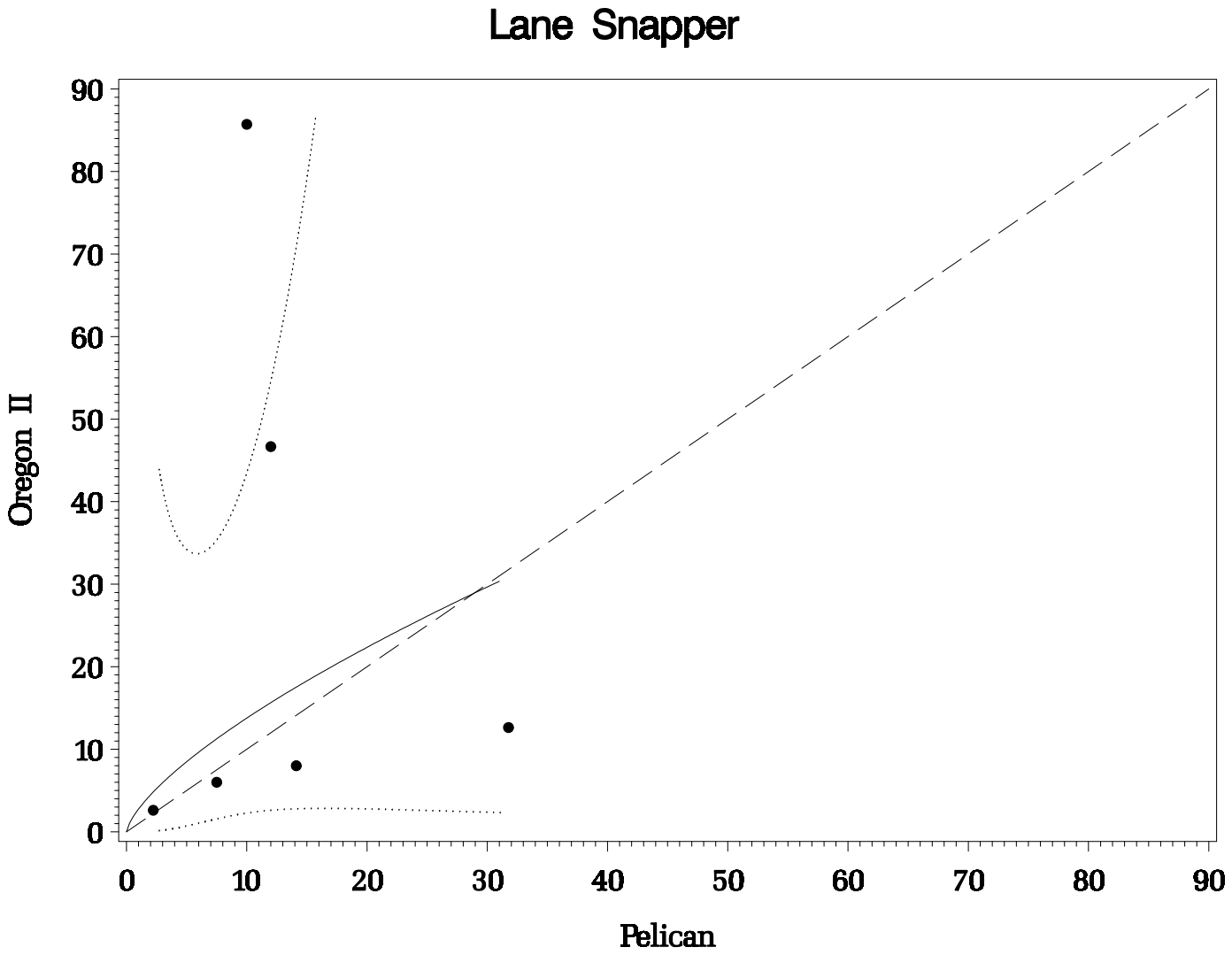

Figure 49. Scatter plot of lane snapper catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

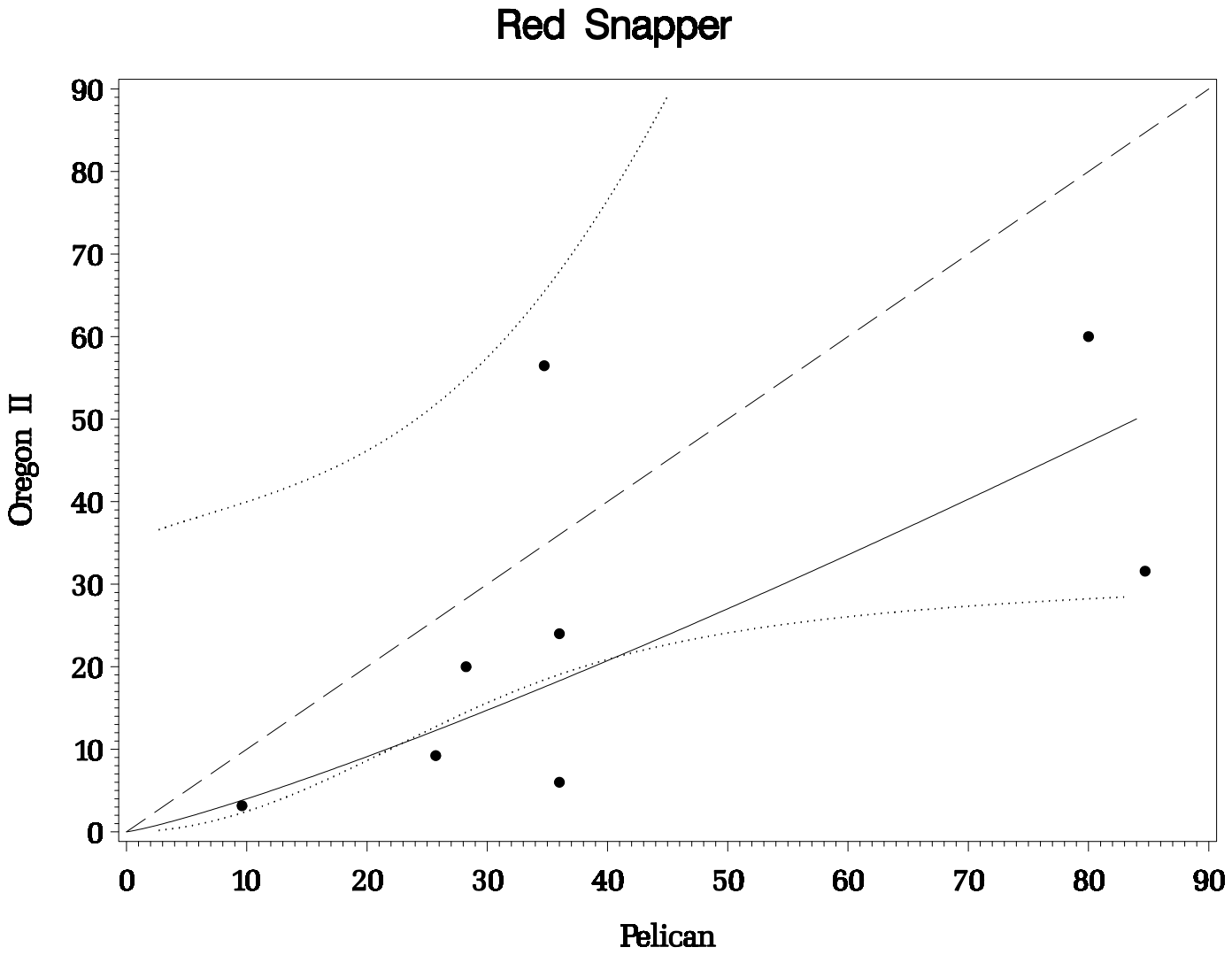

Figure 50. Scatter plot of red snapper catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=8). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

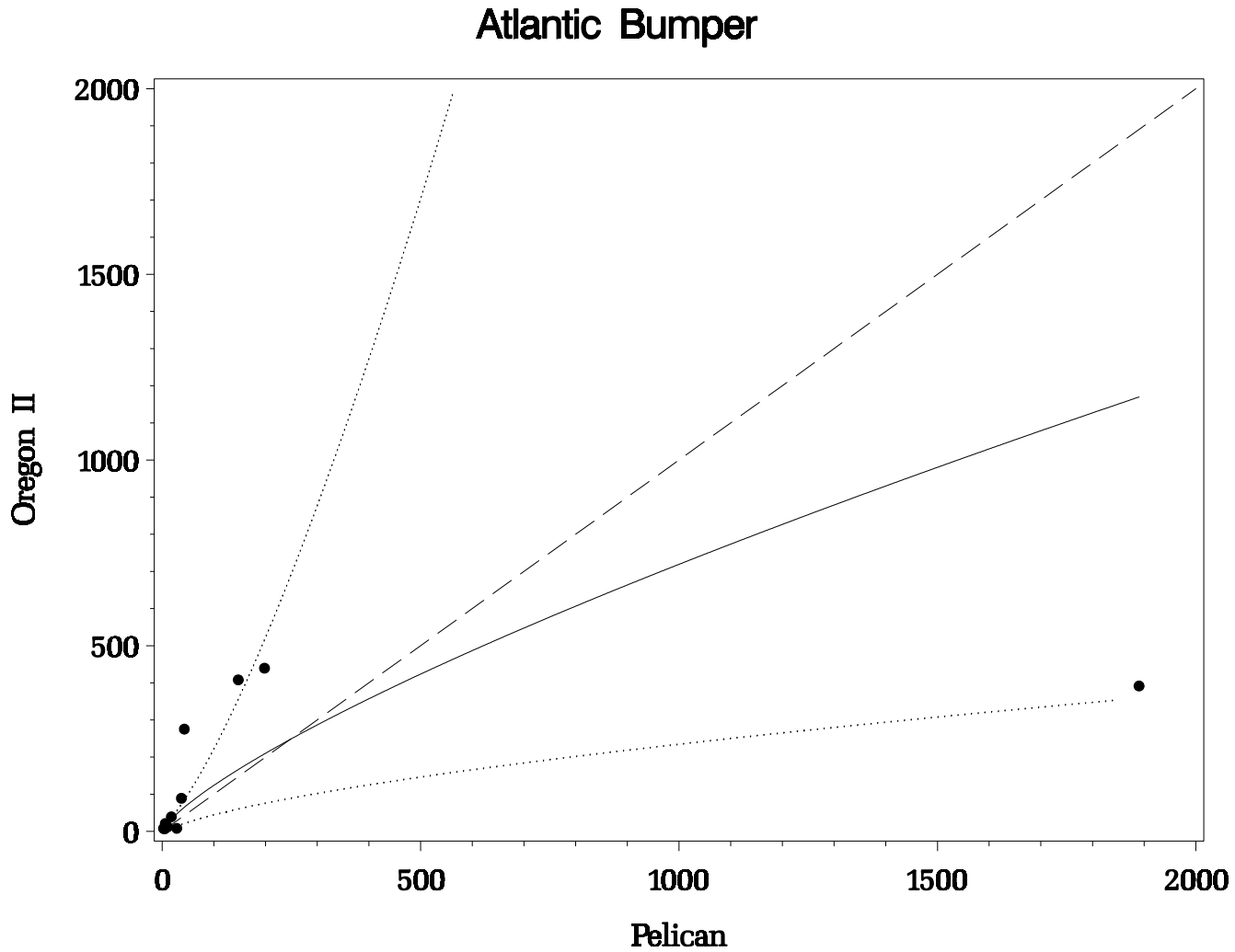

Figure 51. Scatter plot of Atlantic bumper catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=11). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

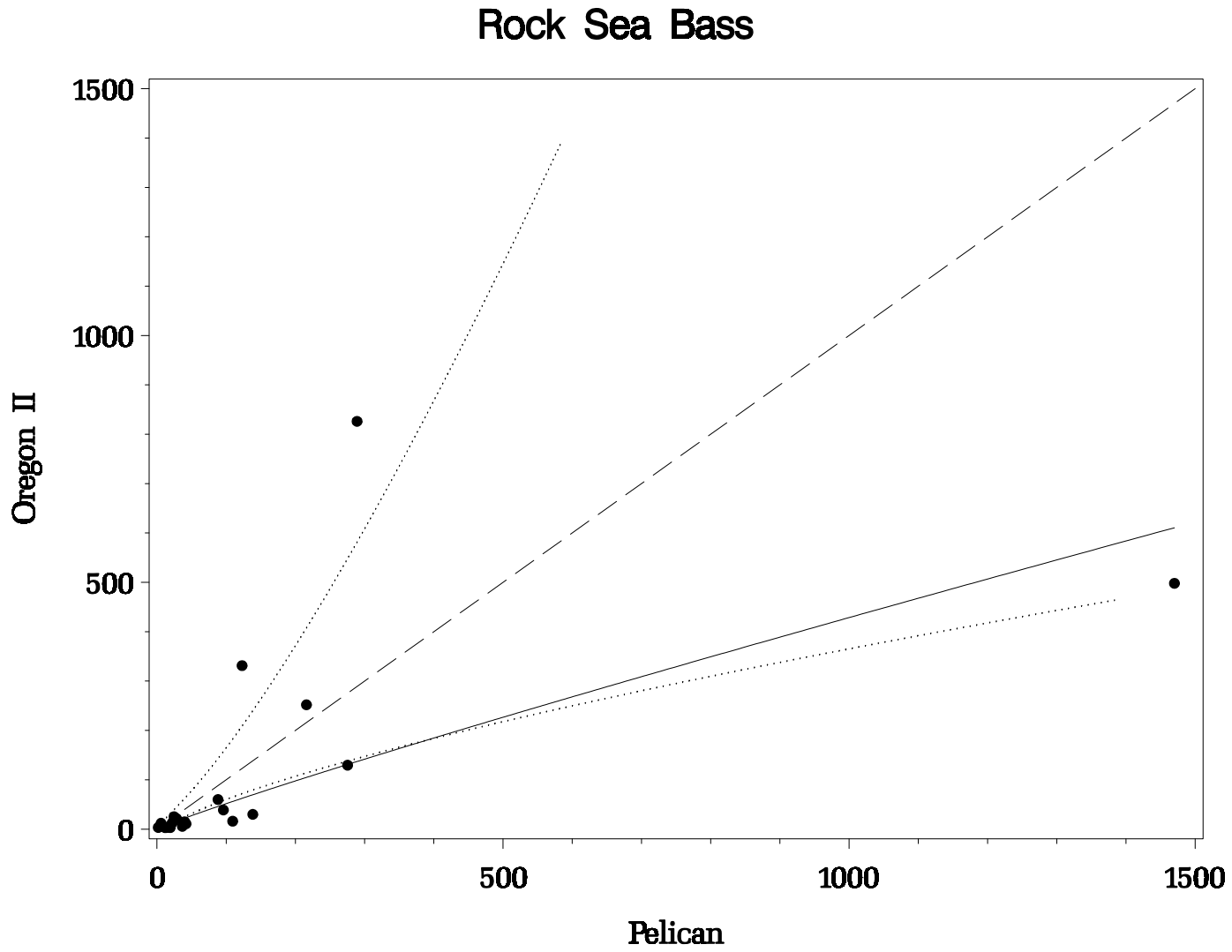

Figure 52. Scatter plot of rock sea bass catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=21). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

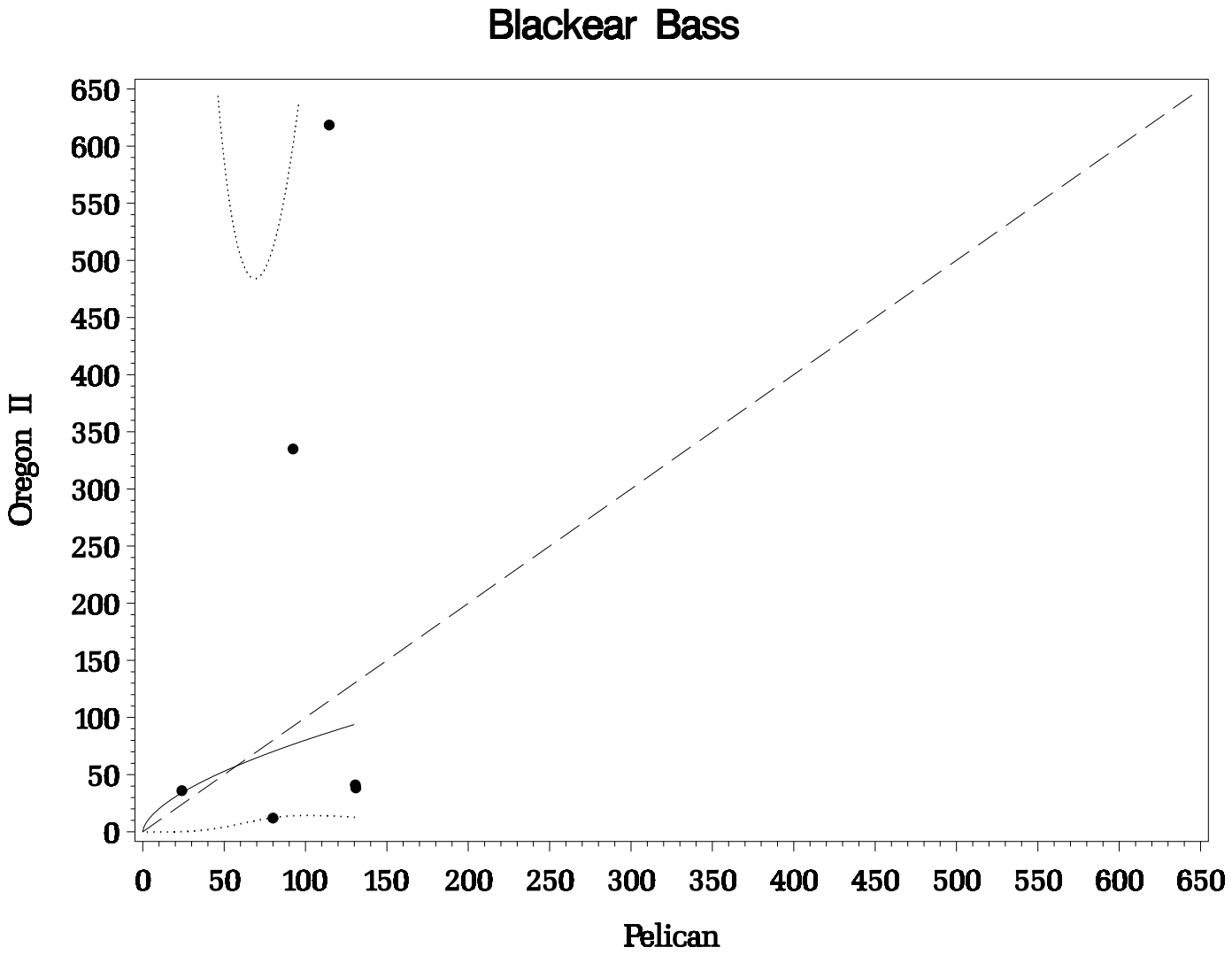

Figure 53. Scatter plot of blackear bass catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

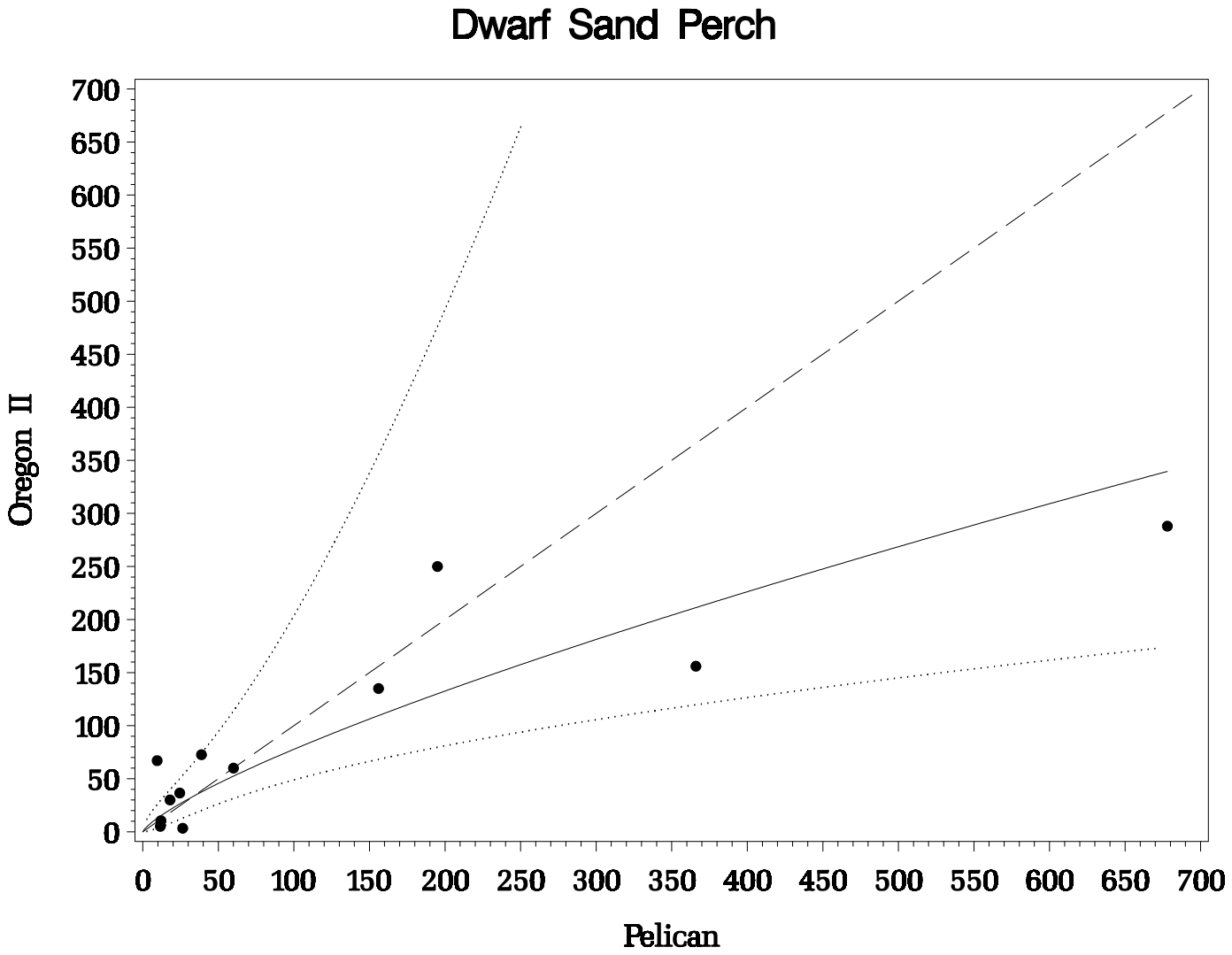

Figure 54. Scatter plot of dwarf sand perch catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=12). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

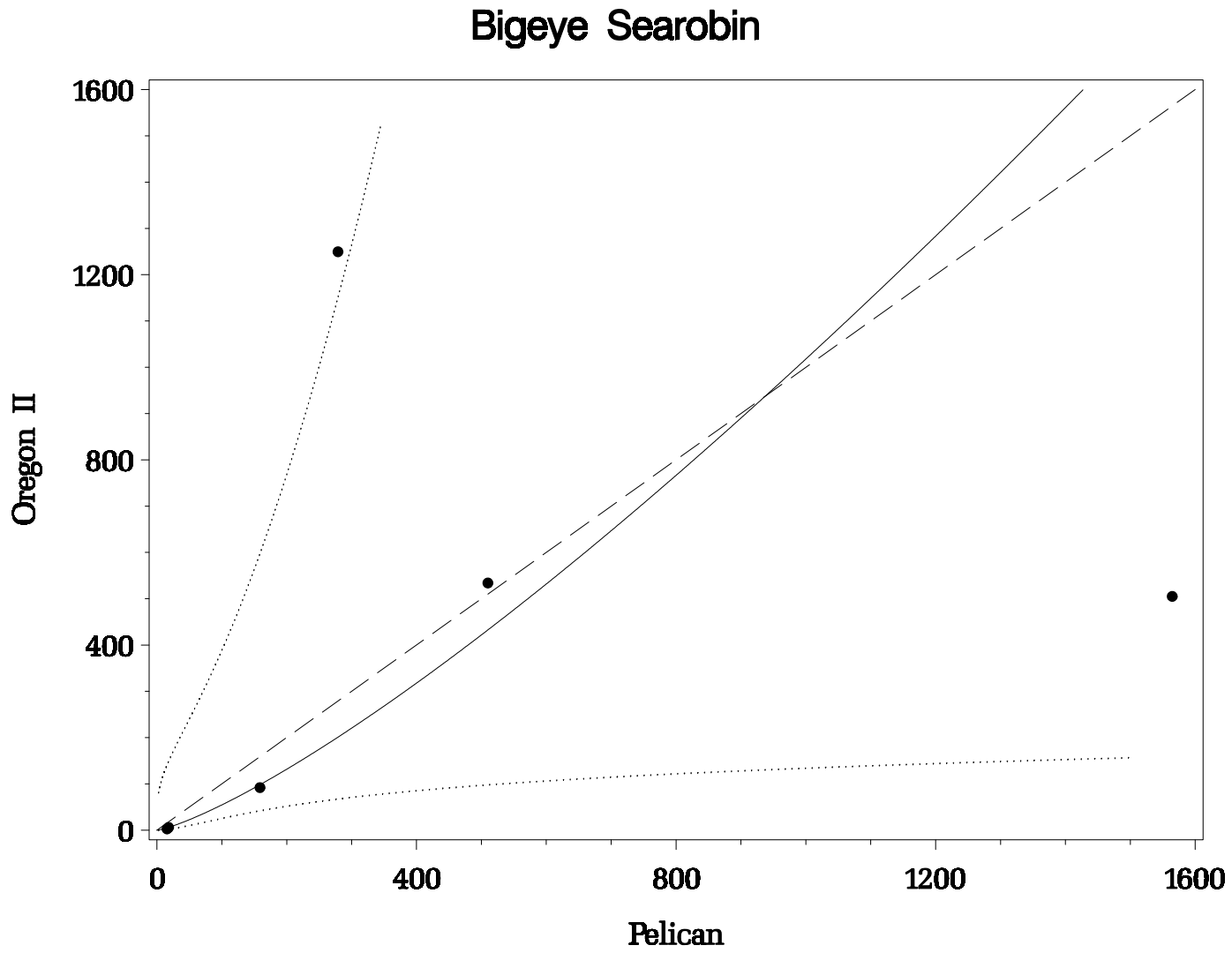

Figure 55. Scatter plot of bigeye searobin catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

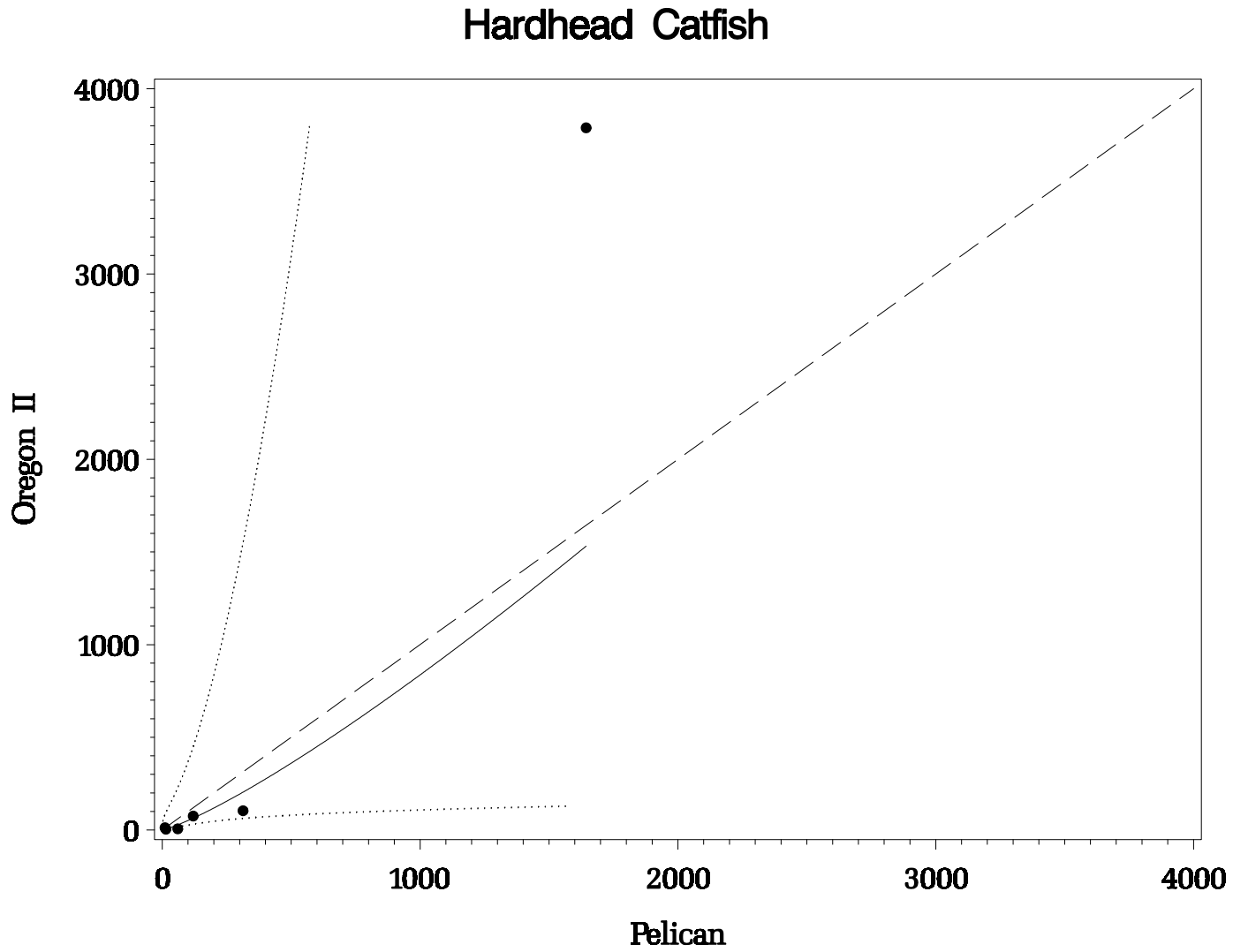

Figure 56. Scatter plot of hardhead catfish catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=5). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

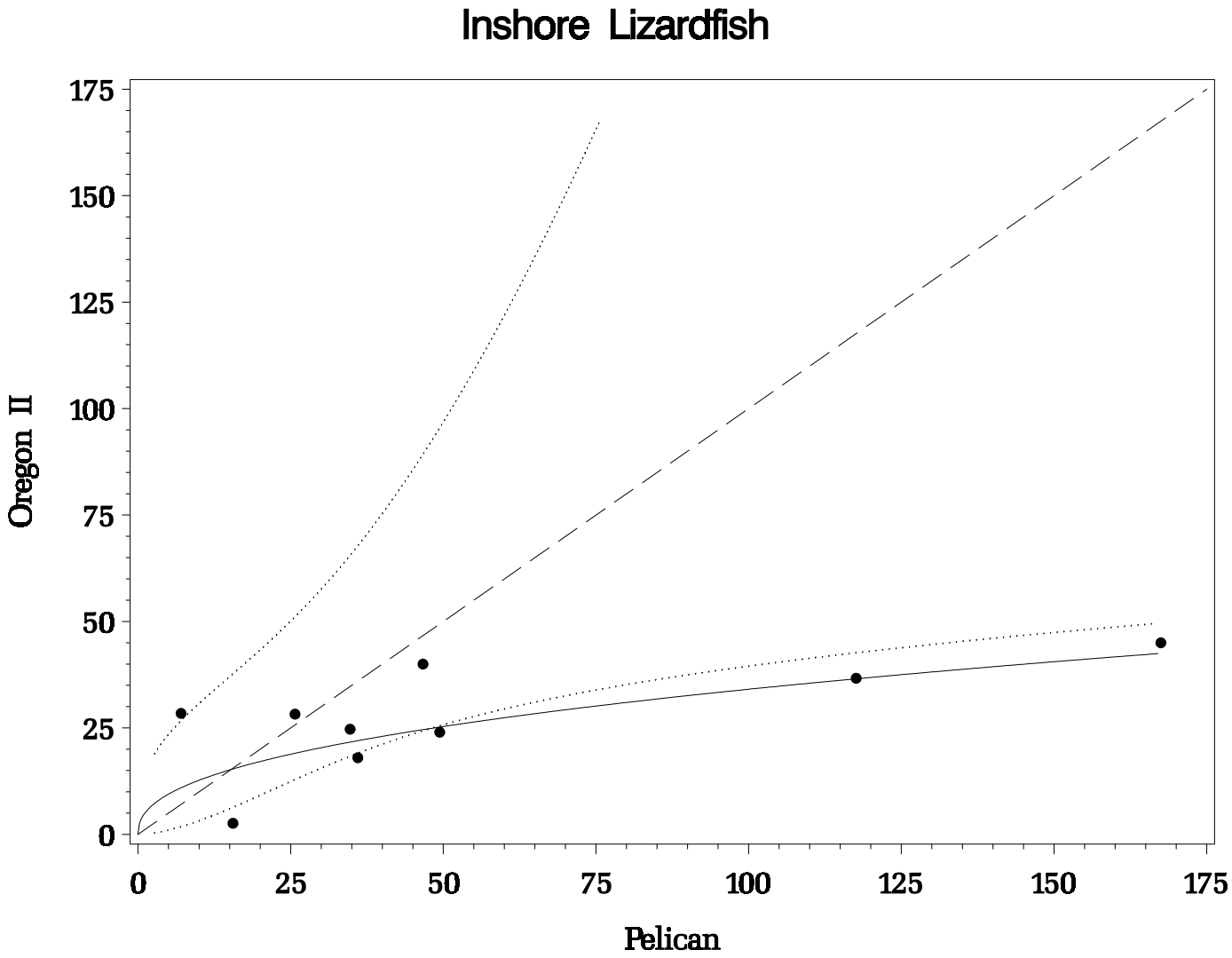

Figure 57. Scatter plot of inshore lizardfish catches by *NOAA Ship Oregon II* and *R/V Pelican* during paired comparison towing (n=9). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

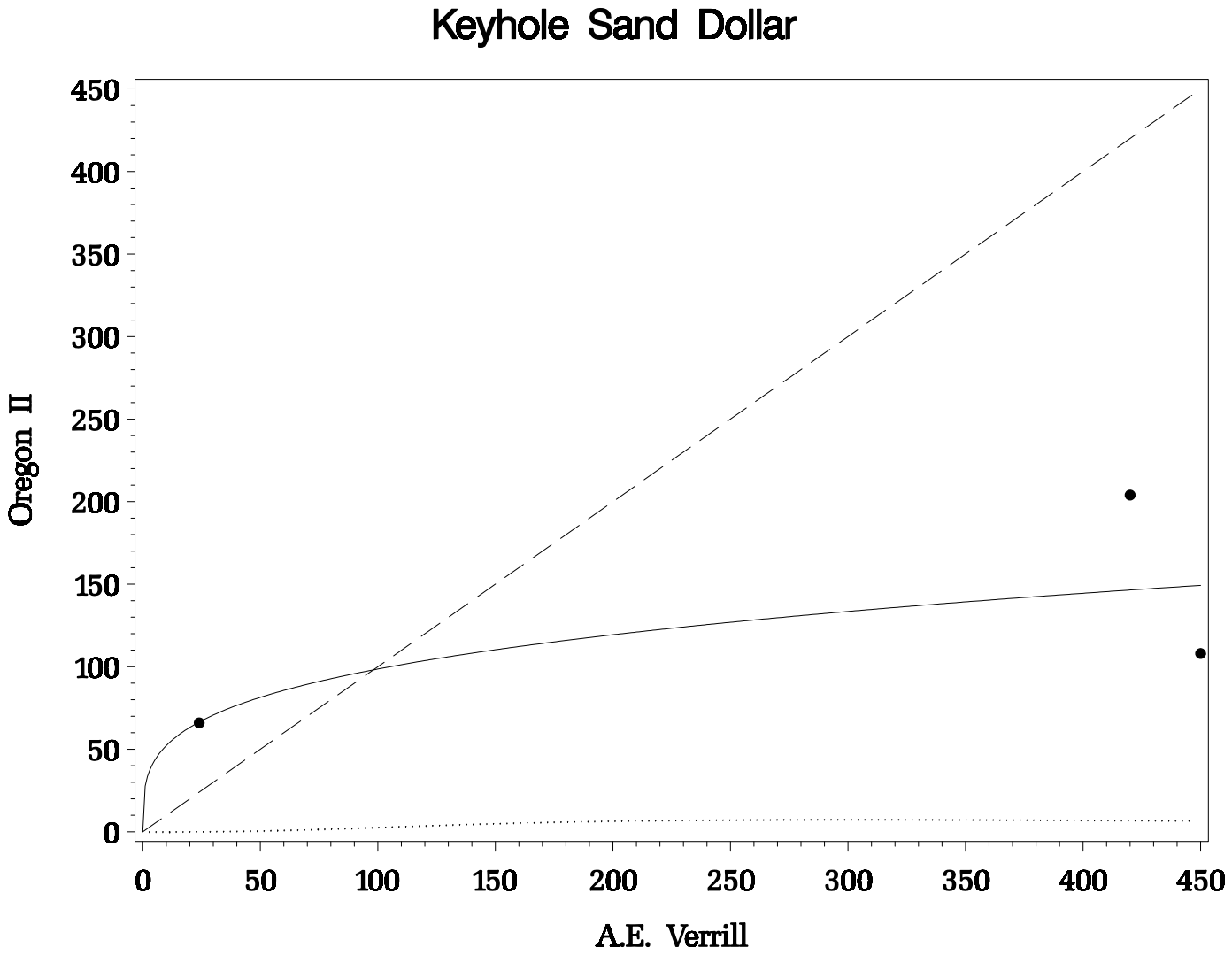

Figure 58. Scatter plot of keyhole sand dollar catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=3). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

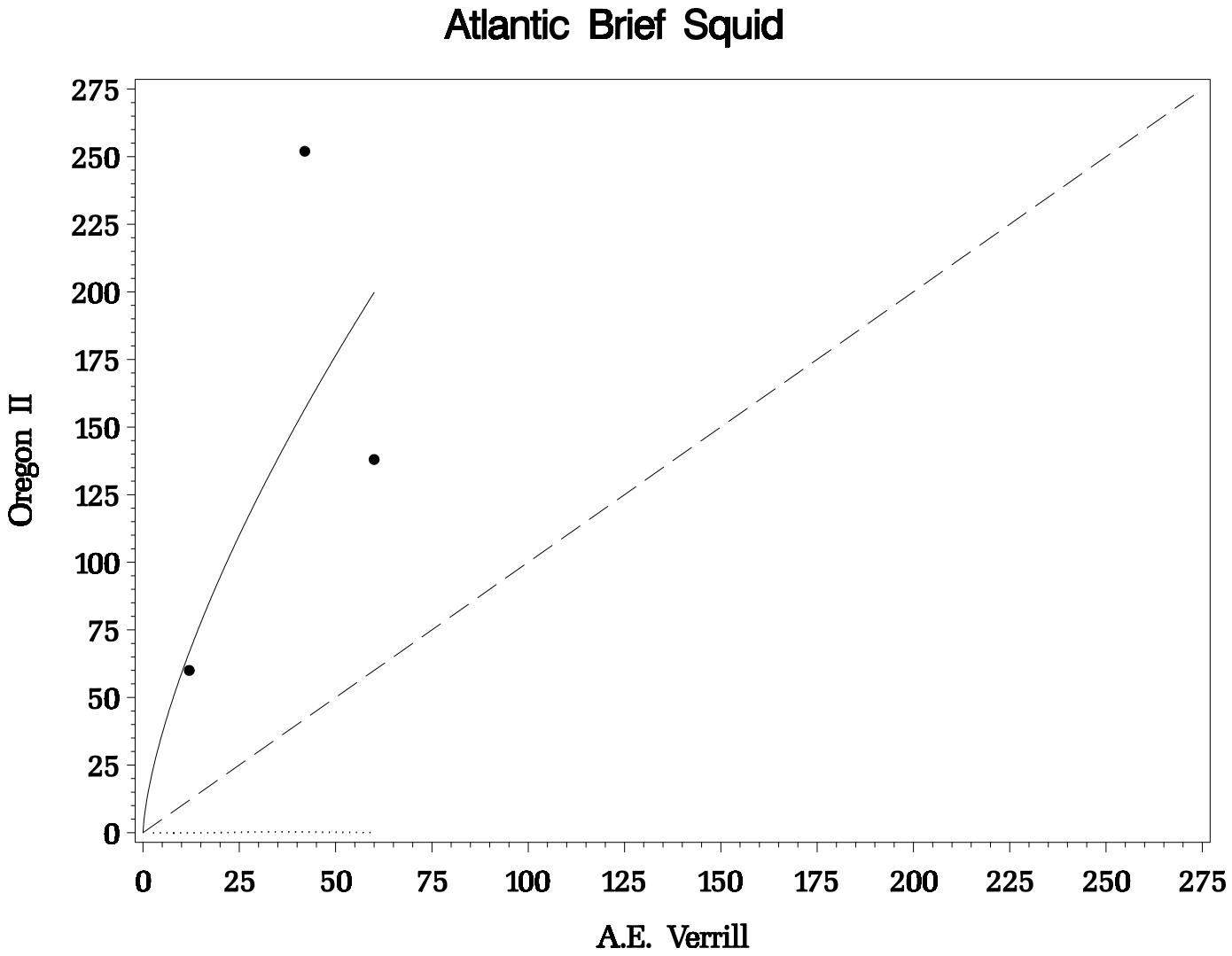

Figure 59. Scatter plot of Atlantic brief squid by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=3). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

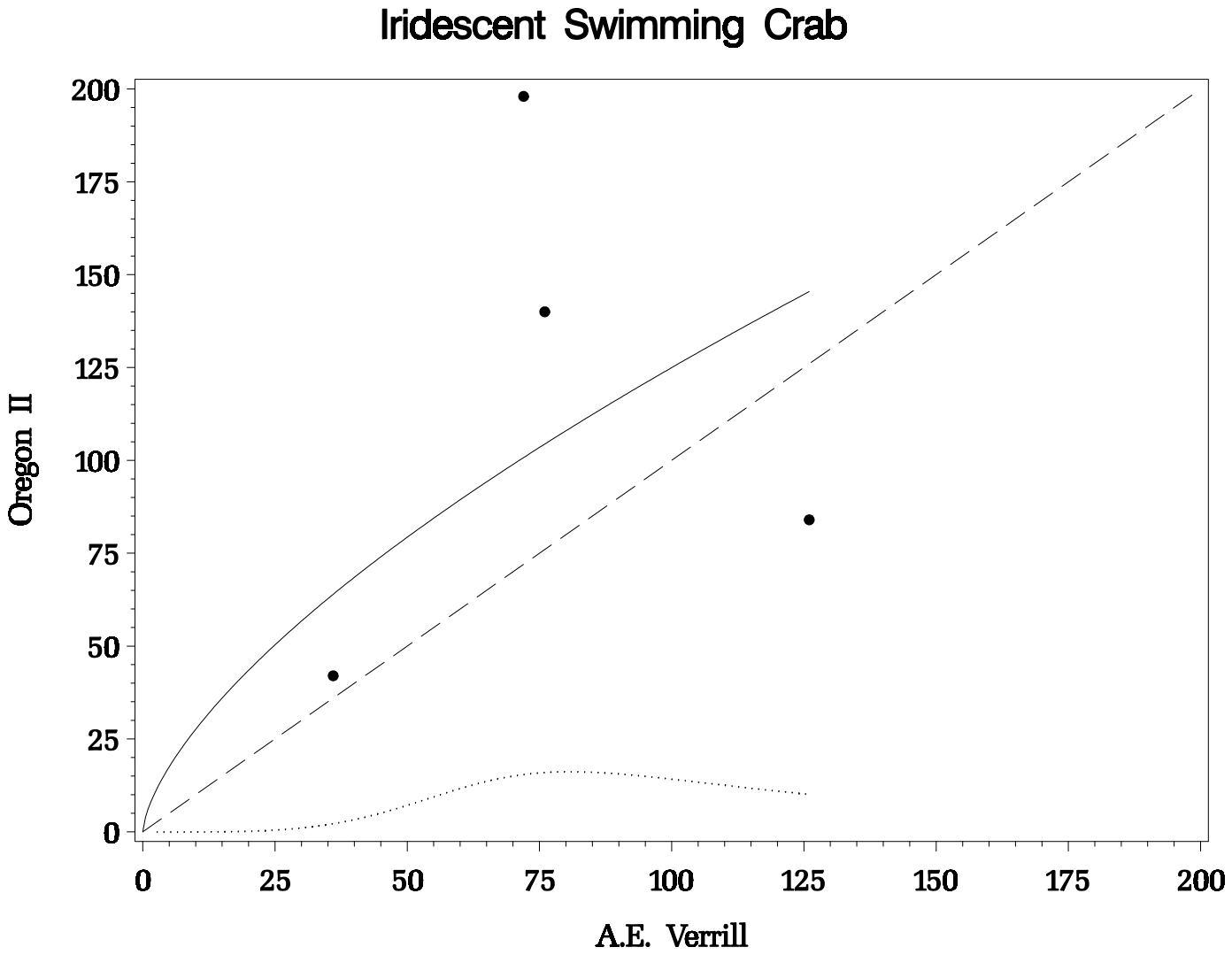

Figure 60. Scatter plot of iridescent swimming crab catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=4). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

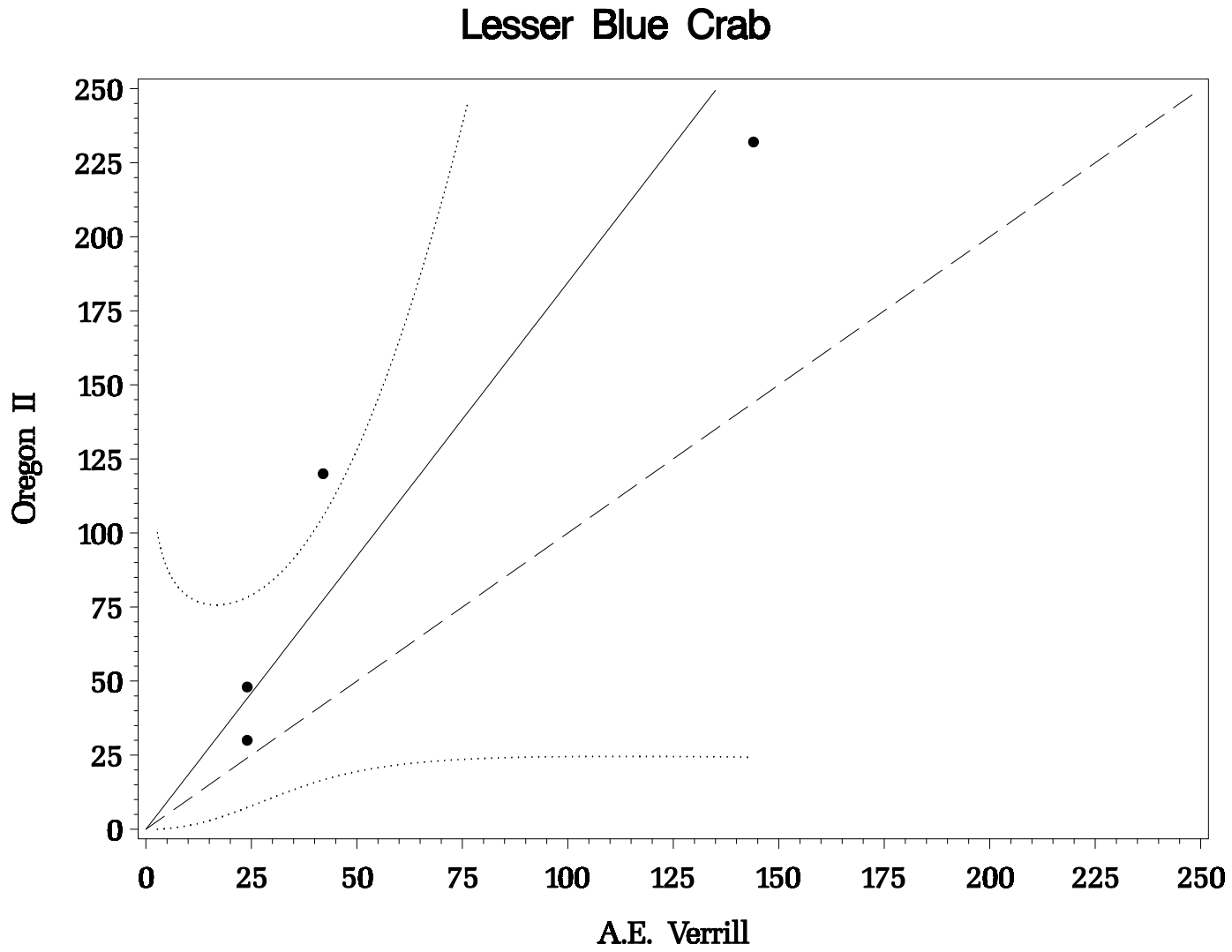

Figure 61. Scatter plot of lesser blue crab catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=4). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

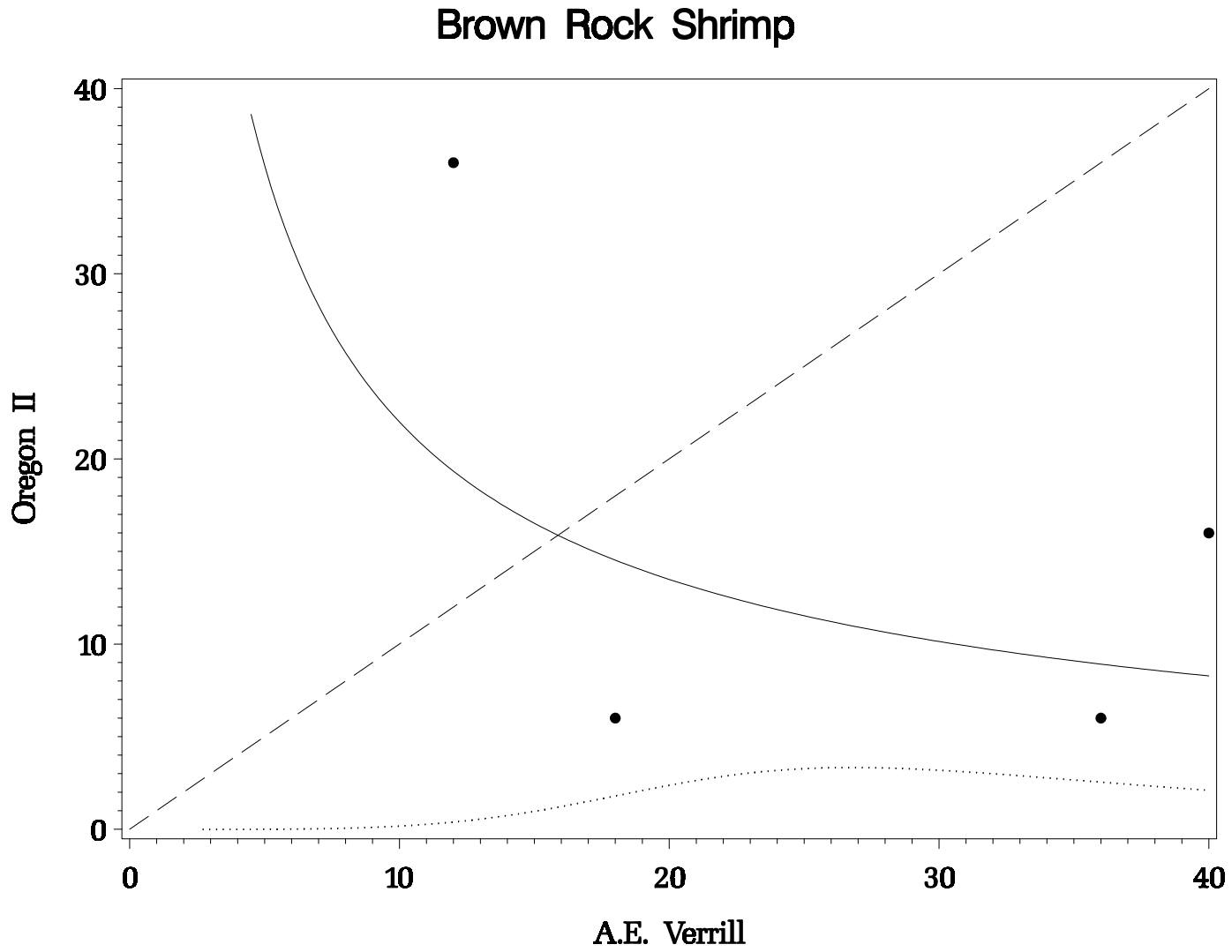

Figure 62. Scatter plot of brown rock shrimp catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=4). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

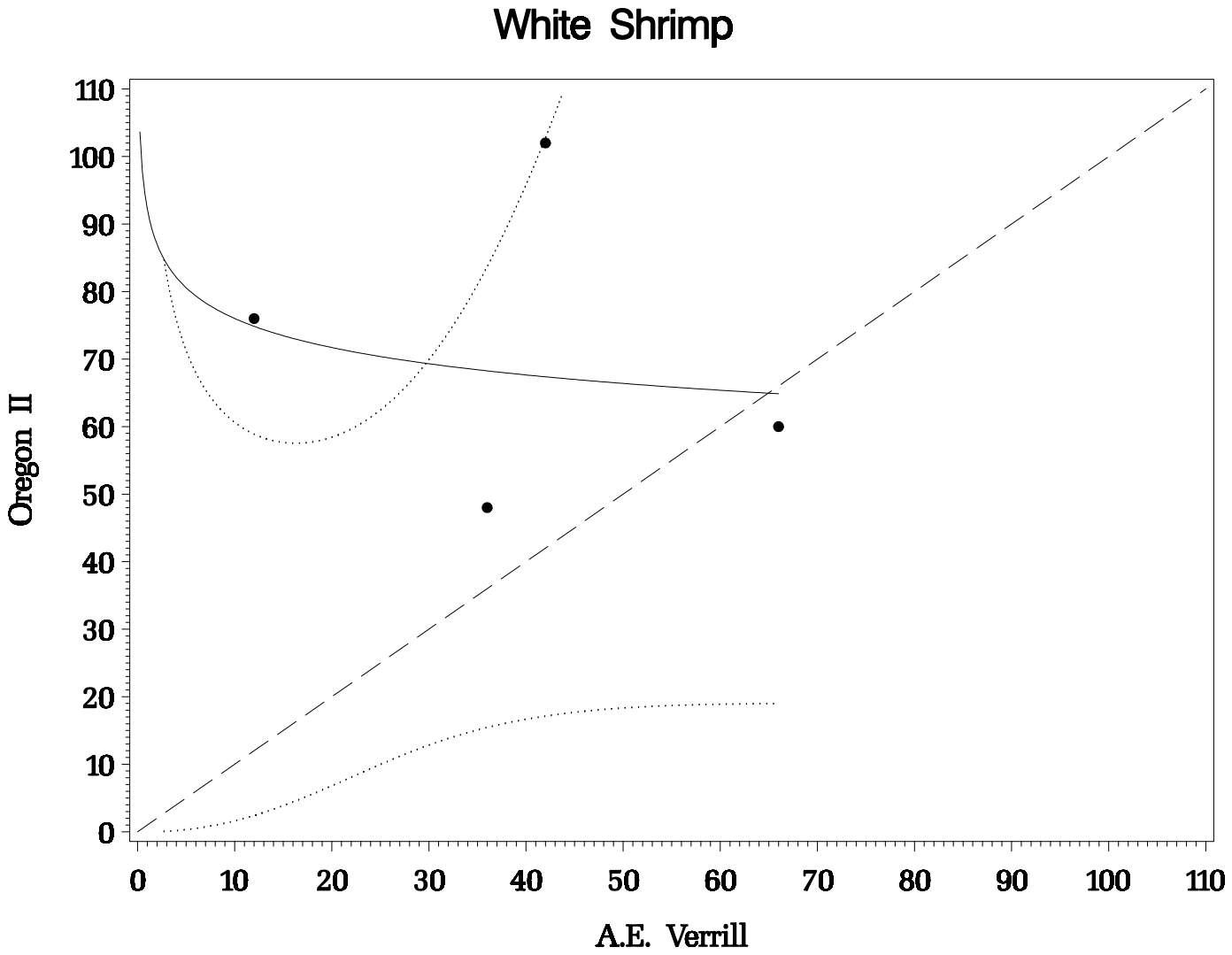

Figure 63. Scatter plot of white shrimp catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=4). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

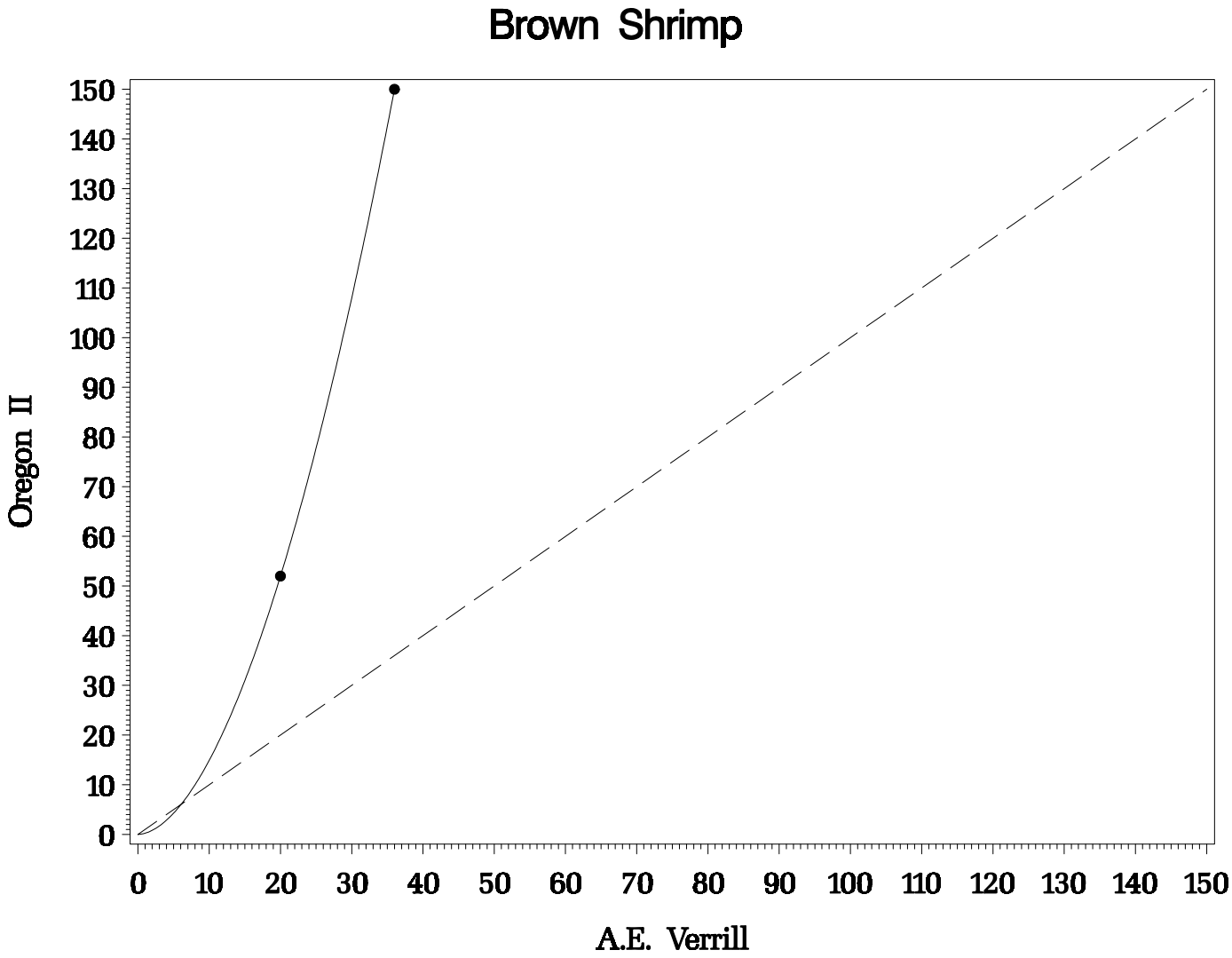

Figure 64. Scatter plot of brown shrimp catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=2). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

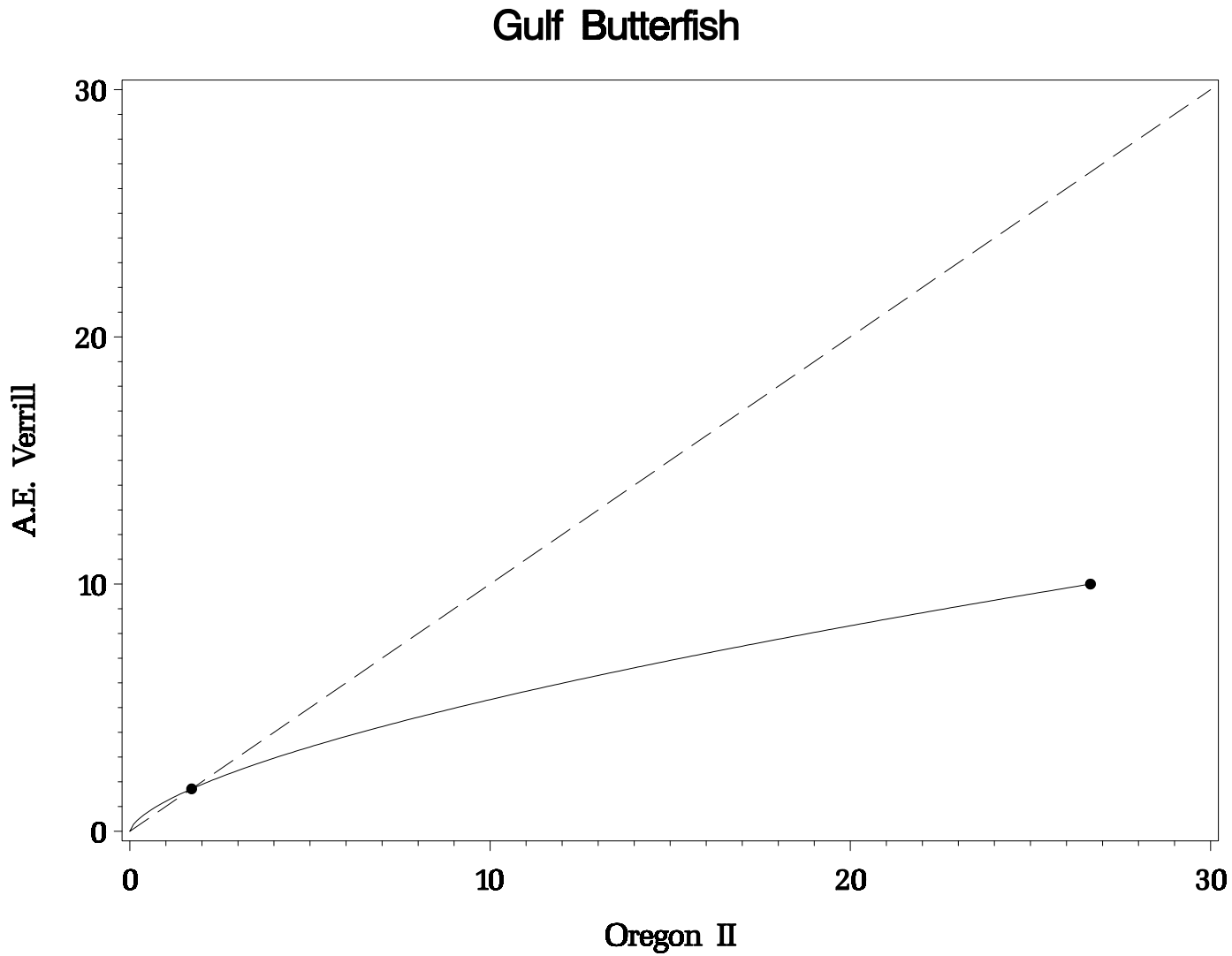

Figure 65. Scatter plot of Gulf butterfish catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=2). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

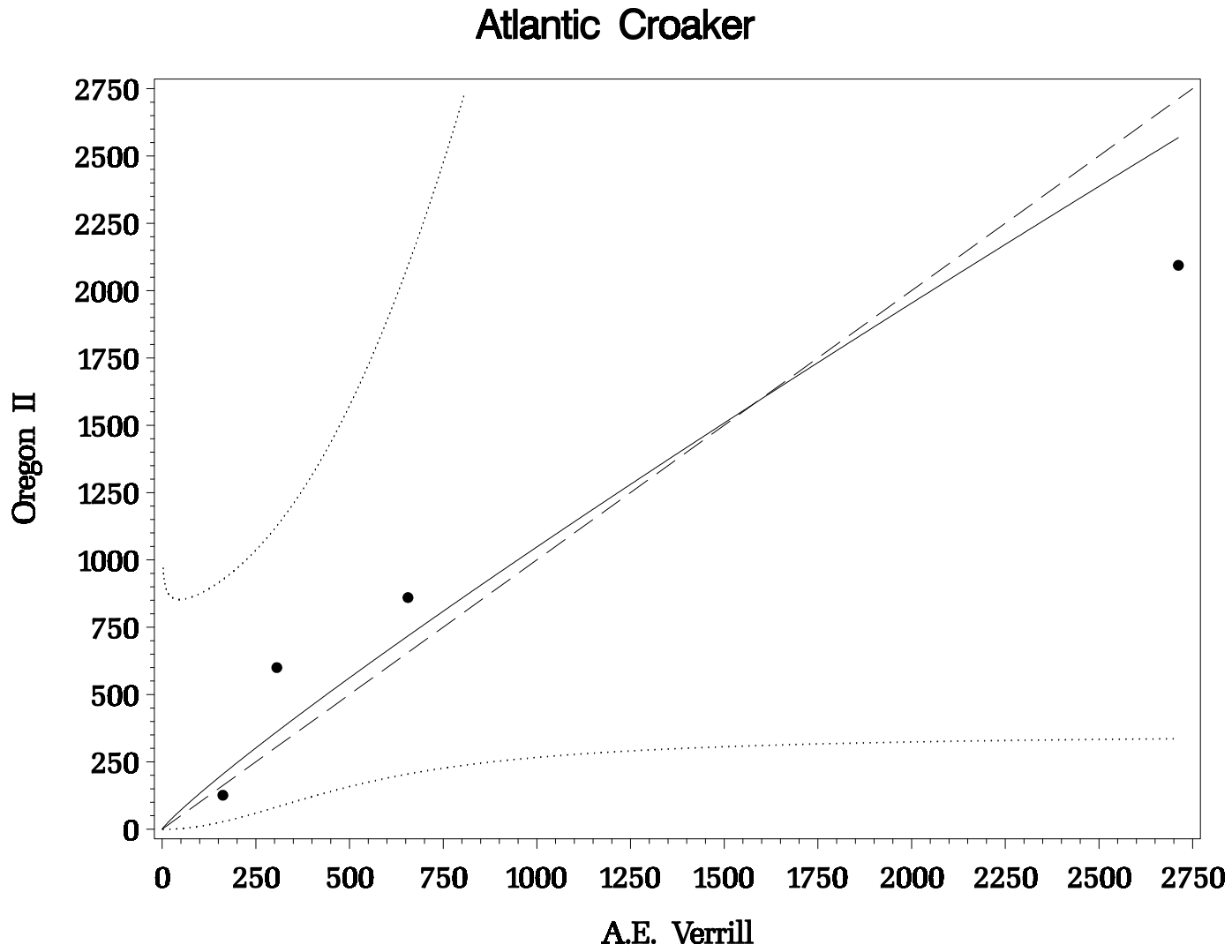

Figure 66. Scatter plot of Atlantic croaker catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=4). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

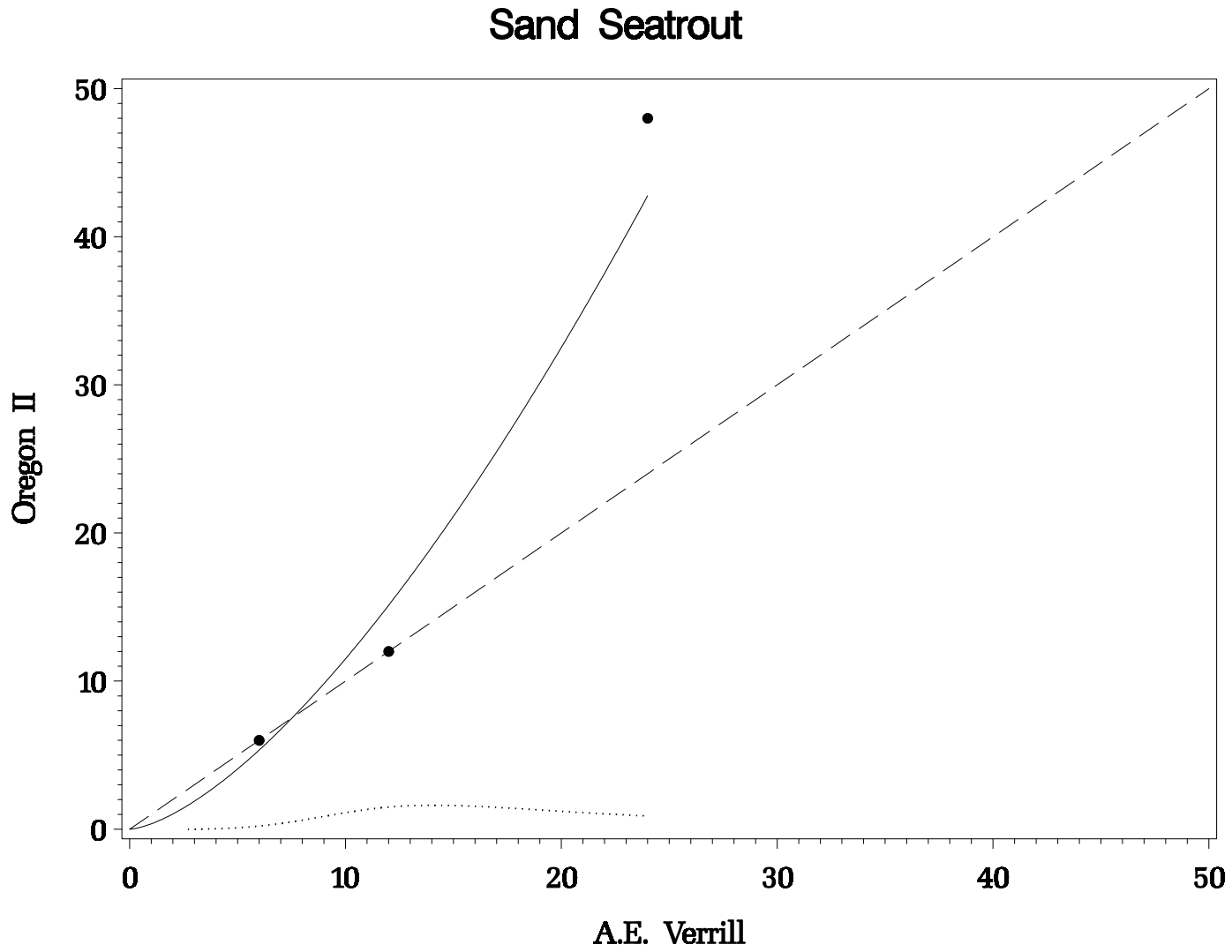

Figure 67. Scatter plot of sand seatrout catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=3). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

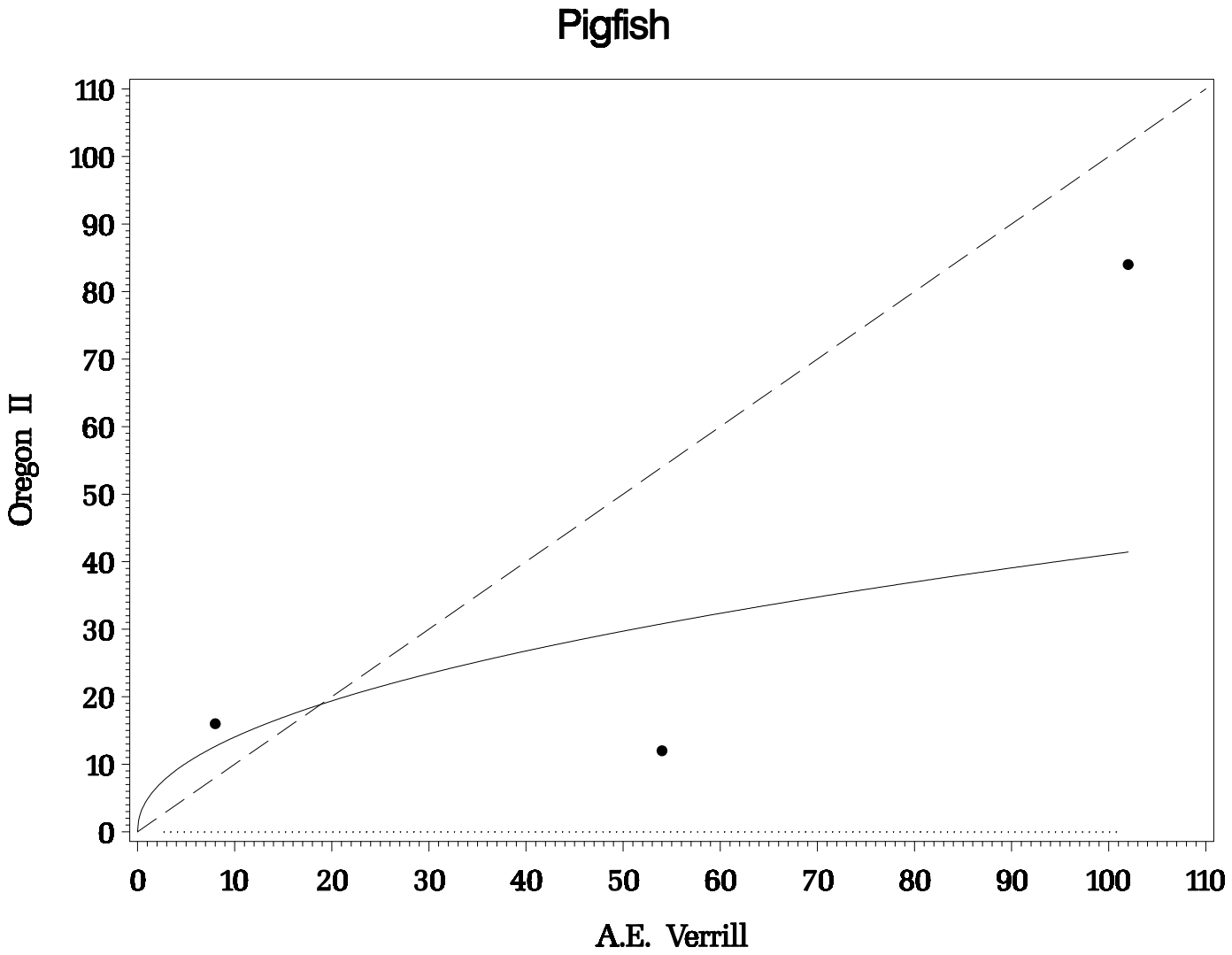

Figure 68. Scatter plot of pigfish catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=3). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

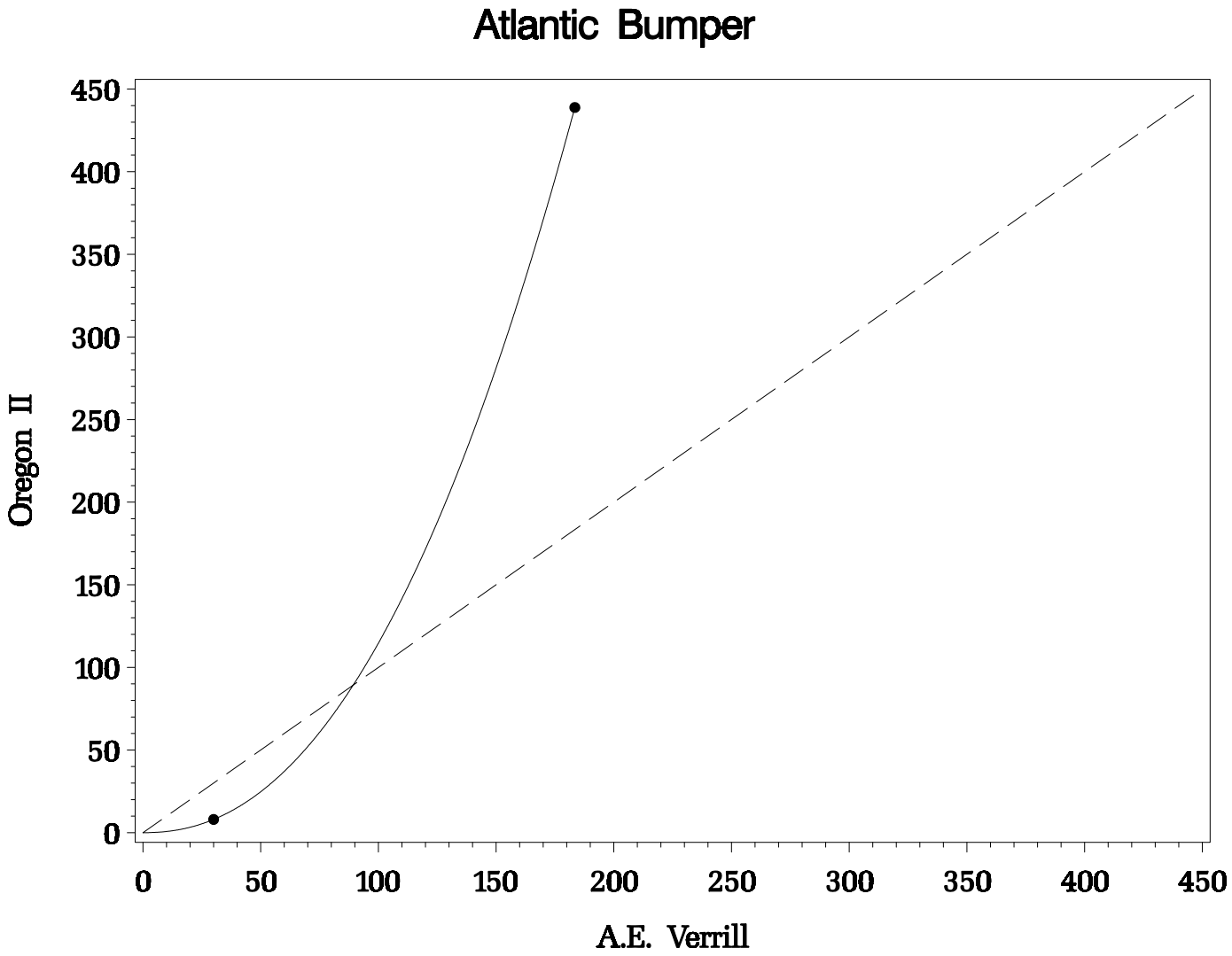

Figure 69. Scatter plot of Atlantic bumper catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=2). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

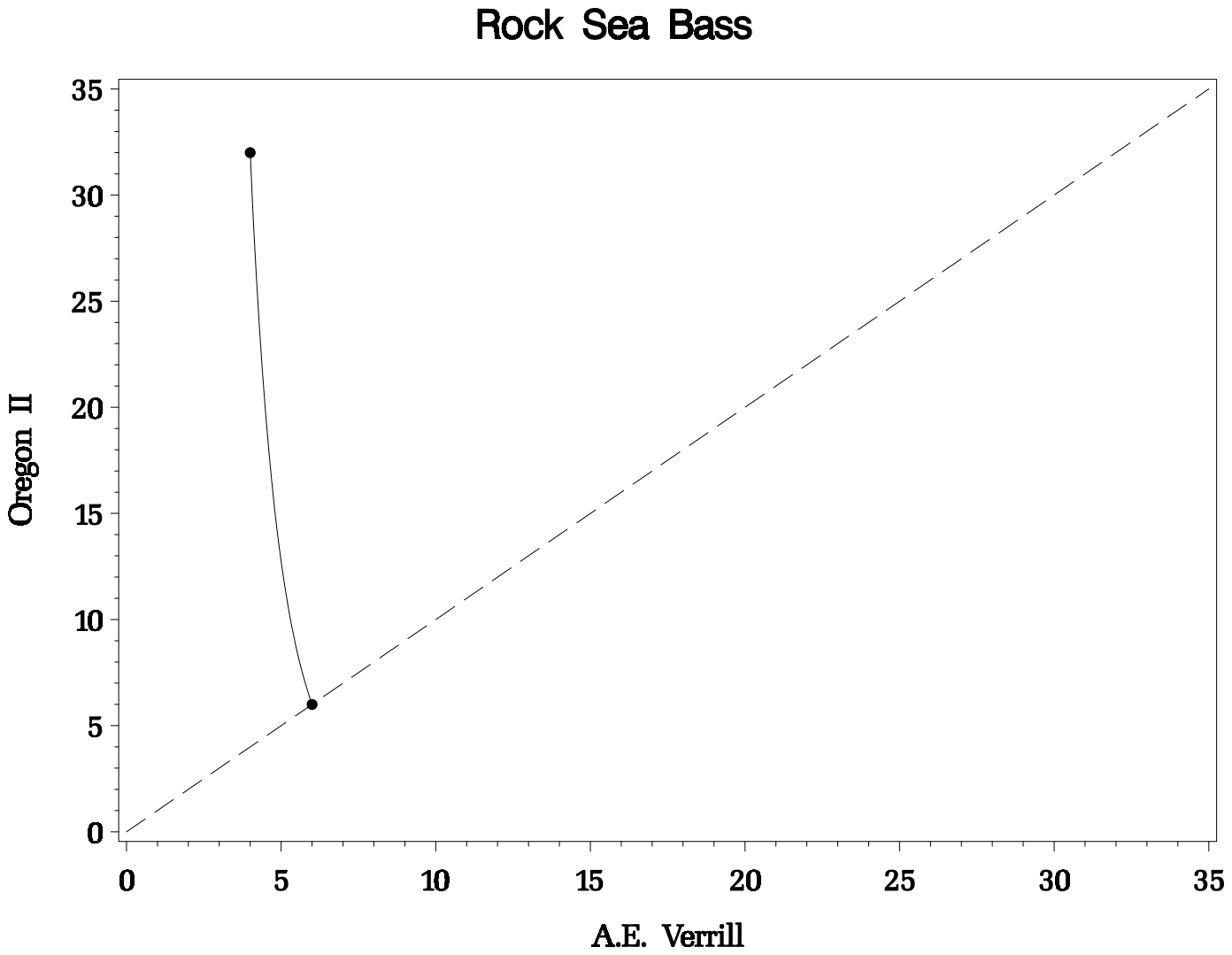

Figure 70. Scatter plot of rock sea bass catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=2). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

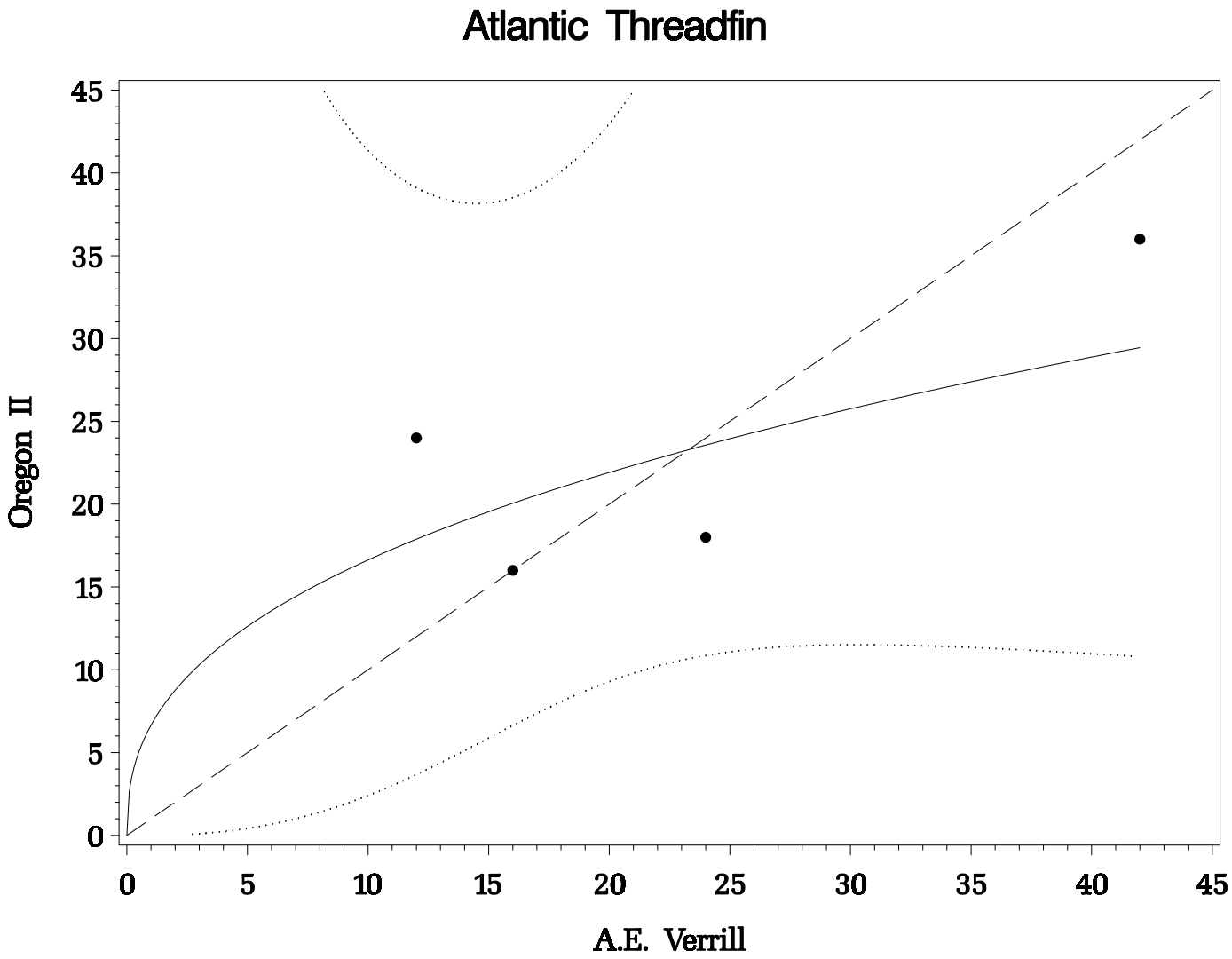

Figure 71. Scatter plot of Atlantic threadfin catches by *NOAA Ship Oregon II* and *R/V A.E. Verrill* during paired comparison towing (n=4). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

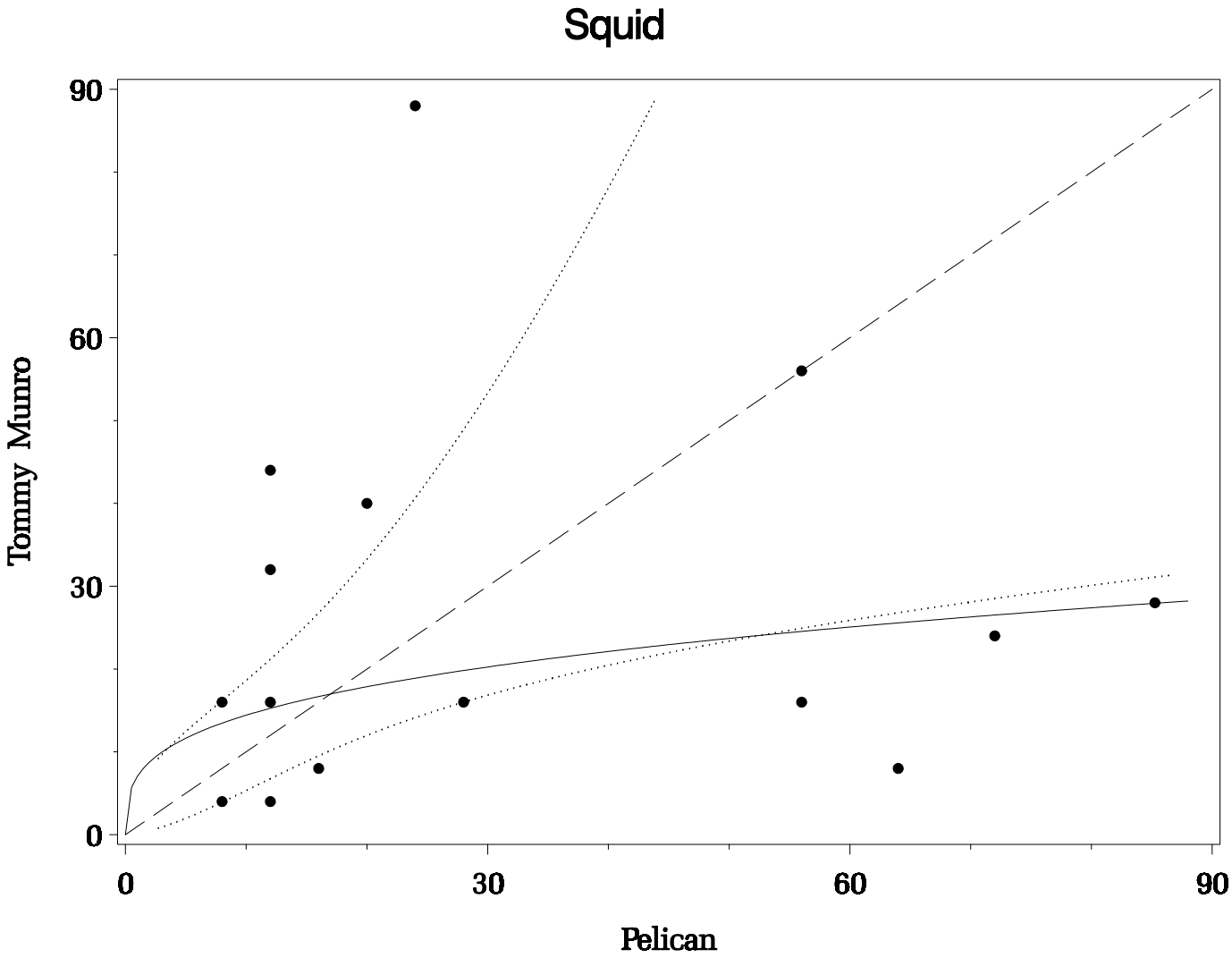

Figure 72. Scatter plot of squid catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=15). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

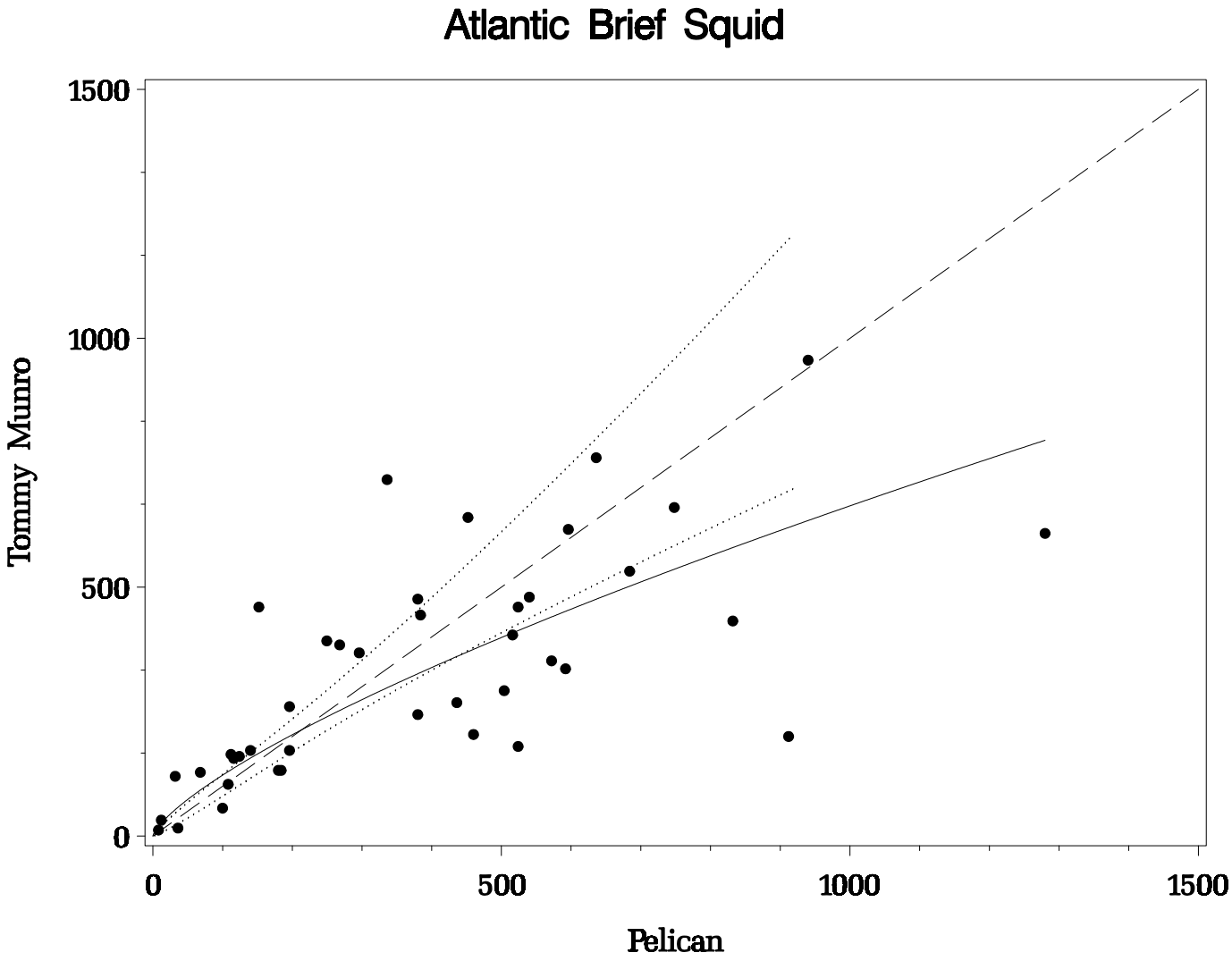

Figure 73. Scatter plot of atlantic brief squid catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=41). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

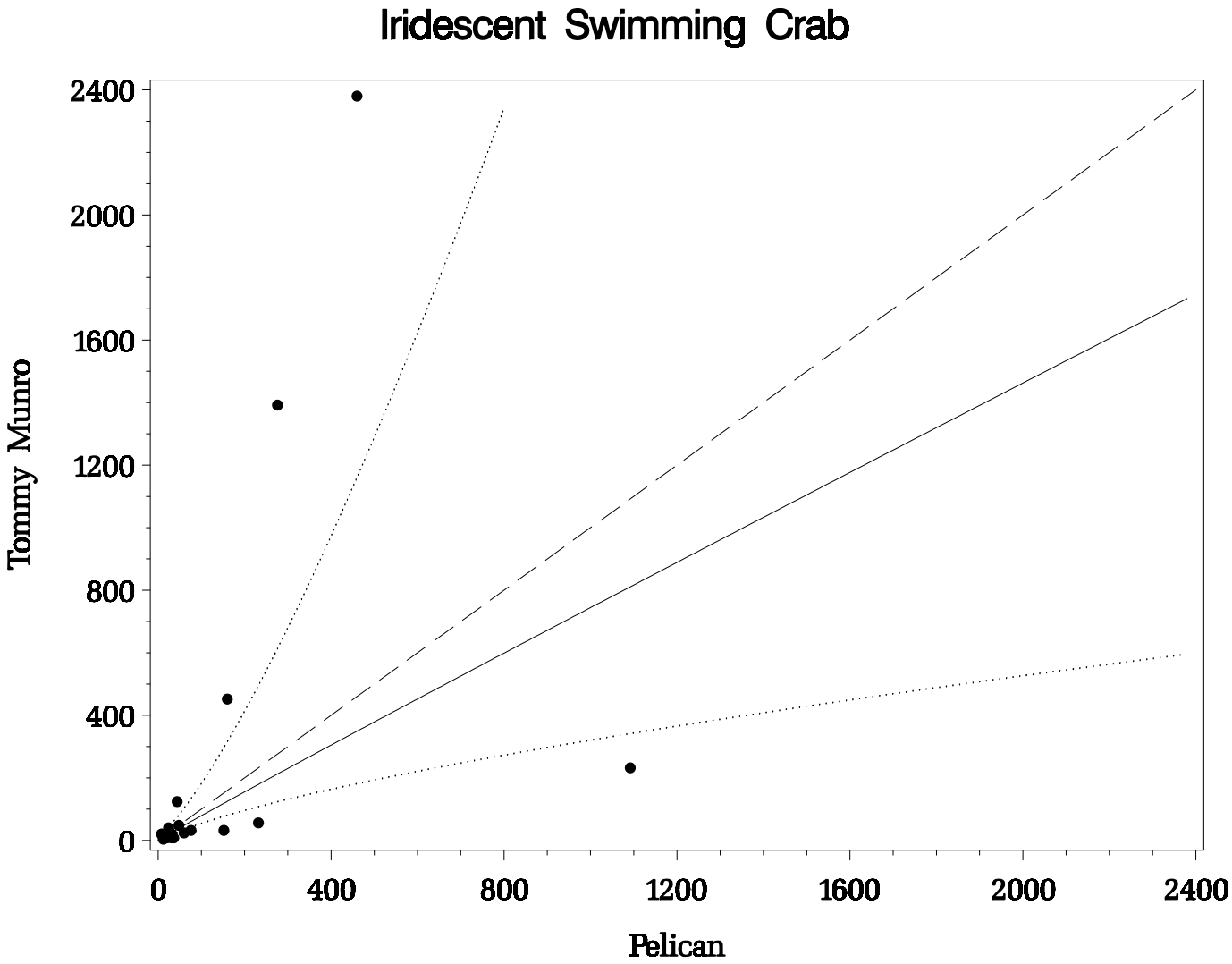

Figure 74. Scatter plot of iridescent swimming crab catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=20). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

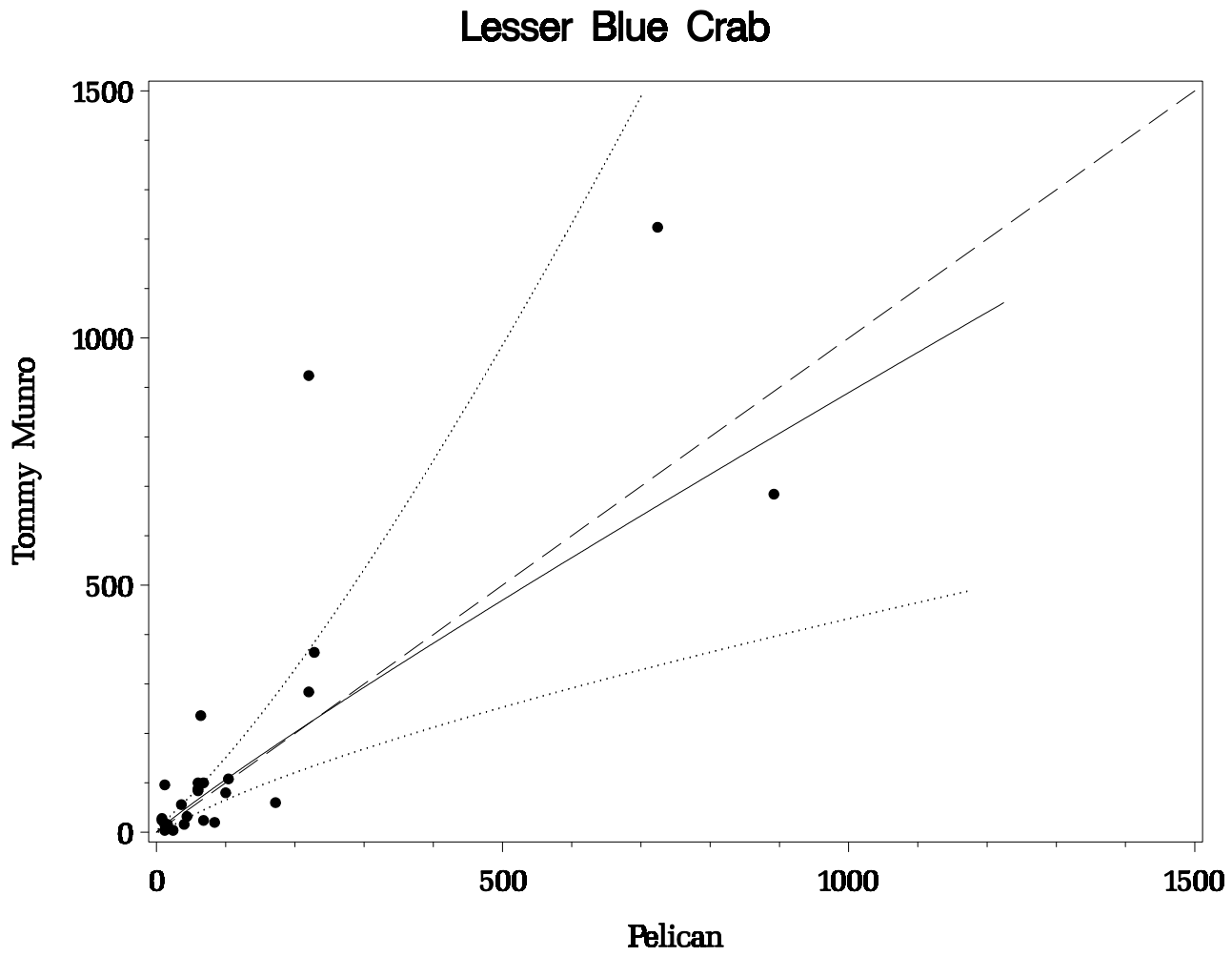

Figure 75. Scatter plot of lesser blue crab catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=25). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

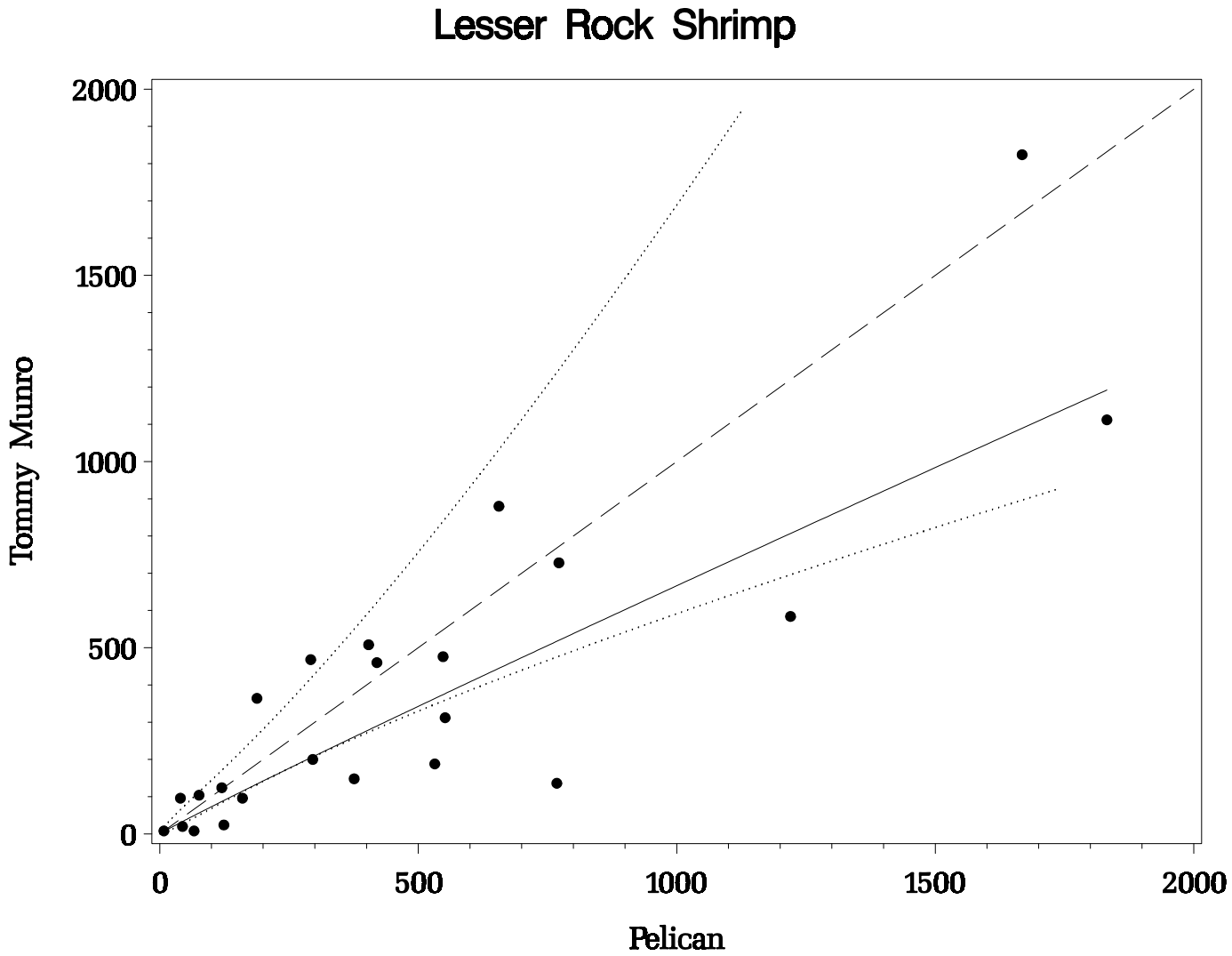

Figure 76. Scatter plot of lesser rock shrimp catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=23). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

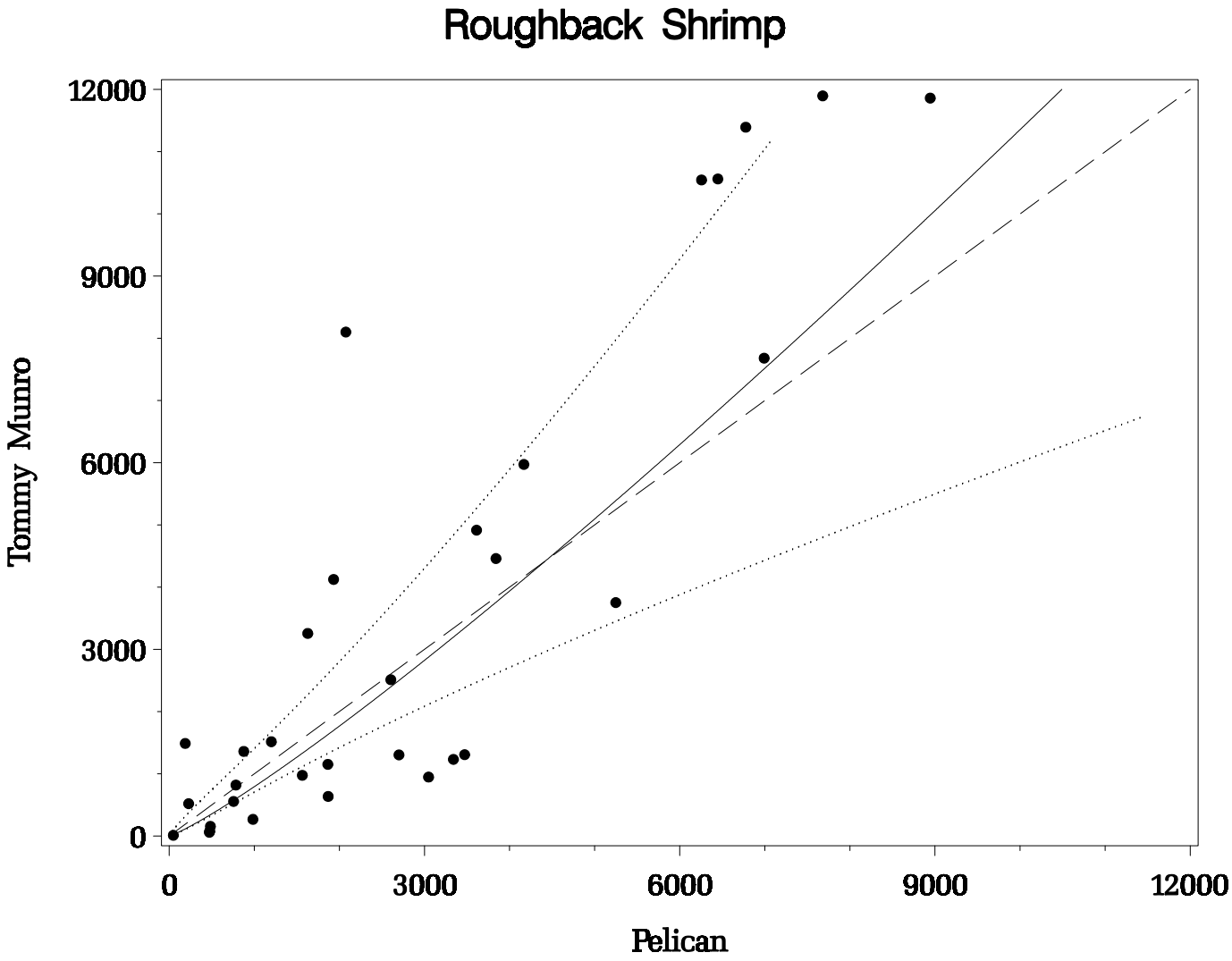

Figure 77. Scatter plot of roughback shrimp catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=32). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

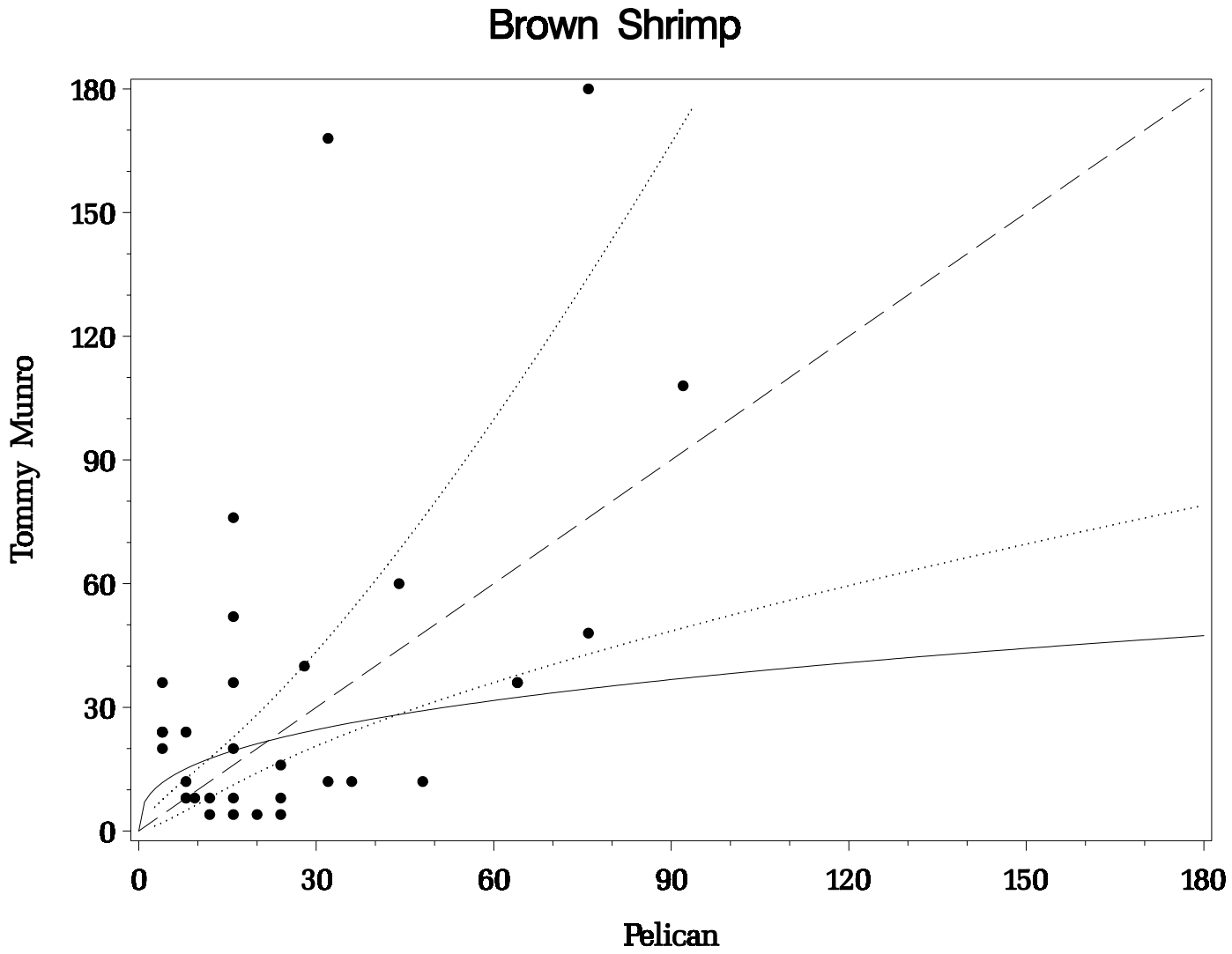

Figure 78. Scatter plot of brown shrimp catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=34). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

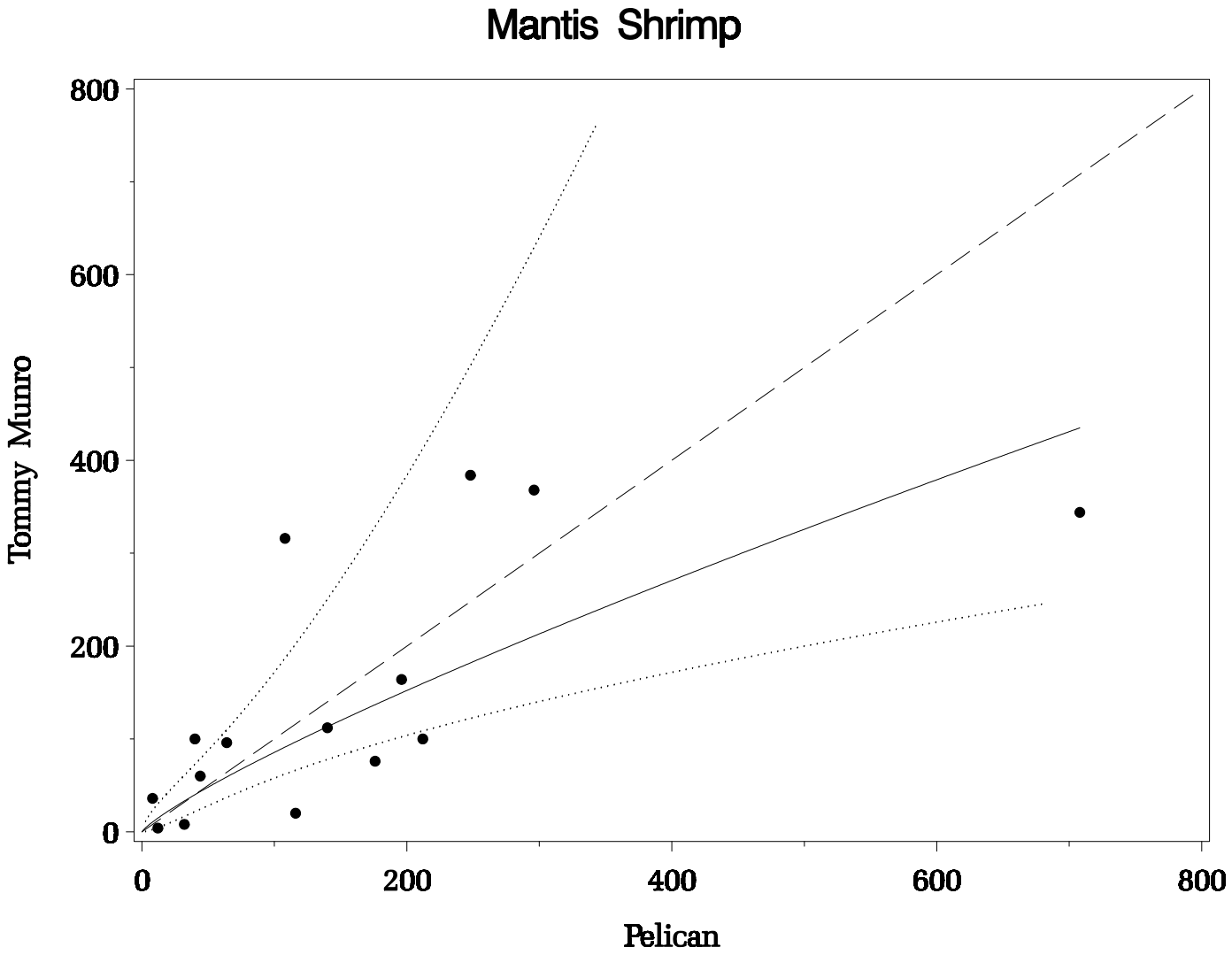

Figure 79. Scatter plot of mantis shrimp catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=15). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

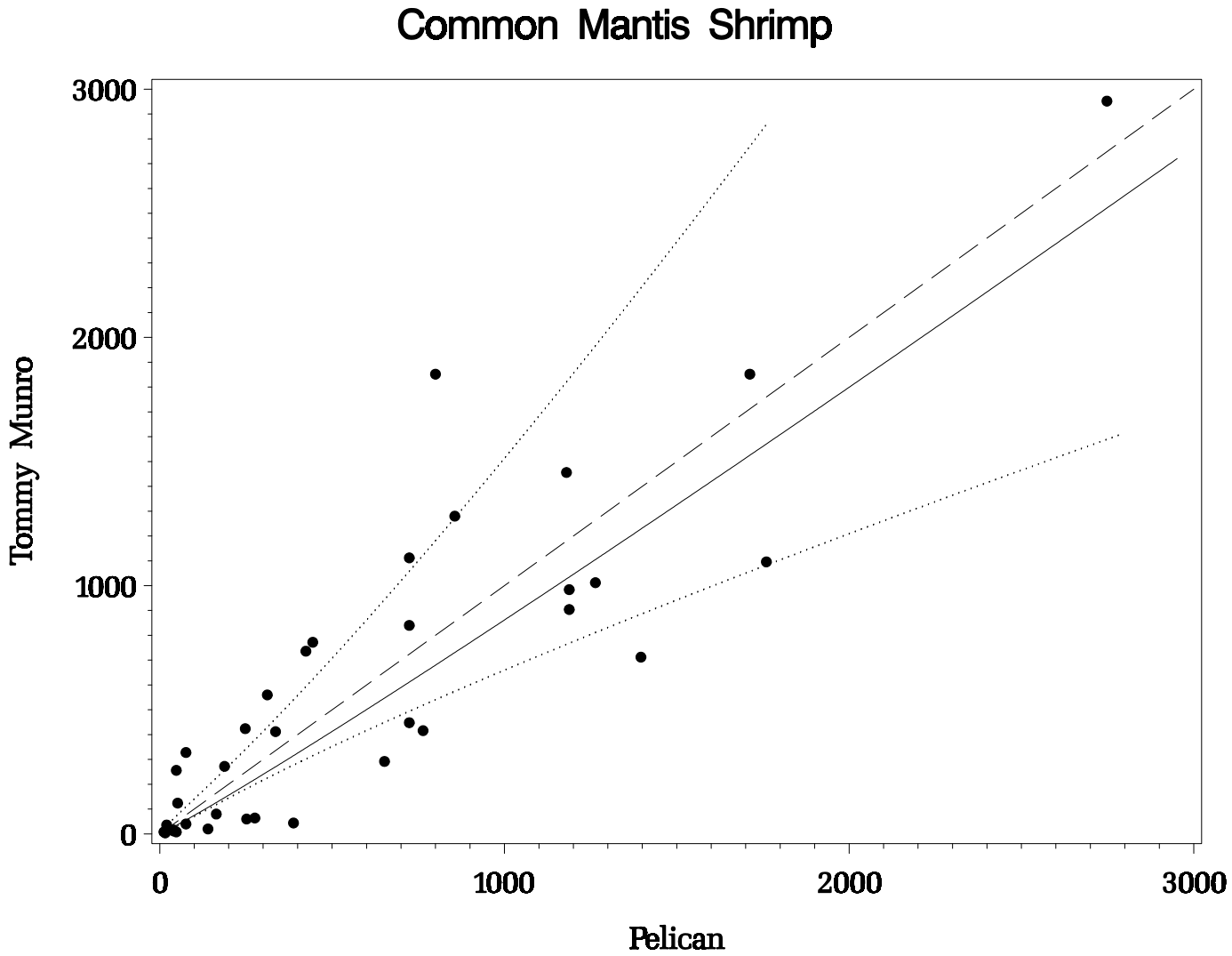

Figure 80. Scatter plot of common mantis shrimp catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=36). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

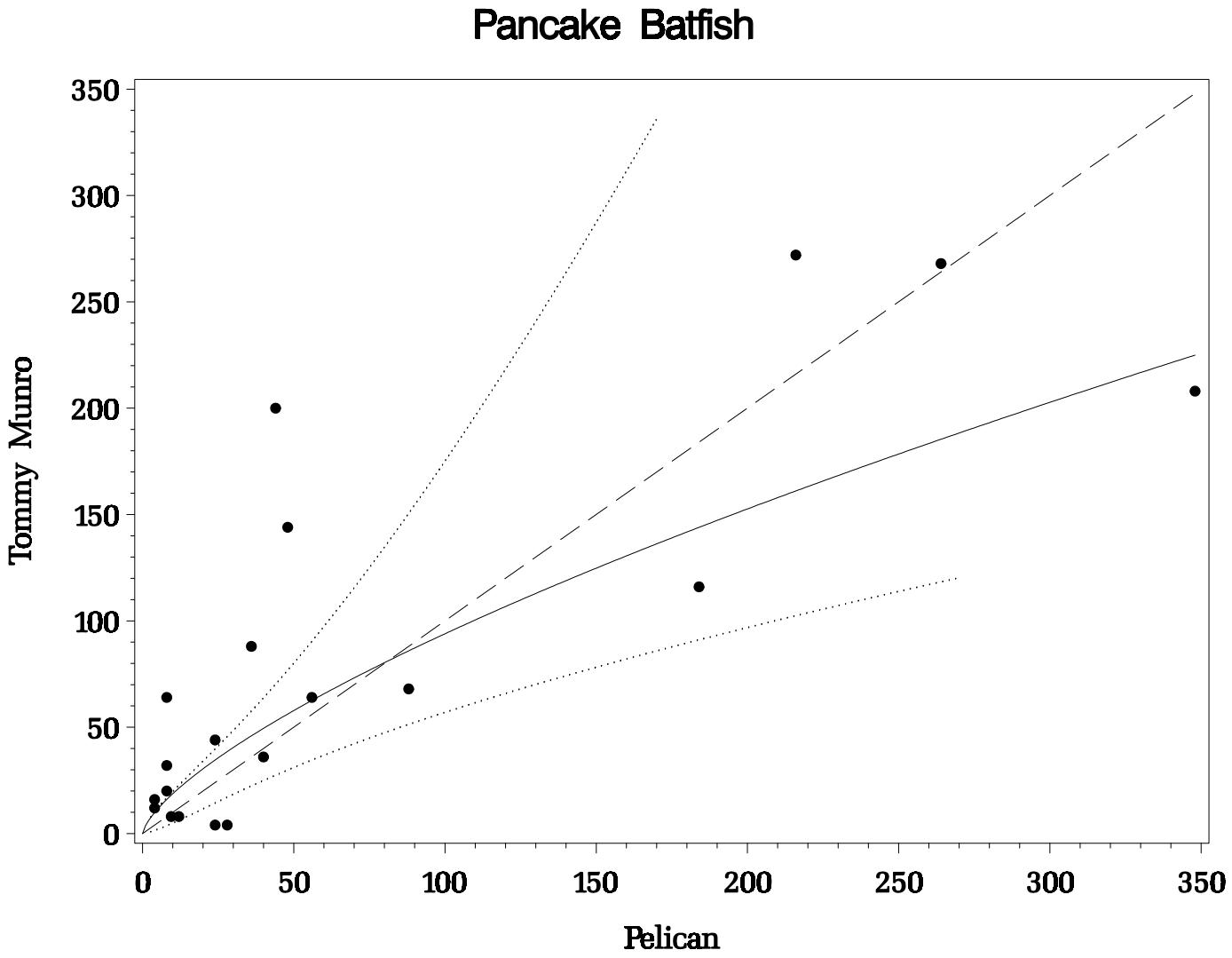

Figure 81. Scatter plot of pancake batfish catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=20). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

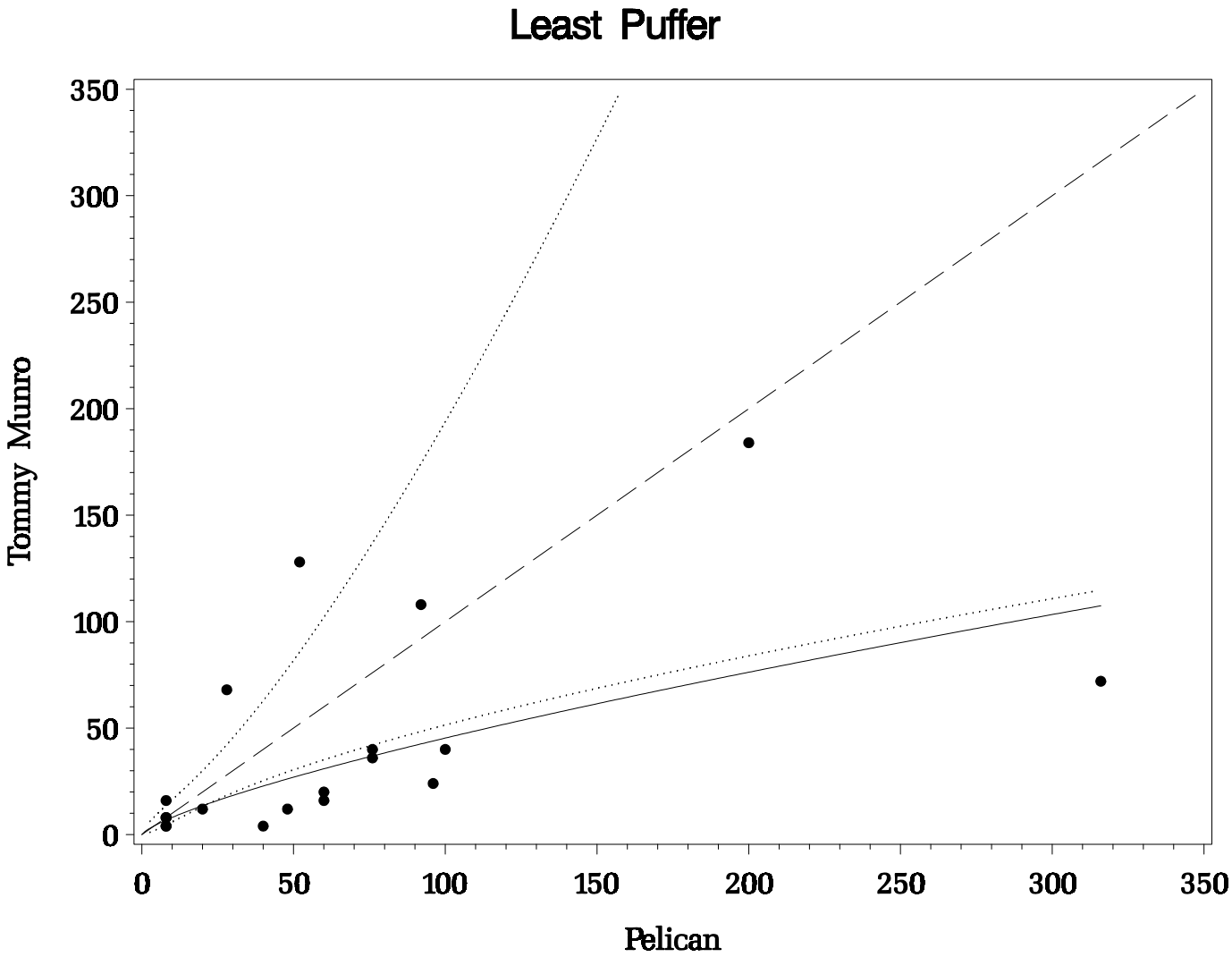

Figure 82. Scatter plot of least puffer catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=19). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

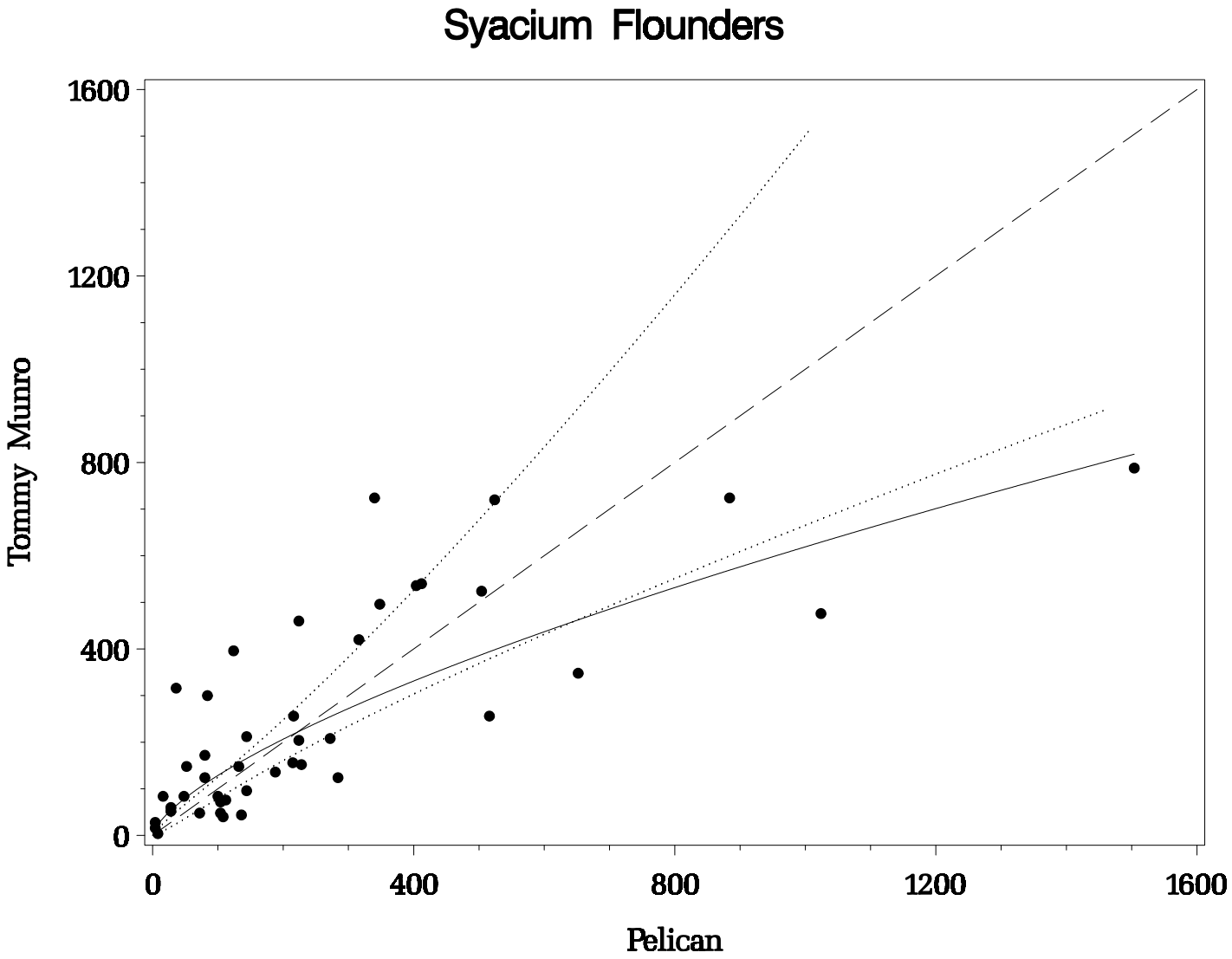

Figure 83. Scatter plot of Syacium flounders catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=43). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

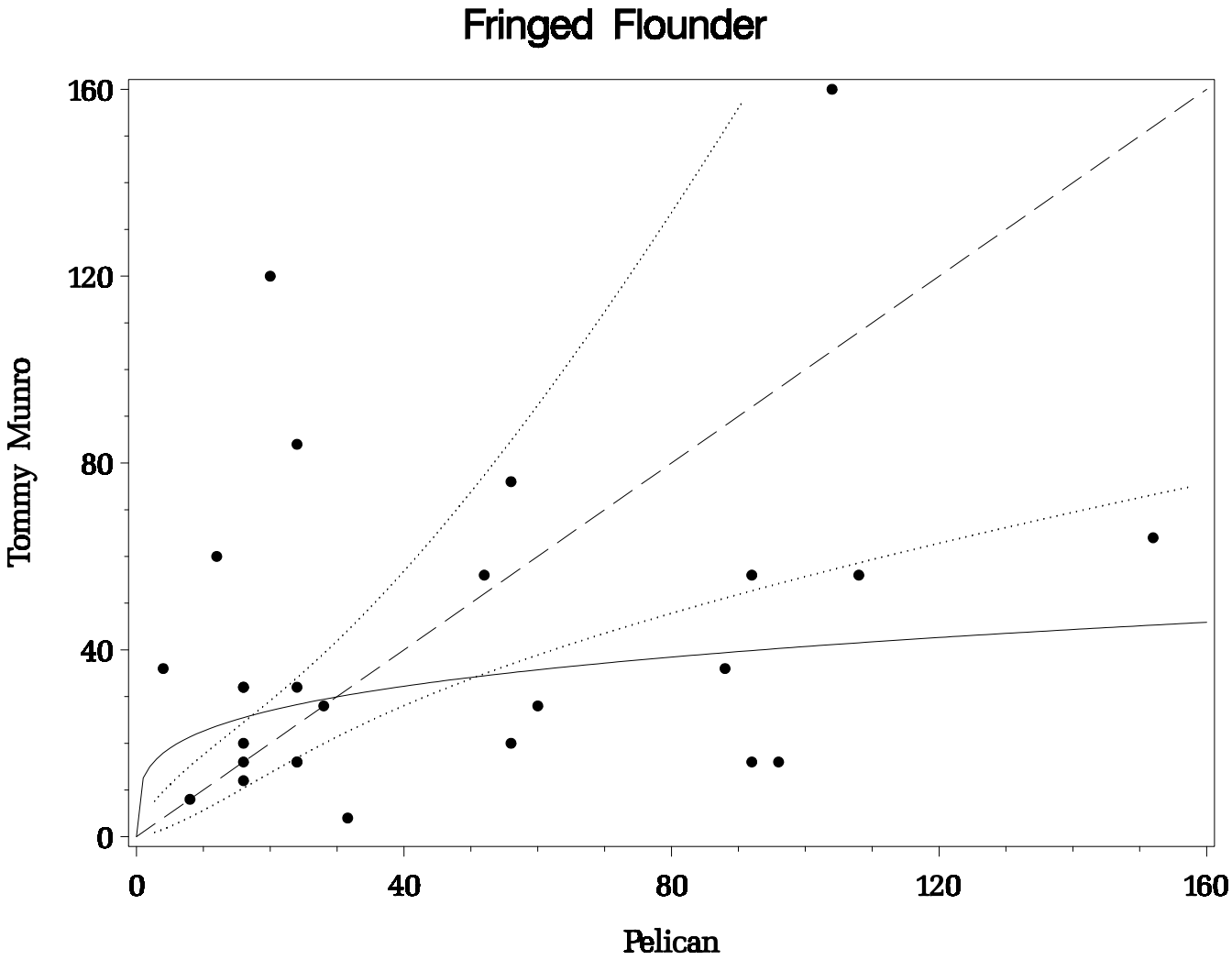

Figure 84. Scatter plot of fringed flounder catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=26). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

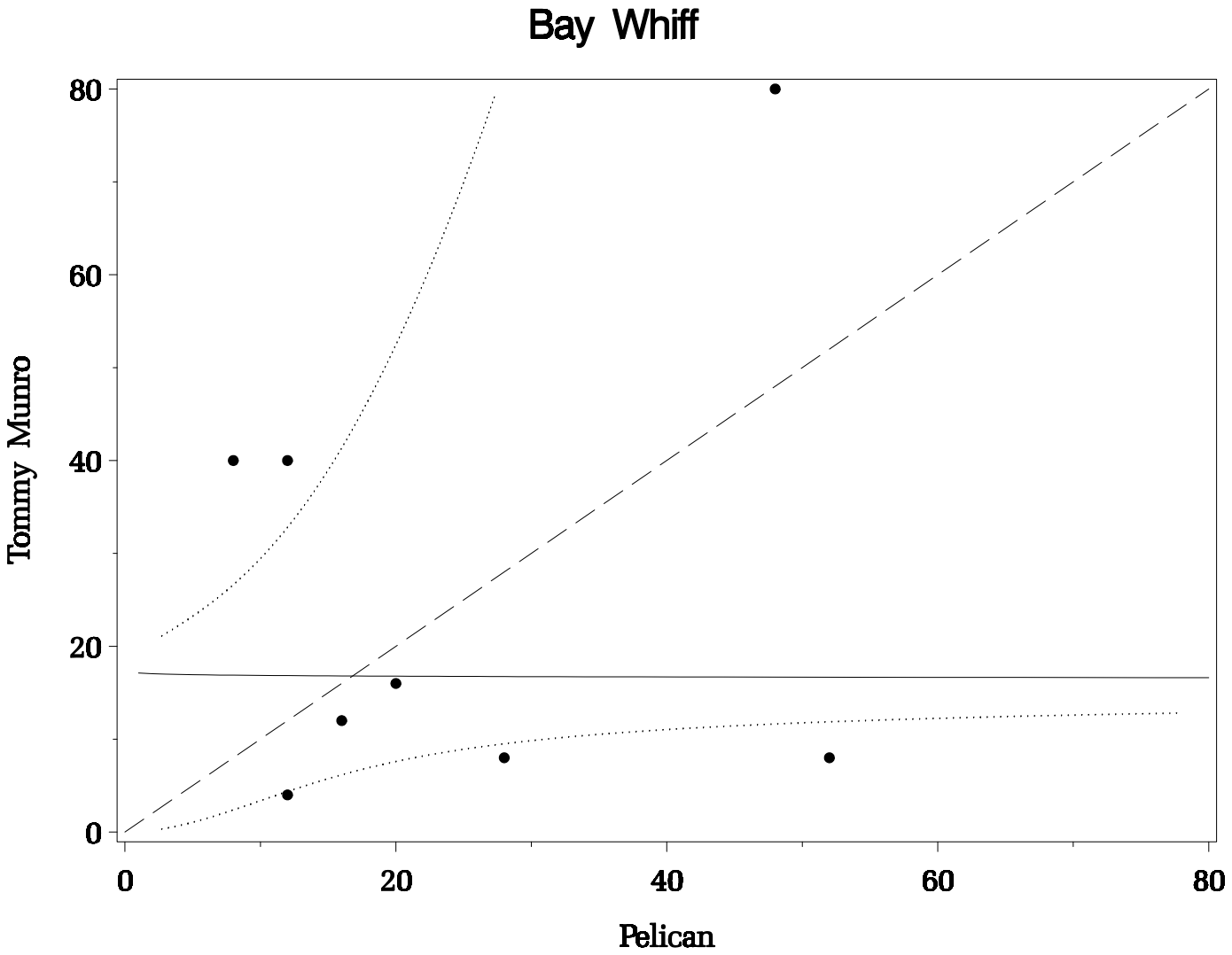

Figure 85. Scatter plot of bay whiff catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=8). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

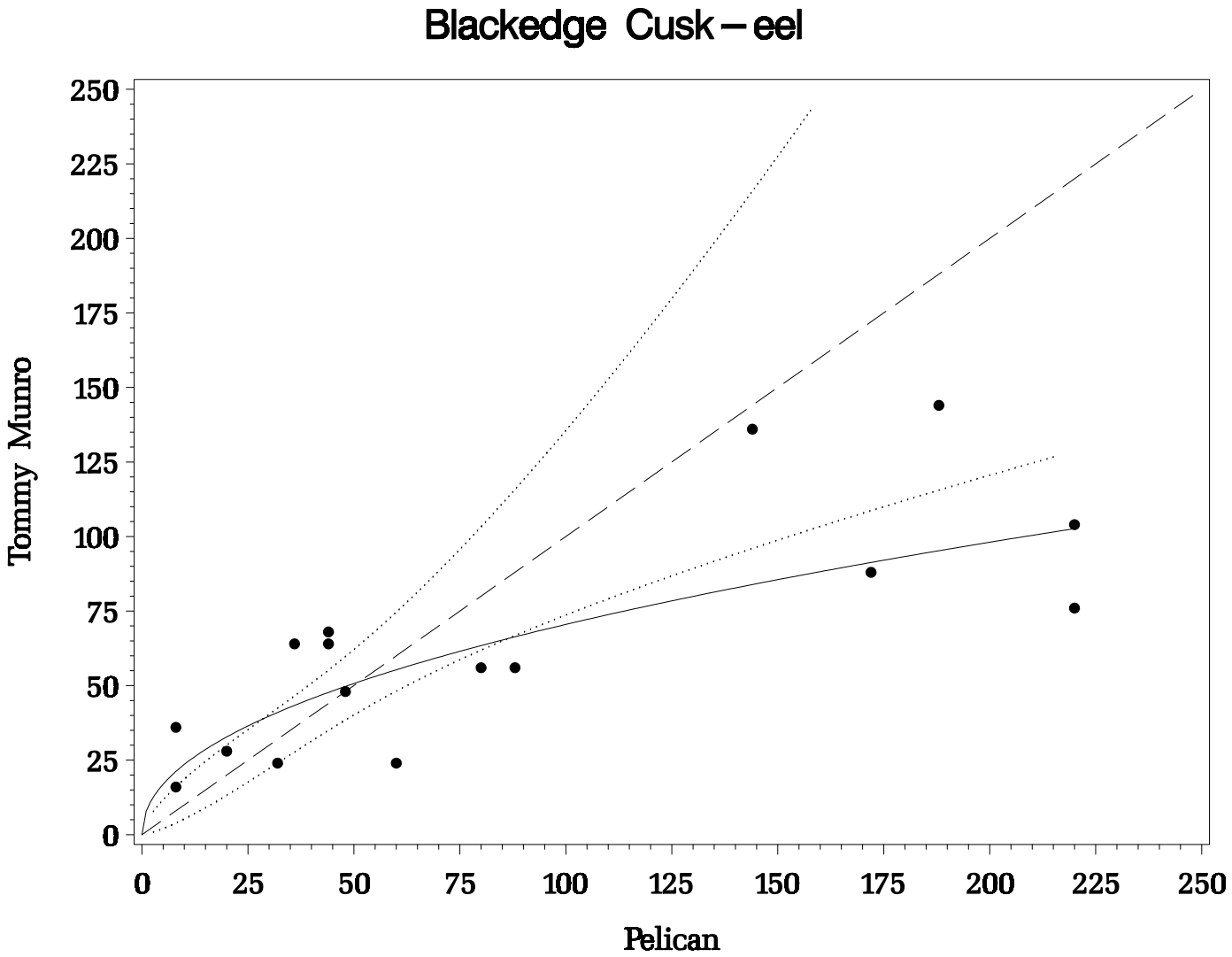

Figure 86. Scatter plot of blackedge cusk-eel catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=16). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

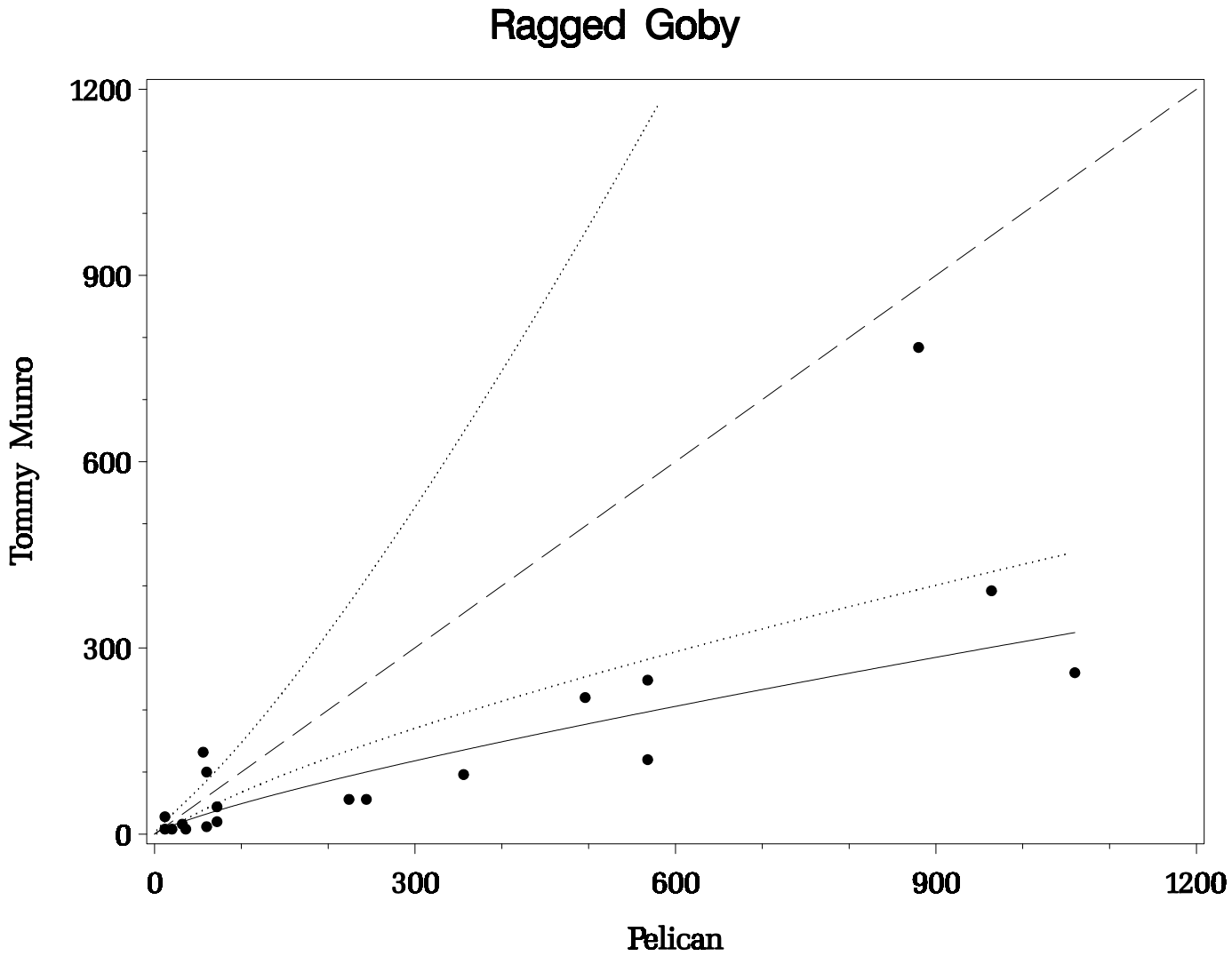

Figure 87. Scatter plot of ragged goby catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=19). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

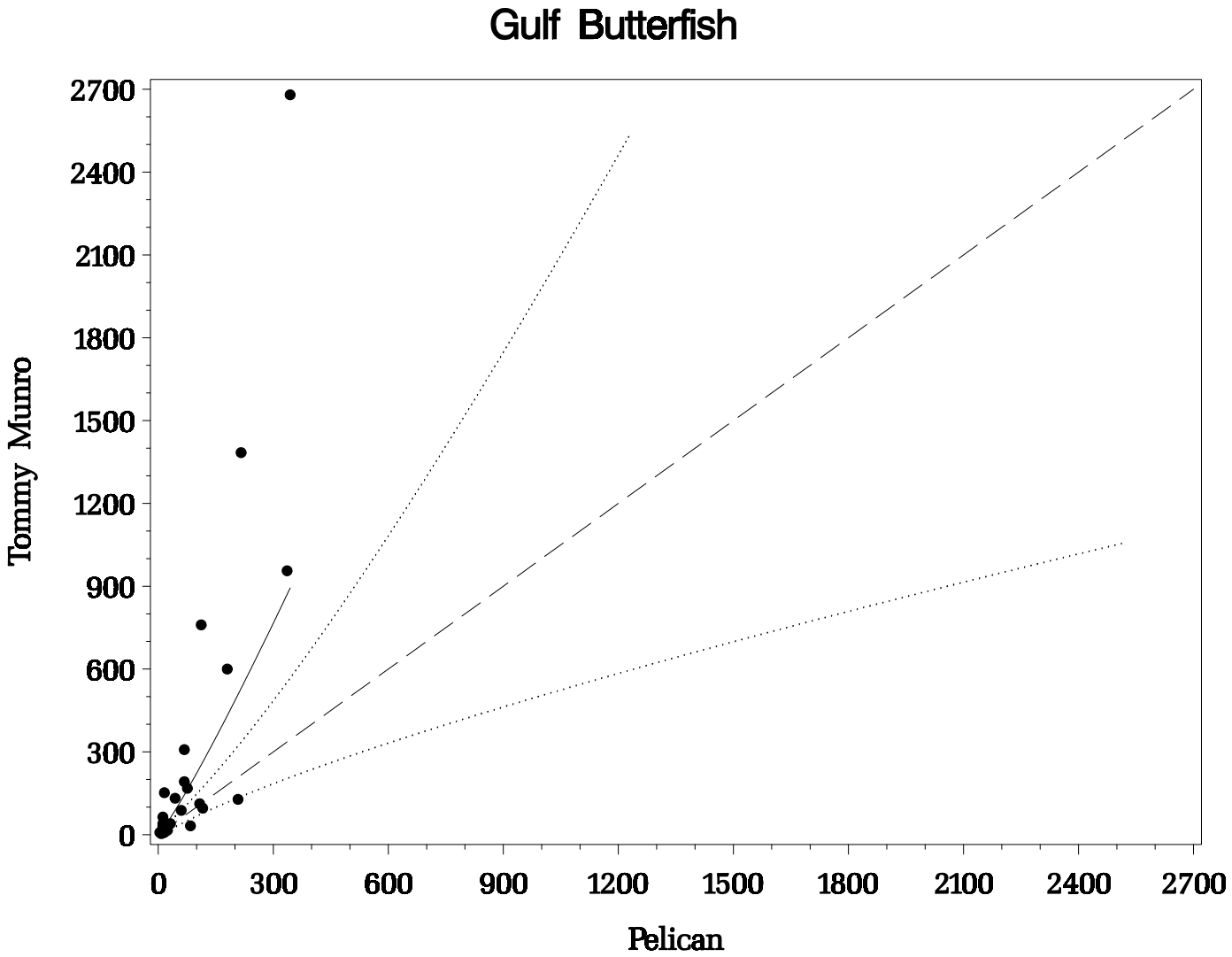

Figure 88. Scatter plot of gulf butterfish catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=25). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

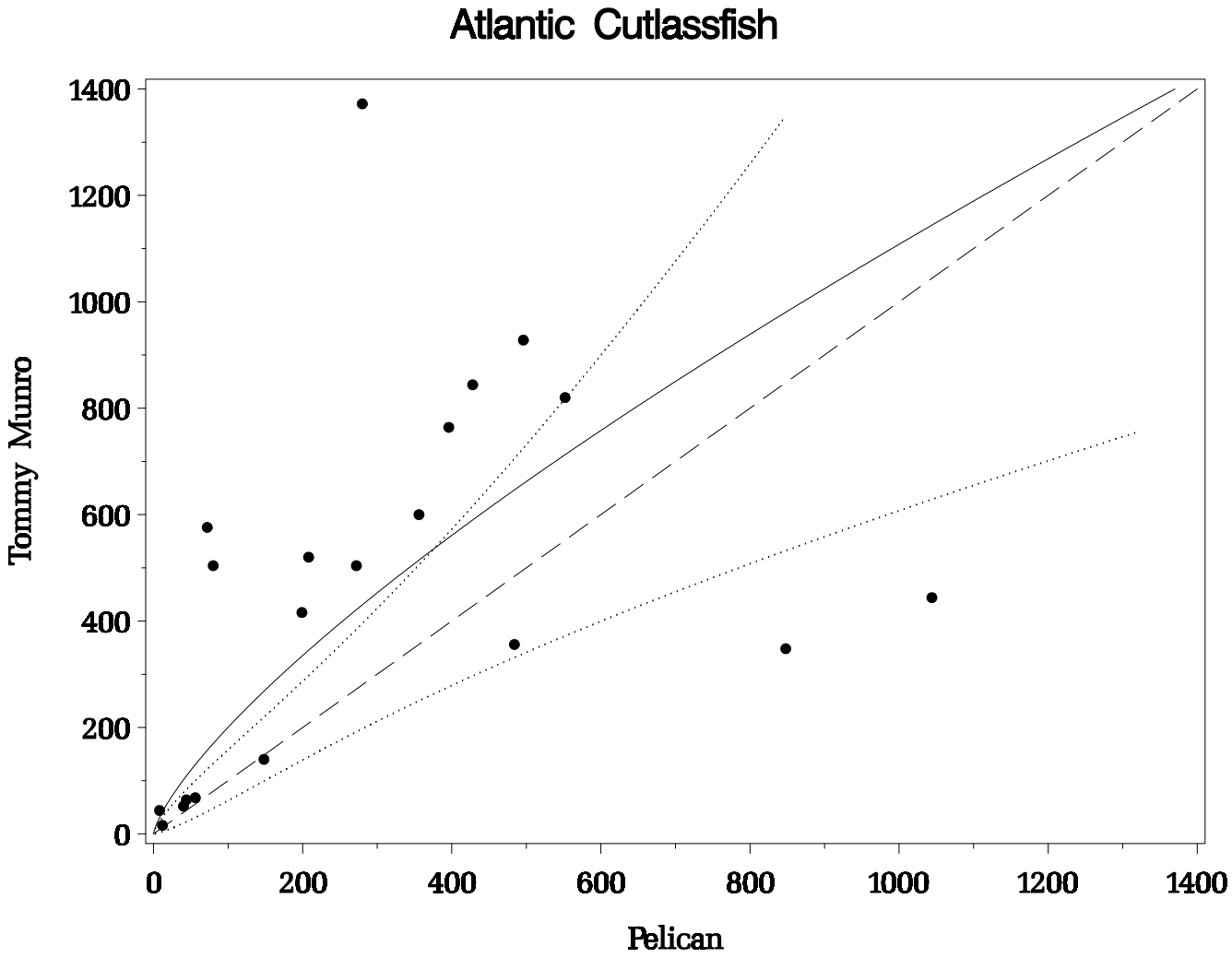

Figure 89. Scatter plot of atlantic cutlassfish catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=20). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

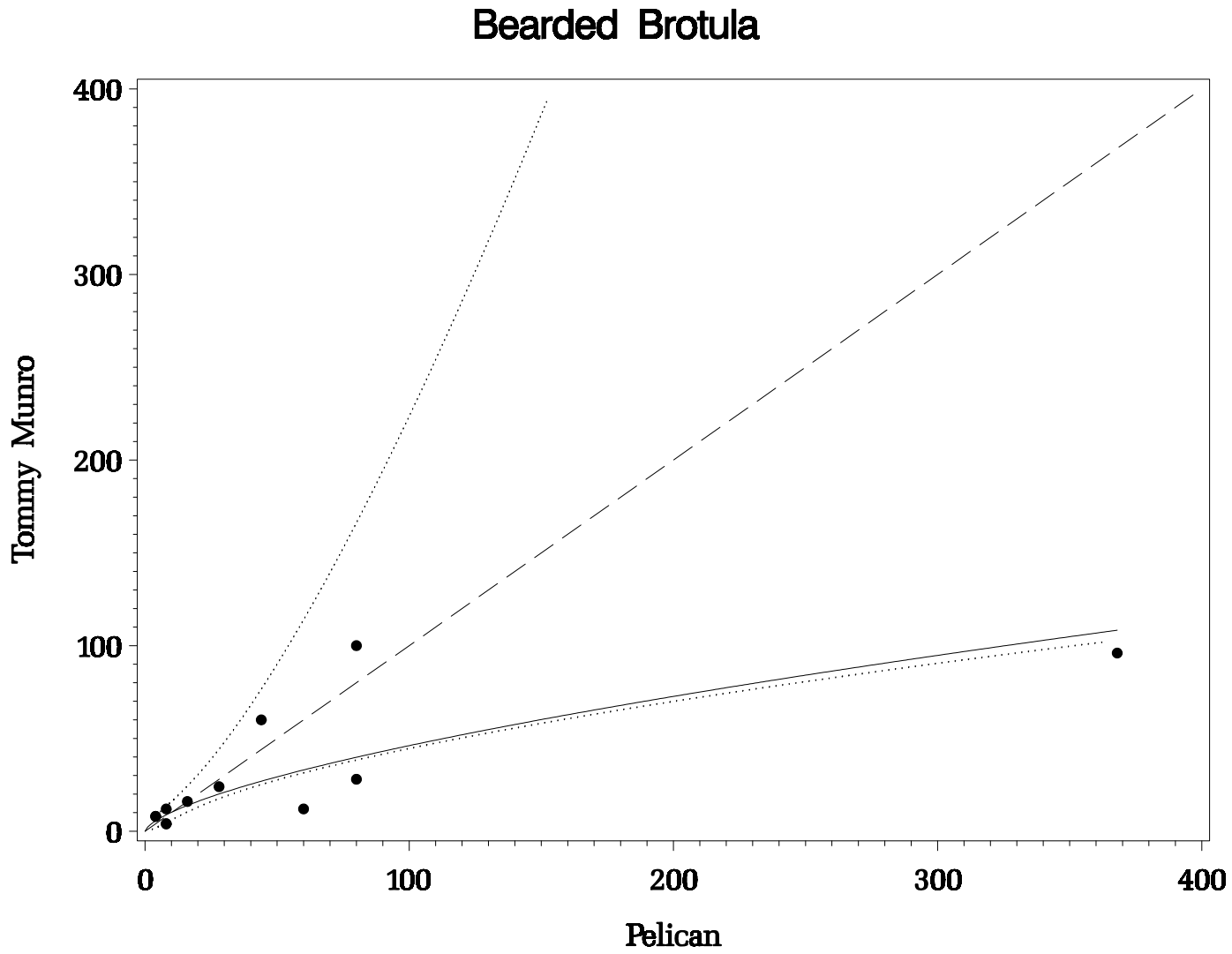

Figure 90. Scatter plot of bearded brotula catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=12). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

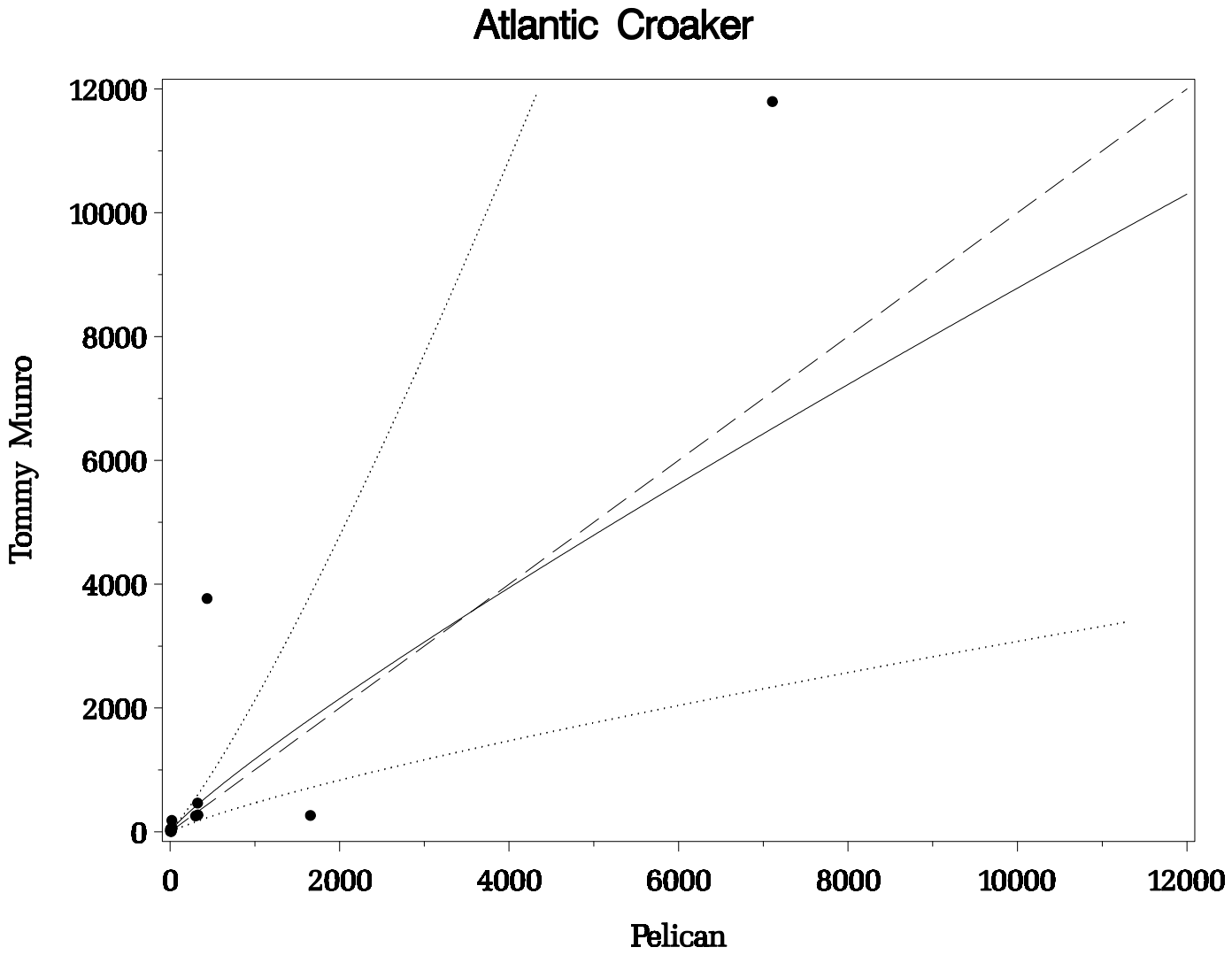

Figure 91. Scatter plot of atlantic croaker catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=18). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

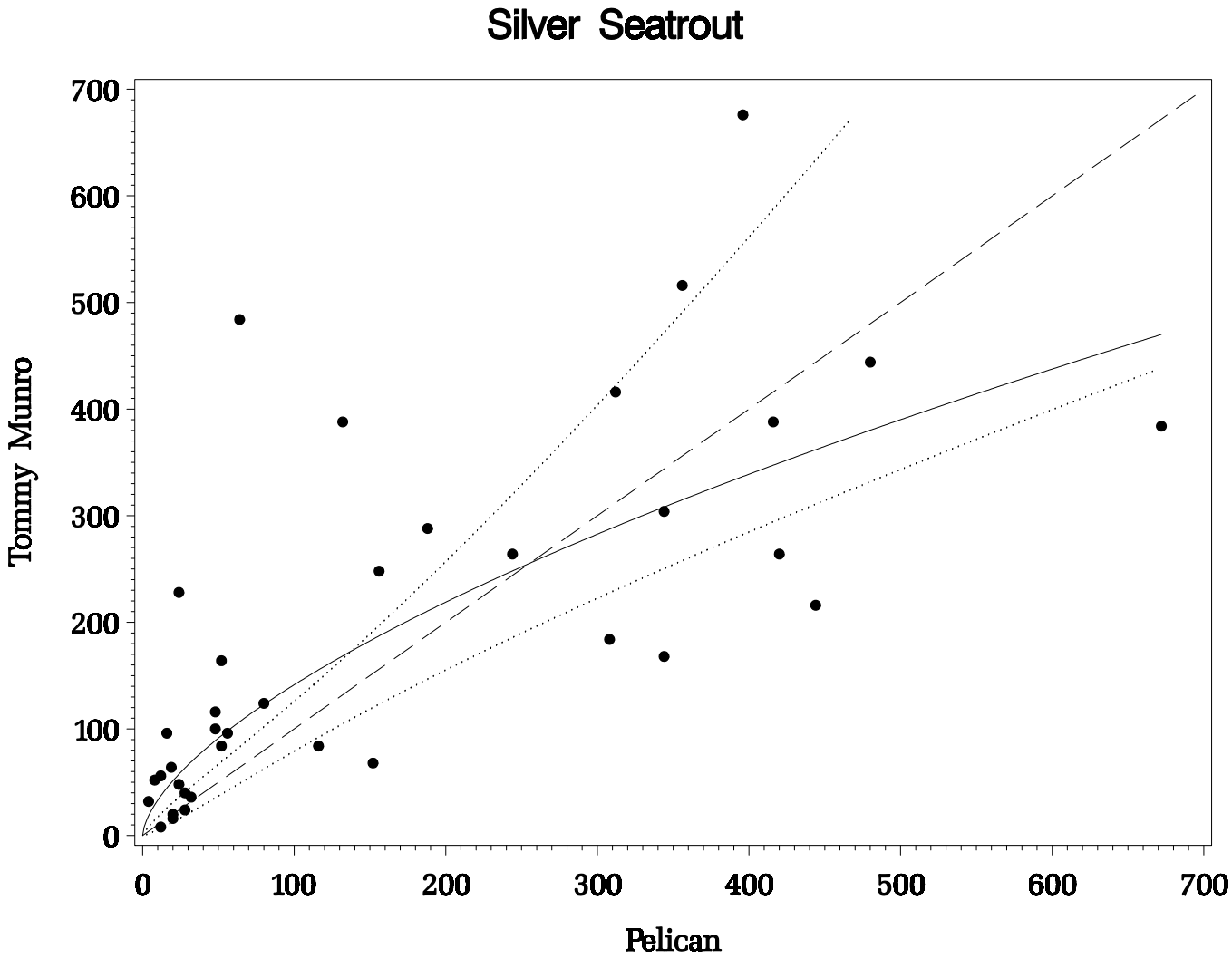

Figure 92. Scatter plot of silver seatrout catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=37). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

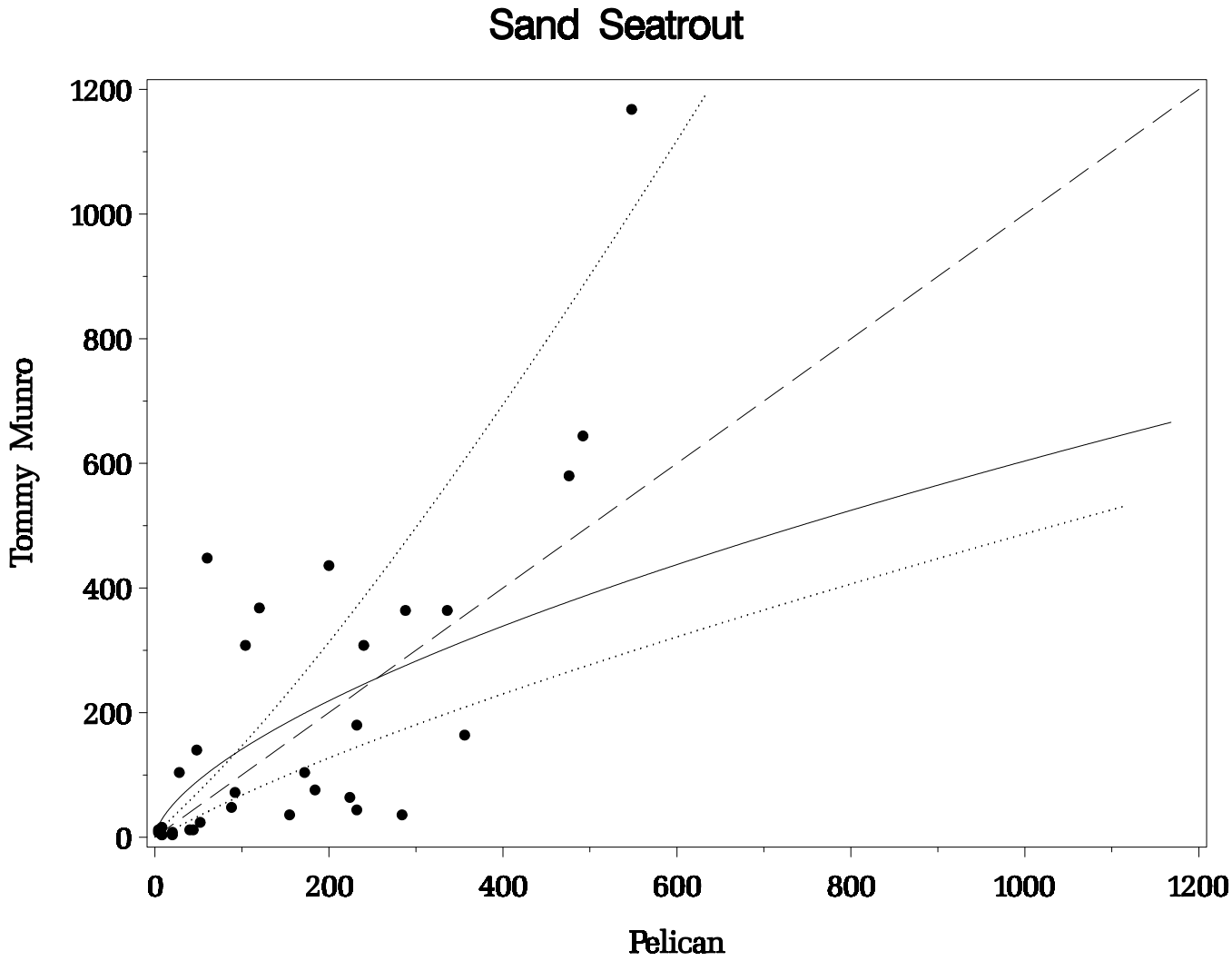

Figure 93. Scatter plot of sand seatrout catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=32). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

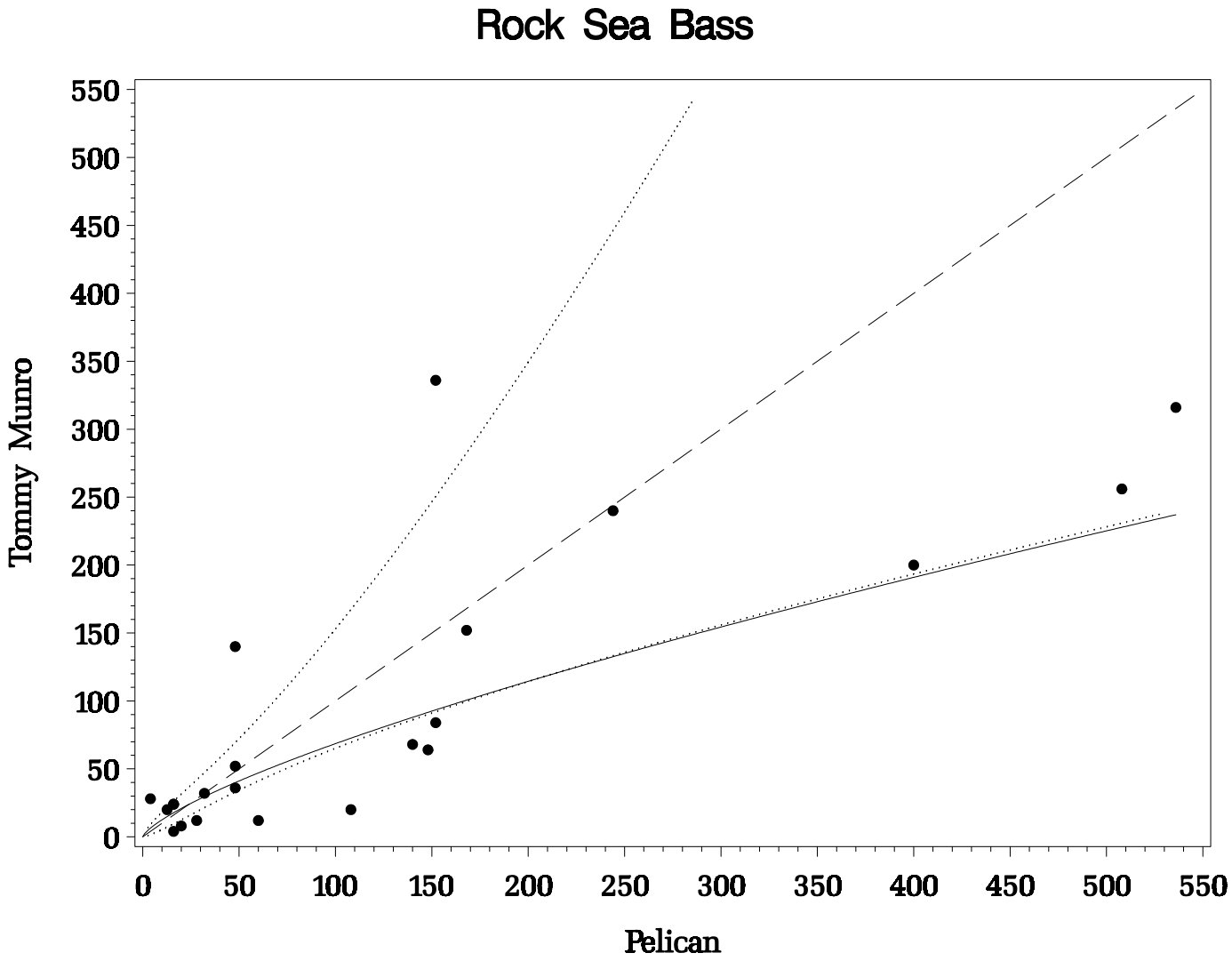

Figure 94. Scatter plot of rock sea bass catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=22). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

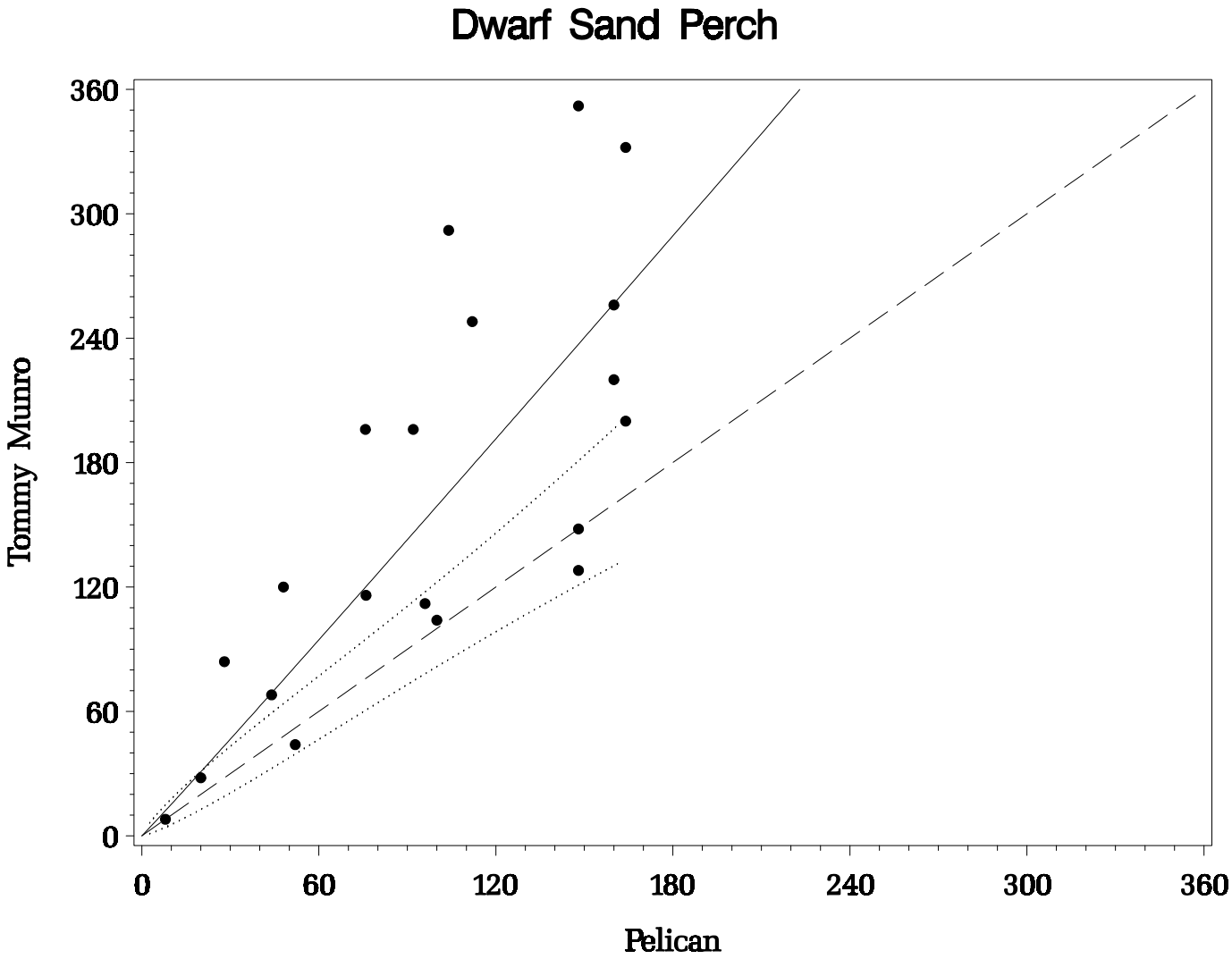

Figure 95. Scatter plot of dwarf sand perch catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=20). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

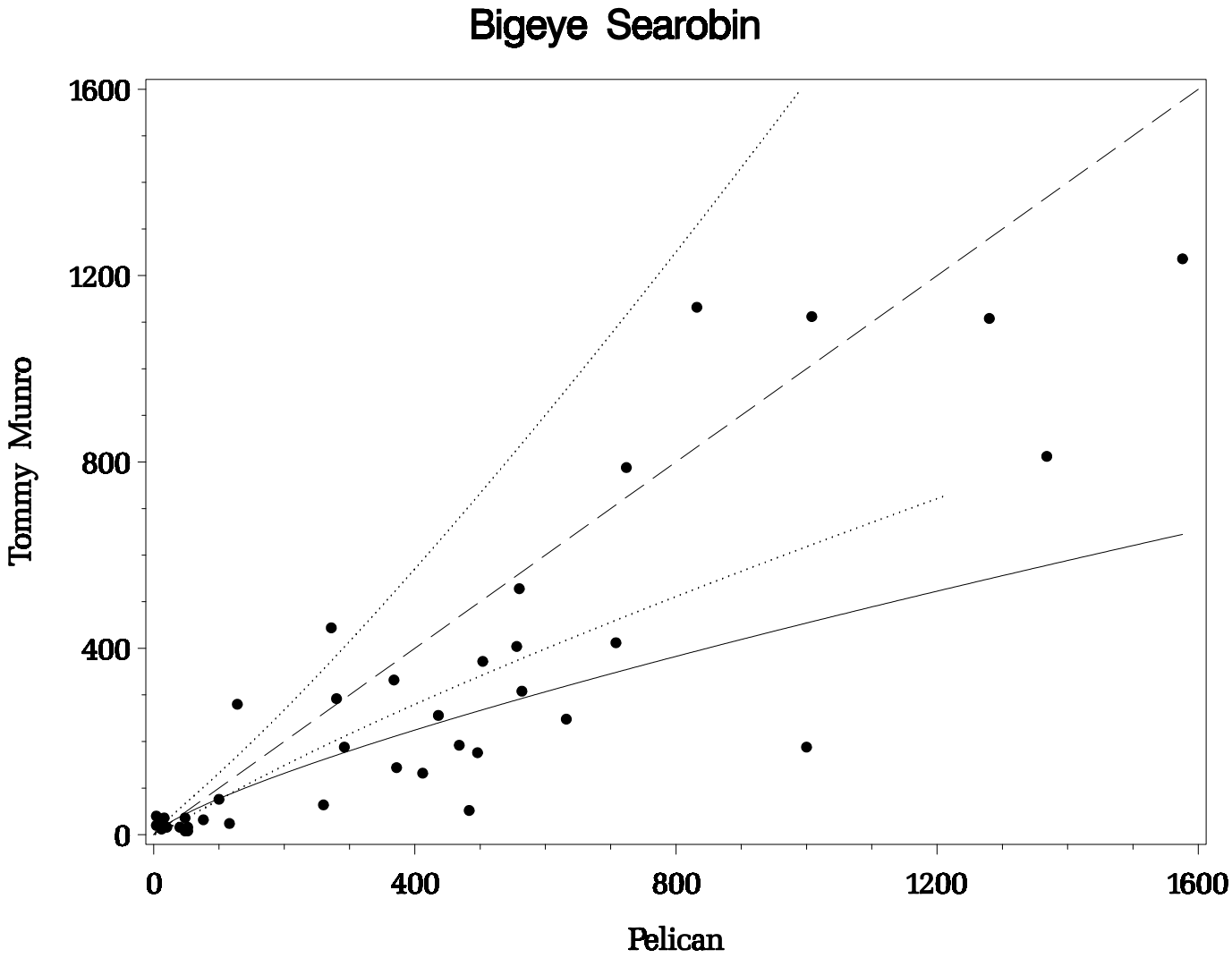

Figure 96. Scatter plot of bigeye searobin catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=39). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

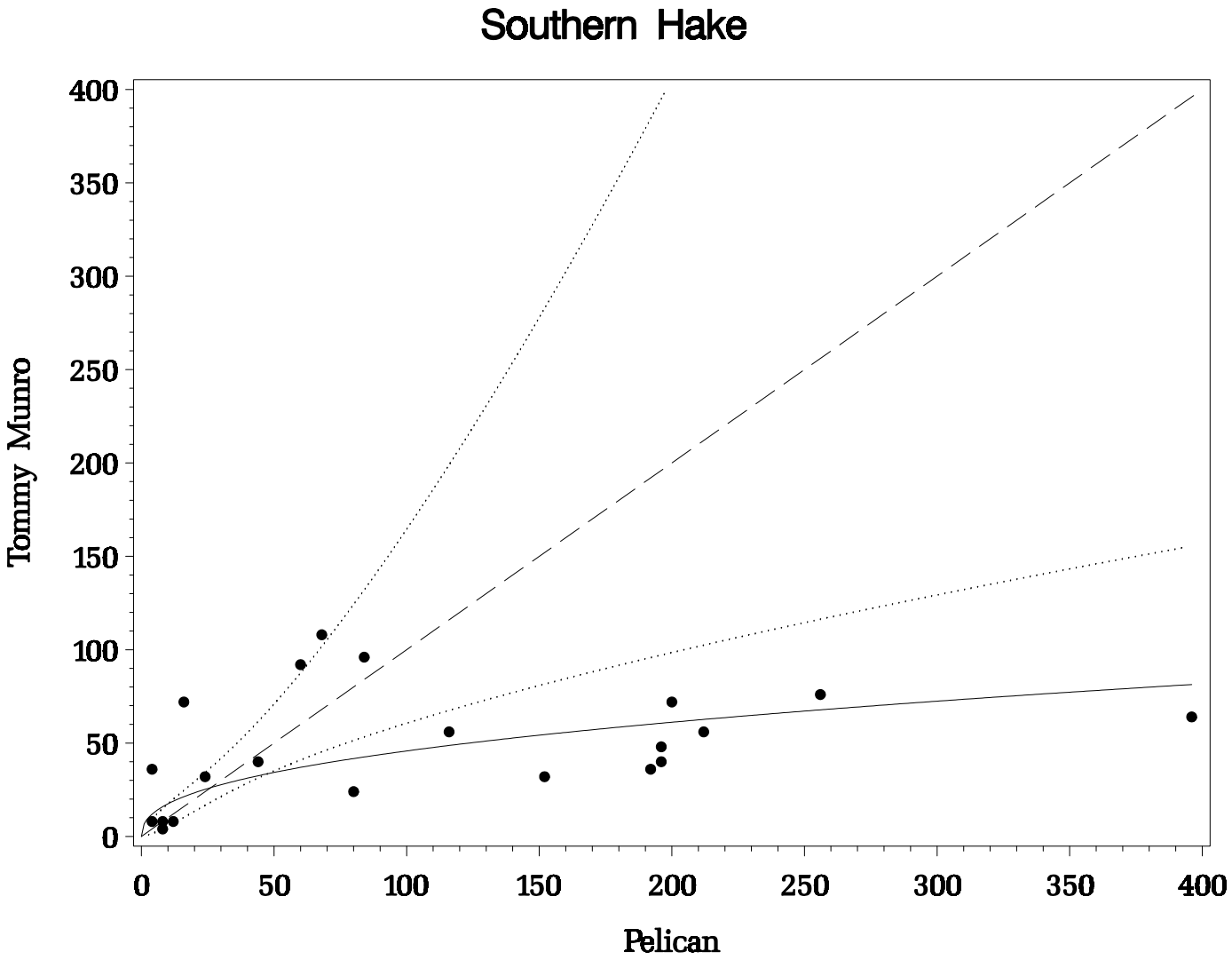

Figure 97. Scatter plot of southern hake catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=21). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

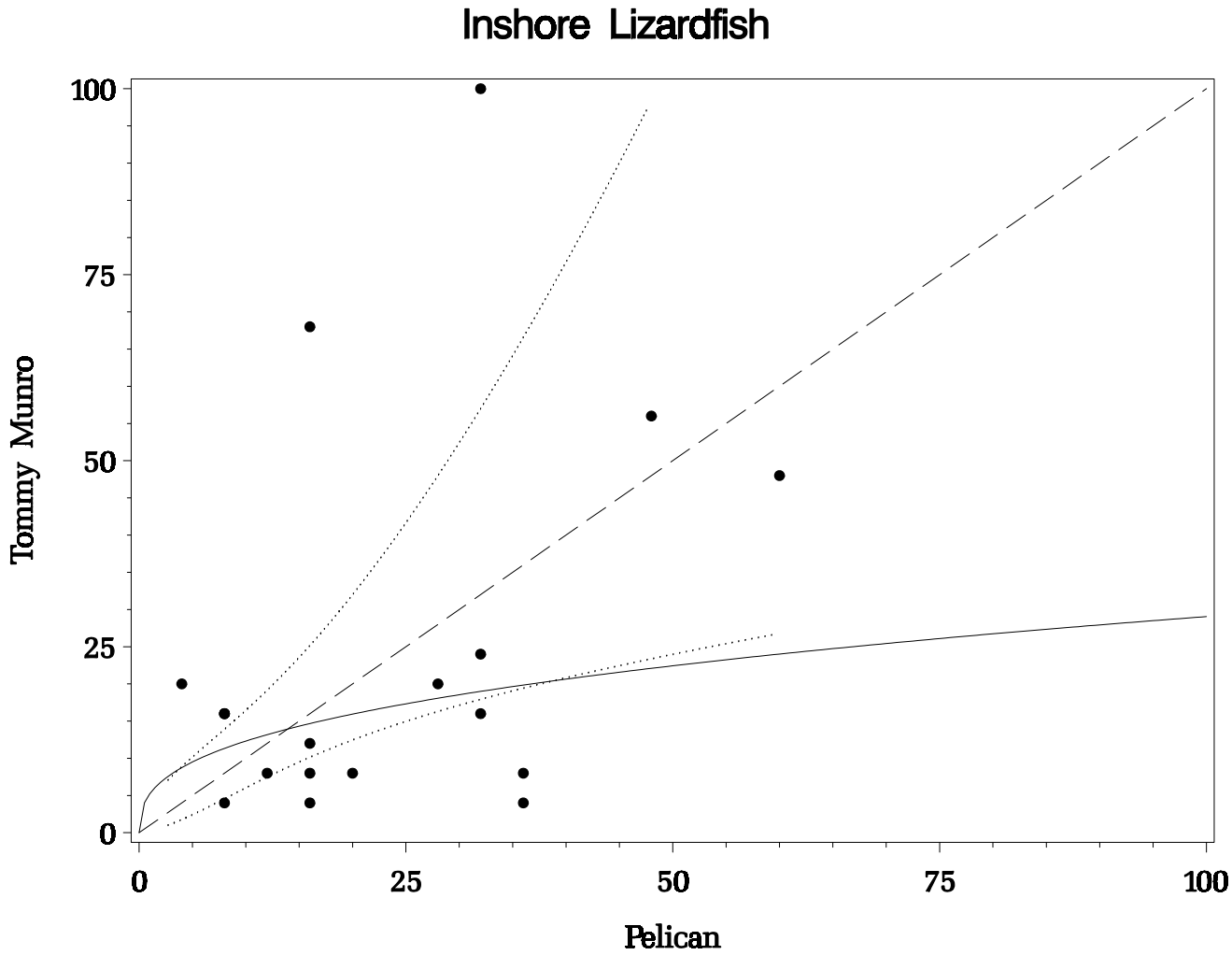

Figure 98. Scatter plot of inshore lizardfish catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=19). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

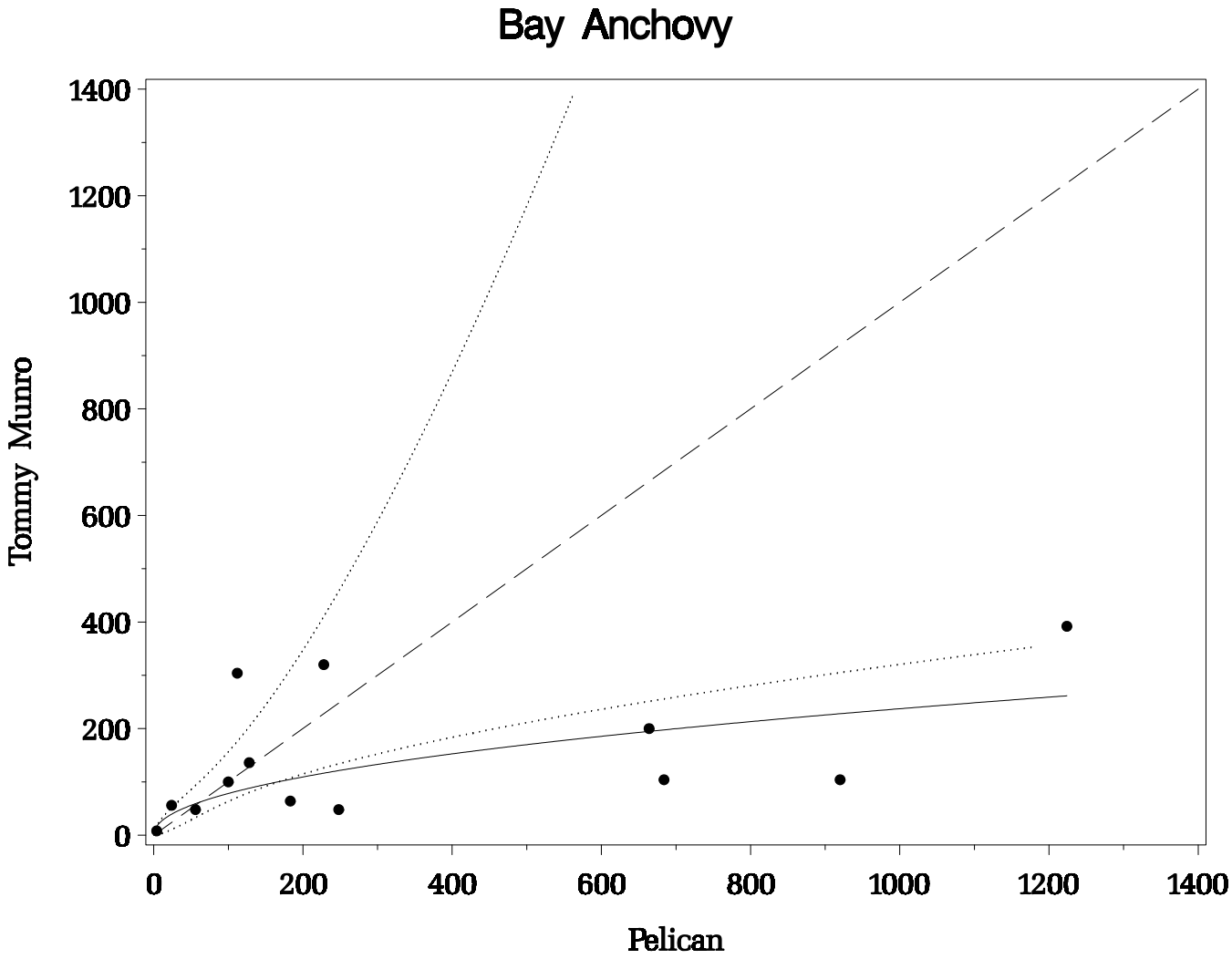

Figure 99. Scatter plot of bay anchovy catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=13). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

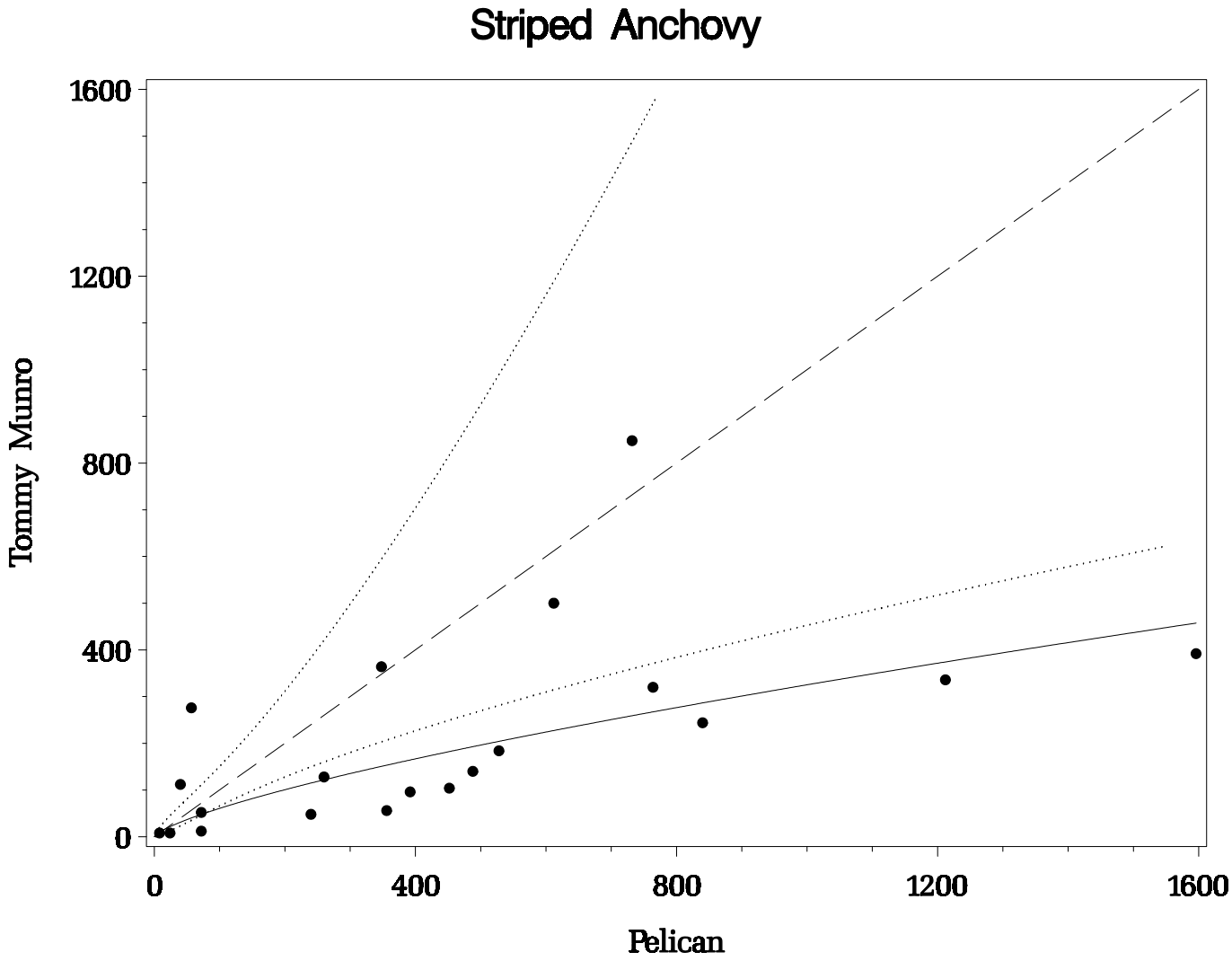

Figure 100. Scatter plot of striped anchovy catches by *Research Vessels Tommy Munro* and *Pelican* during paired comparison towing (n=20). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

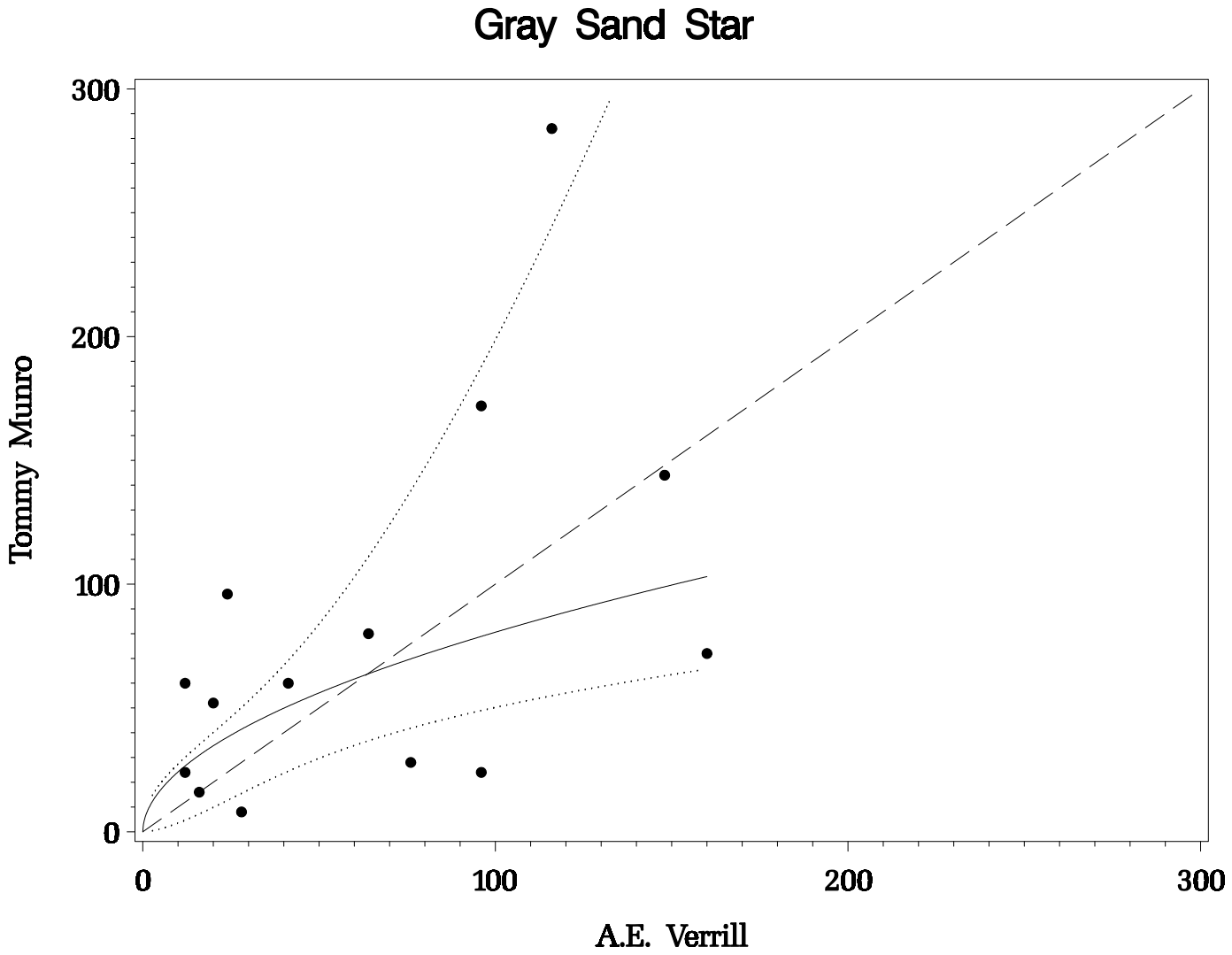

Figure 101. Scatter plot of gray sand star catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=14). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

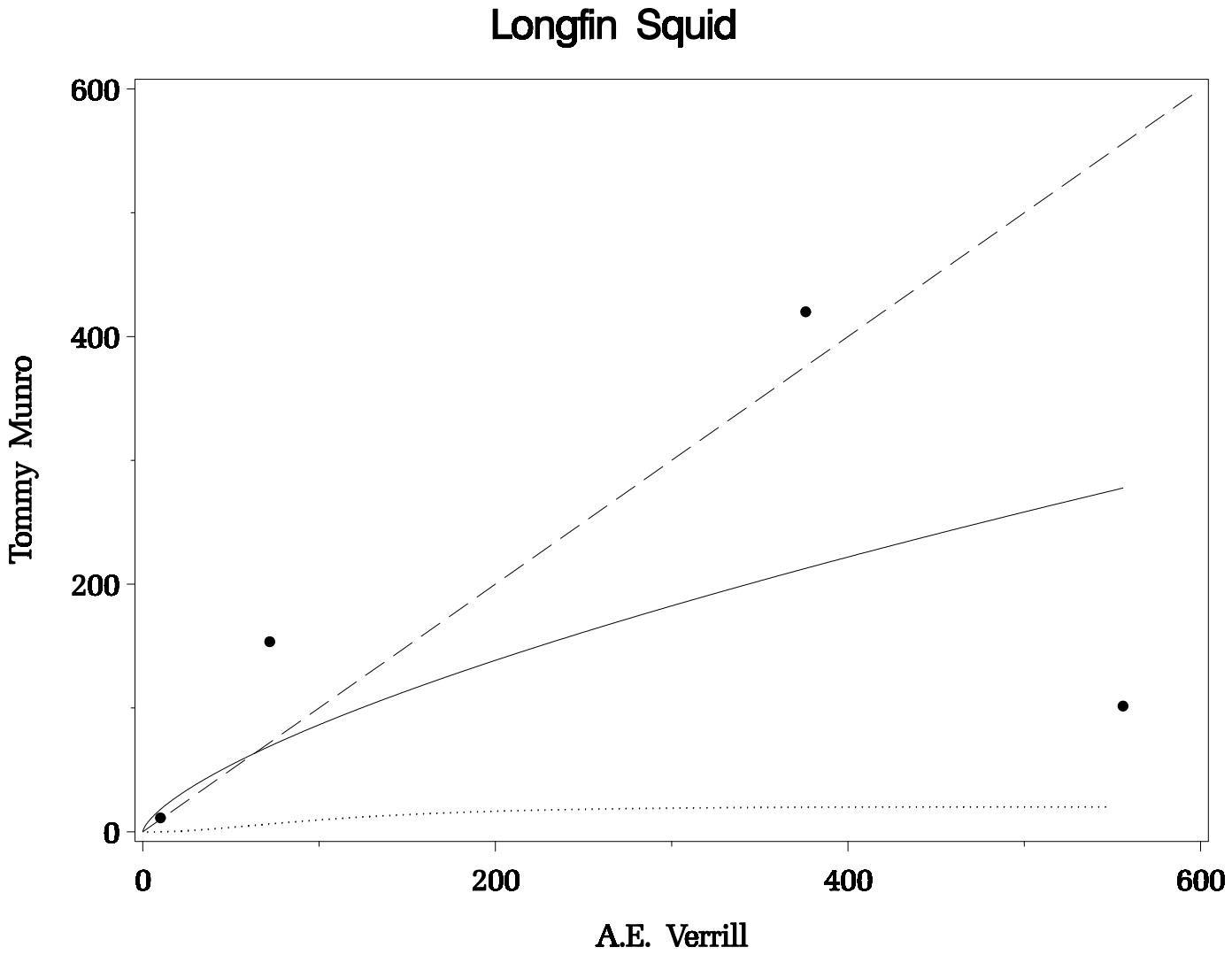

Figure 102. Scatter plot of longfin squid catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=4). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

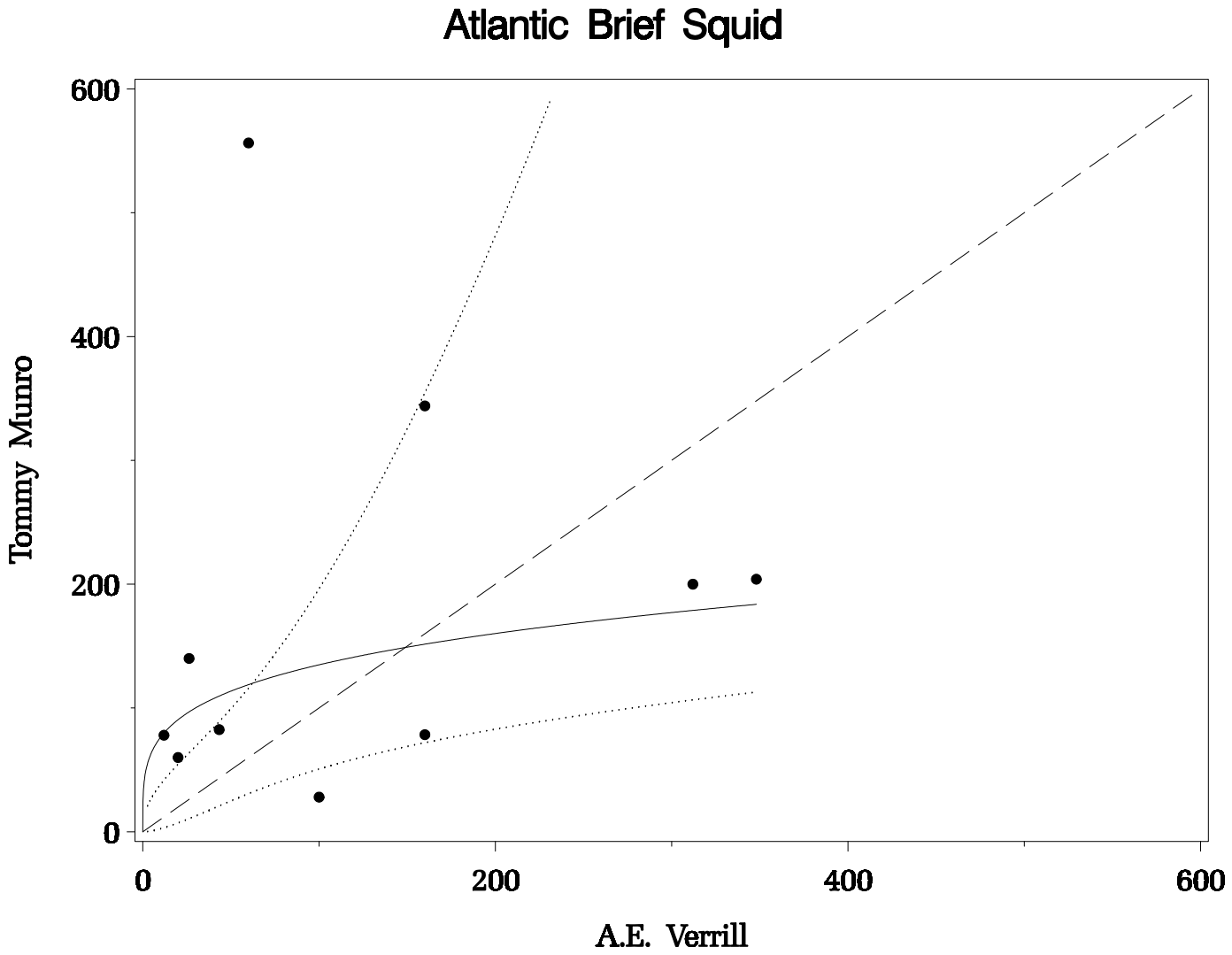

Figure 103. Scatter plot of Atlantic brief squid catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=10). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

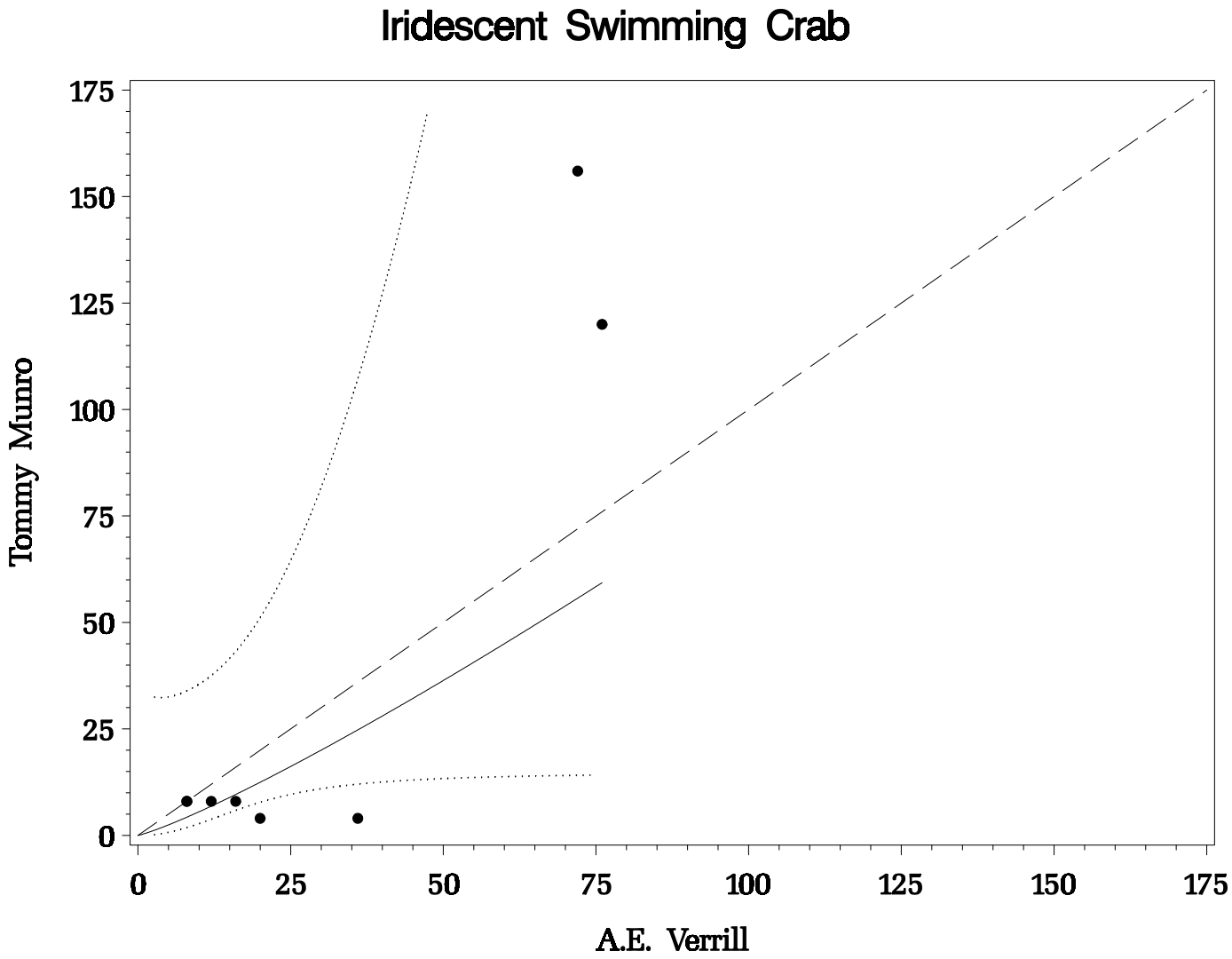

Figure 104. Scatter plot of iridescent swimming crab catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=8). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

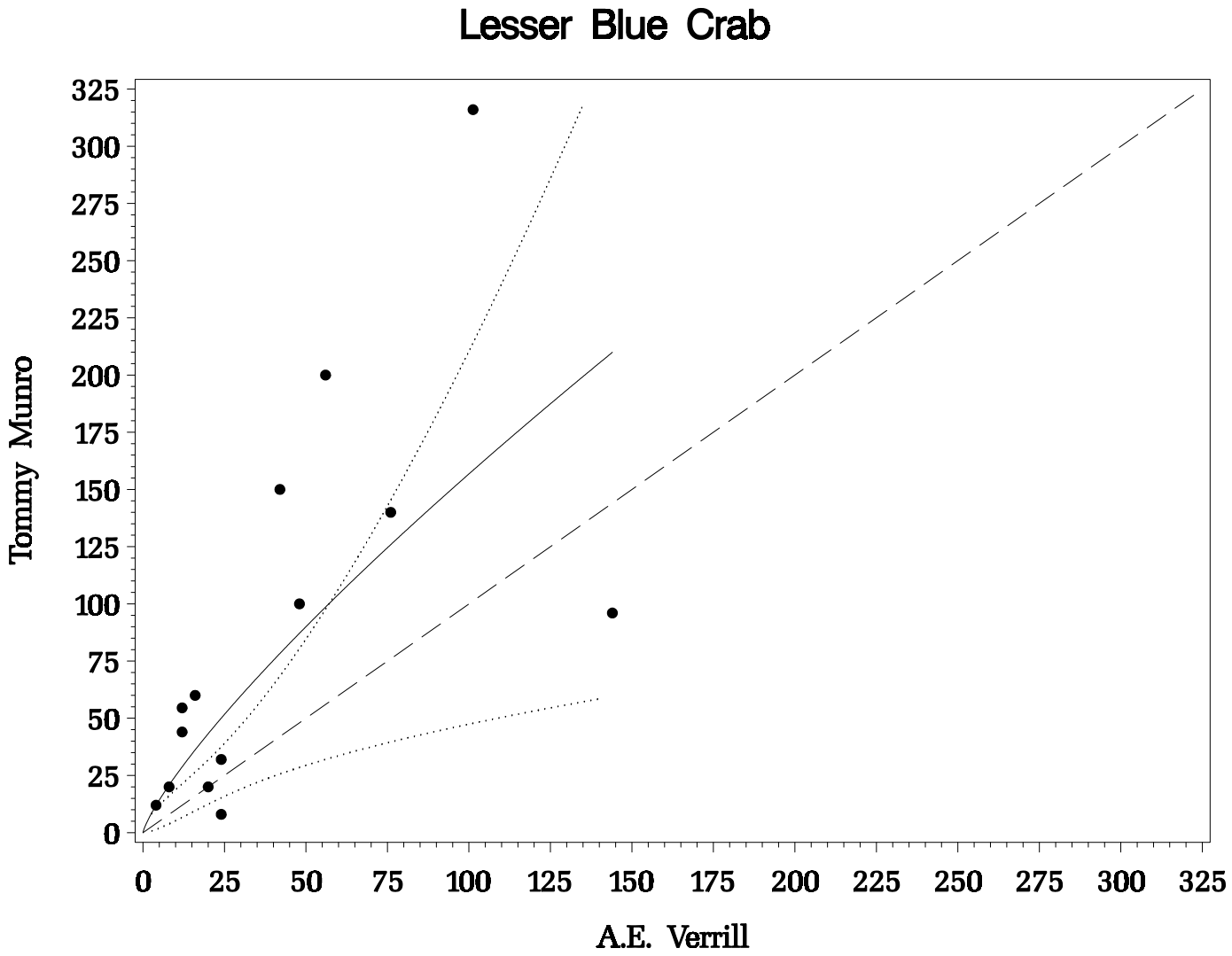

Figure 105. Scatter plot of lesser blue crab catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=14). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

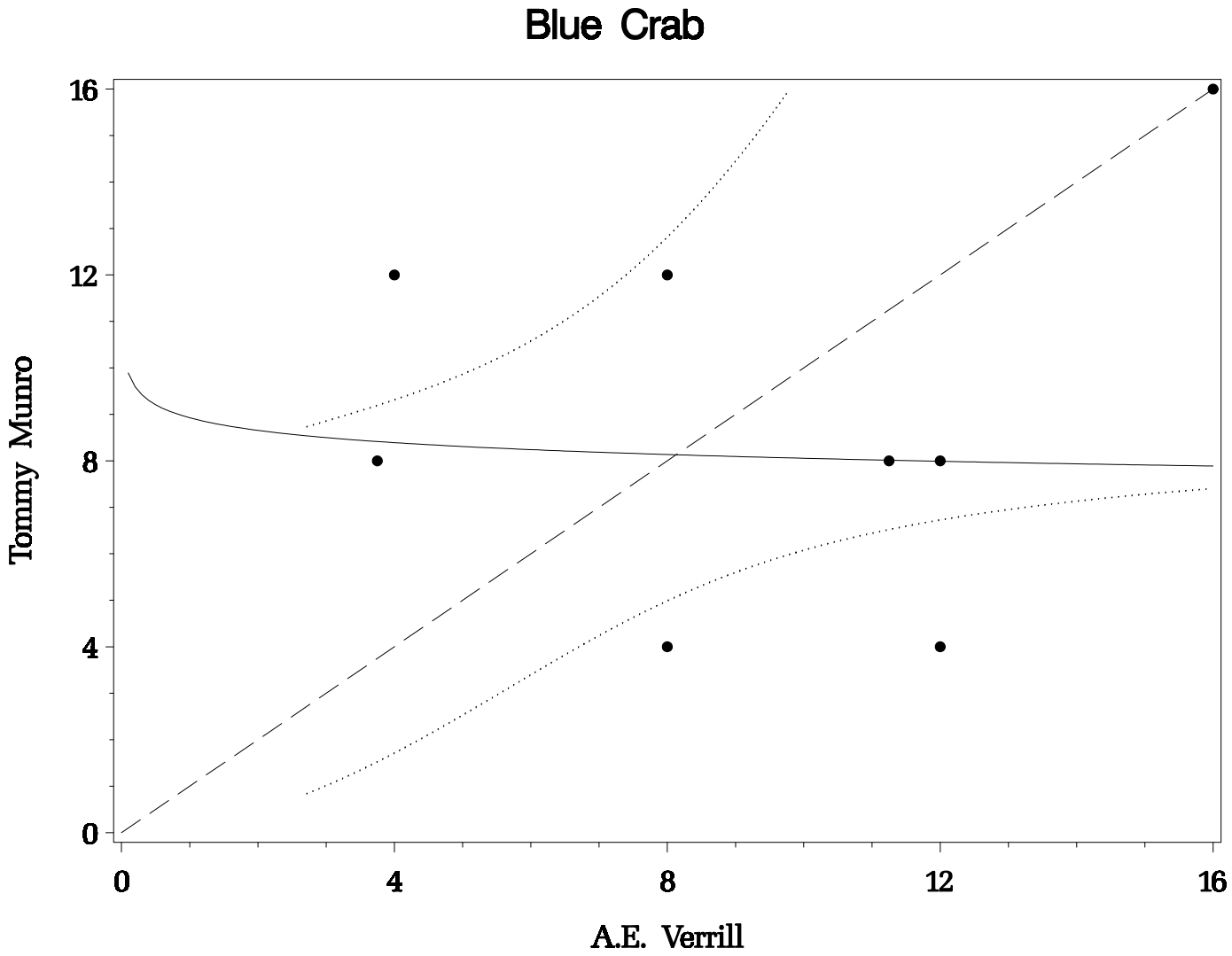

Figure 106. Scatter plot of blue crab catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=8). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

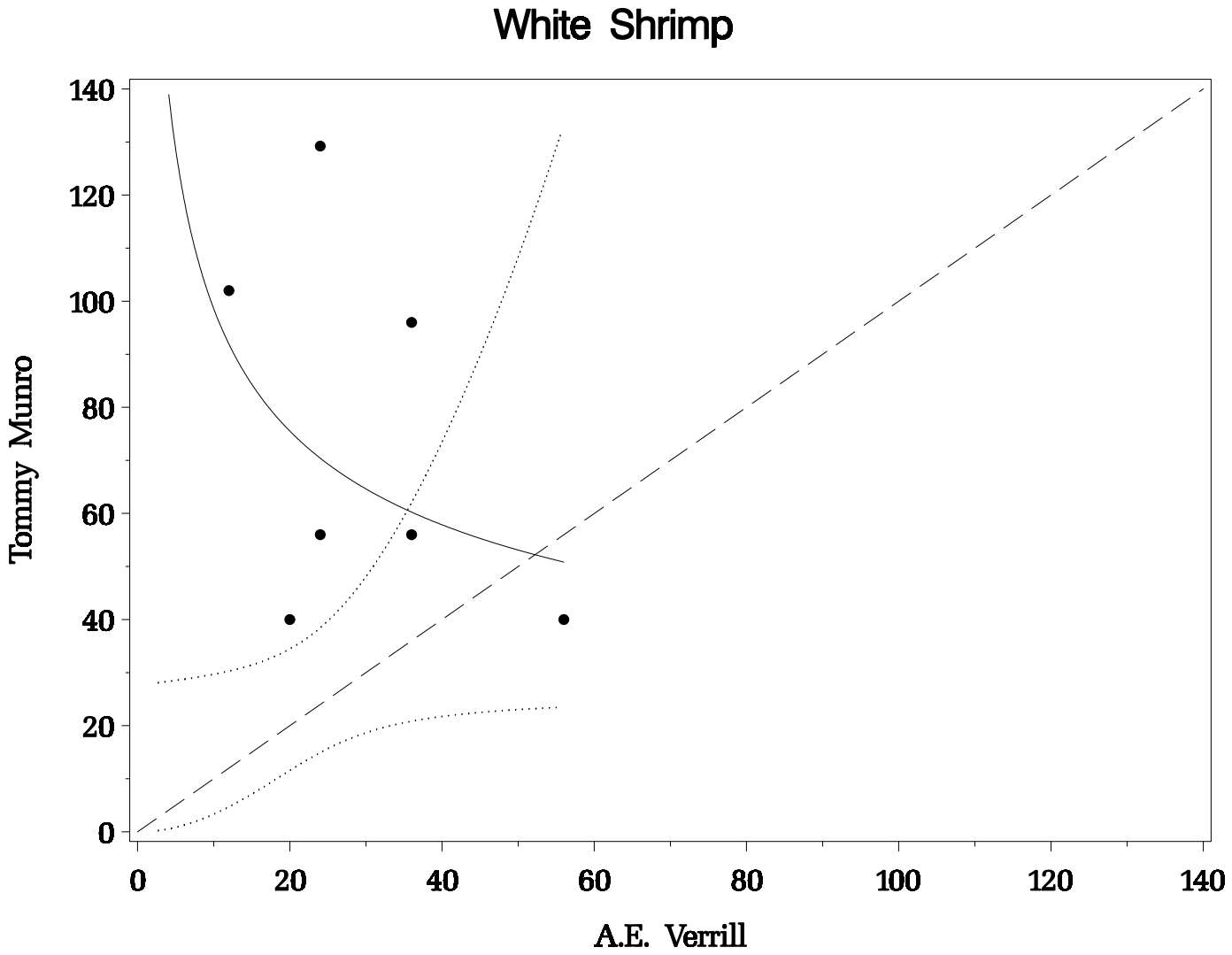

Figure 107. Scatter plot of white shrimp catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=7). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

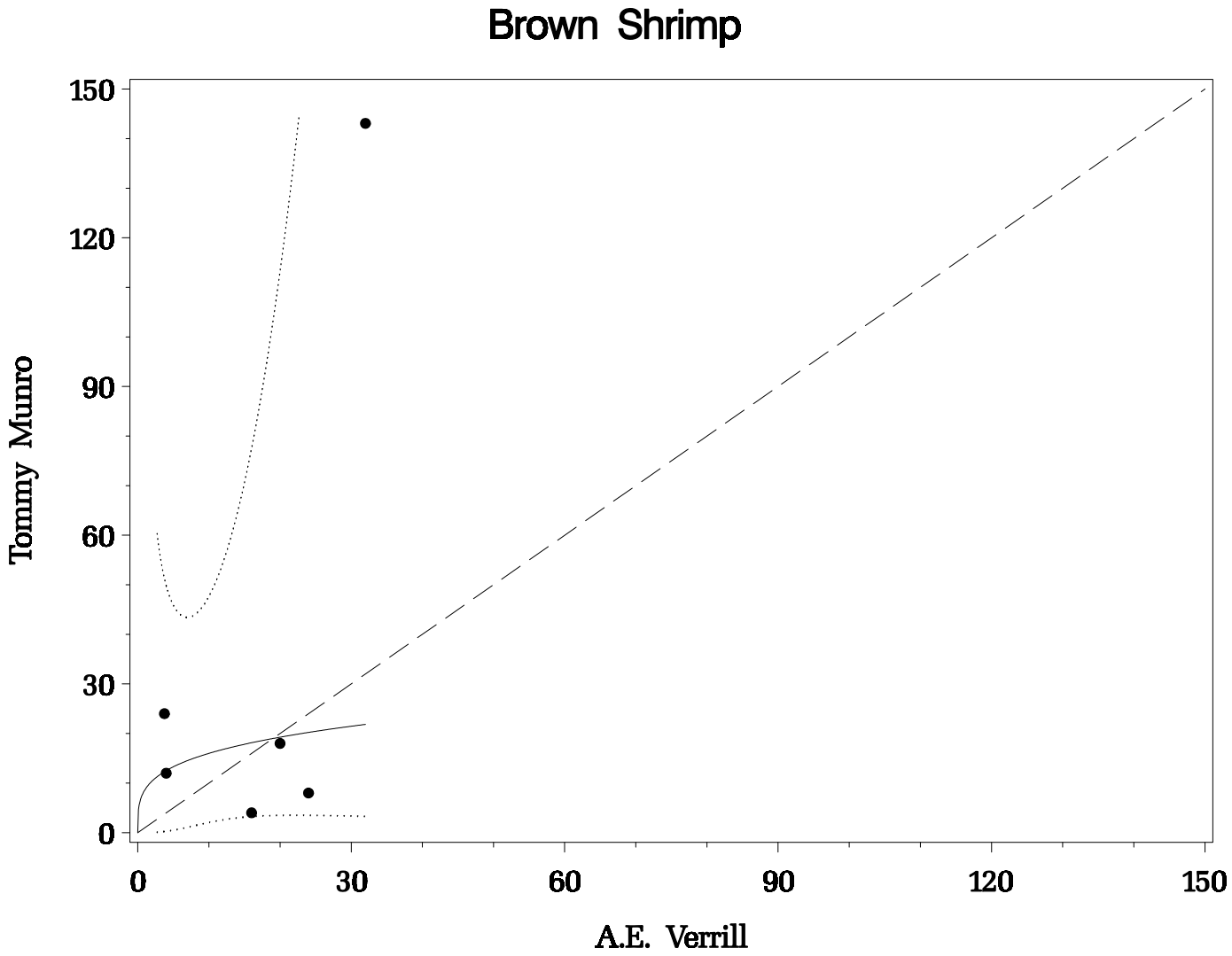

Figure 108. Scatter plot of brown shrimp catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

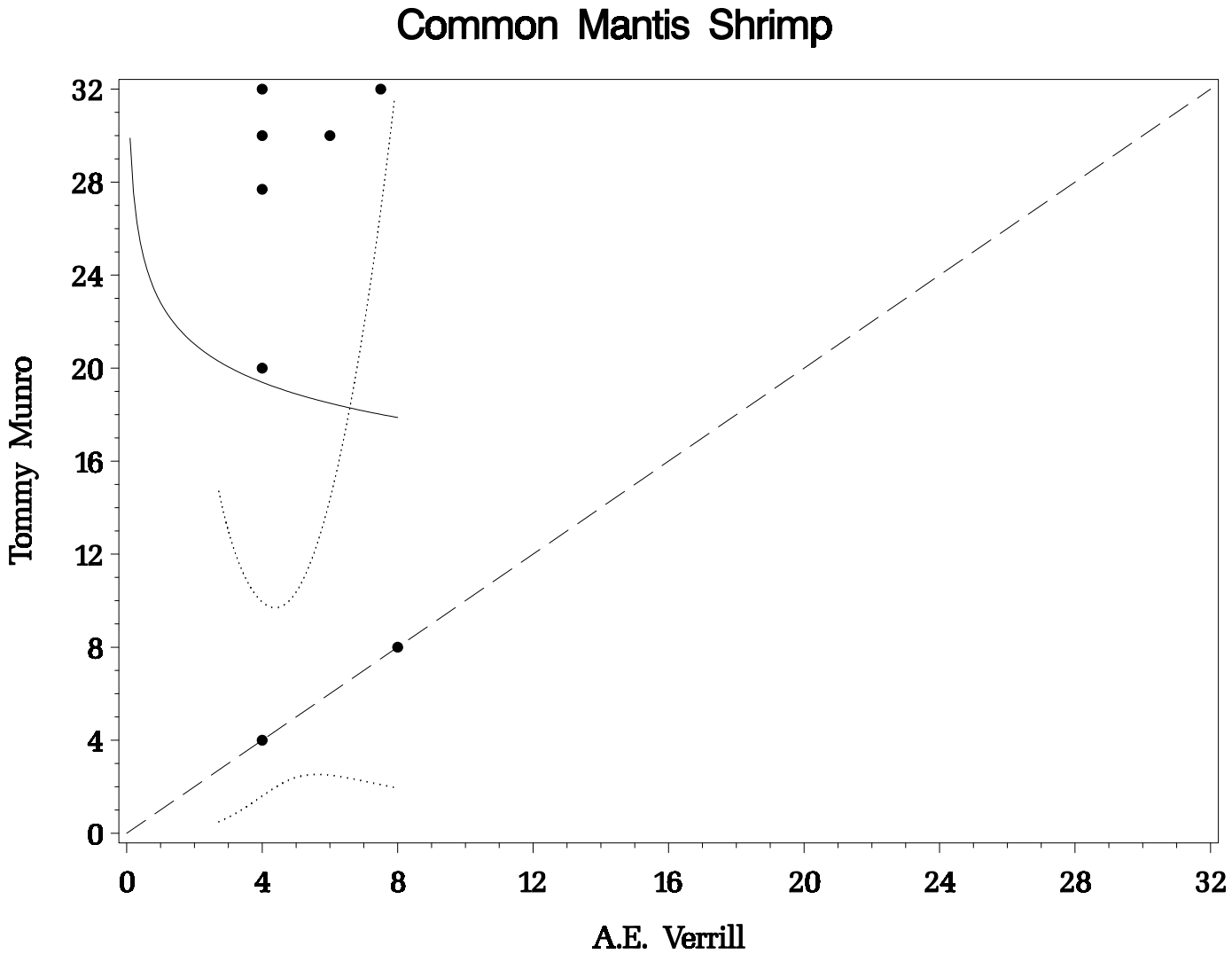

Figure 109. Scatter plot of common mantis shrimp catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=8). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

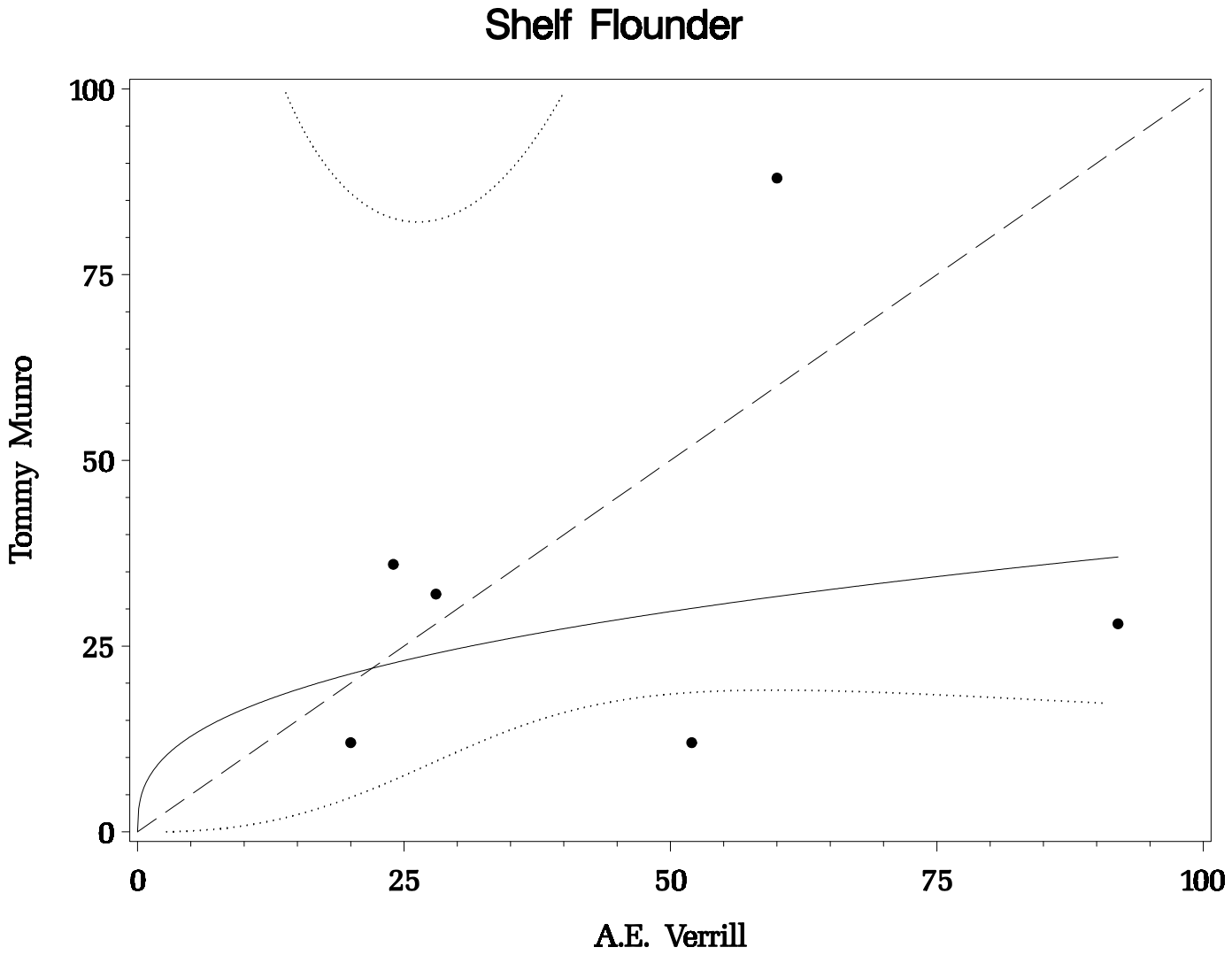

Figure 110. Scatter plot of shelf flounder catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

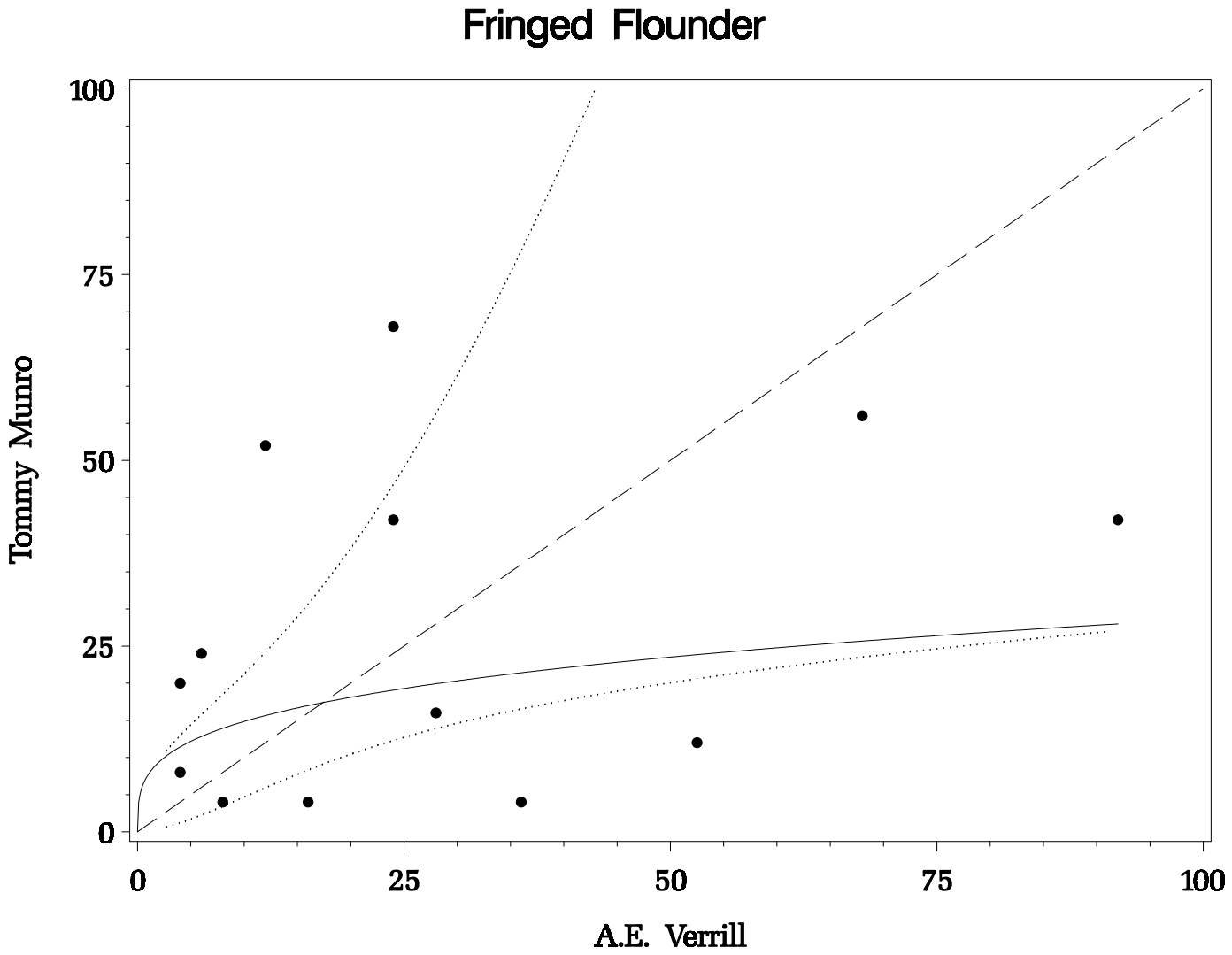

Figure 111. Scatter plot of fringed flounder catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=13). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

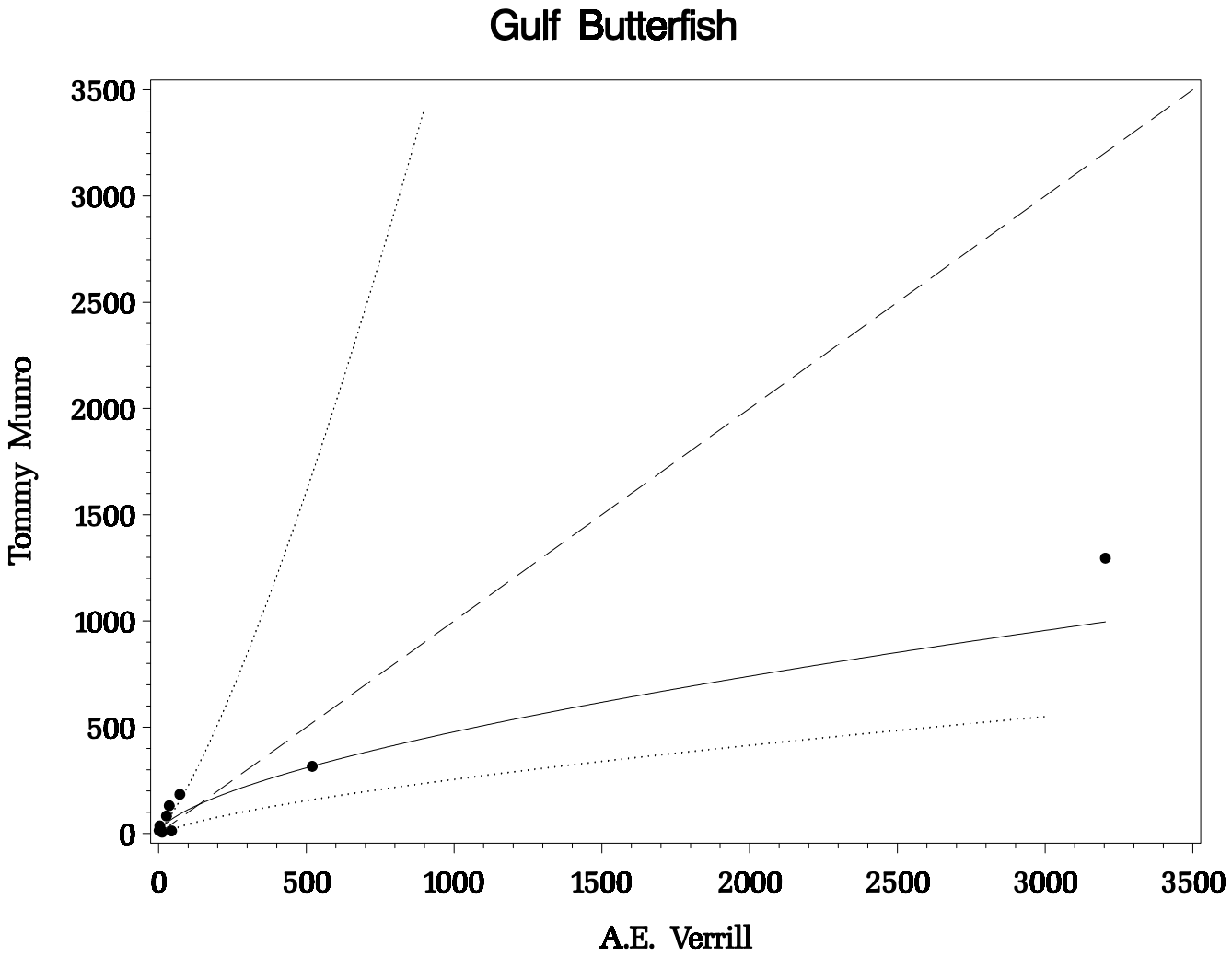

Figure 112. Scatter plot of Gulf butterfish catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=10). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

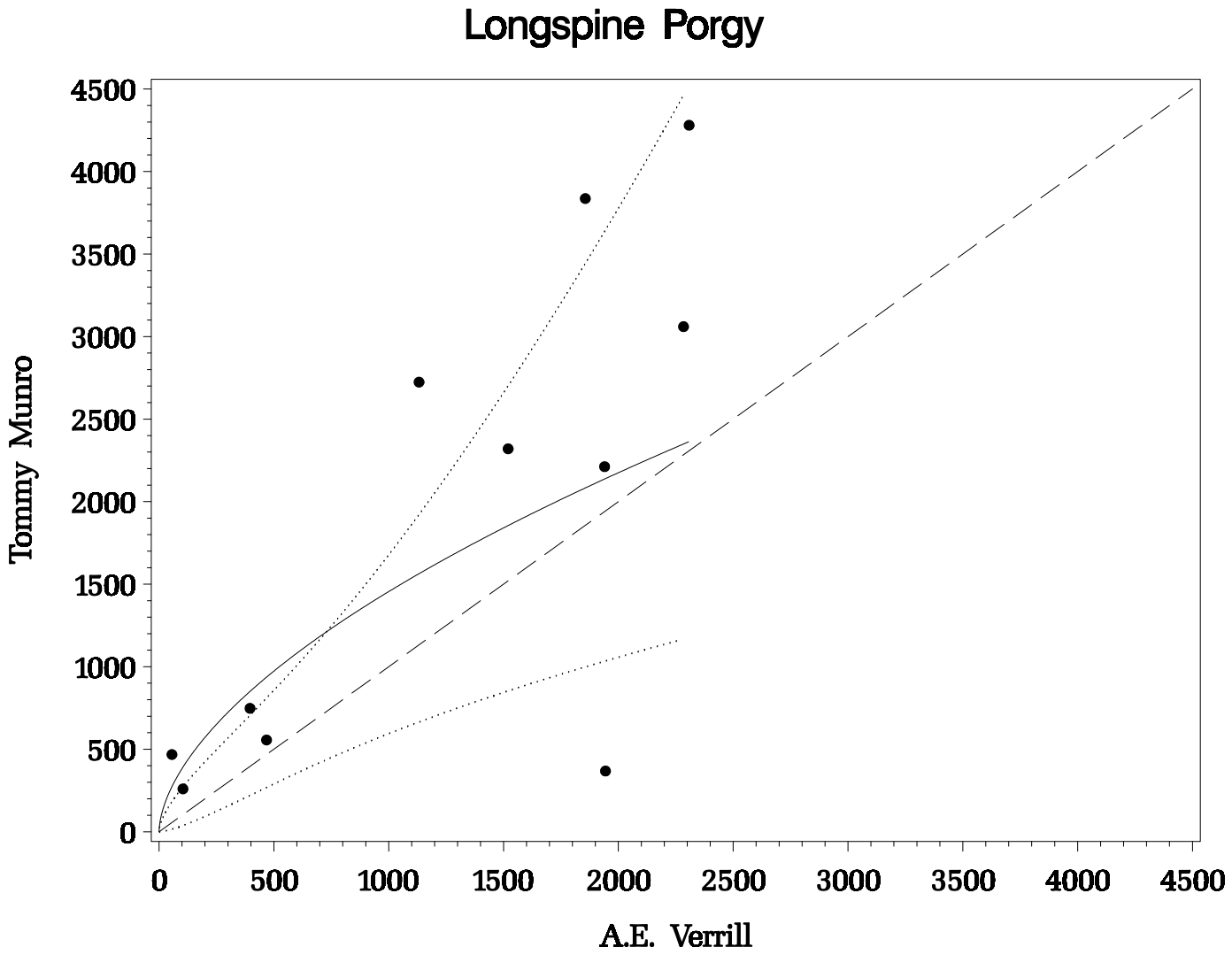

Figure 113. Scatter plot of longspine porgy catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=11). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

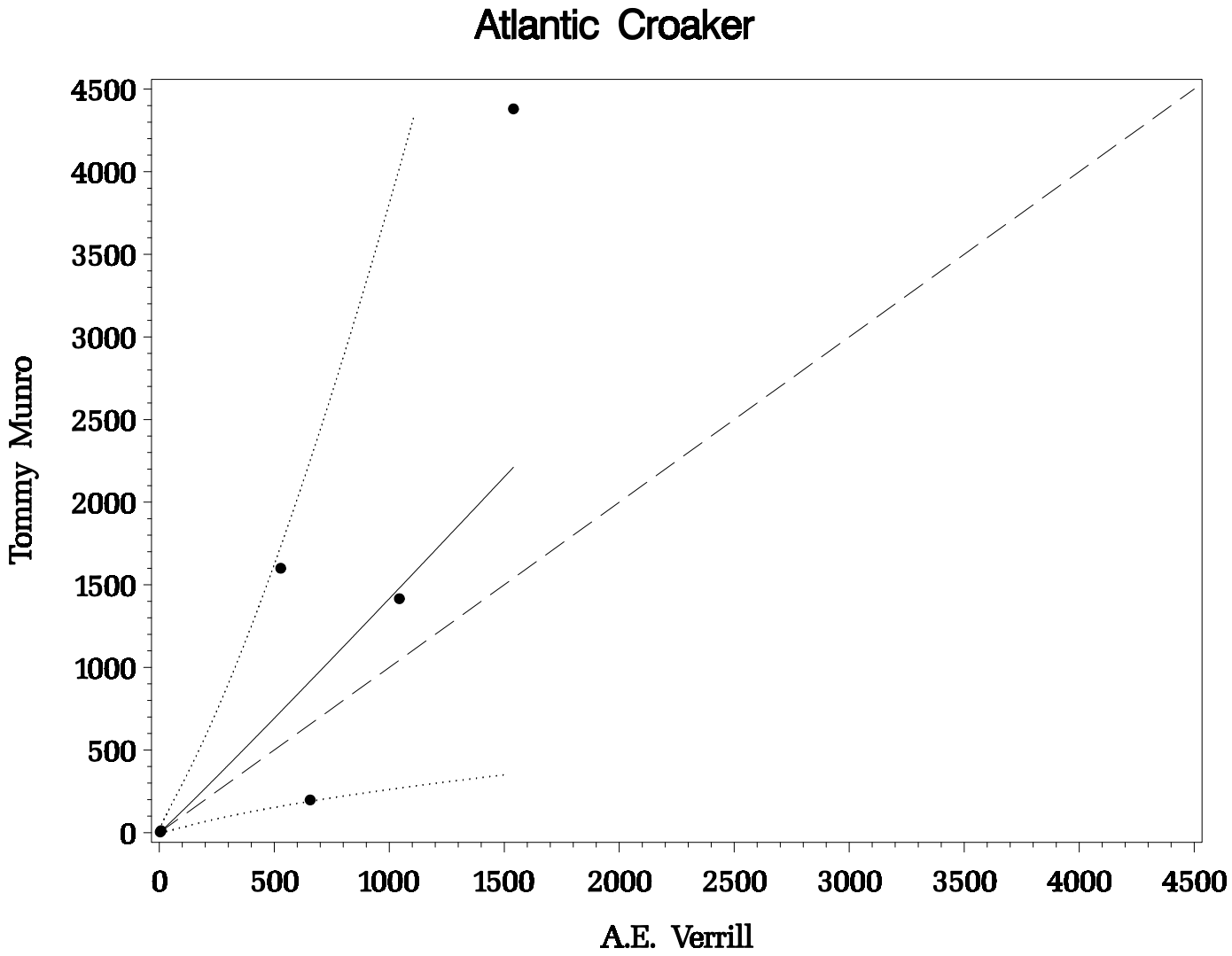

Figure 114. Scatter plot of Atlantic croaker catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

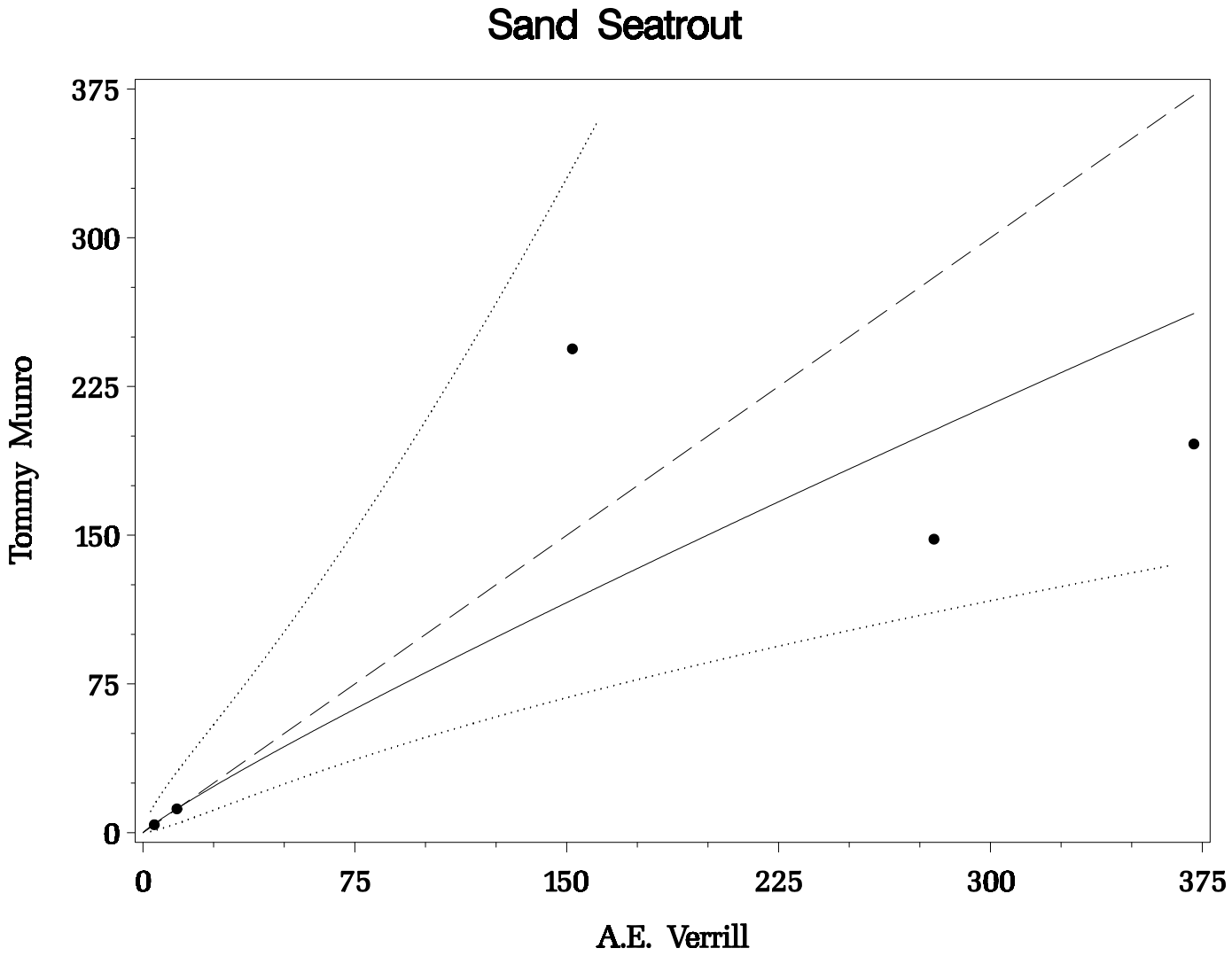

Figure 115. Scatter plot of sand seatrout catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=5). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

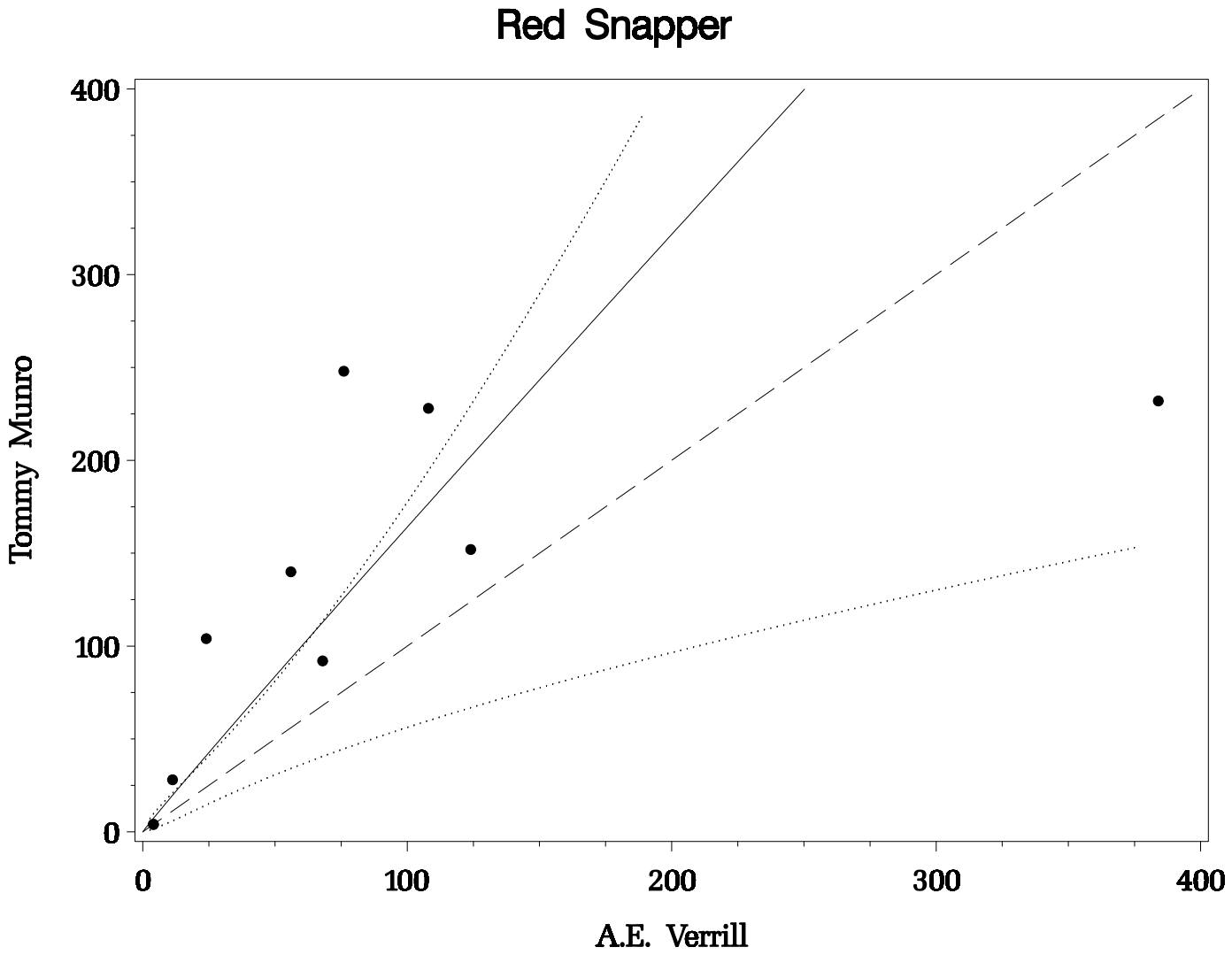

Figure 116. Scatter plot of red snapper catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=10). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

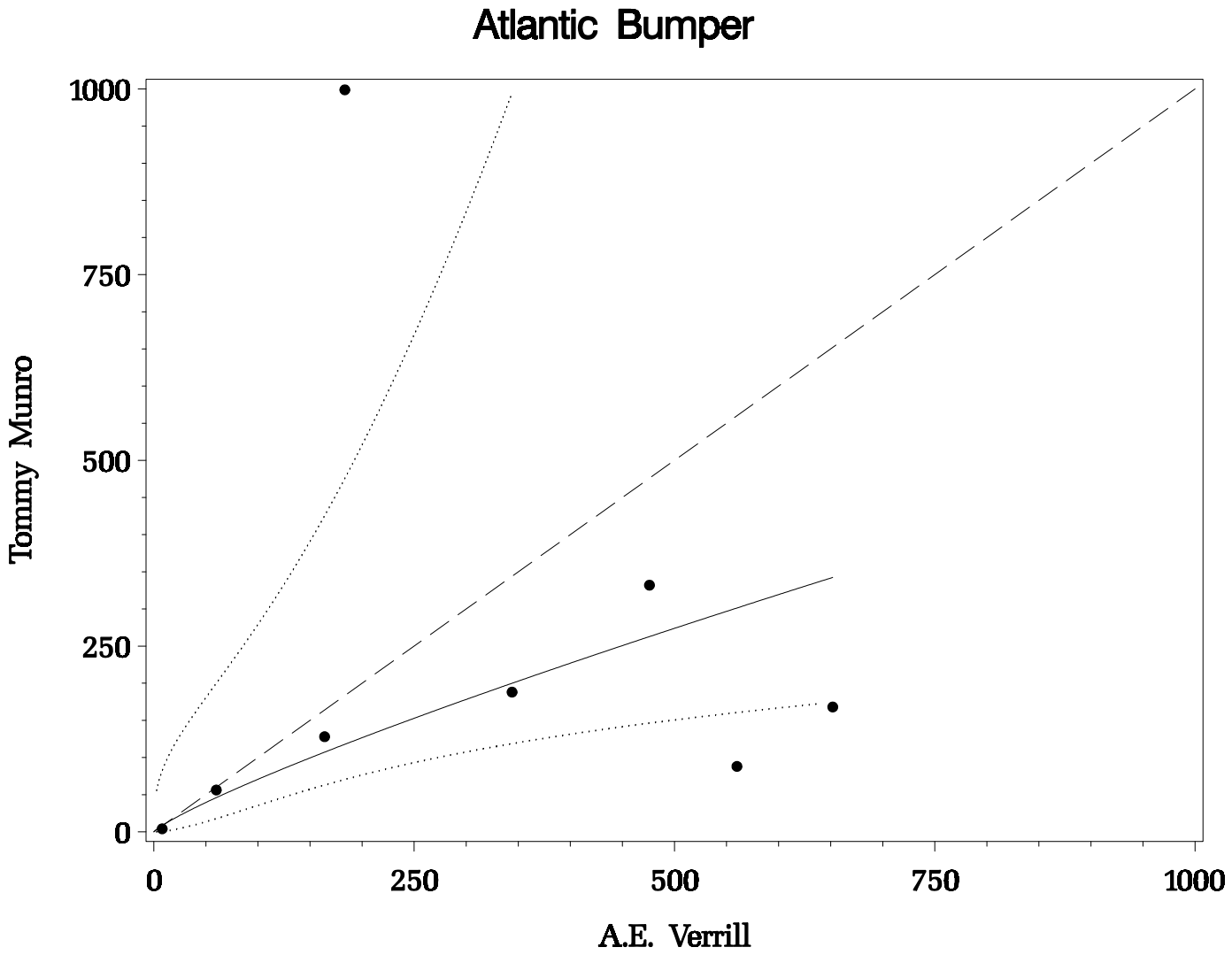

Figure 117. Scatter plot of Atlantic bumper catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=8). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

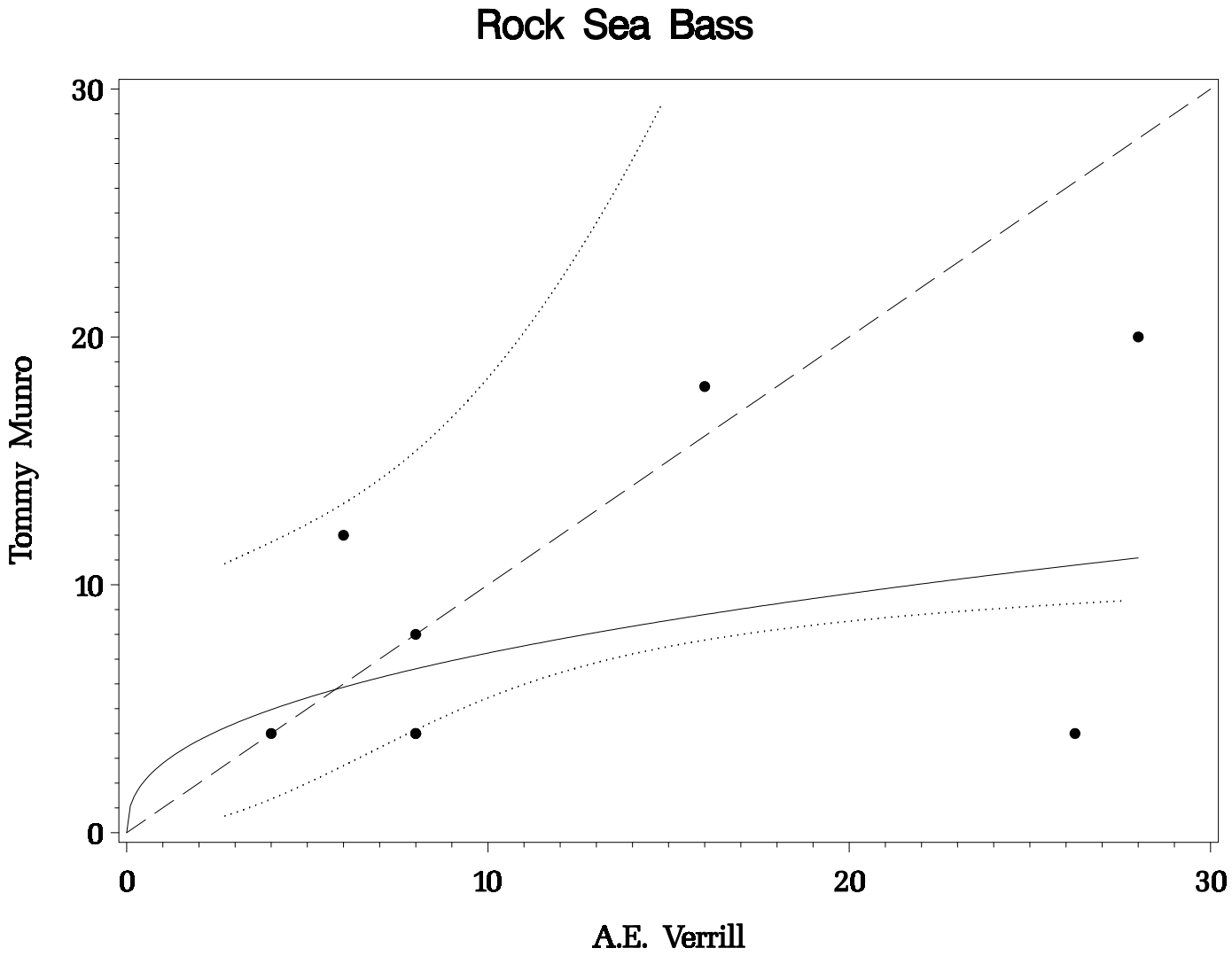

Figure 118. Scatter plot of rock sea bass catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=8). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

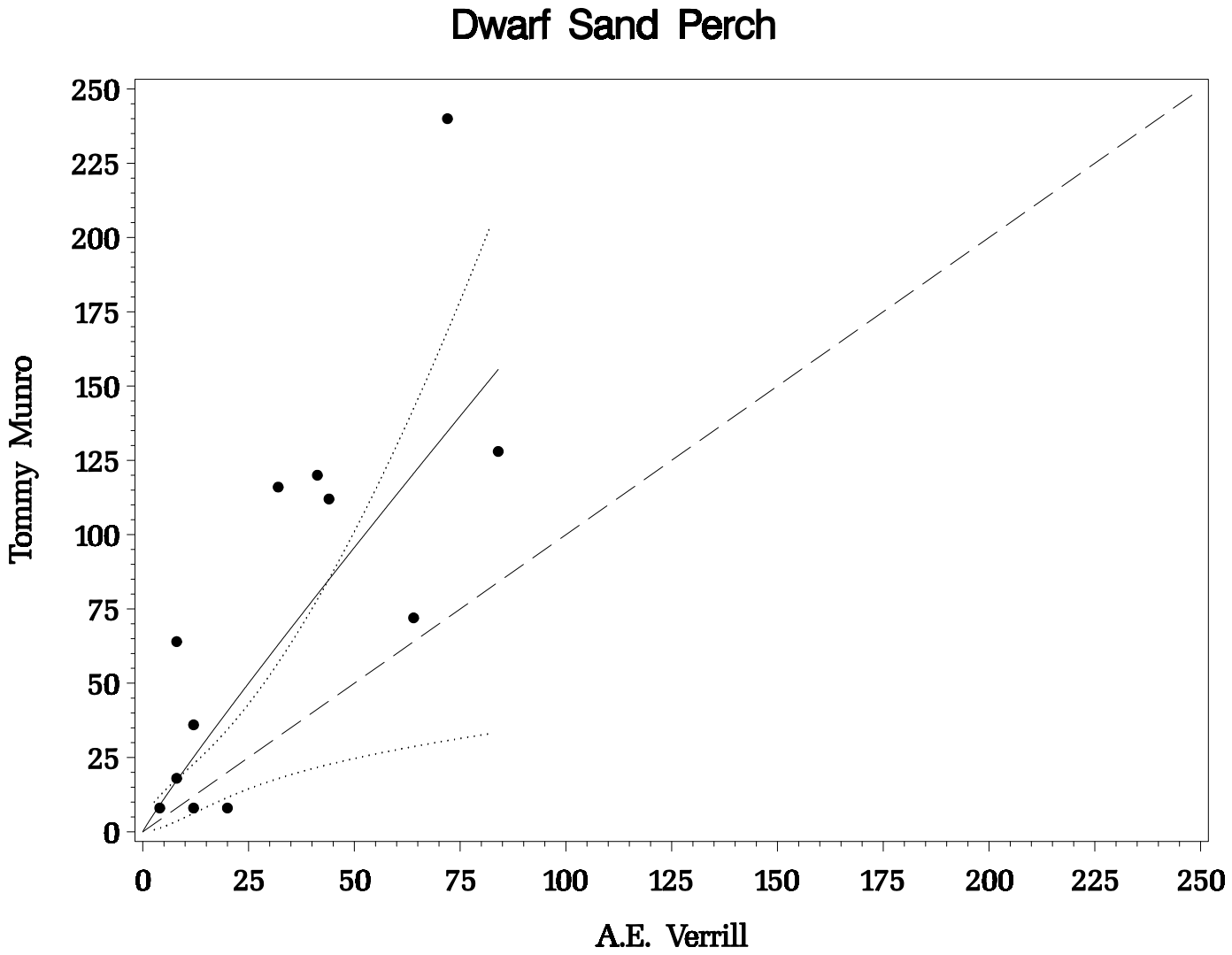

Figure 119. Scatter plot of dwarf sand perch catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=12). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

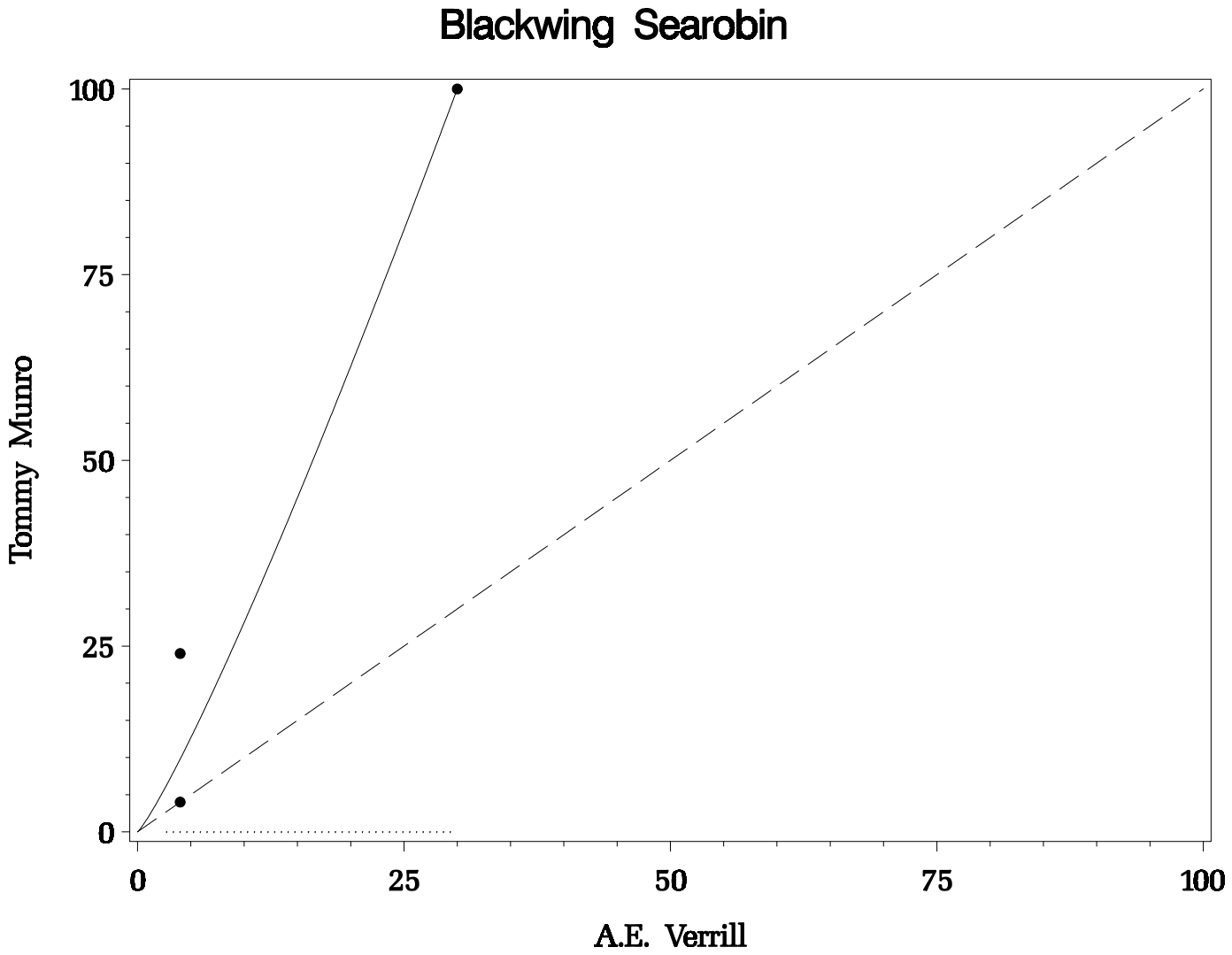

Figure 120. Scatter plot of blackwing searobin catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=3). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

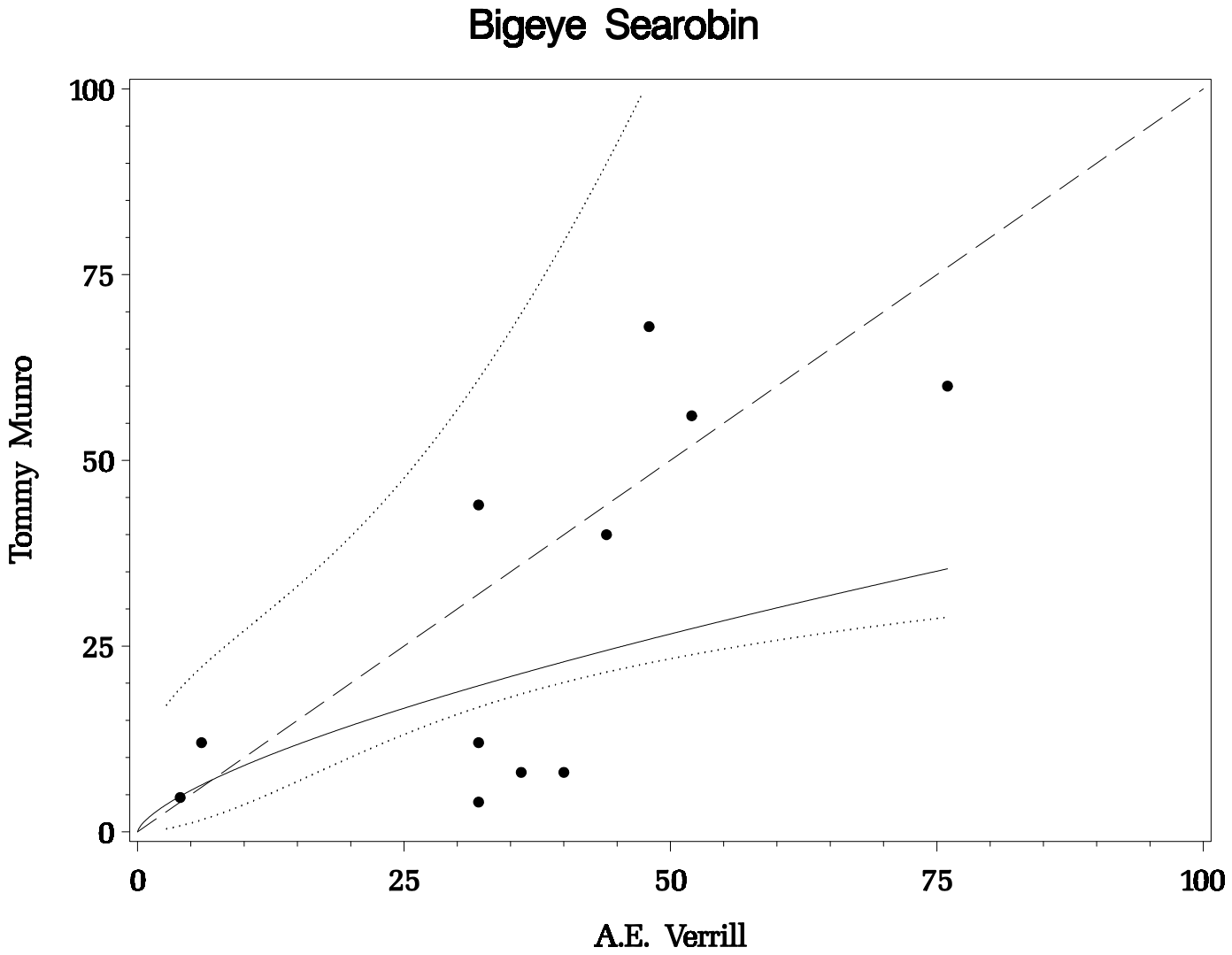

Figure 121. Scatter plot of bigeye searobin catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=11). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

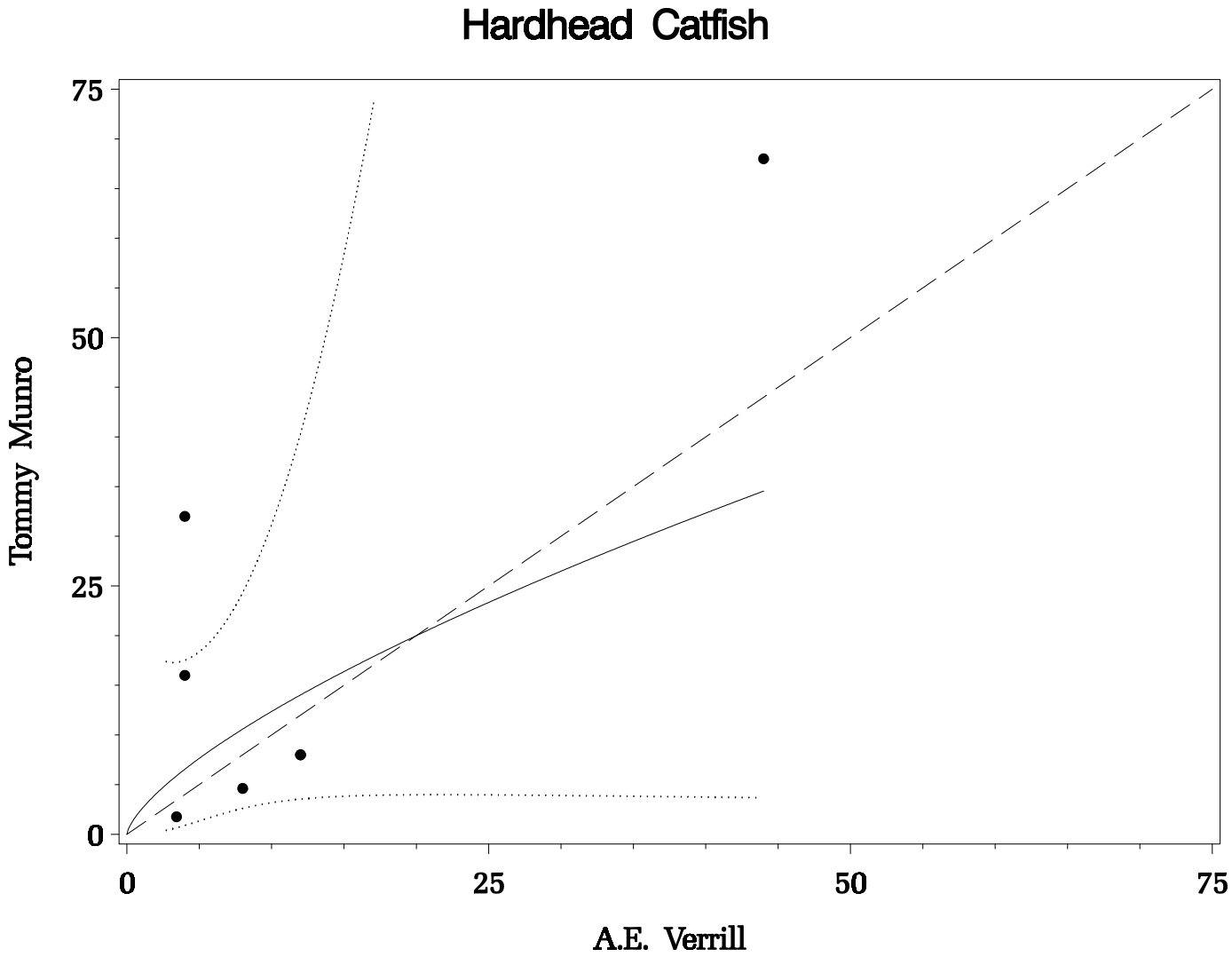

Figure 122. Scatter plot of hardhead catfish catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=7). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

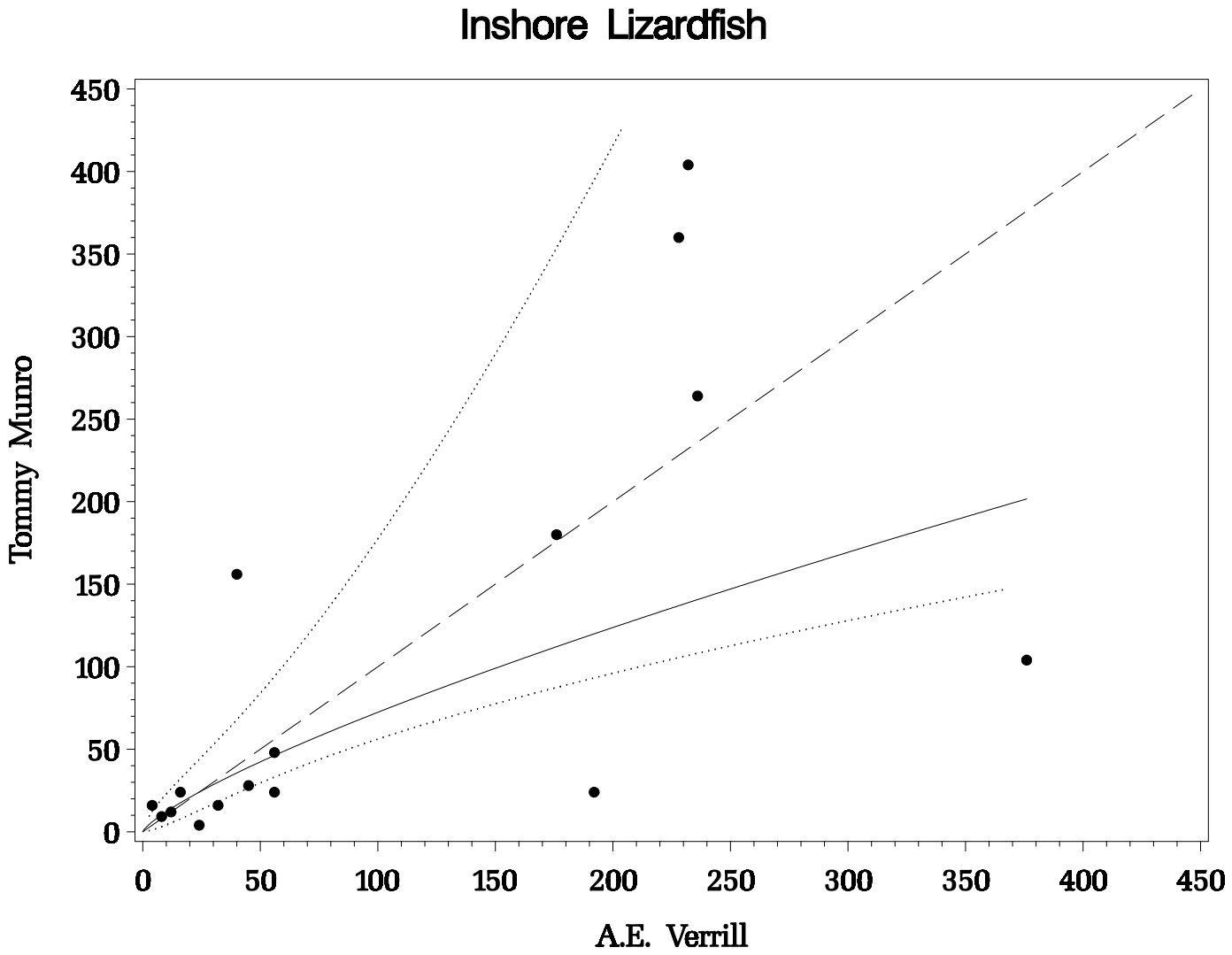

Figure 123. Scatter plot of inshore lizardfish catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=16). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

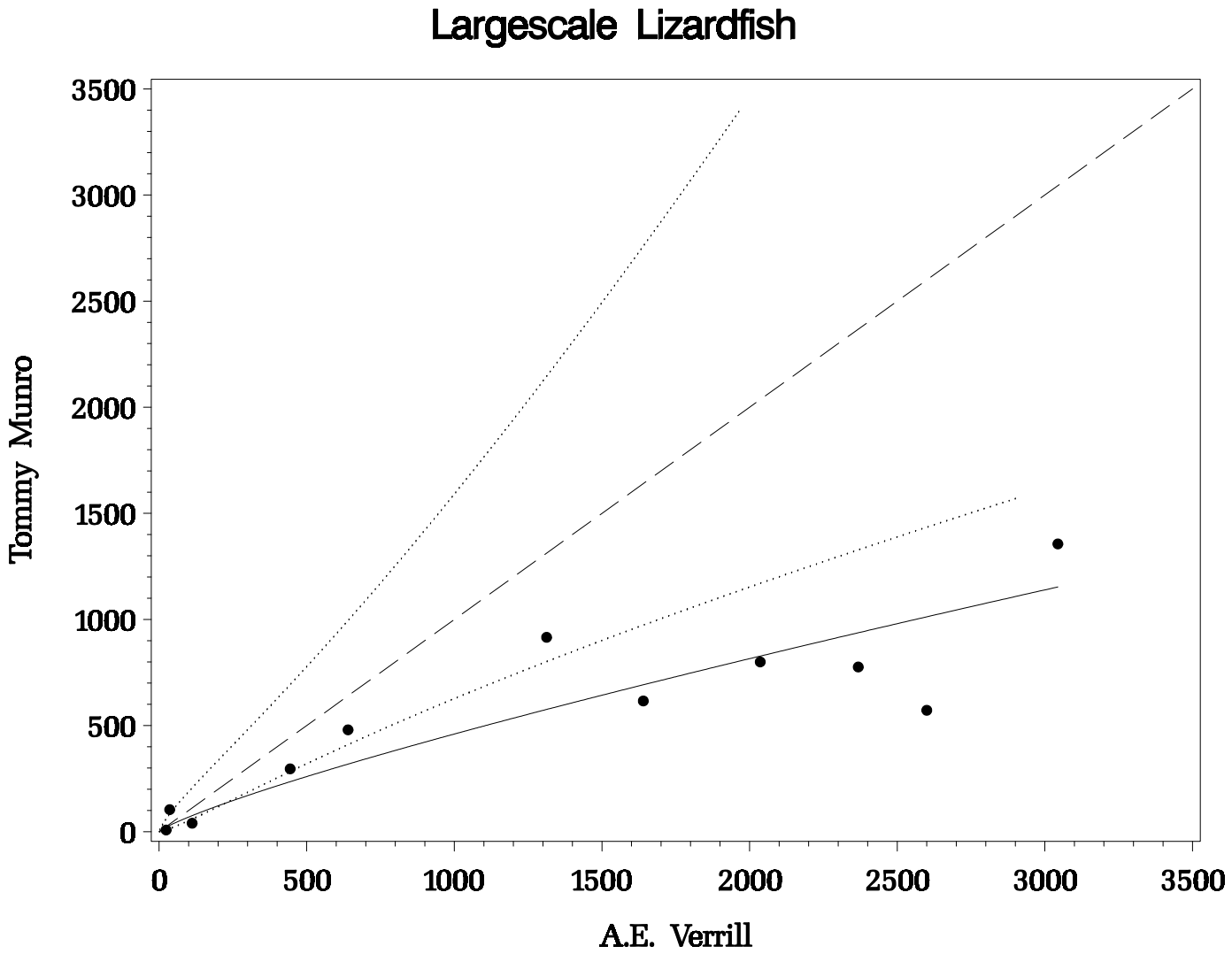

Figure 124. Scatter plot of largescale lizardfish catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=11). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

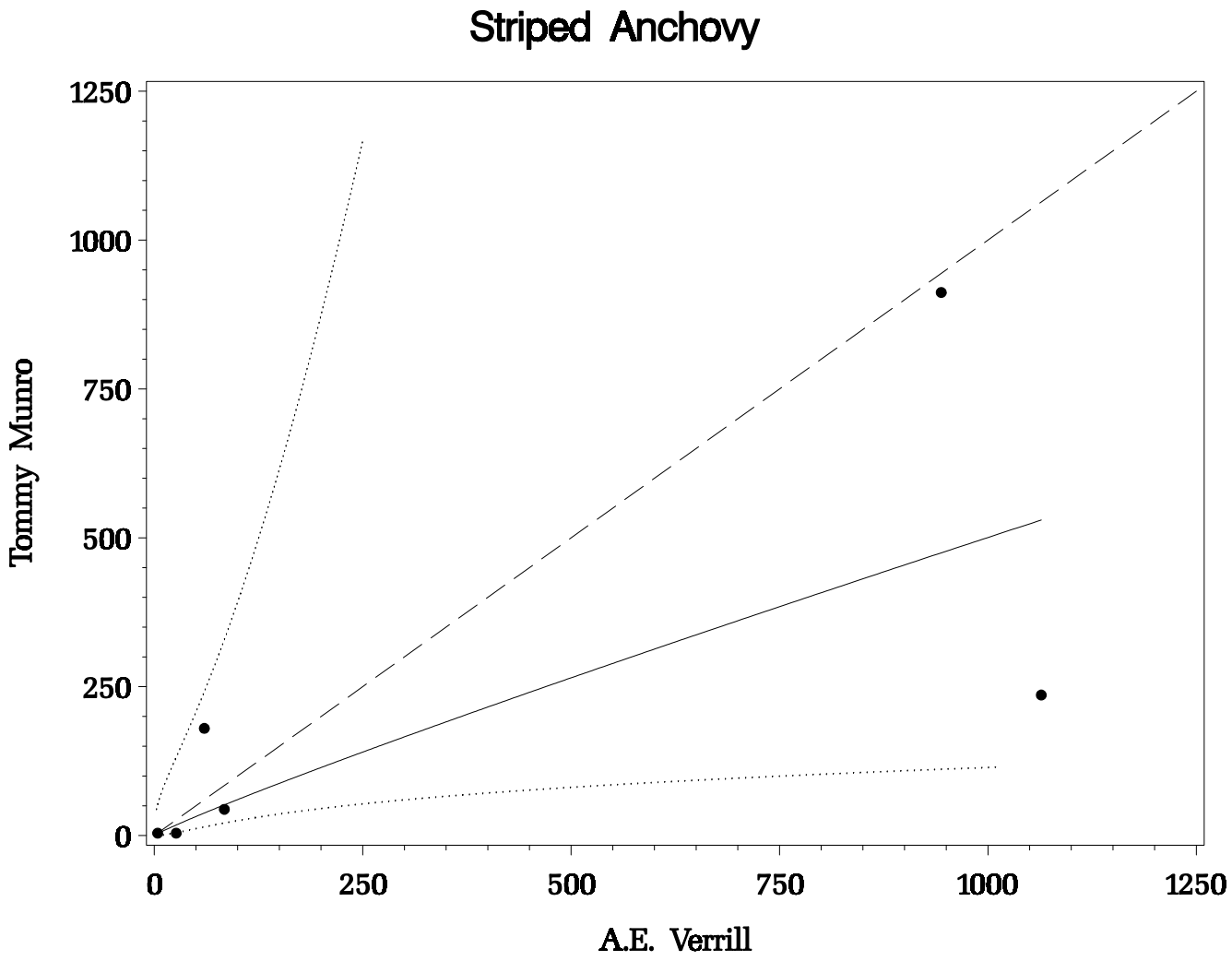

Figure 125. Scatter plot of striped anchovy catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=6). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

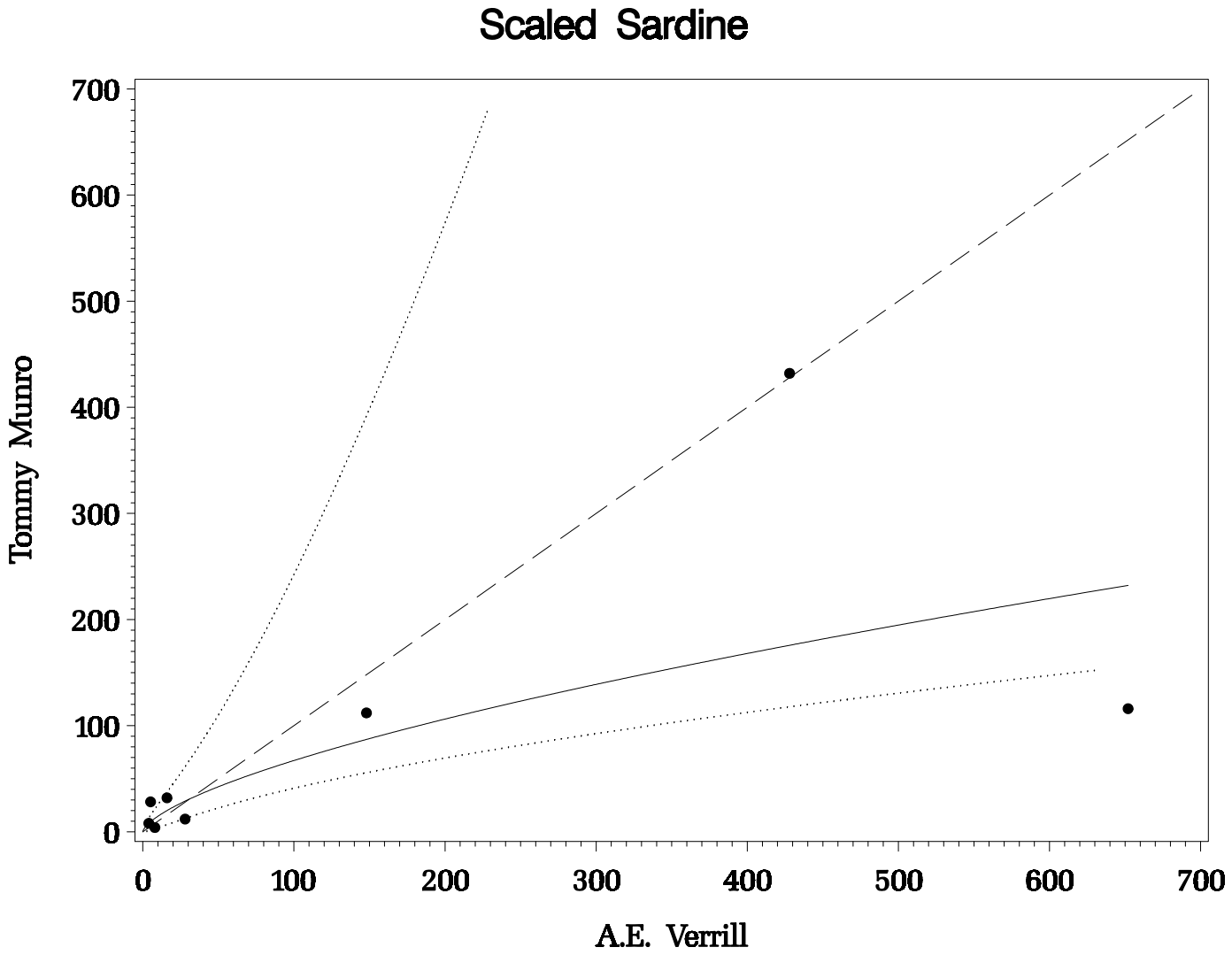

Figure 126. Scatter plot of scaled sardine catches by *Research Vessels Tommy Munro* and *A.E. Verrill* during paired comparison towing (n=8). Solid line represents the least squares best fit, dashed line represents the hypothesized relationship of no difference between vessels, and dotted lines represent 95% confidence intervals for the hypothesized line assuming variance estimates for the fitted line. Fitted line and confidence intervals were computed in the natural log scale then de-transformed to the arithmetic.

Appendix 1. Common and scientific names of organisms analyzed in comparing the relative fishing powers of selected SEAMAP survey vessels.

Family/Common Name	Scientific Name
Clupeidae – herrings	
Scaled sardine	*Harengula jaguana*
Engraulidae – anchovies	
Bay anchovy	*Anchoa mitchilli*
Striped anchovy	*Anchoa hepsetus*
Ariidae – sea catfishes	
Hardhead catfish	*Arius felis*
Synodontidae – lizardfish	
Inshore lizardfish	*Synodus foetens*
Largescale lizardfish	*Saurida brasiliensis*
Gadidae – cods	
Southern hake	*Urophycis floridana*
Ophidiidae – cusk-eels	
Bearded brotula	*Brotula barbata*
Blackedge cusk-eel	*Lepophidium brevibarbe*
Batrachoididae – toadfishes	
Atlantic midshipman	*Porichthys plectrodon*
Ogcocephalidae – batfishes	
Pancake batfish	*Halieutichthys aculeatus*
Triglidae – searobins	
Bigeye searobin	*Prionotus longispinosus*
Blackwing searobin	*Prionotus rubio*
Serranidae – sea basses	
Blackear bass	*Serranus atrobranchus*
Dwarf sand perch	*Diplectrum bivittatum*
Rock sea bass	*Centropristis philadelphica*
Carangidae – jacks	
Atlantic bumper	*Chloroscombrus chrysurus*
Lutjanidae – snappers	
Lane snapper	*Lutjanus synagris*
Red snapper	*Lutjanus campechanus*
Haemulidae – grunts	
Pigfish	*Orthopristis chrysoptera*
Sparidae – porgies	
Longspine porgy	*Stenotomus caprinus*
Pinfish	*Lagodon rhomboides*
Sciaenidae – drums	
Atlantic croaker	*Micropogonias undulatus*
Sand seatrout	*Cynoscion arenarius*
Silver seatrout	*Cynoscion nothus*
Spot	*Leiostomus xanthurus*
Ephippidae – spadefishes	
Atlantic spadefish	*Chaetodipterus faber*
Polynemidae – threadfins	
Atlantic threadfin	*Polydactylus octonemus*
Gobiidae – gobies	
Ragged goby	*Bollmannia communis*
Trichiuridae – snake mackerels	
Atlantic cutlassfish	*Trichiurus lepturus*
Stromateidae – butterfishes	
Gulf butterfish	*Peprilus burti*
Harvestfish	*Peprilus alepidotus*

Appendix 1 continued.

Family/Common Name	Scientific Name
Bothidae – lefteye flounders	
Syacium flounder	*Syacium sp.*
Bay whiff	*Citharichthys spiloperus*
Fringed flounder	*Etropus crossotus*
Shelf flounder	*Etropus cyclosquamus*
Etropus flounder	*Etropus sp.*
Soleidae – soles	
Blackcheek tonguefish	*Symphurus plagiusa*
Tetraodontidae – puffers	
Least puffer	*Sphoeroides parvus*
Luidiidae	
Gray sand star	*Luidia clathrata*
Mellitidae	
Keyhole sand dollar	*Melita quinquesperforata*
Penaeidae – penaeid shrimps	
Brown shrimp	*Farfantepenaeus aztecus*
Pink shrimp	*Farfantepenaeus duorarum*
Roughback shrimp	*Trachypenaeus similis*
Trachypenaeus shrimp	*Trachypenaeus sp.*
White shrimp	*Litopenaeus setiferus*
Squillidae	
Common mantis shrimp	*Squilla empusa*
Mantis shrimp	*Squilla chydae*
Squilla mantis shrimp	*Squilla sp.*
Sicyoniidae – rock shrimps	
Brown rock shrimp	*Sicyonia brevirostris*
Lesser rock shrimp	*Sicyonia dorsalis*
Portunidae – swimming crabs	
Blue crab	*Callinectes sapidus*
Lesser blue crab	*Callinectes similis*
Iridescent swimming crab	*Portunus gibbesii*
Portunus swimming crab	*Portunus sp.*
Loliginidae	
Atlantic brief squid	*Lolliguncula brevis*
Longfin squid	*Loligo pealei*
Squid	*Loligo sp.*